The Neolithic Settlement of Aknashen (Ararat valley, Armenia)

Excavation seasons 2004-2015

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Cover image: View of the Ararat valley from Aknashen

Contents

THE SUBSISTENCE ECONOMY

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Introduction

Ruben Badalyan, Christine Chataigner and Armine Harutyunyan

In the archaeology of Armenia of the first half of the 20th century, the Neolithic period was perceived *a priori* as an obligatory, but not a specific element of archaeological periodization. Its imaginary material embodiment remained vague for a long time, covering a broad spectrum of sites and material, ranging from isolated discoveries of stone polished and perforated axes, to some of the rock carvings of the Aragats, Gegham and Syunik ranges, the settlements of the Kura-Araxes culture and the cyclopean fortresses, which only later received precise chronological and cultural attribution (Bayburtyan 1933).

Together with a gradual refinement of the notion of Neolithic in Armenia, this period was gradually being filled with real material. The Neolithic of Armenia began to acquire a more or less specific content only by separating typologically attributed tools from the mass of artefacts found on obsidian extraction sites, on the Aragats (Arteni) and Hatis volcanoes.

The first knowledge of the Late Neolithic culture of the South Caucasus (Figure 1) started with the excavations of the settlement of Kültepe I near Nakhichevan (1951-1964) (Abibullaev 1982).[1] It was only with the discovery of the site of Shomutepe in the first half of the 1960s in the middle Kura basin, in north-western Azerbaijan, that this newly identified culture was called the 'Shomutepe culture' (Narimanov 1965); then, when in the mid-1960s similar sites (Shulaveri, Arukhlo, etc...) were discovered in Georgia, the name became 'Shomutepe-Shulaveri' or 'Shulaveri-Shomutepe' culture (Kiguradze 1976).

A history of the study of Late Neolithic sites in Armenia

On the territory of Armenia, sites of the same culture or chronologically close, consisting of small anthropogenic mounds ('*blur*' in Armenian) covering an area of 1 to 3 hectares and reaching 4m in height, were identified for the first time in the 1960s in the Ararat valley (Figures 2a and 2b); these were grouped under the name 'group of sites of the Kghzyak blur type': Kghzyak-blur (Ada-blur), Mashtots-blur/Mkhltapa (Tsaghkunk), Kasakh I-III, Sev-blur II, Terteri dzor, and Aghvesi bner (Sardaryan 1967).

Some of these sites and a number of other settlements, compactly located in the lower valleys of the tributaries of the left bank of the Araxes –the Sevjur (Metsamor), Kasakh and Hrazdan rivers –, were the focus of small-scale excavations in the years 1960-90, the results of which, however, remained unpublished. Nevertheless, the data collected made it possible to attribute to the Late Neolithic the sites of Aratashen (Kasakh II?), Aknashen (formerly Verin Khatunarkh), Masis Blur (Engidja) and Tsaghkunk.

A new stage in the study of the Late Neolithic in Armenia was marked by the resumption of excavations at the Aratashen settlement. The latter is located on the north-eastern outskirts of the village of the same name, 5km south-west of Vagharshapat (in Armavir province), on the western (right) bank of the Kasakh river, at an elevation of 852m above sea level (coordinates: N 40°08'08.2", E 44°14'05.3"). Excavations were carried out by S. Sardaryan (1976-1977), then by S. Aslanyan (1988-1990), but their results were not published.[2] Further excavations were carried out from 1999 to 2004 by an Armenian-French expedition under the direction of P. Lombard and R. Badalyan, in the framework of the 'Caucasus' mission.[3] The excavations of Aratashen initiated the formation of a representative data base for the study of the Neolithic culture in Armenia (Badalyan *et al.* 2002; 2004a; 2004b; 2005; Palumbi and Badalyan 2005; Badalyan *et al.* 2007; Palumbi 2007; Chabot *et al.* 2009; Arutyunyan and Mnatsakanyan 2010; Bălăşescu *et al.* 2010; Arutyunyan 2011; Chabot and Pelegrin 2012; Palumbi *et al.* 2014; Vila *et al.* 2017), and they encouraged systematic excavations of similar sites.

In order to gather comparative material, the settlement of Aknashen (Figure 3), 6km southeast of Aratashen, was selected as the most promising site for further research. The choice was due to the Neolithic date of the site established by previous excavations (R. Torosyan, several excavation seasons between 1969 and 1982), its relatively thick cultural layer, its geographical proximity to Aratashen and its good state of preservation (for comparison, note that the Aratashen hill was partially damaged by earthmoving works, while the Masis Blur

[1] For an analytical review of previous publications, and for the results of the new phase of excavations at this site, see Marro *et al.* 2019.

[2] With the exception of an article on the stone tools from the excavations by Aslanyan (Poplevko 2001).

[3] The excavations at Aratashen were funded by the French Ministry of Foreign Affairs, the National Center for Scientific Research (C.N.R.S.) and the Institute of Archaeology and Ethnography of the National Academy of Sciences of Armenia.

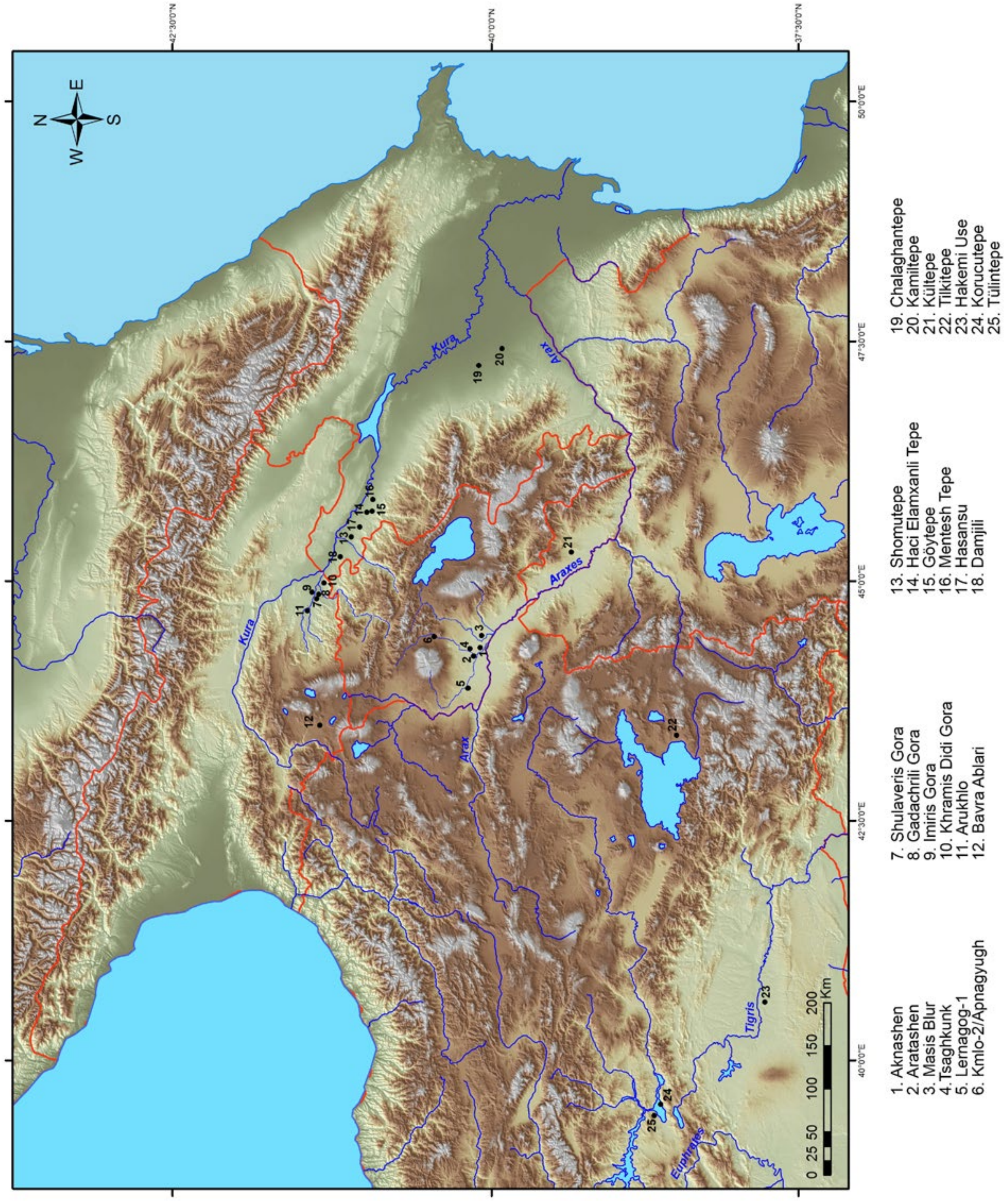

Figure 1. Map of the main sites mentioned in the text.

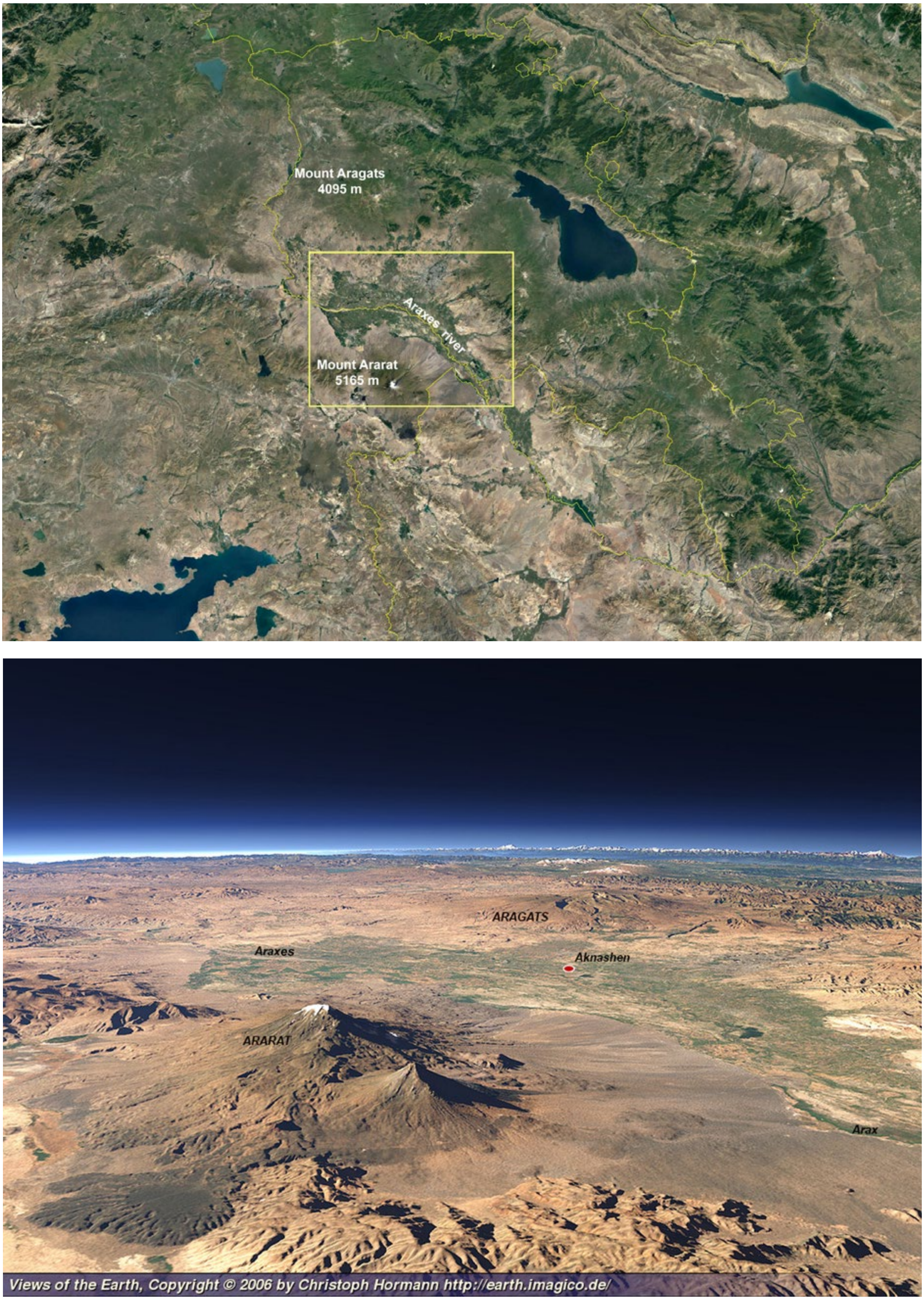

Figure 2. Top: Google map showing the location of the Ararat valley; Bottom: Aerial view of the Ararat valley (after C. Hormann 2006).

Figure 3. Aerial view of the Aknashen *blur* from the east (photo by A. Mkrtchyan).

and Tsaghkunk hills were completely levelled). The excavations at Aknashen were carried out under the direction of R. Badalyan and A. Harutyunyan in 2004-2009 and 2011-2019, in the framework of the Armenian-French project.[4] The work was carried out by means of extensive excavations and digging of stratigraphic trenches, in the process of which all the materials were studied and recorded, samples from the cultural layer were systematically subjected to flotation and about 70 charcoal or bone samples were radiocarbon dated. An interdisciplinary approach was applied both during the fieldwork and in the study of the materials, combining archaeology, biological anthropology, archaeozoology, archaeobotany, geomorphology, geology and geochemistry.

Excavations of Masis Blur in the Hrazdan river basin (at an altitude of 862m above see level) have been resumed since 2012 (Martirosyan-Olshansky *et al.* 2013; Hayrapetyan *et al.* 2014; Martirosyan-Olshansky 2018a). Finally, the settlement of Tsaghkunk on the left (east) bank of the river Kasakh, at an altitude of 872m above sea level and a distance of 7.5km from Aknashen towards the north/north-west, excavated by R. Torosyan between 1966 and 1968, completes the list of Late Neolithic sites currently known in the Ararat valley (available data on Tsaghkunk in Petrosyan *et al.* 2018; Varoutsikos and Petrosyan in this volume).

This paucity of sites, which differs from the density of Late Neolithic settlements in the Kura valley, is clearly the result of centuries of extensive melioration in the Ararat valley. The almost complete anthropogenic transformation of its landscape has resulted in the destruction of many mounds, and considerably complicates the search for Neolithic sites. It is significant that the mounds of Masis Blur and Tsaghkunk were already completely levelled in Soviet times, and could no longer be topographically distinguished in the landscape. Nevertheless, in the search for new sites, one should bear in mind that, as shown by the excavations of Aknashen and Masis Blur, the Late Neolithic cultural

[4] The excavations at Aknashen were also funded by the French Ministry of Foreign Affairs, the National Center for Scientific Research (C.N.R.S.) and the Institute of Archaeology and Ethnography of the National Academy of Sciences of Armenia.

layer continues 1.5 to 2m below the present-day surface of the Ararat valley. The burying of occupation levels under alluvial sediment and aeolian deposits can also be observed in the Kura basin (for instance at Shulaveri in the Marneuli plain, or at Mentesh Tepe), where the ancient surface is located some 2m below the current level of the plain (Javakhishvili 1973: 9-10; Lyonnet *et al.* 2016: 172).

One should also add that, for some sites on the immediate periphery of the Ararat valley, it has been postulated that they yielded material of the Neolithic and Chalcolithic periods, respectively dated to the 7th/6th and 5th millennia BC (Akhtamir at the edge of the Kasakh river canyon in its middle course: about 350 pottery fragments; Simonyan 1998; 2000). If this preliminary data, published without further details on their origin (stratified? fortuitous?) and without associated obsidian items, are confirmed by the publication of materials typical of the Late Neolithic, then the number of sites will increase, and, simultaneously, the area of this culture will extend beyond the borders of the Ararat valley, including landscapes of other nature.

It is possible that on the territory of Armenia, Neolithic sites may have also existed in the valleys of the Aghstev and Debed rivers, at altitudes starting at about 500 meters above sea level. The geographical proximity of this area to the sites of the Shulaveri-Shomutepe group and the similarity of the landscapes make this hypothesis plausible.

The cultural and environmental context of the early Holocene in Armenia

Before dealing with the results of the excavations at Aknashen (2004-2015 seasons), it is necessary to examine briefly the cultural and environmental context preceding the installation of this settlement in the Ararat valley.

In Armenia, several sites were attributed to the early Holocene (10th-7th millennia) (Petrosyan *et al.* 2014), but the only ones whose dates were secured by 14C were the Kmlo-2 cave, phases IV-III (10th-mid 8th millennium), on the eastern side of the Aragats massif, in the middle course of the Kasakh river valley (Arimura *et al.* 2010, 2014), and the rock shelter of Lernagog (first half of the 7th millennium) in the southern piedmont of the Aragats massif, on the Ararat valley's periphery (Arimura *et al.* 2018) (Figure 1). At these two sites, just like on contemporary sites of the South Caucasus whose chronologies were confirmed by 14C, in Georgia (Kotias Klde cave, layers B-A2; Bavra Ablari rock shelter, levels 4-3) (Meshveliani *et al.* 2007; Varoutsikos *et al.* 2018), and in Azerbaijan (Damjili cave, unit 5) (Nishiaki *et al.* 2019b), the subsistence economy was based only on hunter-gathering.

In the early Holocene, at Kmlo-2 (located at 1700m asl), the environment was open and steppe-like. In phase IV (10th-late 9th millennium), the remains of fauna testify to the presence of aurochs and bison, mountain goats and mouflons, and a few horses; in phase III (late 9th - mid 8th millennium), the proportion of wild bovids decreases, and wild boar and deer appear, suggesting the beginning of a transition towards a more forested cover, a hypothesis confirmed by plant remains (presence of oak). The lithic industry from phase IV is marked by a microlithic tradition (backed bladelets, scalene triangles), which evolves in phase III into the production of broader blades and of 'Kmlo tools', which are characterized by fine parallel retouches on the sides. At the end of this phase, geometric microliths in the shape of short trapezes (transverse arrowheads) become predominant (Chataigner *et al.* 2014a). These two phases of Kmlo-2 were described as 'Mesolithic' (phase IV) and 'Late Mesolithic or Early Neolithic' (phase III) (Chataigner *et al.* 2014a). Due to their morphology, the 'Kmlo tools' suggest relations with the cultures of the Pre-Pottery Neolithic B (PPNB) in southeastern Turkey (Çayönü, Cafer Hoyük), in the 8th millennium BC. However, in these regions, the PPNB is characterized by the 'Big Arrowhead Industry' (Aurenche and Kozlowski 1999) and by the practices of agriculture and herding; but none of these innovations appeared in the Caucasus.

The Lernagog rockshelter, which was occupied during the first half of the 7th millennium, is located at an elevation of some 1000m, at the south-western foot of the Aragats massif, at the north-western end of the Ararat valley (Arimura *et al.* 2018). Recent studies, taking up the work of Paffengolts (1948), have shown that throughout the end of the Pleistocene and the beginning of the Holocene, the Ararat valley was occupied by a huge paleo-lake created by a natural dam (lava flow or land elevation; see Badalyan and Harutyunyan in this volume; Karakhanyan *et al.* in this volume; Ollivier in this volume). The Araxes river was the outlet of this lake, whose level gradually became lower with time; at the very beginning of the 6th millennium, Aknashen was founded on a dried-up sector of the lake (on a layer of blue clays, which is the sediment deposited at the bottom of the lake), at an elevation of 832m asl. As a result, the landscape experienced by the human group that settled at Lernagog was very different from the present one: a large lake extended in the vicinity and the western end of the Ararat valley must have been covered in residual lakes and marshes. Judging by the terrestrial and freshwater faunal remains found in the blue clay, deciduous forests covered both the areas between the lakes and the marginal areas of the Ararat valley (Karakhanyan *et al.* in this volume). Faunal remains discovered at Lernagog show that horses were the most hunted species (Arimura *et al.* 2018), which suggests an open steppe environment on the Aragats

Figure 4. View of the Ararat mountain from the Aknashen excavations (2011).

foothills. The lithic industry of Lernagog is marked by the presence of many blades, obtained by percussion or by pressure, as well as by a relative abundance of 'Kmlo tools'. Microliths include backed bladelets, trapezes and segments (Arimura *et al.* 2018). The excavators of Lernagog consider this site to be 'Early Holocene'.

The contribution of the Aknashen excavations

To summarize this brief examination of the origins and history of the study of the Late Neolithic in Armenia, it should be noted that currently, the settlement of Aknashen (Figure 4) is the best preserved and most extensively studied Late Neolithic site in Armenia; it yielded a very substantial quantity of material: more than 60,000 obsidian artefacts (data 2019), more than 45,000 faunal remains (data 2015), more than 1,200 bones and antler tools (data 2019), and more than 10,000 fragments of pottery (data 2019). The succession of seven occupation and abandonment (due to flooding) levels (Horizons VII-I), which reach a thickness of approximately 5m, reflects practically the entire chronological range of the Aratashen-Shulaveri-Shomutepe culture and, moreover, includes an earlier horizon (VII), whose data allow us to raise the question of its formative stage.

This book presents the results of excavations from 2004 to 2015 and the study of the material; data acquired during fieldwork from 2016 to 2019 and which essentially relate to the oldest horizon (VII) will only be selectively presented, in order to provide a general view. A separate article will be devoted to them in the future.

The team of the Aknashen excavations

The 2004-2015 seasons of excavations at Aknashen were carried out under the direction of Ruben Badalyan and Armine Harutyunyan, within the framework of the joint project between the Armenian Institute of Archaeology and Ethnography (IAE) and the French 'Caucasus Mission' directed by Christine Chataigner (Figure 5).

The authors of the volume express their sincere gratitude to all of the members of the Aknashen team.

The various participants in the fieldwork (Figure 6) were *Armine Hayrapetyan* (IAE; 2005), *Susanna Melkonyan* (IAE; 2006-2008), *Artur Petrosyan* (IAE; 2009, 2011-2015), *Ara Petrosyan* (IAE; 2011), *Levon Aghikyan* (IAE; 2011-2012, 2014-2019), *Karen Azatyan* (IAE; 2012, 2014, 2016, 2018-2019), *Narine Sargsyan* (Yerevan State University; IAE; 2013-2015, 2017), *Astgh Poghosyan* (Yerevan State University; 2013-2015), *Sona Hovsepyan* (History Museum of Armenia; 2014, 2016-2019), *Shushanik Hovhannesyan* (History Museum of Armenia; 2014), *Hayk Gyulamiryan* (IAE; 2015), *Aleksan Juharyan* (IAE; 2015), and *Mariam Saribekyan* (IAE, 2019).

Figure 5. Jean-Michel Kasbarian, Counsellor for cooperation and cultural action of the French Embassy, Ruben Badalyan and Christine Chataigner at Aknashen (2014).

Figure 6. The excavation team in 2014. Bottom row from left to right: Levon Aghikyan, Karen Azatyan; upper row: Artur Petrosyan, Sona Hovsepyan, expedition driver Ashot Khachatryan, Shushanik Hovhannesyan, Astgh Poghosyan, Narine Sargsyan, Ruben Badalyan, Armine Harutyunyan and Roman Hovsepyan.

Architectural plans were drawn by *Hasmik Sargsyan* (Yerevan State University; 2005-2009) and *Lilit Ter-Minasyan* (IAE, 2011-2019); work on the topography was carried out by *Smbat and Vahe Davtyan* (Yerevan State University; 2012, 2014, 2019), drone photographs by *Arshaluys Mkrtchyan* (IAE) and photographs of the artefacts by *Vram Hakobyan* (IAE). Restoration of the artefacts was done by *Lilit Manukyan* and *Arev Avetisyan* (IAE), drawing of the artefacts by *Hasmik Sargsyan* (Yerevan State University).

A study in architectural conservation was carried out by *Chamsia Sadozaï* (CRAterre; 2013) and micro-morphological analyses by *Jacques-Elie Brochier* (CNRS; 2009, 2011). Geo-morphological studies were carried out by *Arkadi Karakhanyan* (Institute of Geological Sciences; 2014-2015) and *Vincent Ollivier* (CNRS; 2013, 2015), the study of plant remains by *Roman Hovsepyan* (IAE; 2006-2009, 2012, 2014, 2016, 2018-2019), and that of faunal remains by *Adrian Bălăşescu* (Bucharest Institute of Archaeology; 2006-2009, 2012-2015), *Aurélien Creuzieux* (Archaeological Service of Lyon; 2018-2019) and *Valentin Radu* (National Museum of Romanian History; 2009, 2014, 2019). The graves were excavated and burial practices studied, by *Levon Aghikyan* (IAE), *Françoise Le Mort* (CNRS; 2009) and *Modwene Poulmarc'h* (University Lyon 2; 2012).

The study of the pottery was the work of *Armine Harutyunyan* (IAE); the analysis of obsidian tools by *Jacques Chabot* (Quebec Laval University; 2006-2007, 2009, 2012, 2014-2016, 2018-2019), who was assisted by his students, *Lorenzo Alberton* (2006-2007), *Patrick Eid* (2009, 2012) and *Cynthia Gosselin* (2013-2014); *Bastien Varoutsikos* (Harvard University; 2013) studied part of the lithic material for his PhD dissertation. The drawings of these tools were made by *Julie Leclerc* (Quebec Laval University; 2006-2009, 2011-2012) and *Gauthier Devilder* (CNRS; 2013-2016, 2018-2019). Ground stone finds were studied by *Caroline Hamon* (CNRS; 2013, 2015, 2018-2019) and the bone industry by *Rozalia Christidou* (Université Lyon 2; 2006, 2011, 2013, 2015-2018).

The settlement of Aknashen: stratigraphy and architecture

Ruben Badalyan and Armine Harutyunyan

The settlement of Aknashen is situated in the Ararat valley, in the basin of a tributary from the left bank of the Araxes – the river Sevjur (Metsamor) –, in the province (*marz*) of Armavir, six kilometres to the south of Vagharshapat (formerly Echmiadzin, at the north-eastern edge of the village of Aknashen (formerly Verin Khatunarkh) (Figure 1). Its geographic coordinates are N 40°06.097’ (40°06'05.8"), E 44°17.649' (44°17'38.9").

The site consists of an artificial hill (*blur*) of circular plan, 100m in diameter (covering a surface of about 0.8ha) with a relative height of about three metres above the plain (Figure 2). The absolute altitude of the top of the hill is 838.12m above sea level.

This hill rises among cultivated fields in an agricultural landscape; to the north and south-west, it is edged by

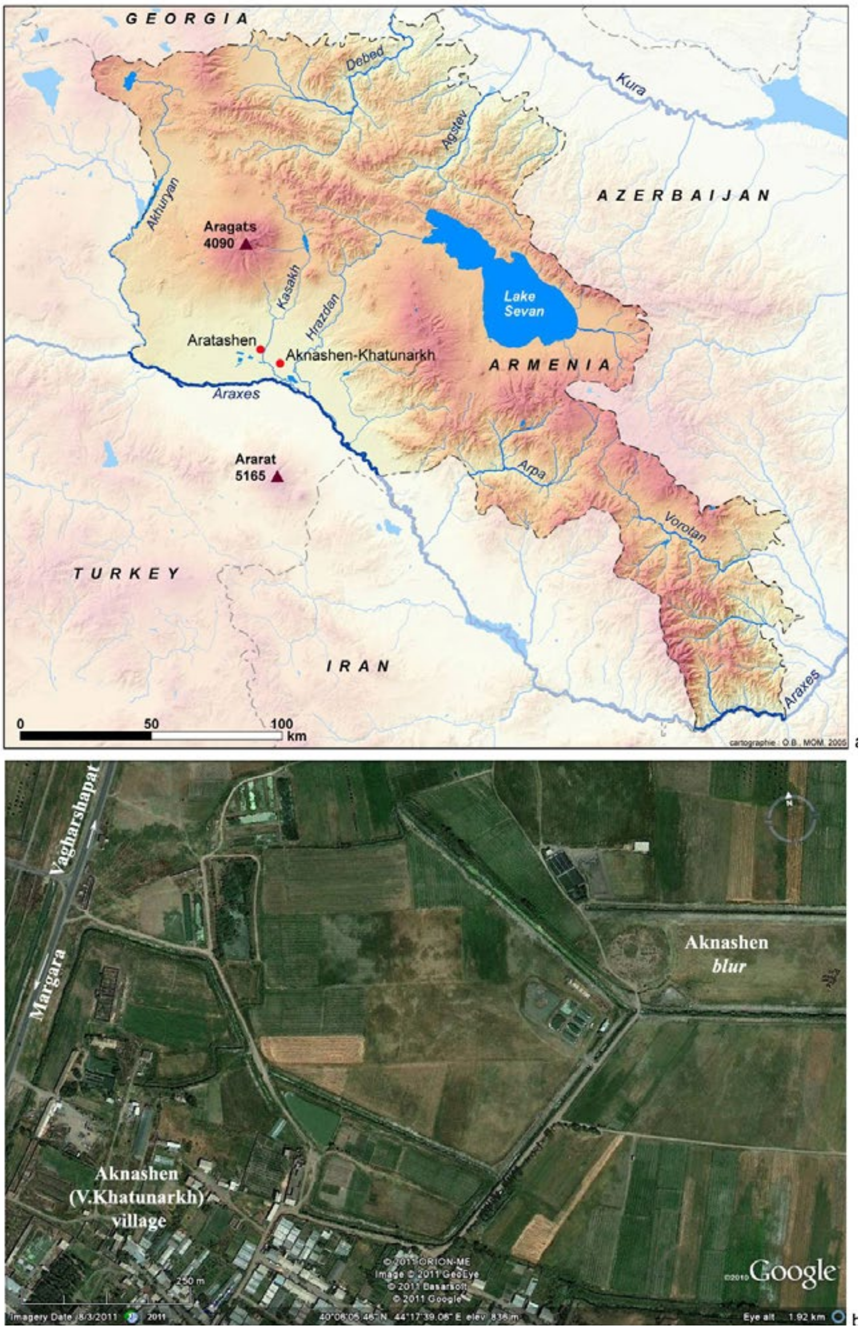

Figure 1. a) Map of the Republic of Armenia showing locations of Aknashen and Aratashen; b) location of Aknashen *blur* (Google map).

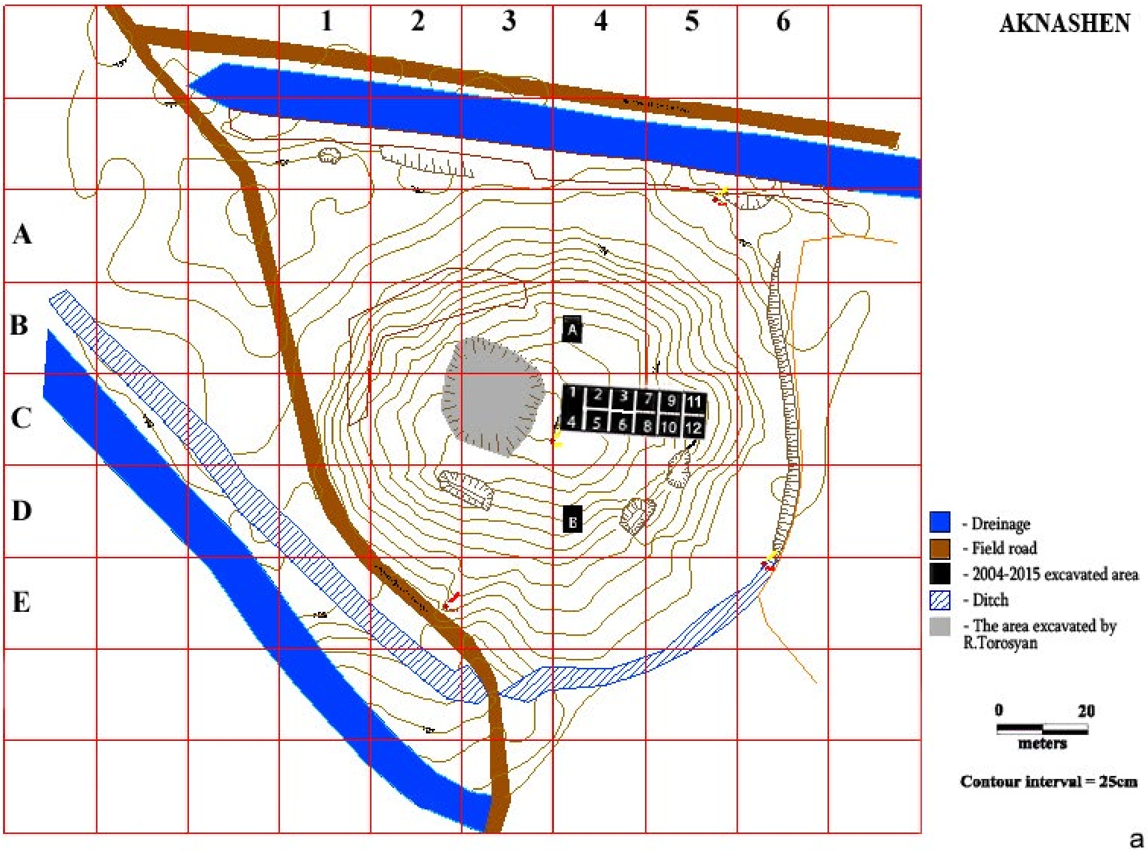

Figure 2. a) Topographic map of Aknashen *blur*; b) aerial drone photo of Aknashen (view from the east).

drainage canals; to the east, south and south-east a shallow ditch follows the contour of its base (Figures 1b and 2).

History of the excavations

In the years 1969-1972, 1974-1977 and 1980-1982, R.M. Torosyan carried out excavations on this site, opening in the western sector of the hill an excavation of about 400m^2 (Figure 2a). The results of these excavations have not been published.[1]

A new stage of excavations at Aknashen was conducted between 2004 and 2015 as part of the Armenian-French program of study of the Neolithic and Chalcolithic cultures of Armenia. This work constitutes the logical continuation of the excavations at the site of Aratashen – a neighbouring (6.3km to the NW from Aknashen) synchronous settlement excavated by the Armenian-French expedition in 1999-2004, which essentially initiated the formation of a representative data base for the study of the Neolithic culture in Armenia (Badalyan *et al.* 2007; see Introduction for more details).

In the eastern sector of the hill an excavation measuring 32 x 10m was carried out, oriented west-east and subdivided into 12 squares (Tr.1 to Tr.12) measuring 4.5 x 4.5m of surface area each. In the north-south line exploratory trenches A (Sond.A) and B (Sond.B) were dug, 6 x 4m of surface area each (Figure 2a). With the goal of verifying beyond the limits of the tell the geomorphological data gathered during the excavation of the site, three trial trenches were dug, each 1.5 x 1.5m. Sond.C and Sond.D are situated to the east of the hill, at 100m and 220m from its top, Sond E lies west of the site at 100m from the top (with an incline of 12° towards the north) (Figure 3).

In the north-west angle of Tr.1, in order to establish a complete stratigraphic column, trial trench 1a (Tr.1a) was dug, 1 x 1m. It is precisely in this sector of limited surface area that virgin soil was reached at an altitude of 832.93m above sea level (Figure 3). Thus the maximum thickness of the cultural layer on the site of Aknashen, according to Trench 1a, is 4.75m with a relative height of the hill above the plain of 3 to 3.5m (the top of the hill is situated at 43cm below the reference point of absolute zero, fixed at 838.12m above sea level).

This thickness of deposits was subdivided into seven horizons based on alternation between cultural levels, containing the remains of earth constructions and artefacts, and strata of compact clayey earth, formed following natural aeolian processes or erosion of abandoned constructions.

Horizon I excavated over 368m^2 (Tr.1 – Tr.12, Sond.A and Sond.B).
Horizons II and III excavated over 344m^2 (Tr.1 – Tr.12, Sond.A).
Horizons IV and V excavated over 229m^2 (Tr.1 – Tr.8, Sond.A).
Horizon VI excavated over 145m^2 (Tr.1 – Tr.5, Sond.A).
Horizon VII excavated over 124m^2 (Tr.1-2, 4-5, Sond.A) [2] (Figure 4).

General stratigraphy

The excavations have enabled documentation of the following chrono-cultural stages of the history of the site:

Late Neolithic – this period includes a cultural phase preceding the Aratashen-Shulaveri-Shomutepe culture, represented by horizons VII and VI, and the Aratashen-

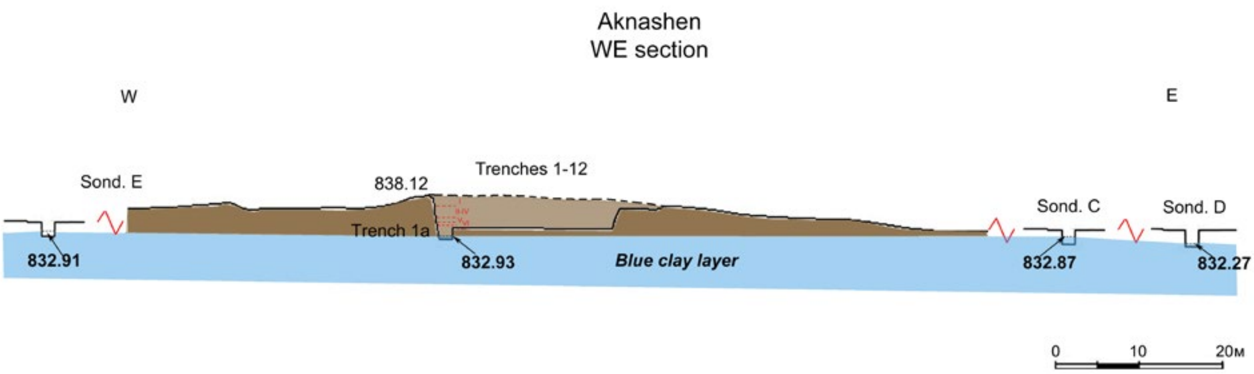

Figure 3. The principal stratigraphic diagram of the cultural layer of the hill and the sediments of the palaeolake. The absolute elevations of the surface of the blue clay layer are indicated.

[1] Only studied and published were a small number of tools in stone, horn and bone (Torosyan 1971), artefacts in obsidian (Korobkova 1987: 143, 145, tab. 35) and faunal remains (Mezhlumyan 1972: 166, appendix 2c). The material is kept in the historical-ethnographic museum of Echmiadzin (town of Vagharshapat).

[2] Data from the year 2015.

Horizon	Trench 1-1a	Trench 2	Trench 3	Trench 4	Trench 5	Trench 6	Trench 7	Trench 8	Trench 9	Trench 10	Trench 11	Trench 12	Sondage A	Sondage B
I	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1
	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2
	UF 3	UF 3	UF 3	UF 3	UF 3	UF 3			UF 3	UF 3	UF 3	UF 3	UF 3	UF 3
	UF 4	UF 4	UF 4	UF 4	UF 4	UF 4								
II	UF 5	UF 5	UF 5	UF 5	UF 5	UF 5	UF 3	UF 3	UF 4	UF 4	UF 4	UF 4	UF 4	
													UF 5	
III	UF 6	UF 6	UF 6	UF 6	UF 6	UF 6	UF 4	UF 4	UF 5	UF 5	UF 5	UF 5	UF 6	
							UF 5	UF 5	UF 6	UF 6	UF 6	UF 6		
IV	UF 7	UF 7	UF 7	UF 7	UF 7	UF 7	UF 6	UF 6	UF 7	UF 7	UF 7	UF 7	UF 7	
	UF 8	UF 8	UF 8	UF 8	UF 8	UF 8	UF 7	UF 7	UF 8	UF 8	UF 8	UF 8	UF 8	
V	UF 9	UF 9	UF 9	UF 9	UF 9	UF 9	UF 8	UF 8	UF 9	UF 9	UF 9	UF 9	UF 9	
	UF 10	UF 10	UF 10	UF 10	UF 10	UF 10	UF 9	UF 9	UF 10	UF 10	UF 10	UF 10	UF 10	
		UF 11	UF 11		UF 11	UF 11	UF 10	UF10					UF 11	
VI	UF 11	UF 12	UF 12	UF 11	UF 12	UF 12							UF 12	
VII	UF 12	UF 13	UF 13	UF 12	UF 13	UF 13							UF 13	
	UF 13	UF 14	UF 14	UF 13	UF 14	UF 14							UF 14	
	UF 14	UF 15	UF 15	UF 14	UF 15	UF 15							UF 15	
	(UF 15 Tr.1a)													

Figure 4. List of excavated UFs ('Unités de Fouille' or 'Units of excavation') by horizons.

Shulaveri-Shomutepe culture itself, represented by horizons V-II

Chalcolithic – besides the situation in horizon I, to be discussed later, Chalcolithic pottery fragments were found in trial trenches Sond.C and Sond.D. It is noteworthy that in Sond.C and Sond.D, no Neolithic cultural layer contemporary to the settlement was discovered; on the contrary, the sherds found (with obsidian temper, notches on the rim, 'mangal' with perforations under the rim) are in no way similar to the material from the tell (for more details, see Harutyunyan in this volume). Thus, two different phases of the Chalcolithic existed at Aknashen during this period.

Early Bronze – not represented except for out-of-context finds of Kura-Araxes pottery in trial trench Sond.C; there, between the depths of 170 and 185cm below the surface of the plain (Sond.C UF5),[3] 11 fragments characteristic of fine-walled pottery with burnished black or grey exterior and rosy yellow internal surface, which clearly belong to two small cups, were found.

Middle and Late Bronze – these periods are represented by intrusive tombs in the hill.

Medieval – the occupation of the hill, traces of which are visible in horizon I in the form of 'tonirs', of hearths, basalt grindstones, etc., as well as by a small number of characteristic sherds brought to light over practically all the excavated surface, clearly occurred in two stages, during the 3rd-5th and 12th-14th centuries AD.

Early Modern period – the territory of the hill was occupied by a cemetery.

Geomorphological conditions of the formation of the site

At the base of stratigraphic columns revealed in trial trenches Sond.E, Tr.1a, Sond.C and Sond.D, virgin soil was reached at absolute altitudes of 832.91m, 832.93m, 832.87m and 832.27m respectively. This virgin soil consists of a thick layer of compact clay, blue-green in colour (Figure 3). It resulted from the deposit of sediments in an aqueous environment and constitutes more precisely the bottom of a palaeo-lake, which occupied the Ararat valley in the post-Würm period.

According to Paffengolts (1948), following the damming of the Araxes river valley by Quaternary lava flows from the Little Ararat volcano, a spillway lake was formed, whose shoreline, according to the results from boreholes, generally followed the isohypse of 833m. At the bottom of the lake on an uneven surface very characteristic dark blue clays were deposited. There existed along the lake shores and in the course of the Araxes river many little lakes that were permanent or flowing, as well as islands between these lakes; the edges of the Ararat valley were covered with forests of broad-leaved trees, to judge by the terrestrial and sweet-water fauna found in the blue clays (Paffengolts 1948: 332; Mkrtchyan 1964: 393-397; for an alternative view of the reasons for the damming and for more details, see Karakhanyan *et al.* and Ollivier in this volume).

The presence of the earliest cultural layer of the site of Aknashen (horizon VII) directly on the surface of the lake deposits is evidence that the settlement was established

[3] UF means 'Unité de Fouille'.

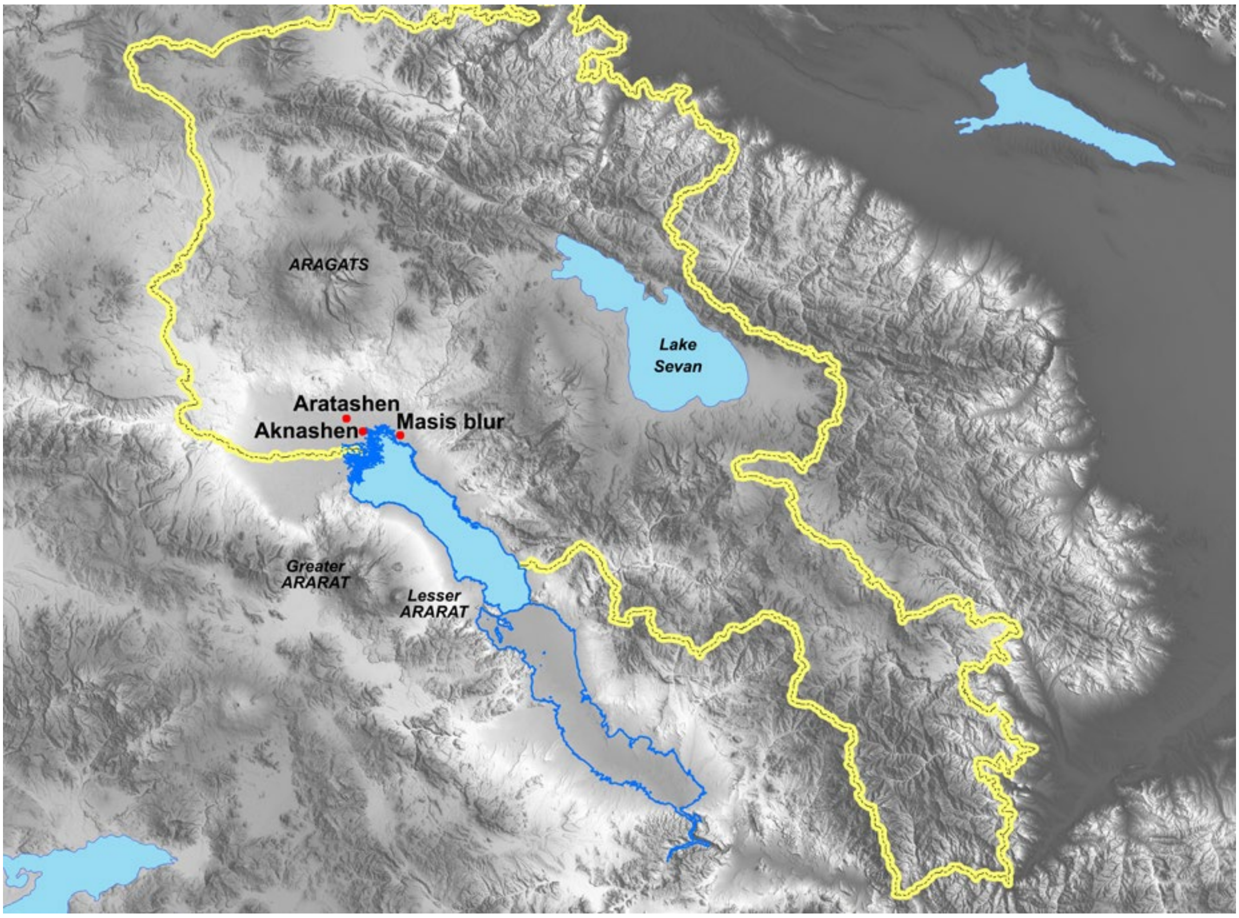

Figure 5. Map showing the possible contours of the palaeo-lake.

in a place discovered following a partial lowering of the level of the lake, on the shore of the palaeo-lake or at a few dozen metres from the shore (Figure 5).

Horizon VII

Below are the general characteristics, very preliminary, of horizon VII based on the data gathered during the excavations of 2017-2018, this presentation being essential for the stratigraphy of the site to be more or less comprehensive.

Horizon VII was first revealed in trial trench Sond.A where it was termed horizon V-3 (Badalyan *et al.* 2010). In Sond.E it corresponds to levels 2 and 3 (Ollivier in this volume). The excavations that followed (2014-2015, 2017-2019) enabled exposure of this horizon over a large surface (Tr.1-Tr.6). Given its considerable thickness – from 0.8 to 1.1m – it is possible that a more refined subdivision will be revealed later, as is suggested by the series of buildings that are superimposed (Figure 6).

The upper level of this horizon consists of circular structures made by construction in cob measuring 5.7 x 6.3m (for example *Building 1*[4] in Tr.2-3), typical of the upper levels of the site, as well as rectangular structures (for example, in Tr.1 and Tr.4, *Building 2* with almost square interior dimensions of 4.15 x 4.12m). Inside this construction a layer is visible which in its consistence and colour resembles the overlying layer of marshy deposits (horizon VI). This layer, however, is not found inside the rectangular habitation *Building 3* in the south-west angle of Tr.4 or anywhere in Tr.1. On the other hand, all the surface of Tr.5, which is without construction in this level, is also covered by a layer of marshy deposits. A similar layer is clearly visible under the cylindrical constructions (str.22 and str.24), which cover the south-west angle of *Building 2* in Tr.4 (Figure 7d). Clearly, this layer should be interpreted as a deposit that occurred in a shallow basin, perhaps an earlier episode of transgression of the palaeo-lake, which, after the insignificant thickness of the deposits (a few cm), existed for only a short period (according to A. Karakhanyan).

Directly under rectangular *Building 2* was discovered the contour of circular *Building 4*, whose interior diameter measured 4.0-4.6m (Figure 6). At the same level as the upper contour of this *Building 4* (UF14-15), at a depth of 450-460cm, numerous concentrations of material were discovered (tools made from pebbles, pebble fragments, obsidian blades, bone tools and faunal remains). Most of

[4] The numbering of the buildings is defined independently within each horizon.

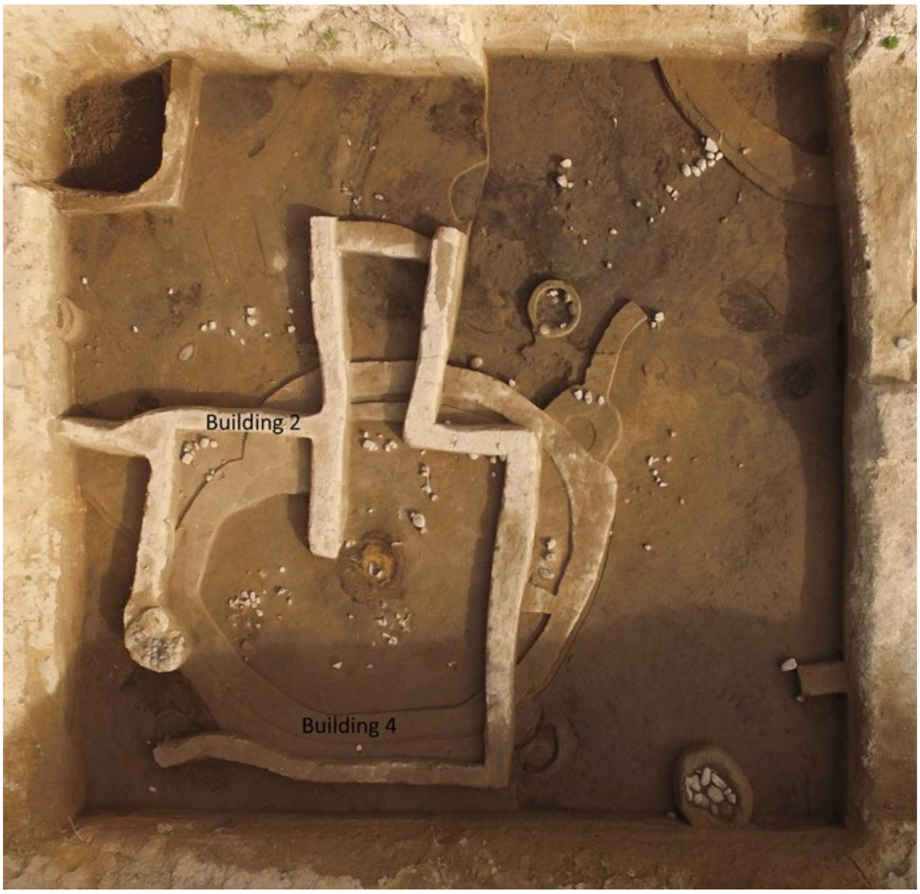

Figure 6. Architectural remains of horizon VII (Tr.1-2, 4-5; 2018).

these heaps were confined to little circular cavities filled with black earth (probably a layer rich in magnesium oxide, which is formed by precipitation in an aqueous environment). This layer, which presents strata of black or dark brown phytoliths that alternate with a dark grey clayey mass 6 to 7cm thick, can be followed everywhere in Tr.2, which enables the proposition that this part of the settlement was not constructed.

The material culture of horizon VII, in light of the basic characteristics of the assemblage of objects, is quite similar to that of horizons V-II, which present the well-established characteristics of the Aratashen-Shulaveri-Shomutepe culture; at the same time, it is characterised by a certain specificity in relation to the overlying horizons (Badalyan and Harutyunyan 2014: 165-166).

The most particular specificity of horizon VII is the total absence of local mineral-tempered or plant-tempered pottery; the rare sherds present belong exclusively to imported pottery, monochrome or painted, Samarra-related or Transitional/Proto-Halaf (for more details, see Harutyunyan in this volume).

The obsidian industry of horizon VII presents similarities as well as differences in comparison to the objects of upper horizons (according to J. Chabot). As for similarities, it is not surprising that an '*ad hoc*' flake industry is also present in this level. More important from a technological point of view is that all the knapping techniques used in the production of long regular blades have also been identified in level VII: indirect percussion, pressure with a crutch and pressure with a lever. This last technique is significant because it is a cultural marker and it appears that the inhabitants of Aknashen possessed this high degree of technological knowledge when they arrived in the Ararat valley. As for differences, the most distinctive aspect of the lithic material from horizon VII is the large quantity of bladelets/microblades, bullet cores and nuclei on pebbles, and microliths.

Differences are also present in the domain of agriculture. While the varieties of cultivated species are the same, wheat and barley have a ration of 4:6 in horizon VII and 7:3 in horizons VI-II (as reported by R. Hovsepyan).

The absolute dating of horizon VII, based on 14C data, is *ca.* 6000-5800 cal BC (for more details, see Chataigner *et al.* -Bayesian analysis- in this volume).

It appears that horizon VII of Aknashen could be considered as a 'formative' stage of the Aratashen-Shulaveri-Shomutepe culture or even as a complex that existed immediately before. The originality of its complex of artefacts and the general characteristics are all together similar to those revealed in the contemporary settlement (5950-5800 cal BC) at Hacı Elamxanlı Tepe on the middle course of the Kura

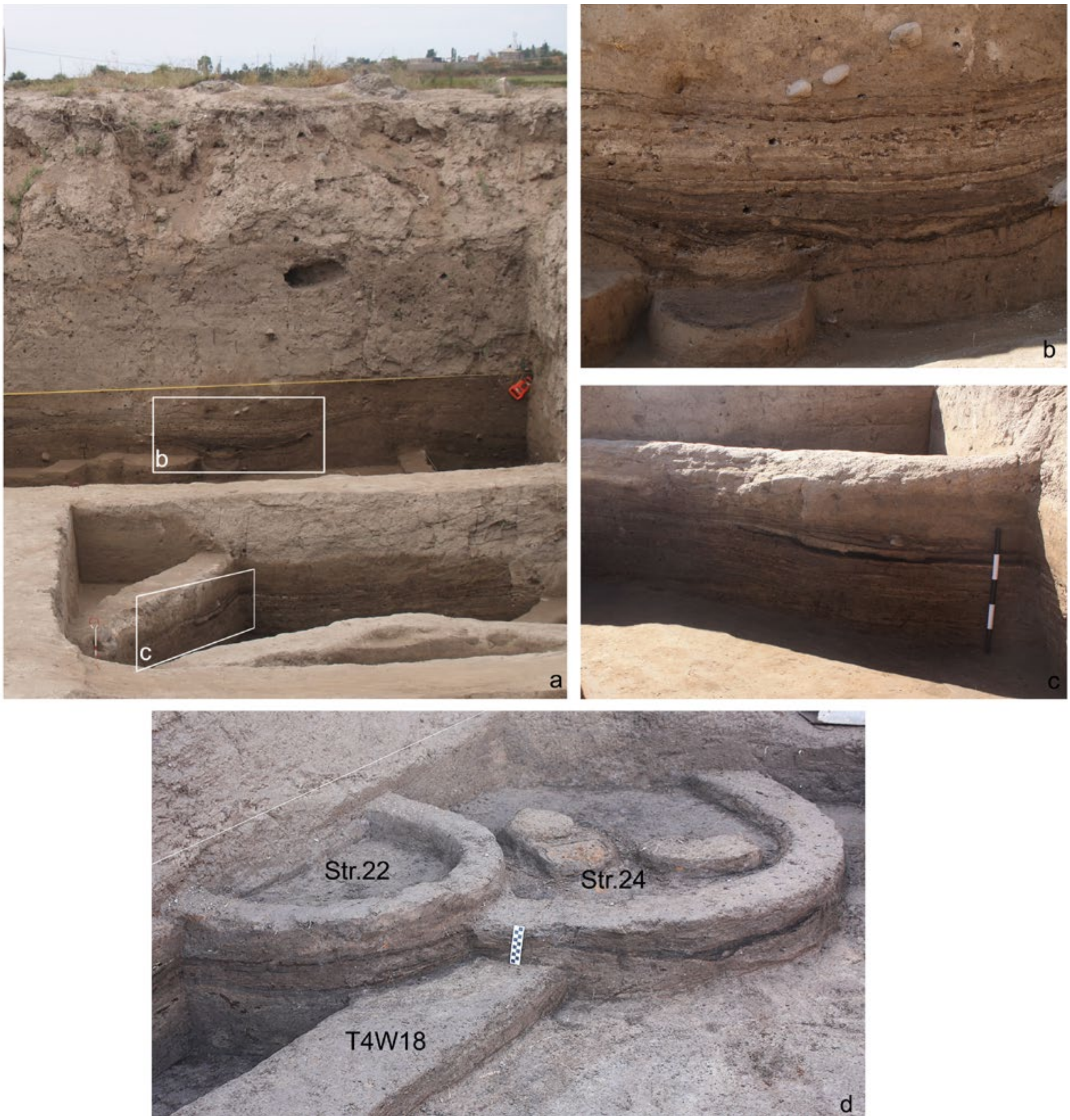

Figure 7. Layers of marshy deposits of horizon VI in Trench 1 (a, b) and Trench 2 (a, c) and similar layers formed in a shorter period dividing structures of horizon VII in Trench 4 (d).

(Nishiaki *et al.* 2015a; 2015b). Particularly striking is the higher quantity of trapezes and bladelets than on other (later) sites of this culture, but also a predominance of barley which is in contrast to the domination of wheat on the later sites. The comparison of the data above shows a contemporaneity and a similarity in the processes of formation and development of late Neolithic culture in the zone situated between the Araxes and the Kura rivers.

Horizon VI

Vestiges

The constructions of horizon VII over all the surface of Tr.1-2 and Tr.4-5 were covered by a foliated clayey-sandy layer 20 to 35cm thick (UF11 in Tr.1 and Tr.4, UF12 in Tr.2 and Tr.5) with fine brownish strata (Figure 7a-c), deposited between the depths (below absolute zero) of 3.48/3.65 – 3.77/3.85m (Tr.1 and Tr.4), 3.86 – 4.18m (Tr.2) and 3.96/4.05 – 4.25m (Tr.5). This clayey-sandy layer contained no remains of constructions, only an insignificant quantity of artefacts and bone fragments scattered sporadically. The profile of this

Horizon	Trench / Trial trench (Sond.) UF Feature/structure	Depth (cm)	Sample type	Labcode	DateBP	Date cal BC (95.4%)
VI	Tr.3 UF12b F25	388	charcoal	Poz-68612	6630±40	5625-5482
VI	Tr.6 UF12	–	charcoal	Poz-88796	7010±50	5990-5757
VI	Tr.6 UF12	–	charcoal	Poz-89192	6920±40	5894-5721
VI	Sond.A UF12	370-390	charcoal	Ly-13665	6920±55	5976-5676

Figure 8. Radiocarbon dates for horizon VI.

layer in a west-east line shows insignificant elevation of its central part. In trial trench Sond.E the levels 4, 5 and 6 correspond to it (see Ollivier in this volume). This layer, which was initially called horizon V-2, consists of deposits of a shallow marshy environment and of erosion products from horizon VII just beneath. In the lower part of horizon VI there are fine sand lenses, whereas in the upper part deposits characteristic of a marsh are predominant. The foliation of this horizon reflects the seasonality of the annual deposits ('varves').

Consequently this horizon VI is evidence for a transgression of the lake, which caused the population to abandon the site and produced a hiatus of a few dozen years (?) in the occupation. The later regression of the lake and the reoccupation of the site that followed led to the formation of horizon V.

Radiocarbon dates

The radiocarbon dates for horizon VI are given below (Figure 8).

Horizon V

Horizon V, 1.0 to 1.2m thick (between the depths of 2.8/3.0 and 3.8/4.0m), was initially revealed in Sond.A (Sond.A UF9-11), then excavated over a surface of 220m^2 in Tr.1-8. This horizon is the best preserved and the richest of the site as much in architectural remains (Figure 9) as in material, notably artefacts found *in situ*. The constructions of horizon V were built directly on the surface of horizon VI; the limit between these two horizons is characterised by fine strata containing phytoliths from plants of marshy zones and by clayey deposits found beneath a series of constructions (for example, *Buildings 1, 3 and 5*).

In this horizon V, two levels can be distinguished.

Lower level (horizon V-1)

Open area, Buildings 2, 3 and 4 (Tr.1/4)

The lower level (V-1) consists of a relatively dense network of constructions in cob and small associated structures, as well as hearths and concentrations of material, which surround in the east and in the south a non-constructed space in Tr.1. There the marshy deposits, situated between the depths of 3.48/3.65m and 3.77/3.85m, are mingled with circular storage structures in cob about 0.5m in diameter (T1S13, T1S14), hearth pits (T1F27-F33) of different diameters, filled with burnt earth and concentrations of material (F32; large tool carved from a scapula, pebbles, obsidian), revealed at a depth of between 3.65 and 3.90m. In all likelihood, the circular cob *Building 2*, situated along the western edge of Tr.1, belongs to this same level.

At the southern edge of this cleared space is situated the circular cob *Building 3*, 2.5m in diameter, its walls being 26 to 35cm thick. Against its eastern side, on the interior, rests a cylindrical storage structure in cob (T4S20). To the south of this structure was excavated part of circular *Building 4*, which enters into the southern baulk. Between these constructions are dispersed storage structures in cob (T4S21, T4S23), measuring from 0.7 to 1m in diameter, the walls being 5 to 10cm thick.

Building 5 (Tr. 5)

To the south-east of the non-constructed area is another cob construction that is complex in form, *Building 5*. A rounded space of 3.35 x 3.5m forms the centre (Figure 10a). On the south face of wall T5W7, blocks of yellow-grey clay of different dimensions are clearly distinguishable, separated by horizontal and vertical bands of dark grey colour. It is possible that in the southern part of this wall there was an opening that crossed the layer of underlying marshy deposits.

In this habitation two floors are distinguished. The lower floor consists of charred clay blocks (or 'lumps'), measuring 20/25 x 25/30cm (T5F24), among which lay a bone arrowhead. This floor is situated at a depth of between 3.58 and 3.74m and is covered by a layer of compact tamped earth, on whose surface – upper floor between 3.44 and 3.63m deep – was found an abundant and varied inventory *in situ* (UF11a T5F22-23; Figure 10b): nuclei in obsidian and in flint, obsidian blades, 13 bone awls, a bone arrowhead, a spoon/palette in bone, three perforated stones, heaps of pebbles (Figure 10c). In the same level, a concentration of objects *in situ* (T5F28 – heap of pebbles, stone axe, bone awls, obsidian

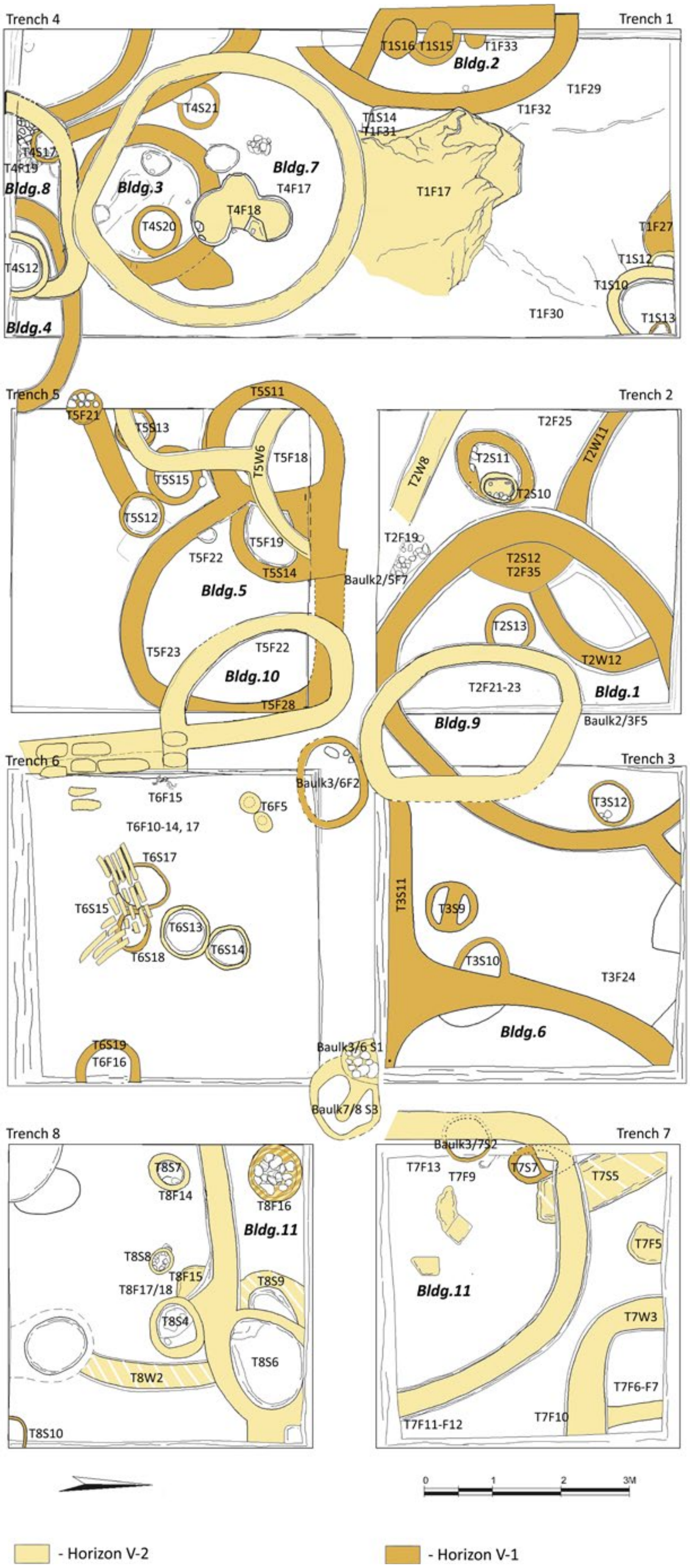

Figure 9. Architectural plan of horizon V.

Figure 10. Horizon V-1: a) Building 5 and surrounding structures; b) upper floor of Building 5 (UF11a F22-23) and c) selected material; d) concentrations of material in Trench 6 (F10-14, 17); e) nuclei and blades in these concentrations.

blades) is also visible in the mass of the wall; it is evident that the existence at some point of a superstructure on the wall of *Building 5* should be presumed.

To the west, as much on the exterior as the interior, two structures in cob lie against the wall (T5S11 and T5S14, which is made of sub-quadrangular blocks), in which were found concentrations *in situ* of pebbles with bone tools and obsidian blades (T5F18, T5F19). Immediately south of these structures a few small structures in cob were revealed (str.12, 13, 15) measuring 60 to 85cm in diameter, with walls of 4 to 6cm thick (Figure 10a). Also brought to light was a small fragment of wall (T5W8), perhaps a panel or a bench, which was covered on one side by a structure in cob (T5S12) and on the other by a hearth pit (T5F21).

Buildings 1 and 6 (Tr.2 and Tr.3)

The non-built space is bordered on the east by the circular cob *Building 1* which measures 4.20 x 5.40m, the width of its walls being 35cm (Figure 11). In the western part of this habitation several structures are concentrated: a) a small area in tamped earth (T2S12), raised against the interior part of the wall to the west, containing a heap of basalt pebbles with two nuclei, tools in flint and stone (T2F35; Figure 11o); b) a storage structure in cob (T2S13) measuring internally 0.83 x 0.87m, the thickness of the sides being 8-10cm; c) a hearth pit (T2F23) 35cm in diameter and 25cm deep with a concentration of small pebbles (17 pebbles of rounded oval shape, measuring 3 x 5cm, ten fragments of charred formless pebbles) and faunal remains. On the floor of the habitation were discovered heaps of cereal grains (T2F21) and fish vertebrae (T2F25). In the eastern part of the habitation were discovered three nuclei together with pebbles (Baulk2/3F5; Figure 11c-e), a structure in cob 70cm in diameter (T3S12), and between this and the wall of the habitation another nucleus, the sixth (Figure 11f). On the interior and exterior of the habitation fragments of walls (T2W11-12) were discovered which enclose small surfaces and join together in the western part of wall T2W10.

Along the SW face of the wall of *Building 1* was discovered a heap of 201 discoid beads in antigorite (Baulk 2/5 UF11 F7; Figure 11p), which lay compactly over an area of 40 x 20cm between the depths 3.47 and 3.51m. On the plan, this concentration corresponds to T2F19 – a circle of eight flat pebbles covered with burnt whitish beige earth, in which fragments of bones, knapping waste of obsidian and a microlith were found. There are no data to determine the nature of this concentration (an intentional hiding place? an area of production?).

Farther to the east of *Building 1* in Tr.3, the fragments of two other constructions were brought to light: a platform (T3S11) along baulk 3/6 and a curved wall (T3W4) that runs in and out of the NE angle of the trench to continue beyond the limits of the excavation (Figure 11a). It is possible that these constructions are parts of the *Building 6*, that has not yet been entirely excavated. On the exterior, near the junction between the platform and the wall, a structure in cob 75cm in diameter was excavated, consisting of two sections (T3S9). Such structures are known in horizons IV-III, where they clearly have larger dimensions. Generally only fragments of bone and obsidian are found in these structures, but str.9 also produced a stone tool with a cavity on the two faces. In the northern part of Tr.3 on a surface of 0.8 x 1.5m (T3F24) (Figure 11a) were concentrated *in situ* fragments of burnt pebbles, lumps of clay, obsidian, faunal remains, as well as tool-pendants in bone (polishers?), bone spoons and a large chalcedony bead/pendant in lozenge form (Figure 11g-n).

Other remains (Tr.6)

In Tr.6, south of Tr.3, almost all the excavated surface was occupied by small structures in cob (T6S17, T6S19/F16), by hearth pits (T6S18) and concentrations of material (T6F10-14, 17; Figure 10d), which contained nuclei and blades in obsidian (Figure 10e), grinders in natural pebbles and bone tools.

In Tr.7 and Tr.8, the lower level of Horizon V was not excavated.

Upper level (horizon V-2)

The upper level of horizon V reflects either a temporary abandonment of the settlement (UF9) in its entirety, or a modification in its spatial structure, after which, in the area of Tr.1-Tr.8, a zone essentially free of constructions was formed.

In Tr.1-Tr.8, as in trial trench Sond.A, the upper level of horizon V consists of a layer of compact tamped earth, situated in Tr.1 to Tr.3 and partly in Tr. 5 and Tr.6 between the depths of 2.9/3.0 and 3.25m; in some places it reaches a depth of 3.6m (UF9 and partly UF10). To this compact layer, in Tr.5 corresponds a soft clayey deposit of an orangey black colour (Figure 12a-b), containing a large quantity of phytoliths. This layer of tamped earth appears to be the result of the destruction of the structures of the lower level; its surface, which forms a hard crust, is subdivided by partly distinct fissures (Figure 12c-d). In general, the formation of such a fissured crust occurs during evaporation of water from flooding or torrential rains on the clayey deposits.

Concentrations of bones and artefacts

On the surface of the crust *in situ* lie fairly large heaps distributed haphazardly, composed of tools in bone, pebble and obsidian, faunal remains, some of which are in anatomical connection, as well as structures in pebbles and in cob. The structures in cob are oval in

Figure 11. Horizon V-1: a-b) Building 1 in Trenches 2 and 3 and Building 6 in Trench 3; c-f) nuclei discovered in Building 1; g-n) concentrations of materials in the yard between Buildings 1 and 6 (F24); o) concentration of obsidian and stone tools *in situ* (str.12 F35); p) discoid beads in antigorite (Baulk 2/5 UF11 F7).

Figure 12. A layer of compact tamped earth in Trench 1 of horizon V-2 (c, d) and corresponding with it a soft clayey deposit of an orangey-black colour in Trench 5 (a, b).

shape and measure from 55 x 43cm (Tr.2 str.10, walls 3cm thick; in places pebbles are included in the wall) to 3.25 x 2.25m (*Building 9*, thickness of the walls reaches 28 – 35cm).

Around the constructions in cob were found fairly dense heaps of artefacts and faunal remains, including fish bones, clearly indicating areas of work and of refuse from consumption. These heaps (measuring 25 x 45cm – Tr.2 F14; 90 x 70cm – Tr.2 F13; 140 x 100cm – Tr.2 F16; Figure 13a-c) contain, besides complete and fragmentary bones and natural pebbles (Figure 14a), raw materials and specialised tools, related to a specific domain of production. In particular, four nuclei form end-scrapers in obsidian (being both lateral and end-of-blade) and the fragments of 15 obsidian blades were found in Tr.2 F12 along with tools in horn and stone (Figure 14b-d,f-g).

The antler of a stag (Figure 14e), surrounded by small bones and obsidian blades (Tr.6 F8), clearly indicates a preparation. A characteristic feature of heaps in Tr.1, Tr.2 and Tr.3 is the exceptionally high concentration of punches/awls in bone; these make up 88.9% of the bone artefacts discovered here (Tr.1 - 14 bone tools, of which 13 awls; Tr.2 – respectively 14 and 13; Tr.3 – 17 and 14). Such a situation suggests that in this part of the area of the site, a specific type of production actively occurred.

In the upper level of horizon V, notable is a large quantity of fish bones, of which a considerable part was discovered grouped together, in hearth pits or in heaps

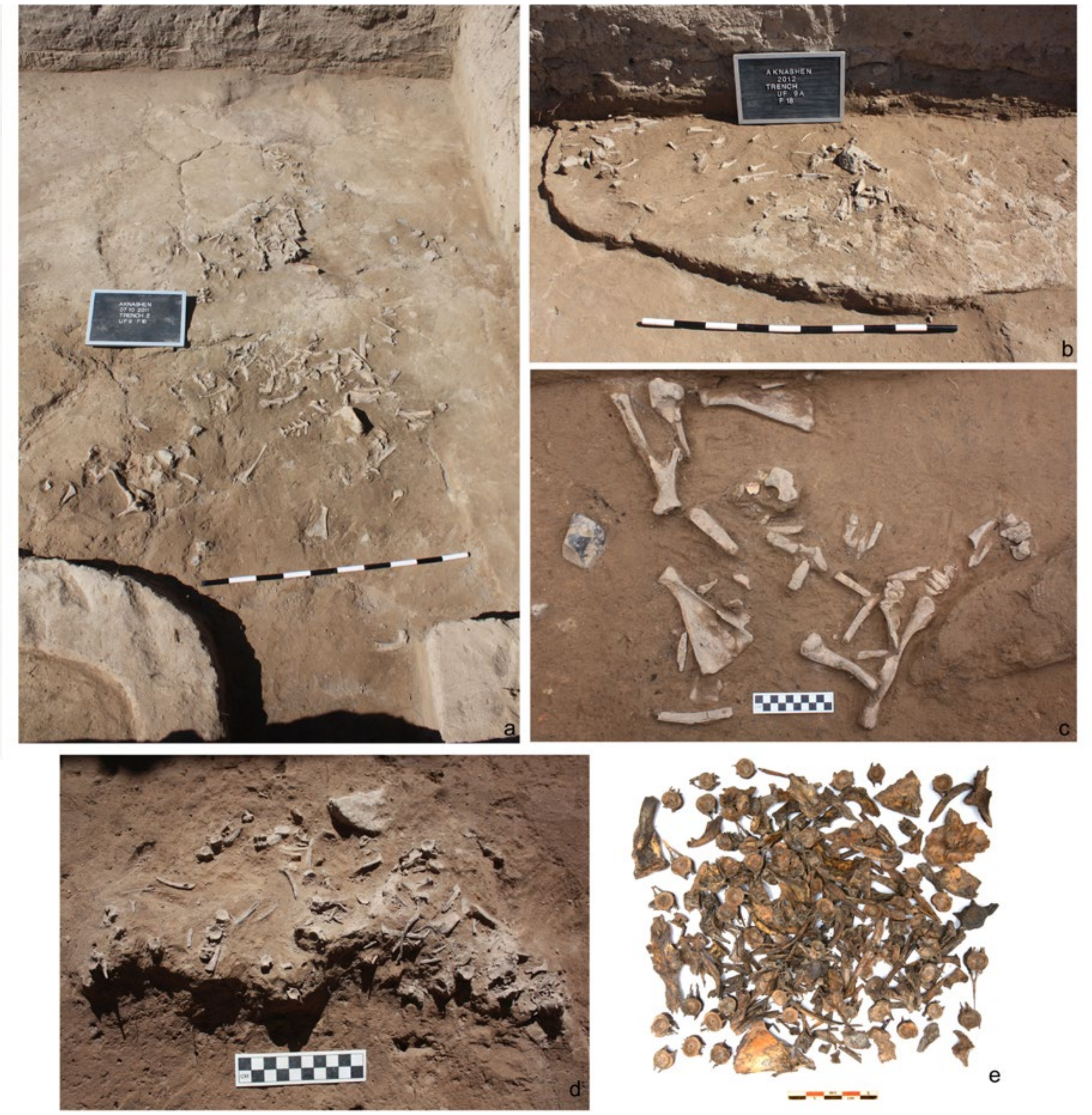

Figure 13. Accumulation of artefacts, faunal remains and fish bones on the surface of tamped clay in horizon V-2: a) Tr.2 UF9 F16; b) Tr.2 UF9a F18; c) Tr.4 UF9b F15; d-e) Tr.7 UF 10 F13.

Figure 14. Accumulation of materials on the surface of tamped clay in horizon V-2: a) complete and fragmentary bones and natural pebbles in Tr.1 UF9 F21; b-d, f-g) four nuclei and the fragments of obsidian blades with tools in horn and stone in Tr.2 UF9 F 12; e) the antler of a stag in Tr.6 UF10 F8.

containing several dozen or hundreds of bones; in rare cases, a few bones (mainly vertebrae) were found in anatomical connection. The most remarkable heaps are the concentration of 279 fish bones on a surface of 40 x 20cm (Tr.7 UF10 F13), of which 115 are examples of *Capoeta capoeta* (Figure 13d-e), and that of 65 bones (Tr.8 UF8 F14), of which 25 are of *Cyprinus carpio*. In all the absolute majority of fish bones of horizons I-VII is concentrated precisely in horizon V (almost 89%) (for more details, see Bălășescu and Radu in this volume), which is evidence for active fishing (seasonal) during this period, clearly conditioned by the proximity of the lake after its transgression.

Constructions

In a homogenous, continuous clay body on the floor of Tr.6 (Figure 9), over a surface of 1 x 0.5m, five dark parallel bands 7.5 to 8.5cm wide, separated by light-coloured bands 2.5 to 3.0cm wide, were clearly distinguished (Figure 15f). They pass under the walls of *Buildings 3 and 4* of horizon IV. Obviously, this is a fragment of wall that collapsed in a single block – again proof of the abandonment of the site at the end of horizon V.

In the north-west angle of Tr.6, two basalt mortars (diameter 35cm, height 21-22cm) were found *in situ* in an open space (T6F5) (Figure 15d-e). The mortars were upside down, obviously, in order to preserve them.

In the upper level of horizon V (V-2) the use continued of several oval and circular constructions, the preserved height of which does not exceed 30-35cm. The first is the circular cob *Building 7*, 4.0 to 4.35m in diameter (Figure 15c). Its lower floor (corresponding to the lower level of this horizon (V-1) is covered by an upper floor, at a depth of 302cm. The centre of the habitation is occupied by a hearth with three lobes (T4F18), dug to a depth of 36cm; its overall diameter is about 1.5m. Its fill consisted of soft ashy earth with a large quantity of charred or unburned bones, pebbles and obsidian blades. On this upper floor lay scattered material (T4F17) – stone tools (grinders in basalt or made from pebbles), obsidian and faunal remains.

Against this structure to the south, another construction was excavated (*Building 8*), to which is added T4S12 (diameter 0.8m, thickness of walls 10cm) filled with burned earth and clumps of clay. This construction continues in the south baulk of the excavation.

Figure 15. Horizon V-2: a-b) pebble structure/ hearth (Tr.8 UF8 F16) inside Building 11 (courtyard); c) Building 7; d) mortars *in situ;* e) a view of Trench 6 with mortars of horizon V on the surface, and the walls of horizon IV overlapping the collapsed wall fragment; f) fragment of a collapsed wall (Tr.6 UF9b str.15); g-q) selected materials from accumulations in the courtyard in Trench 8.

Several oval constructions in cob measuring 2.8-3.25 x 1.7-2.25m with walls 28 to 35cm thick were excavated in Tr.2 and Tr.5 (*Buildings 9 and 10*). The most densely constructed area was found in Tr.7 and Tr.8, where several small structures are surrounded by a wall in cob, which clearly encloses a courtyard (*Building 11*), subdivided by partitions or benches. Around these structures (T8S4, T8S7) a large accumulation of material *in situ* was revealed: bone artefacts (punches, pendants, a decorated fragment of spatula), obsidian artefacts (including several microliths) and stone tools (notably two objects in the shape of choppers and a flat axe), a flint end-scraper, discoid sherds perforated in their centre (Figure 15g-q), antigorite beads and a large quantity of fish bones (T8F14-F15, T8F17-F18). Near the western part of this *Building 11*, on the floor, at a depth of 2.9m, a hearth composed of two sections was found (Baulk7/8S3), measuring 0.96 x 1.20m and filled with ash and burned earth, as well as, on the side, a small structure in cob (Baulk3/6S1). The latter measures 0.60m in diameter with an edge in clay of 5-6cm and is filled with large pebbles.

In the north-west angle of Tr.8 is a structure (T8F16) made of 41 complete pebbles and 52 fragments disposed in several rows on a surface measuring 0.6 x 0.6m and surrounded by an edge in cob 6 to 8cm thick (Figure 15a-b). This structure was in all likelihood created in level V-1 and it is possible that it was still in usage in level V-2.

Conclusion on horizon V

Thus level V-2 constitutes a stage in the history of Aknashen, during which at least one part of the site was an open space, containing no constructions, in which a seasonal population (?) engaged in domestic activities in an intensive way.

The artefacts as a whole in horizon V present a typical assemblage of the Aratashen-Shulaveri-Shomutepe culture for the obsidian and bone industries. The most important element in the material culture of horizon V is the appearance in the upper level (V-2) of local Neolithic pottery with sandy temper (mainly group Grit II); a small number of sherds from a lower level (V-1) are highly fragmented and appear rather to be intrusive from a higher level (for more details, see Harutyunyan in this volume).

Radiocarbon dates

For all of horizon V, the radiocarbon dates are the following (Figure 16).

Horizon IV

Above horizon V is horizon IV, 0.5 to 0.8m thick (at depths between 2.05/2.40 and 2.80/2.90m) which was formed after a more or less prolonged abandonment of the settlement, as shown by the upper level of horizon V. Thus its plan differs from that of horizon V, although the tendency towards a concentration of constructions near the centre of the tell (Tr.1-2,4-5) continues. From a stratigraphic point of view, horizon IV is homogenous; the formation of several levels of floors in the habitations is not accompanied by reconstruction of the latter; only minor changes were made to structures of less importance.

Buildings 1 and 2 (Tr.1/4 and Tr.5)

The essential elements of the occupation of this horizon are *Buildings 1 and 2*, situated in Tr.1/4 and Tr.5 (Figure 17). These are circular structures in cob with interior diameters of 5.0m and 2.85 x 4.5m respectively; they were built at the level of depths 2.73 – 2.80m. The walls are 25 to 50cm thick and are preserved to a height of 55-70cm. The buildings are contiguous and it is not possible to determine which of the two was built first. Clearly *Building 1* lasted for a longer time. Foundations for the walls were dug in the clayey layer beneath, as the floors of the habitations lie 5-10cm above the base of the walls.

Building 1

On the exterior face of *Building 1*, on the west side, are two semi-circular ‘buttresses’ disposed in a symmetrical fashion; they measure 65 x 55cm and 125 x 65cm respectively. It is possible that they had framed an entranceway, but the space between these two reinforcing features had been damaged by an intrusive structure, T4 str.1/11. Inside the building, following a north-south line, runs a straight wall (pylon?) 2.2m long and 30-35cm wide (T4W5), which rests against the internal (north) face of the south wall and subdivides the building into two parts (Figure 18a).

In this construction several levels of floors were revealed, all to the west of the pylon. Against the interior face of the wall in the western part of the room and at the base of this wall, a hearth 80cm in diameter (T4F12)

Horizon	Trench/trial trench UF	Depth (cm)	Sample type	Labcode	DateBP	Date cal BC (95 4%)
V	Tr.1 UF9	296	charcoal	UGAMS-5802	6940±30	5894-5732
V	Tr.1 UF9	311	charcoal	LTL-12037A	6936±45	5969-5726
V	Tr.2 UF9 str.9	324	charcoal	LTL-12038A	7031±45	6011-5801
V	Tr.2 UF10 F19	337-351	charcoal	LTL-13038A	6938±45	5970-5726
V	Tr.3 UF9	299	charcoal	LTL-12039A	7005±45	5988-5770
V	Tr.3 UF10	342	charcoal	LY-10437 (SacA-34240)	6960±30	5969-5743
V	Tr.3 UF10 F18	340-347	human bone (skull)	LTL-13037A	6970±35	5975-5747
V	Tr.4 UF9a	337	charcoal	LTL-12040A	6949±45	5972-5732
V	Tr.4 UF10 F21		charcoal	LTL-13039A	6892±35	5883-5713
V	Tr.6 UF11 F15	355	human bone (tibia)	Poz-70153	6730±40	5720-5564
V	Tr.8 UF8		human bone (left femur, sub-adult)	Poz-82221	6620±40	5622-5481
V	Tr.8 UF8 F15	305-323	charcoal	LTL-13041A	6597±45	5621-5478
V	Sond.A UF10	315-348	charcoal	UGAMS-2292	6900±50	5895-5669
V	Sond.A UF10 F5	317-335	charcoal	AA-68560	6930±44	5968-5723
V	Sond.A UF11	348-370	charcoal	AA-68561	7035±69	6026-5746

Figure 16. Radiocarbon dates for horizon V.

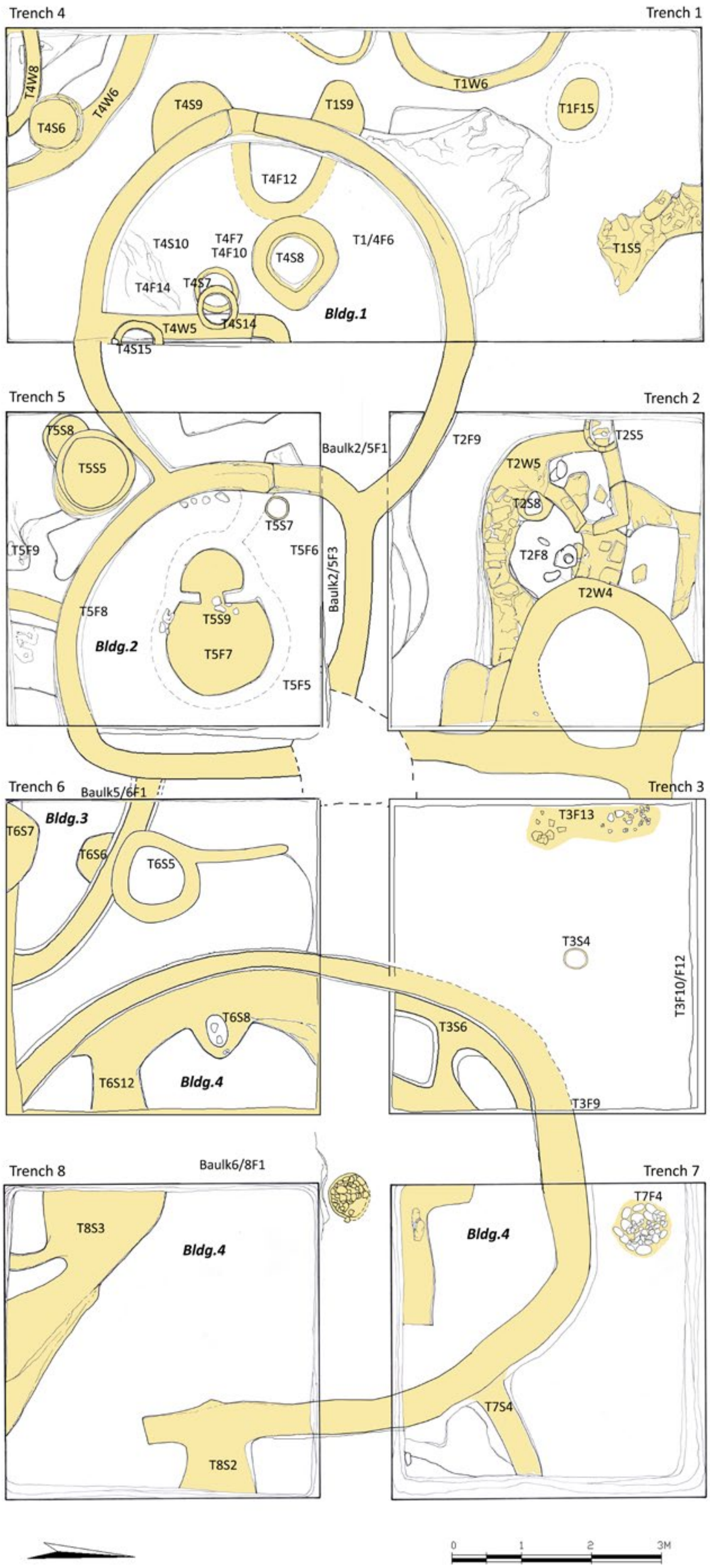

Figure 17. Architectural plan of horizon IV.

Figure 18. Horizon IV: a) part of Building 1 in Trench 4 with interior and exterior cob structures; b) a hearth inside Building 1 with pebbles and bone palette (Tr.4 UF8a F12); c) concentration of material on the floor of Building 1 (Tr.4 UF7a F10); d) accumulation of faunal remains (Tr.1/4 UF7c F6).

had been dug into the underlying clayey layer starting at a depth of 262cm. This hearth contained charred black-orange earth and a few scattered pebbles, among which were found a bone palette and a large piece of flint (nucleus?) (Figure 18b). On this same level two cylindrical structures in cob (T4S14 and T4S15 –on the pylon–) were revealed. All the southern space between the wall of the habitation and the pylon was occupied by clumps of cob from another structure (T4S10) and by material in bone and in obsidian, of which two nuclei: one in the southern part of the habitation (T4F14) and the other in the northern part of the baulk between trenches 2 and 5 (Baulk2/5F1).

The level of the following floor is situated between the depths of 237 and 253cm, on a layer of tamped earth situated between depths 250 and 259cm (T4F11). Here were found concentrations of material containing blades and nuclei in obsidian, faunal remains and a bone shaft (T4F10; Figure 18c), as well as a structure/hearth in cob filled with burned earth, bones and pebbles (T4S8), and a cylindrical storage structure in cob (diameter 60cm, thickness of walls 7cm) (T4S7) at the location of T4S14 with a slight shift.

Finally, between the depths of 220 and 230cm the upper level of the floor was clearly revealed, where a large quantity of material was concentrated: besides obsidian and bones, three flat pendants in bone, stone tools and artefacts perforated in their upper part, tools made from antler (T4F7), two punches/awls, discoid beads in paste, a small flat axe in stone, stone tools and a dense heap of faunal remains (T1/4F6) (Figure 18d).

Building 2

In *Building 2* (T5W4), the following situation was observed: in the centre of the habitation, in the layer of tamped earth, a hearth in the shape of 'eight' was dug, composed of two sections (total dimensions 2.10 x 1.50m; T5S9/F7), which was used throughout the existence of the building. It was filled with black-orange burned earth and fragments of whitish blocks of clay; the earth beneath the large section was burned to a depth of 310cm.

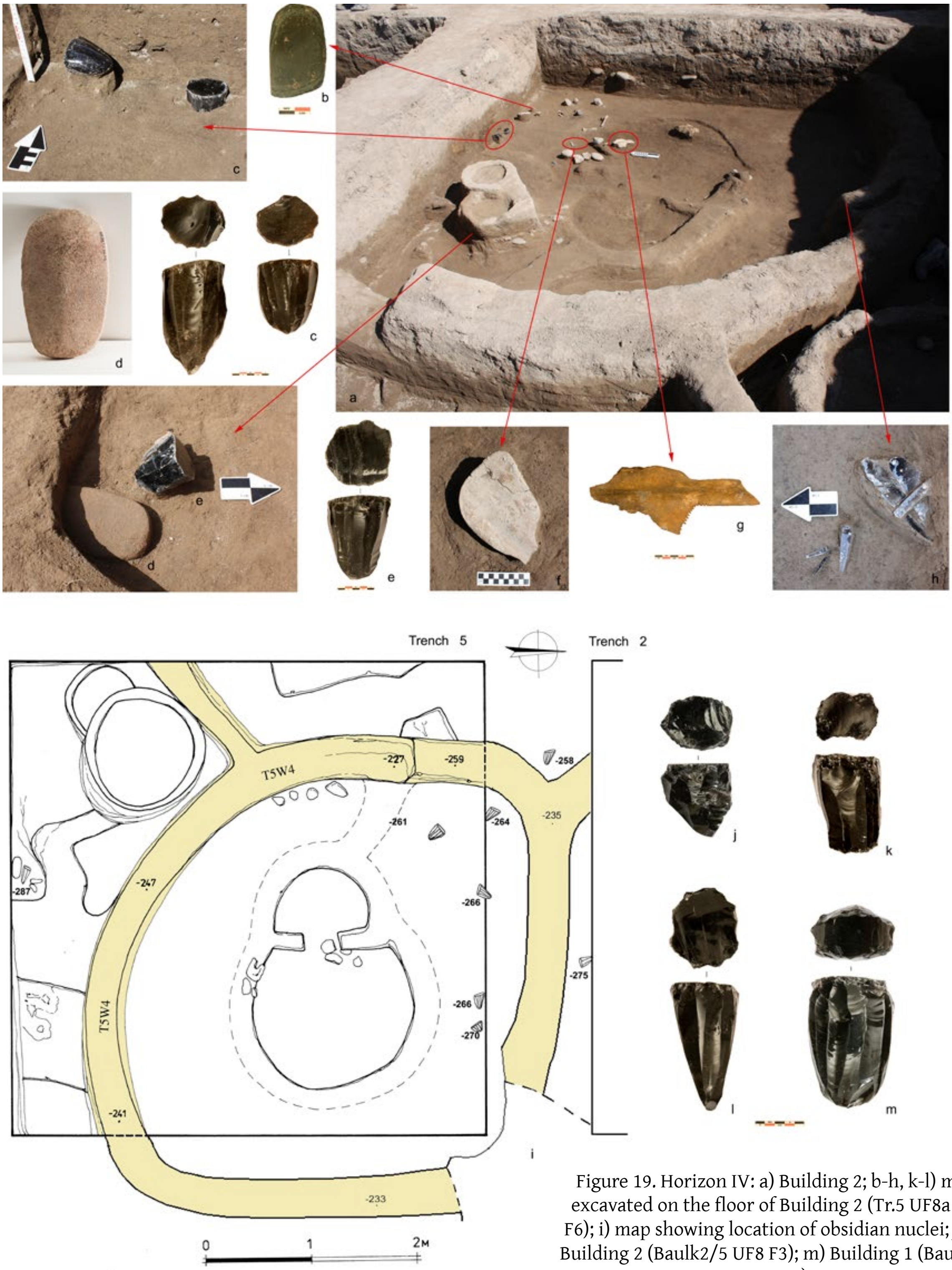

Figure 19. Horizon IV: a) Building 2; b-h, k-l) materials excavated on the floor of Building 2 (Tr.5 UF8a str.9/F7, F6); i) map showing location of obsidian nuclei; j) outside Building 2 (Baulk2/5 UF8 F3); m) Building 1 (Baulk2/5 UF8 F2).

At a depth of 255-260cm a floor was revealed (UF8a) upon which lay material *in situ*: five nuclei in obsidian, a bone palette, a bone tool on palette with a toothed edge, four bone awls, a small oval grindstone (20 x 11.5cm), a heap of obsidian blades (T5F6-F7; Figure 19). Outside the building, at the same level, two other nuclei were found, one under the north wall of *Building 2* (Baulk2/5F3), the other near the south baulk of Tr.5 in a pit (Figure 19i). North of the hearth a cylindrical structure in cob was found, several times reconstructed depending on the elevation of the floor, with a slight shift in the plan (T5S7). The level of the following floor is associated with an area made of sub-quadrangular 'lumps' with orange edges and a black core, measuring 28 x 32cm (T5S6), as well as a heap of bones (T5F5).

Fallen blocks of clay (Tr.1 and Tr.2)

In the northern part of Tr.1 and in Tr.2 collapsed blocks of clay were brought to light.

In Tr.1 the heap of collapsed material (T1S5) occupies the north-east part of the excavation at a depth of 222-251cm and consists of a mass of clay blocks measuring 10/13/25 x 10/12 x 7cm, which stretches in a north-south line (width 0.65-0.80cm, length 3.4m). At a depth of 251cm, the blocks lie upon a compact mass of clay (UF7e F12) which covers all of the excavated zone except the centre. Between the collapsed material and wall T1W6 (oval structure in cob beneath the west baulk) a hearth pit was dug (T1F15).

In Tr.2 the clay blocks measuring 10/13/26 x 12/26 x 10 x 15cm constitute the base of the curved wall T2W5 in the centre of the excavation, while north of this a small area was discovered (T2S4, 1.8 x 1.5m) made of charred sub-rectangular lumps (Figure 20a,c). Between the blocks, small cylindrical structures that were highly charred were distinguished (T2S5, T2S8); in the centre of the area a lozenge-shaped space (T2F8) was found,

Figure 20. Horizon IV: a) architectural remains of horizon IV in Trenches 1, 2, 4, 5; b-c) two stages of excavation of construction in Trench 2 (T2W5, F8, str.4-5, 8); d-h) indicates the locations of finds.

Figure 21. Horizon IV: a) view of horizon in Trench 6; b) detail of the wall in the baulk profile.

with a soft fill containing a fragment of a thick-walled vessel stuck in the floor (?) *in situ* and a stone pestle (measuring 32 x 35cm, the diameter of the cavity being 14cm (Figure 20b).

Building 3 (Tr.6)

South-east of *Building 2* another building was constructed, *Building 3*, about 5.6m in diameter, whose south part is situated beyond the limits of the excavated zone. Inside the building were brought to light two platforms in cob, a concentration of 118 discoid beads in antigorite over a surface of 40 x 25cm (Baulk5/6F1). On the exterior (in Tr.6), a structure in cob rounded in shape (exterior diameter 130cm, interior diameter 82/85cm) was constructed against the habitation with a fragment of straight wall extending towards the north,135cm long and 16cm wide (T6S5).

Building 4 (Tr.3, Tr.6-8)

A large part of the space inside Tr.3 and Tr.6-8 is occupied by the *Building 4*, exterior diameter 7.0 to 8.7m. Its walls are 30-40cm thick and consist of an undifferentiated compact mass of cob; however, in Tr.6 in the east face of the baulk (T6S12) were revealed a minimum of four horizontal bands of light-coloured clay, with a length of 1m and a thickness of 7cm, separated by dark strata of clay 1 to 2cm thick (Figure 21a-b), which could be followed up to the cob wall T6W2.

Inside the building the remains of floors and/ or ruins of constructions were excavated, revealing a large accumulation of faunal remains, pebbles, brick fragments, ashes. Against the walls, structures of various shapes and dimensions were built: a hearth in the form of a small oval pit with burned earth and two large pebbles inside on the bottom (T6S8); a large structure made in two sections (T3S6). In the north of the building is a structure of pebbles (T7F4), discovered at a depth of 2.50-2.72m. It consists of pebbles disposed in a circle (diameter 70cm) in several layers, coated with clay around the lower part (Figure 22a-b). The upper layer contains a large quantity of whole (11) or fragmentary (36) pebbles burned right through, while the lower layer is composed of oval pebbles that are larger and not burned (14 whole and 14 fragmentary).

Other remains

Also belonging to horizon IV is a series of contexts, observed outside the constructions: a heap of large animal bones (Baulk1/2F4); a vessel fragment (Figure 22c) associated with a structure in pebbles, comprising more than 30 natural pebbles measuring 4-5 x 3-4cm (T3F13); concentrations on small surfaces (maximum 15 x 15cm) of an assemblage (from 50-60 to more than 300 units) of small flakes and splinters of the same obsidian (Tr.5 UF7a; Tr.3 UF 7a; Baulk2/3 UF7 F2); for example, in Tr.2 UF7b – 18 whole microflakes and 260 micro-fragments. Finally, in horizon IV (Baulk6/8F1) at a depth of 245-258cm, human bones were found, probably the remains of a tomb (see Poulmarc'h *et al.* in this volume).

Radiocarbon dates

For horizon IV the following radiocarbon dates were obtained (Figure 23).

Horizon III

Horizon III includes UF 6 in trial trench Sond.A (between 2.07 and 2.40m in depth) and in Tr.1 to Tr.6 (between 1.8/2.0 and 2.4m in depth), as well as UF4

Figure 22. Horizon IV: a-b) pebble structure/hearth (Tr.7 UF6 F4) outside of Building 4/courtyard; c) Grit-tempered II pottery sherds *in situ* and the restored oval-shaped spouted vessel (Tr.3 UF8 F13).

Horizon	Trench/Trial trench, UF, Feature/structure	Depth (cm)	Sample type	Labcode	DateBP	Date cal BC (95 4%)	Date cal AD (95.4%)
IV	Tr.1 UF8		human bone (tibia)	LTL-5734 A	6860±45	5842-5655	
IV	Tr. 3 UF7a F7	232-240	charcoal	UGAMS-2821	6740±50	5730-5561	
IV	Tr. 3 UF7b	243	charcoal	UGAMS-4079	6640±30	5627-5483	
IV	Tr. 3 UF7b	262	charcoal	UGAMS-4080	6590±30	5616-5478	
IV	Tr. 4 UF7a str.8		charcoal	UGAMS-5803	6800±30	5731-5635	
IV	Tr. 4 UF7c	232	charcoal	UGAMS-6462	6770±30	5722-5627	
IV	Tr. 4 UF8a	268	charcoal	UGAMS-6463	6880±30	5841-5674	
IV	Tr. 4 UF8b-	271	charcoal	UGAMS-5804	6600±25	5617-5480	
IV	Tr. 5 UF7a	240	charcoal	UGAMS-4081	6720±30	5713-5564	
IV	Tr. 5 UF8a		charcoal	UGAMS-5805	6970±25	5971-5755	
IV	Tr. 6 UF7a	234	charcoal	UGAMS-4082	6560±30	5611-5476	
IV	Tr. 6 UF8a	284	charcoal	LTL-12041A	6832±45	5802-5631	
IV	Baulk6/8 UF7 F1		human bones	Poz-56369	6640±50	5633-5480	
IV	Tr. 7 UF5 F2 (tomb)		human bone (rib)	UGAMS-6460	3830±30	2351-2198	
IV	Tr. 7 UF5 F2 (tomb)		human bone	LY-6992	3860±35	2464-2203	
IV	Tr. 7 UF7	293	charcoal	LY-10438 (SacA-34241)	6650±30	5630-5484	
IV	Tr. 8 UF6b F5	255-260	grape	UGAMS-4085			modern
IV	Sond.A UF7	240-265	charcoal	AA-68559	6868±40	5842-5664	
IV	Sond.A UF8’	265-290	charcoal	UGAMS-2293	6550±50	5619-5383	

Figure 23. Radiocarbon dates for horizon IV.

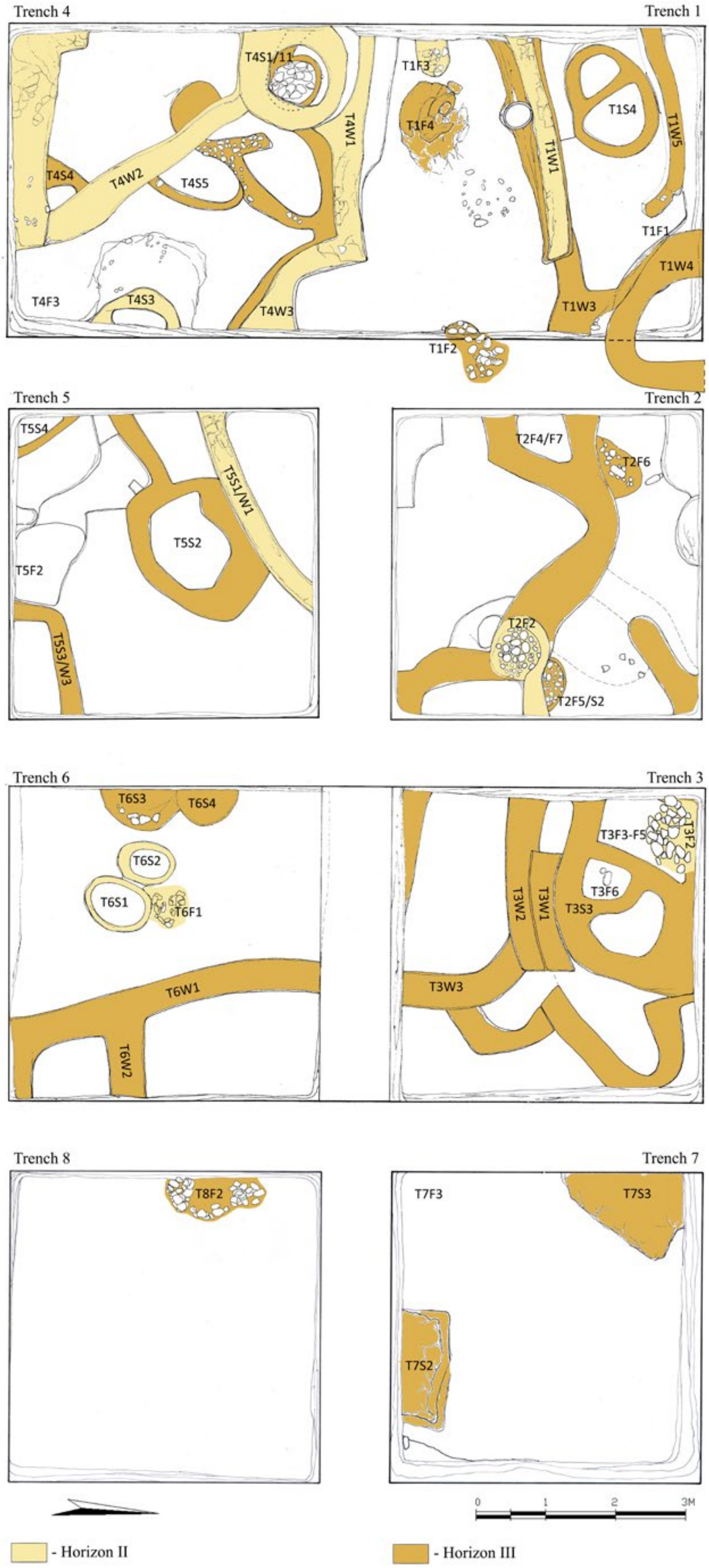

Figure 24. Architectural plan of horizons III and II.

and UF 5 in Tr.7-8 (between 1.95/2.05 and 2.55m in depth). Its thickness is 0.35 to 0.60m. This horizon has been greatly disturbed by tombs of Early Modern period, which have been dug from the top of the hill. The remains of constructions are represented only by scattered fragments of curved walls 0.3-0.45cm thick, concentrated in Tr.1-6. In Tr.7-8, also disturbed by the installation of a rubbish dump and by a modern digging, horizons II-III are represented only by unrecognizable collapsed entities of mud. The surviving walls do not permit reconstruction of a plan for horizon III (Figure 24), but it is evident that in this horizon there are no circular buildings like those of horizon IV.

Clay structures in two sections

The essential element in horizon III is the presence of two types of cob constructions, round structures and two-cell structures (T1S4; T4S1/11; T3S3; T5S2), whose dimensions vary between 0.75 x 0.85m and 1.65 x 1.25m (Figure 25a,c); they are similar to the structures with two sections brought to light in horizons IV and V. However, unlike the latter, here no trace of fire was revealed. The bottoms of these structures have a funnel shape and consist of a clay layer 10 to 12cm thick. Inside and around the structures a varied assemblage is present *in situ*, of which a large part is mineral-tempered pottery represented by vessels that are more or less fragmentary (for example: T1F1; T2F4/F7; T3S3a/F6) (Figure 25b,d).

Pebble structures

Another element of this horizon is the presence of heaps of pebbles that form structures that are more or less compact. A large heap, made up of 22 fragmentary pebbles and three whole pebbles, of which some carry traces of use, was brought to light near the eastern baulk of trial trench Sond.A (Ak.05 Sond.A UF6 F2). Certain fragments belong to oval grindstones. 40cm to the south of this large heap were found three nuclei in obsidian and cylindrical tools made from pebbles (Figure 26d-e).

Such heaps were excavated in practically all the trenches of the excavation; they comprise 43 whole

Figure 25. Horizon III: a) cob structure in two sections (Tr.1 UF6 str.4); b) stone tools and pottery of Grit-tempered I group excavated *in situ* in Trench 2 (Tr.2 UF6 F4/F7); c) cob structure in two sections (Tr.3 UF6b str.3); d) stone tools and pottery of Grit-tempered I group excavated *in situ* in Trench 3 (Tr.3 UF6b str.3/F6).

Figure 26. Horizon II: a) architectural remains in Trench 6 (Tr.6 UF5); b) pebble structure/hearth in Trench 2 (Tr.2 UF5 F2). Horizon III: c) pebble structure (Tr.2 UF6 F5) underlying the above structure/hearth; d-e) nuclei excavated *in situ* in Sond.A (UF6 F2).

and fragmentary pebbles on a surface of 0.9 x 0.8m (T1F2) up to 74 pebbles of average dimensions (55 fragmentary, 15 whole and 4 tools), concentrated in an area of 1.5 x 0.8m (T8F2). Large pebbles (10 formless fragments and 36 whole rounded pebbles) mixed with layers of earth were discovered at a depth of 1.81-2.08m inside a large structure in cob (T4S11, de 75 x 85cm overall diameter);[5] this structure, situated between Tr.1 and Tr.4, had existed in horizons III and II as str.1 and was remodelled. Finally, to be noted is a dense heap of small rounded pebbles, surrounded by a border in cob measuring 0.7 x 0.43m (T2F5/S2) (Figure 26c).

On the pebbles from the heaps mentioned, no trace of fire was found in the form of soot. Obsidian artefacts and bone tools were associated in a more or less large quantity with most of these heaps.

Hearth pits

In horizon III hearth pits that contained ash and small charred bones were also excavated. A hearth in the form of a funnel (measuring 1.3 x 1.0m), with a bottom composed of two rows of clumps of burned clay and filled with organic matter and charred bones, was brought to light in trial trench Sond.A UF6 F3. Another hearth (T5F2) consists of a pit in the form of a bell (upper diameter 0.7m, lower diameter 1.0m, depth 0.3m), carpeted with pebbles in its lower part.

Besides the absence of architectural planning, horizon III is distinguished above all by a difference in the quantity of pottery and in its composition. The quantity, in relation to horizon IV, increases more than twofold, and in this assemblage, group Grit I reaches 55% (see Harutyunyan in this volume).

[5] This structure was followed from horizon II, starting at a depth of 152cm below absolute zero, where it was initially identified as a circular construction in cob (str.1); lower down, between depths of 207 and 212cm, it was identified as an amorphous structure of pebbles, which directly covered structure 11, previously described.

Radiocarbon dates

For horizon III the following radiocarbon dates were obtained (Figure 27).

Horizon II

The singling out of horizon II is somewhat arbitrary in that later intrusions profoundly disturbed the architectural elements present. It is characterized essentially by a clear reduction (in relation to horizon III) of structures and situations *in situ*.

Horizon II comprises UF4-UF5 of trial trench Sond.A (between 1.48/1.56 and 2.07/2.12m deep), UF5 and in part UF6 of Tr.1-6 (between 1.3/1.45 and 1.62/2.05m deep) and UF3 in Tr.7-8 (between 1.4 and 1.96/2.05m deep). Its thickness is 0.35 to 0.65m.

Architectural remains

This horizon, highly disturbed by intrusive tombs which descend to a depth of 2.00m, consists of partially preserved surfaces of tamped earth, of walls in cob with fragments of lumps and of oval or circular structures (Tr.1 str.2 = T1W1; T1F3; T2F2; T3F2-F5; T4S1; T5S1/F1; T6S1-S2) distributed in an unsystematic manner in the excavated zone (Figure 24). It is not possible to establish a plan of these structures. In Tr.1, Tr.4 and Tr.5, fragments of straight and curved walls are preserved, from 30 to 35cm in width (T1W1, T5W1, T4W1-T4W3). In the upper part of the walls, in places, blocks of earth measuring 10/15 x 22/30cm may be distinguished. In the north-west angle of Tr.4 a large structure in cob was brought to light (T4S1), measuring 0.9m in diameter, with walls 0.2m thick. It appears that this structure was built in horizon III and continued to be used during horizon II.

In Tr.2, a structure made of large pebbles disposed densely (measuring 0.7 x 0.7m), was discovered, surrounded by a border in cob of 15cm and constructed against a small bit of wall that passes under the baulk

Horizon	Trench/Trial trench, UF	Depth (cm)	Sample type	Labcode	DateBP	Date cal BC (95 4%)	Date cal AD (95 4%)
III	Tr.1 UF6	184/190-212	charcoal	Poz-22745	6910±40	5889-5719	
III	Tr.2 UF6 (T2W2)	206	charcoal	UGAMS-4078			modern
III	Tr.3 UF6A	215-232	charcoal	Poz-22746	6420±40	5475-5320	
III	Tr.4 UF6	157-167	charcoal	Poz-22747	6790±40	5736-5626	
III	Tr.6 UF6B	207-236	charcoal	UGAMS-2820	6690±50	5714-5484	
III	Tr.7 UF4	240	charcoal	UGAMS-4083	180±30		modern
III	Tr.7 UF5 str 2	235	charcoal	LTL-13040A	6506±45	5606-5371	
III	Tr.8 UF4	230	charcoal	UGAMS-4084	1690±30		250-430
III	Sond.A UF6	205-240	charcoal	LY- 13664	6350±70	5477-5130	

Figure 27. Radiocarbon dates for horizon III.

Horizon	Trench/Trial trench, UF	Depth (cm)	Sample type	Labcode	DateBP	Date cal BC (95 4%)	Date cal AD (95 4%)
II	Baulk Tr.1/Tr 2 UF5	174	seed	UBA-16001	6597±26	5616-5479	
II	Tr.4 UF5	157	charcoal	UGAMS-6461	6480±30	5481-5371	
II	Tr.6 UF5		charcoal	UGAMS-2290	840 ± 40		1164-1251

Figure 28. Radiocarbon dates for horizon II.

between Tr.2 and Tr.3 (T2F2) (Figure 26b). All of the remaining surface was covered with collapsed cob of various forms (Figure 26a), in which sometimes clumps of burned clay and concentrations of material could be distinguished.

Radiocarbon dates

For horizon II the following radiocarbon dates were obtained (Figure 28).

Horizon I

The upper horizon of the site (horizon I), 0.8-0.9m thick (UF2-UF4), is represented in trial trench Sond.A by a Neolithic level that is very little disturbed (only one intrusive tomb of the late Bronze Age in the central part of the trial trench), whereas in Tr.1-8 and in trial trench Sond.B this level had been repeatedly disturbed. The grassy layer and the underlying layer consisted of a soft clayey component in which much digging and collapse of possible earth structures were found. Between the depths of 0.8 and 1.6m several layers of very compact tamped earth, apparently of natural origin, were observed. These layers consisted of 10 to 15cm of clay and were covered by a compact crust 1 to 1.5cm thick. They occupy almost all the surface of the trenches and are cut by late tombs. The largest surface area of tamped earth is found between the depths of 0.95 and 1.15m.

Horizon I was completely destroyed by intrusive tombs of the middle and late Bronze Age, then by two occupations in the medieval period (the remains of which consist of tonirs, hearths, basalt grindstones, etc.) and finally by a Early Modern period cemetery which penetrated the cultural layer of the hill in places, down to a depth of more than 2m (in Tr.1-8 and in Sond.B, more than 160 tombs were excavated (Figure 29a); in addition there are rubbish dumps and holes dug by animals.

Because of all these disturbances, there exists no plan of this upper level for the Neolithic period. The material is preserved *in situ* only in places, in some sectors. In Tr.3 UF3, in places where there was no medieval occupation, found *in situ* at the depth of 1.12m were three axes/hoes (F1) with perforations for attaching handles (Figure 29c); they are in hornfels and quartz diorite and they are similar to those that have been discovered, for example, in the lower level of Kültepe of Nakhichevan (Abibullaev 1982, pl.IV:1-3). In Sond.B UF3, at a depth of 1.57-1.77m, between tombs 2 and 8, fragments of a large vessel (F1) were found that present three oval protuberances on the edge of the rim (Figure 29b).

In substance, horizon I provided only artefacts, essentially obsidian and pottery sherds (bone artefacts are rare and simple – only three punches/awls and one edged tool). In general there are no significant differences between the obsidian industries of the first and the underlying horizons. The *chaînes opératoires* are the same: the procedure on flake (semi-improvised *ad hoc* knapping) being less represented than the procedure on blade using highly elaborated knapping techniques. For the blades that are well preserved (at least 5cm long) J. Chabot was able to determine that the three main techniques of superblade debitage were performed: indirect percussion, pressure with a crutch and probably pressure with a lever (so far for this level, two specimens may indicate the presence of this complex technique). All three techniques are also known in the earlier levels of the site (see Chabot *et al.* in this volume).

The absolute majority (67%) of the pottery of horizon I belongs to the plant temper category (Chaff-tempered ware), with a combed surface treatment, a horizontal row of perforations under the rim and decoration in relief on the edges (of which the above-mentioned vessel comes from Sond.B UF3 F1). Traditionally these characteristics are considered to be Chalcolithic. In the underlying horizons, the quantity of this pottery decreases strongly (see Harutyunyan in this volume). Another group of pottery, clearly less abundant in this horizon, is typically Neolithic with mineral temper. It is distinguished from the preceding not only by its techno-typological characteristics but also by the shapes of the vessels. These are crude cylindrical open vessels with a projection at the base. The destruction to which this horizon was subjected does not allow definitive determination as to whether the two groups of pottery coexisted or whether the situation observed is the result of later disturbance.

In parallel, the chronological appartenance of the plant-tempered pottery cannot be unambiguously determined, because of the technological heterogeneity (plant temper/mineral temper) of pottery production in the South Caucasus in the 6th – 5th millennia BC.

Figure 29. a) Plan of horizon I; b) situation in Sond.B showing intrusive tombs of later periods and remains of the Chaff-tempered vessel *in situ* and after restoration; c) axes/hoes (Tr.3 UF3 F1) *in situ*.

The typological specificity of the three axes/hoes mentioned above, unknown in the lower horizons of the site, where they are replaced by another type (see Hamon *et al.* in this volume) suggests a late date.

Unfortunately, in the absence of confirmed contexts, there exist no 14C dates for this horizon. However its lower chronological limit can be defined by the upper limit of horizon II after 5400 BC. Given that at Aknashen no pottery was found characteristic of Aratashen level '0' with incisions on the rim and crushed obsidian as temper (Palumbi 2007; Palumbi *et al.* 2014; Arutyunyan and Mnatsakanyan 2010; Arutyunyan 2011), which is characteristic of the 'Sioni' type of sites, it may be concluded that horizon I of Aknashen is earlier than level '0' of Aratashen (Badalyan and Harutyunyan 2014: 164).

Thus, the chrono-cultural attribution of horizon I remains a problem within the framework of our knowledge of the Neolithic and the Chalcolithic and requires more research.

Conclusion

The settlement of Aknashen and the contemporary sites of the Ararat valley, which are stratified anthropic hills indicative of more or less prolonged occupation by groups of farmer-herders, were formed from the progressive superimposition of the ruins of buildings of habitation, which are the earliest evidence for architecture in the region.

Based on the data presented in this chapter, we can characterise fairly precisely the architectural plans and the construction technique of the buildings at Aknashen and present a few observations on the changes in the plan of the village and the factors which led to them.

As has been demonstrated, we have observed that no development occurred in horizons V-II, either in the architectural plans of the buildings or in the construction technique. From the beginning to the end of the stratigraphic sequence represented by these horizons, the buildings are circular in plan and constructed in cob. At the same time, however, certain changes are evident in the general plan of the village (in the part which has been excavated), changes conditioned by variations in the nature of the occupation.

The principal criterion for typology and for determination of the probable function of the constructions at Aknashen is mainly their size, and to a lesser degree, certain elements of the interior layout; the construction technique and the distribution of objects provide no clear information.

The dimensions of the buildings at Aknashen vary in an important way. The largest is *Building 4* (horizon IV), one of a kind, with an interior surface area of 36.8m²; it appears rather more to be an enclosed zone (courtyard) than a covered building. The dimensions of most of the other buildings are much more modest – from 9.6 to 18.0m² (between 3.5m and 4.8m in diameter) (*Building 1*, horizons V-1; *Buildings 7 and 11*, horizon V-2; *Buildings 1 and 2*, horizon IV).

It is to be noted that no trace enabling the reconstruction of the manner of covering the buildings could be found. First of all no evidence exists for the presence of a support for a flat covering, such as little ditches or even stone bases. In a few buildings, one observes a progressive decrease in the thickness of the walls, from 60cm at the base (in *Building 1* of horizon V-I, for example, two blocks are clearly visible at the base) up to 25-28cm (width of a single block). In this case, the covering would appear more logically to have been dome-shaped, even if the reconstruction of buildings with domes of the Shulaveri-Shomutepe culture, already proposed by A. Javakhishvili, has recently come into question.

The following category consists of constructions in cob, found in all the horizons, without precise shape but tending generally towards a circular form, with a surface area of between 2.0 and 3.8 m² (between 1.6m to 2.2m in diameter). The thickness of their walls is similar to that of the walls of habitations, 25 to 40cm. These constructions can be either isolated or built against the wall of a habitation. Their fills are not distinguished by anything in particular. The absence of distinct situations within these structures prohibits determination of their function.

To the last category of cob structures, that of the smallest, belong constructions of circular or oval plan, in the form of cylinders or barrels, whose diameter varies between 0.35-0.70 and 1.00-1.30m. These structures were built by placing twists or rolls/clay blocks in spirals or in rings, the thickness of the walls varying from 2-5 to 10-12cm. They were excavated in all horizons and are found as much inside the houses as outside, in courtyards and open spaces. With rare exceptions, no remarkable object has been found in these structures; generally, in the tamped earth fill, often quite compact, only a low number of small bones and obsidian artefacts were discovered.

In previous publications, the construction technique of the Neolithic structures of Aknashen was defined by the term '*pisé*' (Badalyan *et al.* 2010; Badalyan and Harutyunyan 2014) or 'cob' (Chataigner *et al.* 2014a). The clarification of the terminology and the definitions shows that in this case, it is preferable to use the latter term – cob (*bauge*) in its broad meaning (Hamon *et al.*

2016: 164-165; Baudouin *et al.* 2018: 60-61; Baudouin 2019: 124; Marro *et al.* 2019: 91,108). The material used in the constructions of Aknashen was a local clayey earth (mud) with the addition of a large quantity of organic matter (essentially the residues from threshing of cultivated cereals and a wild plant, *Alyssum desertorum*). The walls of the buildings were raised in place using lumps and blocks of this clay (modules, lumps, clods; the width of visible blocks is 20-22cm, their thickness 7-9cm, length 25-50cm, up to 90cm in rare cases), then rendered on the two faces with a clayey solution containing, to the naked eye, more sand and less organic material.

This technique corresponds to the variant 'lumps and layers of mud/cob' (Baudouin 2019: 124). A similar technique was also used on contemporary sites in the Ararat valley, at Masis Blur, where the excavators also observed the parallel practice of *pisé* (Hayrapetyan *et al.* 2014)[6] and in the basin of the Araxes at Kültepe of Nakhichevan (Marro *et al.* 2019). On the sites of the basin of the Kura, where the dominant tradition of construction was the use of more or less standardised plano-convex mud bricks (Javakhishvili 1973; Baudouin *et al.* 2018), there is only one case (Gadachrili Gora, horizon I) for which the cob technique has been proposed (Hamon *et al.* 2016; Baudouin *et al.* 2018).

A comparative analysis enables observation of clear differences in the plan (of the settlement) between horizons V and IV and horizons III and II. Although the chaotic situation in the upper horizons could be in large part due to their destruction, the impression nevertheless exists that these basically correspond to fences, hearths and work areas in the open air. These changes are correlated with a reduction in the discoveries of artefacts (especially in horizon II) and with a development in the manner of herding ovicaprids. According to A. Bălăşescu, in the earliest horizons (VII-III) the caprines were exploited primarily for meat production. In the most recent horizons the percentage of caprines exploited for milk and wool rises,[7] and these animals reach their maximum in Horizon II (Bălăşescu and Radu in this volume), which clearly suggests a more mobile animal economy.

The thickness of the cultural layer of the late Neolithic of the site and the time period covered by the 14C dates are evidence of prolonged use, over several centuries, of this small area as a place of habitation by human groups. Moreover, the presence of layers of compact tamped earth formed following natural processes between the horizons, as well as the shifting of layout plans in the horizons in relation to each other, give the impression that each of the horizons represents a distinct episode of occupation.

The duration of these episodes and thus the character of the occupation – seasonal or year-round – for each episode/horizon is determined, in general, based on a certain number of indicators which, in our case, are in apparent contradiction with each other. On the one hand, the fact that all the biological classes of caprines are present on the site suggests that lambing took place on the site and that the settlement was inhabited throughout the year (Bălăşescu and Radu in this volume). On the other hand, Aknashen is characterised by a large number of accumulations of artefacts *in situ*, including in particular, stocks of high-value raw material (dozens of obsidian nuclei, some of them in their original state, weighing 3000 to 5400 gr.), a large number of intact tools in stone and in bone, ready to use, as well as a concealment of tools for the purpose of preserving them (two mortars overturned in horizon V, Tr.6), which is considered to be proof of seasonal occupation with a short absence of the inhabitants in anticipation of returning (Kadowaki *et al.* 2015: 423; Baudouin 2019: 144), probably because they practised transhumance (Nishiaki *et al.* 2018).

The fact that most of the concentrations of artefacts mentioned above were found in the upper strata of the horizons, that the layout plan of the horizon situated just above is different and that the tools and stocks of raw material of the horizon just below were not used, show that the population that left these resources in place did not always return, which reflects the discontinuous character of the occupation.

Obviously, this indicates a situation not of seasonality (that is, a cycle of several months during the year) but of cyclicity, with a duration of several years for each episode or cycle (probably the duration corresponding to the operation of the buildings in cob or in bricks, evaluated by Nishiaki *et al.* 2018 to be 11.4 years), during which the horizon was inhabited all the year.

Certain data are evidence that the population of Aknashen exploited natural resources in relatively distant mountain zones (obsidian, wild goats) beyond the Ararat valley or along its edge. These statements enable the proposition (see Bălăşescu and Radu in this volume) that year-long occupation by a fairly large part of the population did not exclude seasonal migrations practised by certain families or even by certain categories of sex and age in the community of Aknashen.

[6] On the basis of which the authors see (not evident for us) essential divergences in the traditions of construction between Aratashen and Aknashen on the one hand and Masis Blur on the other. (Hayrapetyan *et al.* 2014:182).

[7] At the same time as the significant reduction, in particular, of the quantity of tools in bone and above all that of punches/awls, the percentage of the latter in the bone industry passes from 62-70% in horizons V-III to 86% in horizon II.

Mortuary practices at Aknashen

Modwene Poulmarc'h, Levon Aghikyan and Françoise Le Mort

Introduction

In the Southern Caucasus, Neolithic burials are rare. If we except burials that could be attributed either to Neolithic or to Chalcolithic levels, only four sites including Aknashen yielded Neolithic tombs (Poulmarc'h and Le Mort 2016).

Since excavation began at Aknashen in 2004, many burials ranging from the 6th millennium to the contemporary period have been uncovered. According to 14C dates, five deposits (Tr.3 UF10 F18; Tr.1 UF8; Tr.6 UF11 F15; Baulk 6/8 UF7 F1; Tr.8 UF8) belong to the first half of the 6th millennium and one (Tr.7 UF5 F2) to the second half of the 3rd millennium (Figure 1). The skeletal remains dated from the 6th millennium can be related to the Neolithic occupation of the settlement and are currently the oldest human remains discovered in Armenia. One of the burials (Tr.7 UF5 F2), which was previously published as a very likely Neolithic one according to its stratigraphic position in Horizon IV (Badalyan *et al.* 2010), is actually dated from the second half of the 3rd millennium that is during the transition between the Early and Middle Bronze Age, as shown by two 14C dates (Figure 1).

In addition to these deposits, a number of isolated bones have been found in different layers (Figure 2).

Location	Year	Laboratory code	Date BP	Date cal. BC (95%)
TR.3 UF10 F18	2012	LTL-13037A	6970 +/- 35	5980-5750
TR.1 UF8	2009	LTL-5734A	6860 +/- 45	5850-5650
TR.6 UF11 F15	2014	Poz-70153	6730 +/-40	5718-5564
Baulk 6/8 UF7 F1	2012	Poz-56369*	6640 +/- 50	5636-5486
TR.8 UF8	2014	Poz-8221	6620 +/- 40	5622-5490
TR.7 UF5 F2	2008	Ly-6992 (SacA-19543)	3860 +/- 35	2464-2203
TR.7 UF5 F2	2008	UGAMS-6460	3830 +/-30	2351-2198

*This date was financed by the ANR-12-JSH3-0003-01 ORIMIL, directed by E. Herrscher (CNRS UMR 7269). The other dates were founded by the Mission Caucase.

Figure 1. 14C dates for the human remains

Method

Excavation

Among the six deposits, two (Tr.3 UF10 F18; Baulk 6/8 UF7 F1) were excavated according to the methods of archaeothanatology (Duday *et al.* 1990; Duday 2009) by one of us (MP), in order to collect a maximum of information that may assist in the understanding of

Location	Discovery	Identification	Age
TR.1 UF9	2011	Piece of occipital bone and fragment of long bone	Adult?
Baulk 3/7 UF6	2011	Distal epiphysis of a left femur	Immature
Baulk 3/7 UF6	2011	Left ischium	Immature
Baulk 3/7 UF6	2011	Diaphysis fragment of a radius	Immature
Baulk 1/2 UF6	2011	Right first metacarpal bone	Adult
TR.1 UF7 T1W5	2011	Fragments of thoracic vertebrae	Adult
TR.5 UF11a	2012	Right talus	Adult
TR.6 UF6	2012	Right humerus	Immature
Baulk 2/5 UF7	2012	Fragment of a molar	Adult
Baulk 4/5 UF8	2013	Proximal hand phalanx	Adult
TR.1 UF11	2013	Left first metatarsal bone	Adult
TR.7 UF9	2014	Left fourth metacarpal bone	Adult
TR.6 UF10	2014	Diaphysis fragment of a radius	Unknown
TR.5	2014	Proximal hand phalanx	Adult

Figure 2. List of isolated human bones.

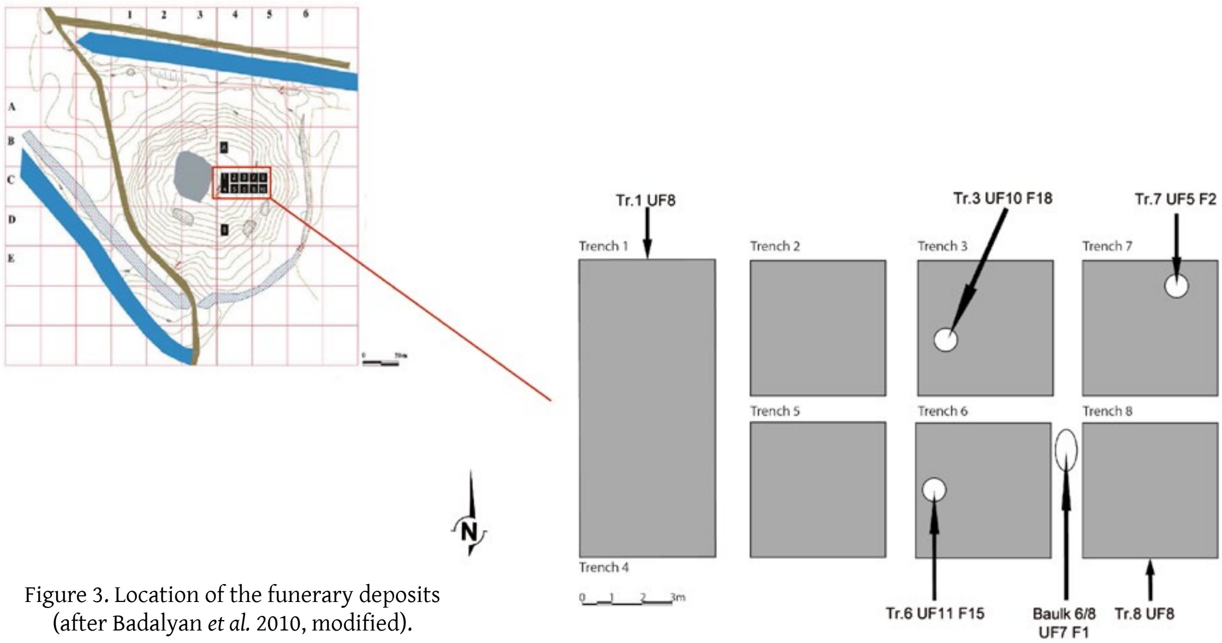

Figure 3. Location of the funerary deposits (after Badalyan *et al.* 2010, modified).

the funeral gestures. This innovative approach is based upon field anthropological observations. It includes an accurate record of the position of each bone as well as the recording of any element of the tomb.

The skeleton from deposit Tr.7 UF5 F2 was embedded in a compact clay matrix. Part of the bones were therefore taken out in blocks of soil at the time of the discovery,[1] waiting for further excavation in the laboratory. In 2009, the soil was carefully separated from the bones in the laboratory. While excavating the human remains, the exact position of each bone element or fragment of an element, its anatomical orientation as well as relation to other bone elements, were recorded according to the methods of archaeothanatology by one of us (FL). The data collected in the field were then combined with those recorded in the laboratory so as to describe the body position.

Deposit Tr.6 UF11 F15 was excavated by L. Aghikyan in 2014. In addition, while studying the fauna, A. Bălăşescu identified two groups of human bones (deposits Tr.1 UF8; Tr.8 UF8) that most likely come from accidentally disturbed burials.

Sex determination and estimation of age at death

Because of the poor state of preservation of the human remains and the incompleteness of most of the skeletons, biological identification of individuals could not be systematically performed. Thus, the state of preservation of the adults' hip bones did not allow sex determination. Regarding the immature individuals, there is currently no reliable and reproducible method to determine the sex of the immature individuals (Majó 1996; Tillier 2005).

The age at death of the adults was estimated according to the method developed by Schmitt (2005), based on the observation of the sacro-pelvic surface of the ilium. For the immature individuals, dental calcification (Moorrees *et al.* 1963) was preferentially used. When the teeth were missing, we used the method of Maresh (1970) that takes into account the diaphyseal length of long bones. The age at death of the perinatal individuals was estimated according to Adalian's method, also based on the length of long bones (Adalian 2001; Adalian *et al.* 2002).

Description of the funerary deposits

Each deposit contains a single body; two individuals are adults (Tr.3 UF10 F18; Baulk 6/8 UF7 F1) and four are immature (Tr.1 UF8; Tr.6 UF11 F15; Tr.8 UF8; Tr.7 UF5 F2). They were found in various areas (Figure 3), at different layers, but no clear link with habitat structures could be established.

Neolithic deposits

Tr.6 UF11 F15 (horizon V)

This burial was discovered in trench 6 (UF11 F15), close to the western wall of the trench, at a depth of 3.55m, under the lower level of horizon V, underlying the T5W5 wall and the adjacent platform built of clay blocks (Figures 3 and 4). The deceased is a perinatal individual the age of which is estimated at 39 weeks of gestation (± 3.5 weeks), according to the length of the left tibia (66mm).

[1] This burial was excavated on the field by Maureen Marshall in 2008.

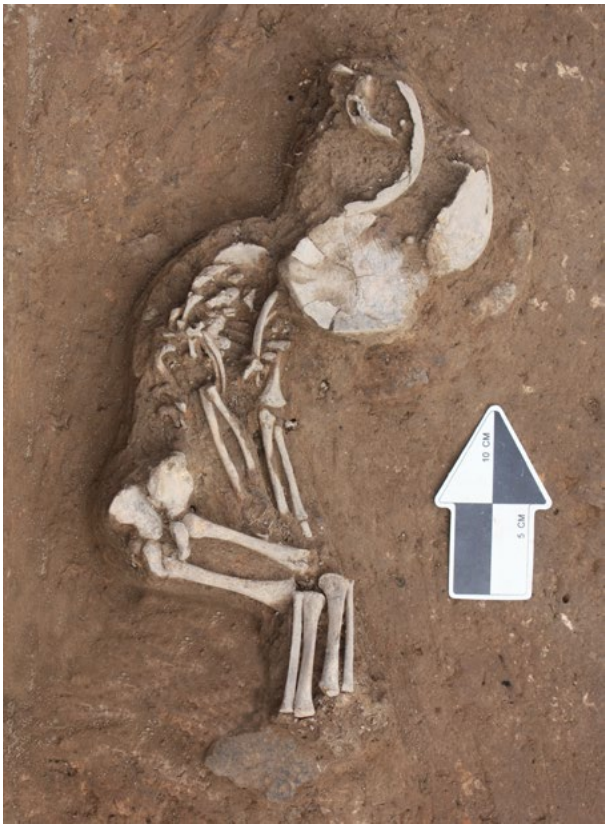

Figure 4. Funerary deposit Tr.6 UF11 F15: burial of a perinatal individual [photo R. Badalyan].

The skeleton was lying in a flexed position on the left side, the axis joining the pelvis to the top of the skull following a southwest – northeast orientation. The upper limbs were extended, the hands resting near the knees. The thighs were flexed at a right angle to the trunk and the legs were flexed at a right angle to the thighs.

A detailed analysis of the position of the bones, especially those that would have been in disequilibrium after decay of the soft tissues, indicates that body decomposition occurred in a filled space, which means that the pit was filled with earth immediately after burial. At the time of discovery, the limits of the burial pit could not be recognized; it might thus be assumed that the pit was refilled with the earth taken off while it was dug.

There was no archaeological material associated with the burial.

Tr.3 UF10 F18 (horizon V)
This deposit has been brought to light at a depth of 3.40m in Trench 3 (UF10 F18), in a compact and homogenous level of beaten earth 20cm thick, which contained lithic artefacts and faunal remains (Figure 3). It is made of an incomplete skull without mandible resting partly on its superior and left side and facing southeast (Figure 5) and possibly an incomplete left hip bone (age at death estimated between 20 and 39 years) found among the fauna of the same level. The size and

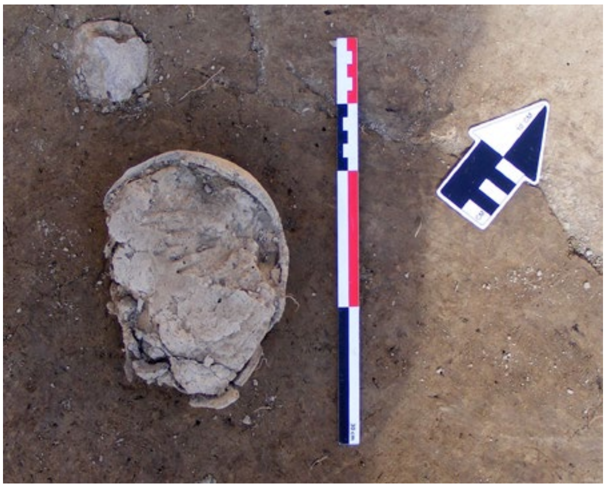

Figure 5. Funerary deposit Tr.3 UF10 F18: skull *in situ* [photo M. Poulmarc'h].

thickness of the remaining parts (frontal, parietal and occipital bones) indicate an adult subject. The deposit might correspond to a disturbed burial.

A depression 2cm wide and 3cm long can be observed on the left part of the occipital bone not far from the lambda (Figure 6a). It corresponds to a downwarping of the cranial vault, visible both on the exocranial (Figure 6b) and endocranial (Figure 6c) faces. The subject survived as indicated by the healing of the bone. Such a depression could have been caused either by a blunt object striking the back of the skull or by a fall. It has to be noticed that the shape of the depression is consistent with the heel of stone axes found at the site in the Neolithic levels (Figure 6d), which could be an argument for a case of interpersonal violence.[2]

Tr.8 UF8 (horizon V)
A group of child bones was identified among the fauna uncovered during the 2014 campaign[3] in trench 8 (UF8) (Figure 3). It includes a right ilium, a right ischium, a right pubis, a fragment of a left ilium, a right femur, the distal part of a left femur, a left tibia, an incomplete fibula and four lumbar vertebrae (Figure 7). All those human remains very likely belong to the same individual according to their stage of development; furthermore right and left bones are symmetrical. The age at death of the deceased is estimated between 1 year and 6 months and 2 years, according to the length of the right femur (165mm). The remains seem to come from a burial that was accidentally disturbed.

Tr.1 UF8 (horizon IV)
A group of human bones belonging to a perinatal individual was identified among the faunal remains

[2] The diagnosis was made by Olivier Dutour (EPHE - PSL Research University Paris and UMR 5199 - PACEA – Pessac, France) from photos.
[3] By A. Bălăşescu.

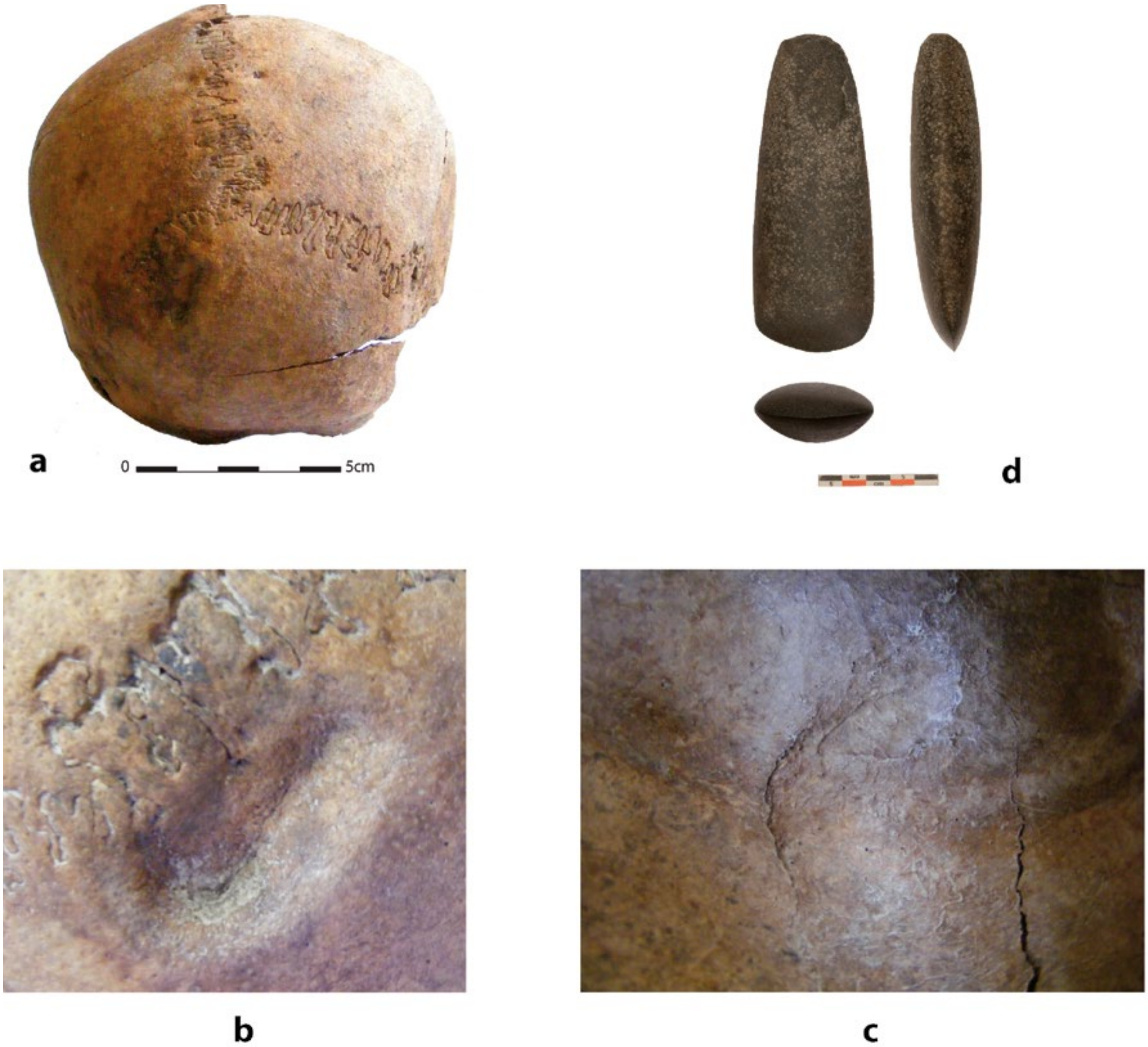

Figure 6. Funerary deposit Tr.3 UF10 F18: a) posterior view of the skull; exocranial (b) and endocranial (c) view of the depression; d) Neolithic stone axe from Aknashen [photos: a-c) M. Poulmarc'h; d) V. Hakobyan].

uncovered during the 2009 campaign[4] in trench 1 (UF8) (Figure 3). It includes a left humerus, the proximal part of a right ulna, a right and a left femur, a right and a left tibia, a fibula the side of which could not be determined, two left ribs, three posterior fragments of right ribs and undermined fragments of rib (Figure 8). The right and left bones are perfectly symmetrical, indicating that they very likely belong to a single individual the age at death of which could be estimated at 38 weeks of gestation (± 3.34 weeks), according to the length of the left femur (71.9mm). It seems that these skeletal remains come from a burial that was accidentally disturbed.

Baulk 6/8 UF7 F1 (horizon IV)

This deposit was uncovered during the excavation of the baulk situated between trenches 6 and 8 (Figure 3), at a depth of 2.45m. It consists of the left lower limb, tightly flexed and resting on its lateral side, the right foot, two proximal and two middle hand phalanges from an adult individual. Other bones from the lower limbs discovered in the baulk can be attributed to the same individual, based on symmetry criteria (Figure 9). The spatial organization of the skeletal remains found *in situ*, which respects the anatomical logic (Figure 9a), shows that it is a burial that has been disturbed. The preservation of unstable anatomical connections (distal part of the foot) indicates a primary deposit. Unfortunately no direct relation with adjacent structures could be established.

Early - Middle Bronze Age deposit

A child burial was found in the northeastern part of Trench 7 (UF5 F2), north of a curvilinear wall (Figures 2 and 10). Its age at death is estimated between 5 years and 3 months and 7 years, based on the degree of dental maturity.

[4] By A. Bălăşescu.

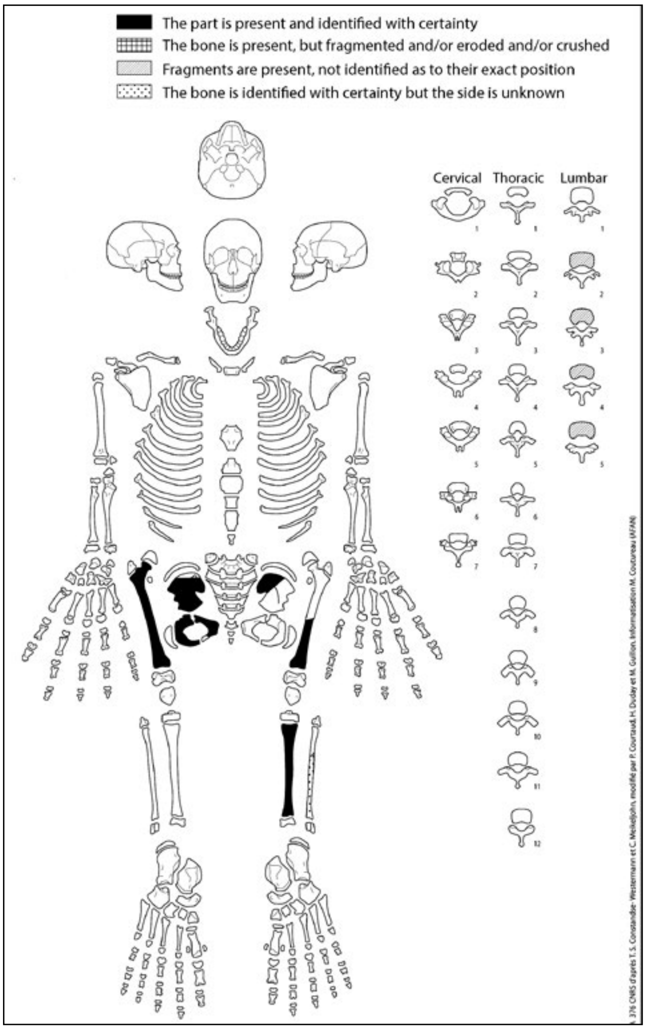

Figure 7. Funerary deposit Tr.8 UF8: preservation file of the child burial.

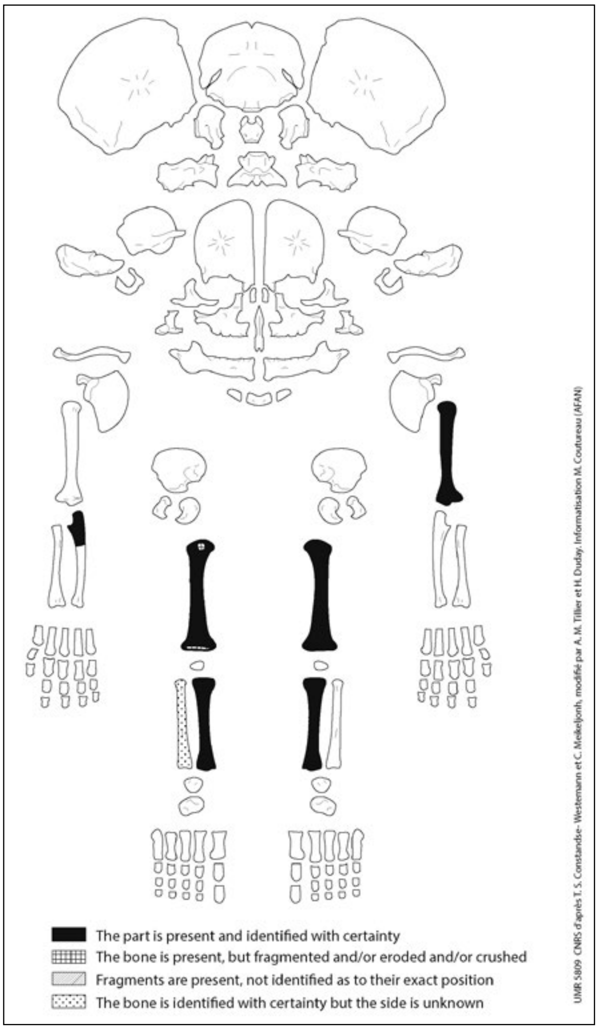

Figure 8. Funerary deposit Tr.1 UF8: preservation file of the perinatal individual.

The body was lying on its left side, in a flexed position, presenting three-quarters of the back. The skull was crushed. The position of the upper limbs could not be identified, except for the right arm, which was in a position of slight abduction. The thighs were flexed at a right angle to the trunk and the legs were flexed at the thighs. The axis joining the pelvis to the top of the skull followed an east-northeast – west-southwest orientation, the head facing the north-northwest.

At the time of the discovery, the limits of the burial pit could not be recognized; it might thus be assumed that the pit was refilled with earth taken off while it was dug.

Under the left temporal bone, a broken copper or bronze ring was discovered. In addition, two pieces of obsidian were found in the pelvic area, but it is not clear if they were associated with the body or just included in the filling of the burial pit, since the matrix contained inclusions among which were other pieces of obsidian, a few sherds and fragments of animal bones (Badalyan *et al.* 2010).

In addition to these six funerary deposits, several isolated human bones were discovered in the different trenches of the site, at different levels (Figure 2). They could come from disturbed graves.

Discussion and conclusions

In the Southern Caucasus, other Neolithic burials are known in Azerbaijan at Kamiltepe and Mentesh Tepe and in Georgia at Arukhlo (Figures 11 and 12) (Poulmarc'h 2014; Poulmarc'h and Le Mort 2016). The data from Aknashen are consequently of interest for the knowledge of the funerary practices of the Neolithic populations of the region. Five Neolithic funerary deposits, all corresponding very likely to primary single burials, have been recognized. They include two adults and three immature individuals among which two died during the perinatal period. Even if the limits of the pits could not be recognized, according to the disposition of the human remains, at least some of them were pit graves.

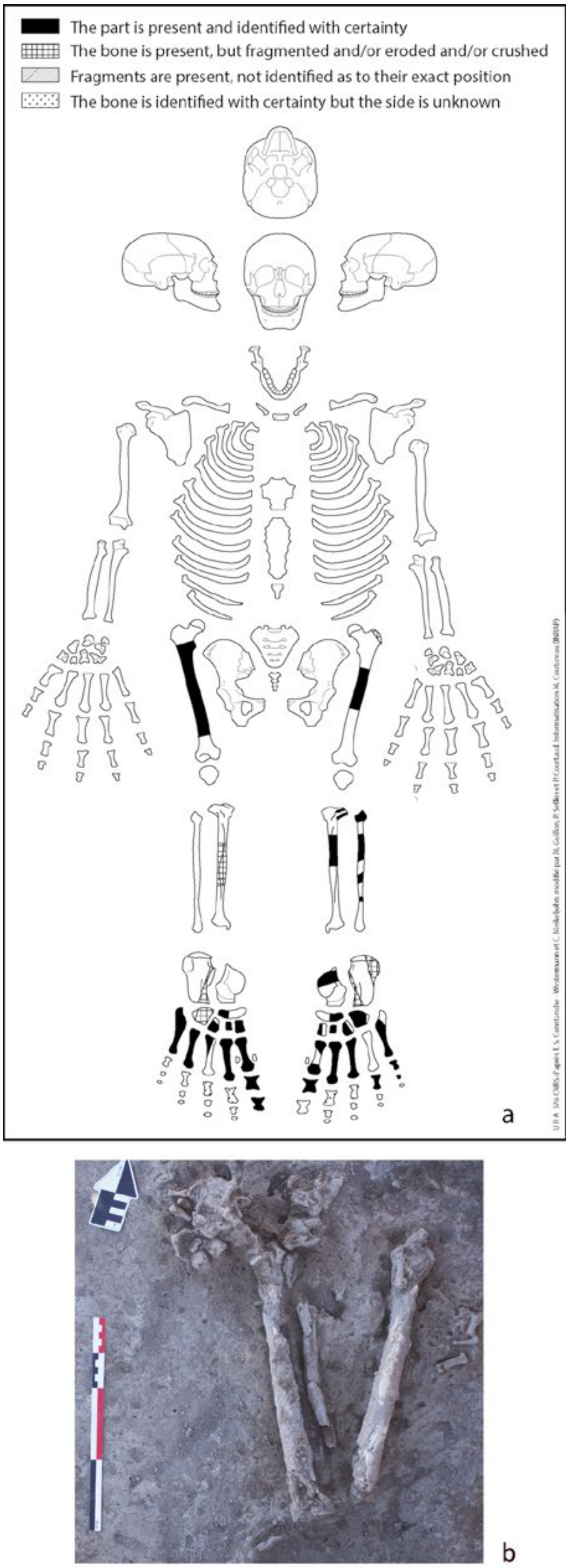

Figure 9. Funerary deposit Baulk 6/8 UF7 F1: incomplete burial of an adult; a) preservation form; b) skeletal remains *in situ* [photo M. Poulmarc’h].

Figure 10. Funerary deposit Tr.7 UF5 F2: child burial [photo R. Badalyan].

At Kamiltepe and Mentesh Tepe, all the burials are pit graves. They contain a single individual, adult or immature, except for the collective grave recently uncovered at Mentesh Tepe which hold at least 30 individuals including 11 adults and 19 immature individuals more than one year old (Lyonnet *et al.* 2012, 2016; Poulmarc’h 2014; Pecqueur *et al.* 2017; Poulmarc’h *et al.* 2017) (Figure 12). Unlike the other sites, Arukhlo yielded a cremation which was discovered in a house (Hansen *et al.* 2007b). According to Wahl (pers. comm.), the deceased was an adult male and the total mass of the bones as well as the lack of teeth could indicate a secondary deposit of burned bones.

The funerary deposits uncovered at Aknashen can be compared to the single burials from Kamiltepe and Mentesh Tepe but they yielded perinatal individuals the funerary treatment of which was previously unknown. It has to be noticed that at Aknashen, like at Mentesh Tepe, there are more immature individuals than adults.

At Aknashen, like at Kamiltepe, Mentesh Tepe and Arukhlo, the place of living and the place of the dead seem to have been closely linked.

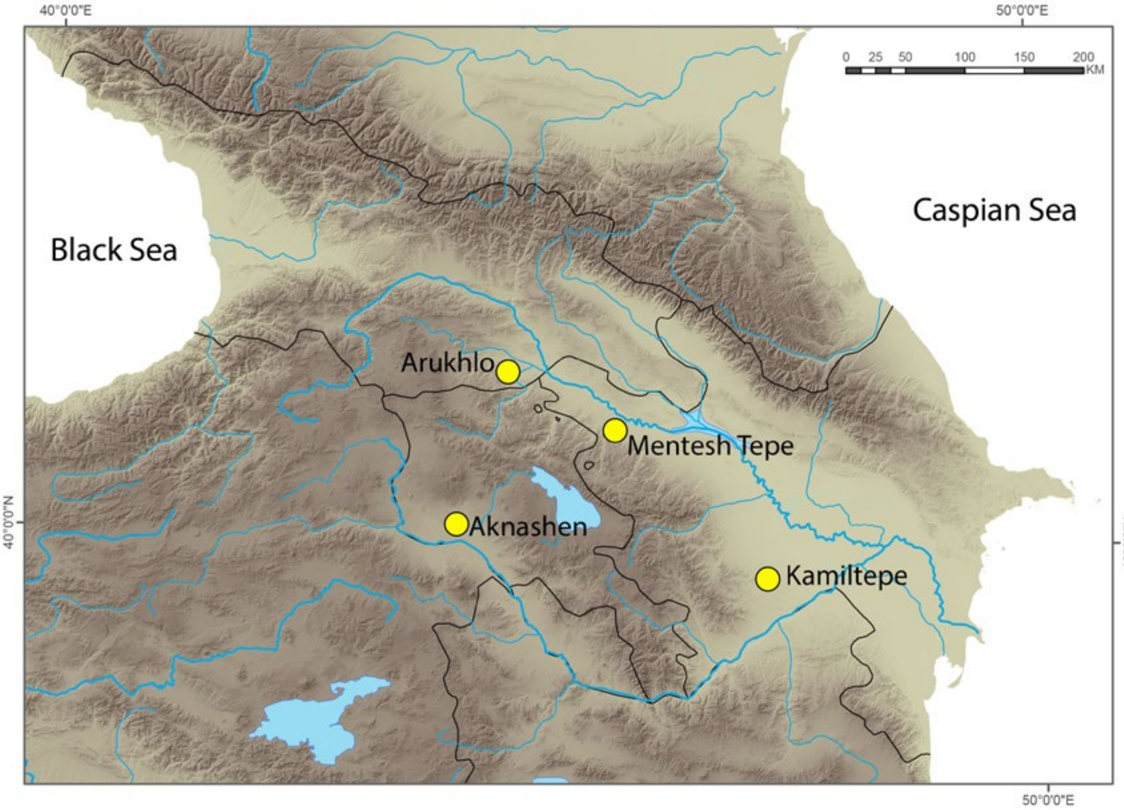

Figure 11. Distribution map of the Southern Caucasus sites where the presence of Neolithic burials was recorded.

Site	Date BP	Date cal. BC	Type of burial	Age	Sex	References
Arukhlo (Georgia)			Cremation	Adult	Male	Hansen *et al.*, 2007; J. Wahl pers. comm.
Kamiltepe (Azerbaijan)						
- MPS 4			Single inhumation	Adult	Unknown	
- MPS 23	6290 +/- 40	5367-5207	Single inhumation	Adult	Unknown	Poulmarc'h 2014; Poulmarc'h *et al.*, 2017
- MPS 103			Single inhumation	Adult	Unknown	
Mentesh Tepe (Azerbaijan)						
- ST 342			Collective burial	11 adults and 19 immature individuals	4 males and 8 females	
- ST 343	6950+/-40	5911-5736	Single inhumation	5yrs 3mths – 6yrs 6mths		Lyonnet *et al.* 2012, Lyonnet *et al.* 2016; Poulmarc'h 2014; Pecqueur *et al.* 2017; Poulmarc'h *et al.* 2017
- ST 388				Disturbed single inhumation or secondary deposit?	4yrs 9mths – 7yrs	
- ST 578	6820+/-40	5771-5636	Single inhumation	Immature		

Figure 12. Neolithic burials in Georgia and Azerbaijan.

Acknowledgements

The authors are deeply grateful to C. Chataigner and R. Badalyan for giving them the opportunity of studying the funerary deposits uncovered at Aknashen. Their work was founded by the 'Mission Caucase' (French Ministry of Foreign Affairs, dir. C. Chataigner) and the International Associated Laboratory France-Armenia 'HEMMA' (CNRS – State committee of Science of Armenia). Special thanks are due to the colleagues with whom they had the pleasure of working on excavation, especially to A. Harutyunyan, as well as to O. Dutour for his substantial contribution to the paleopathological diagnosis.

Tectonic impact on the Ararat Depression during the Late Neolithic: the example of the Aknashen settlement

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Introduction

From 2013 to 2016, geo-archaeological studies were conducted at the Late Neolithic settlement of Aknashen (N 40°06'04.78" E44°17'38.73"). Aratashen, another Late Neolithic settlement located 6km W-NW of Aknashen, was studied in 1999-2005. The third Late Neolithic settlement of Masis Blur, situated 11km east of Aknashen, was investigated in 2014-2015.The settlements of Aknashen, Masis Blur, and Aratashen are located 838m, 862m and 852m above sea level, respectively, and are all situated within the northern part of the Ararat valley (Figure 1).

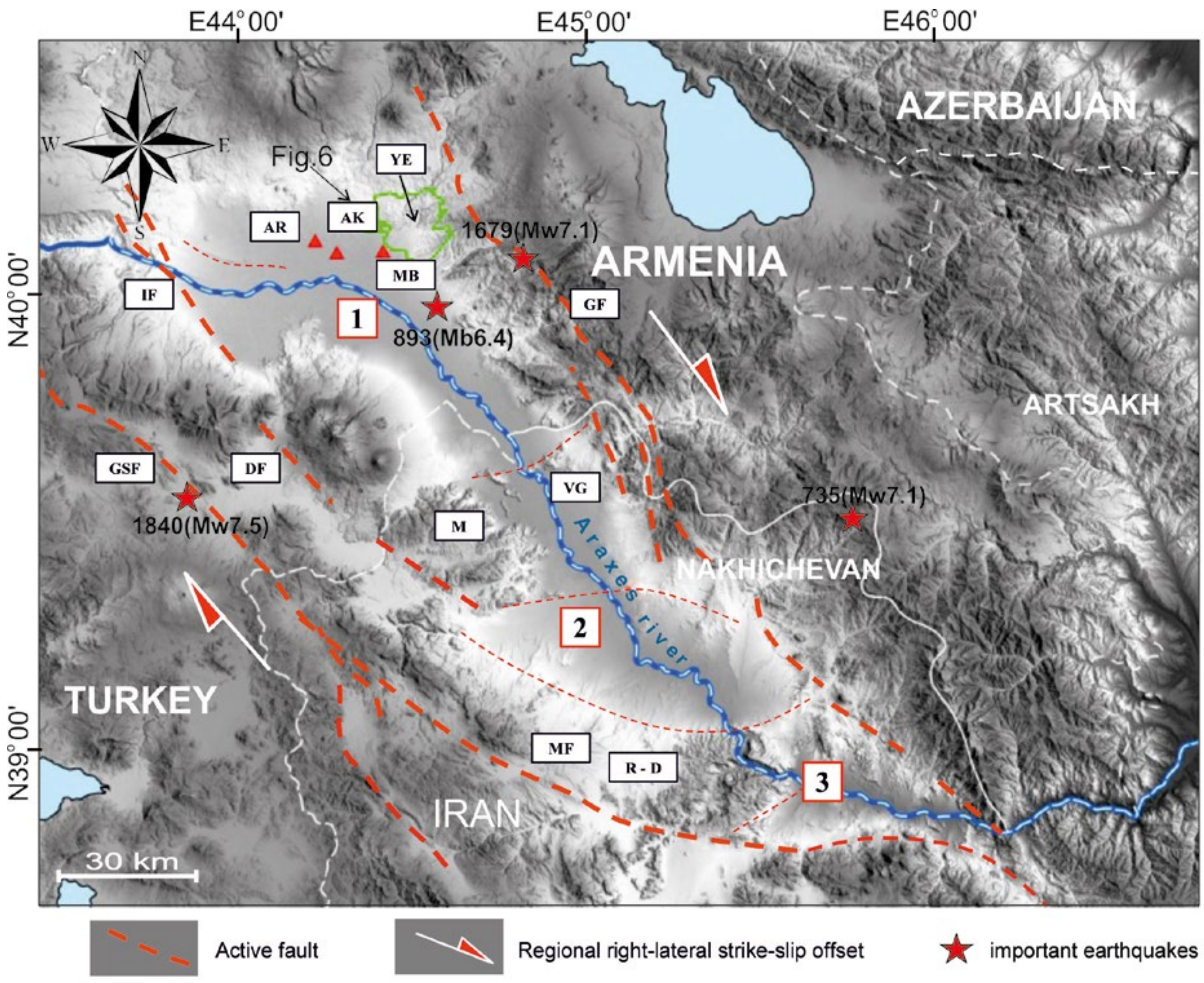

Figure 1. Active faults in the Ararat Depression. DEM 45 (SRTM 3), important earthquakes according to NorAtom seismic catalogue (2011).
Settlements: AK – Aknashen; MB – Masis Blur; AR – Aratashen; YE – Yerevan city.
Active faults with a right-lateral strike-slip component: GF – Garni Fault; IF – Igdir Fault; DF – Dogubayazet Fault; GSF – Gailatu-Sieh-Cheshmeh Fault; MF – Maku Fault.
Sub-depressions: 1- Yerevan; 2 - Nakhichevan; 3 – Julfa.
Uplifts separating the sub-depressions: VG – Wolf Gate; M - Maku; R-D –Reshteh-Ye-Dagn massif.

According to some interpretations, the Ararat valley is controlled by regional-scale compressional and transpressional tectonics. The NW-SE oriented reverse faults and thrusts are dipping north (Karakhanyan *et al.* 2016; Avagyan *et al.* 2018) which indicates tectonic activity in the post Oligocene-Miocene period. Thrust and oblique-reverse movements continued after deposition of the Oligocene–Miocene molasse, Quaternary travertine and even the Würm-age lake sediments (Avagyan *et al.* 2018).

The main purpose of the studies was to elucidate the environmental conditions present during the Late Neolithic period, their possible impacts on the life of the inhabitants, and any effects that strong earthquakes and floods may have had on the pattern of settlement.

Area description

The Ararat valley is about 220km long and from 25 to 30km wide. The valley area is shared among four states – Armenia, Azerbaijan, Iran and Turkey, and this has been complicating realization of studies in border areas. The Ararat valley represents a tectonic or volcano-tectonic depression flanked by large active faults on both sides. These faults are the Garni Fault, the Dogubayazet Fault, the Gailatu-Sieh-Cheshmeh Fault and the Maku Fault (Figure 1). The northern and southern parts of the depression are bordered by the large Quaternary volcanoes of Aragats and Ararat.

Not much is known about the structural position of the Ararat depression. Dewey *et al.* (1986) point out that it is a complex *pull-apart* graben on a wide zone of right-lateral transcurrent motion. In contrast, Yilmaz *et al.* (1998) consider that the Ararat depression is a left-lateral *pull-apart*-type basin, developed along a zone of extension between two '*en échelon*' segments of the left-lateral strike-slip fault system.

Like Dewey *et al.* (1986), we consider the Ararat depression to be a large structure of *pull-apart basin* type, bordered by large active faults with the mechanism of right-lateral strike-slip and reverse faulting (Karakhanian *et al.* 2004). The inside of the Ararat depression can be subdivided into several sub-depressions, the largest of which would be the Yerevan depression (1 in Figure 1) and the Nakhichevan depression stretching in an east-west direction (2 in Figure 1). The smaller and shallower Julfa depression, situated south of the Nakhichevan depression, closes the Ararat valley in the southeast (3 in Figure 1). The indicated sub-depressions are separated from each other by west-east-oriented faults. Vertical motions along these faults lifted blocks of the Paleozoic basement up to the surface in the Wolf Gate area, north of Maku city, and near the Reshteh-Ye-Dagn massif (these localities are referred to as VG, M, and R-D respectively, in Figure 1).

The Araxes, which is a large river, flows along the central axis of the Ararat depression. Changes in the orientation and geometry of its channel provide evidence of tectonic and seismic activity in the Quaternary, including the Holocene (Karakhanian *et al.* 2004; Karakhanyan *et al.* 2016). The major active faults capable of generating strong seismic impacts in the Ararat valley are the right lateral strike-slip Garni Fault, Yerevan Fault and the Sardarapat Faults, and the Vedi and Urtsadzor thrust faults (e.g. Karakhanyan *et al.* 2013).

Archaeo-landscape reconstruction

Four deep trial trenches were dug at the Aknashen settlement (Figure 2B). The first trench was opened in the northern corner of the western wall of the excavation area (Tr.1a); two more trenches were excavated 100m and 230m farther south of the excavation area (Tr.C and Tr.D), and the last trench was excavated 200m NW of the excavation area (Tr.E). Dense blue clays were exposed at the base of sections in all four soundings; the clays represent water basin sediments and the elevation of their roof varies in the range of 832.27 to 832.93m.

In 'Geology of Armenia', the renowned Armenian scientist Paffenholtz (1948: 332) suggested that a large running-water lake existed near the Wolf Gate (local ethnographic name, VG in Figure 1) in the Ararat valley during the Würm glaciation; the lake was formed by the damming of the Araxes river by the lava flow from the Lesser Ararat volcano. Paffenholtz (1948) estimated the depth of the lake at 90-100m, and the drilling data suggest that the lake shoreline had an elevation of about 833m. The dark-blue clays were deposited on the lake bottom. According to the data of Paffenholtz (1948), many minor stagnant or running-water lakes existed on the shores and in the channel of the Araxes river. Judging by the terrestrial and freshwater faunal remains found in the blue clay, deciduous forests covered areas between the lakes and on the marginal areas of the Ararat valley (Paffenholtz 1948).

The blue clay discovered in the trenches within and beyond the area of the Aknashen settlement excavations was bedded at the same elevation of about 833m as described in Paffenholtz (1948), therefore it may be related to the sediments of the lake that existed in the Ararat valley (Figure 3).

GIS technologies may help to reconstruct the contour of the shore line of this lake. The 833m elevation contour indicated in Figure 3 is based on the DEM data with the rates of vertical resolution of 45m and 5m and encircles the Ararat valley almost entirely, so the lake could have been 144km long and between 12 and 18km wide. According to Figure 3A, the lava flow from the Lesser Ararat terminated at the point where the lake was 10km

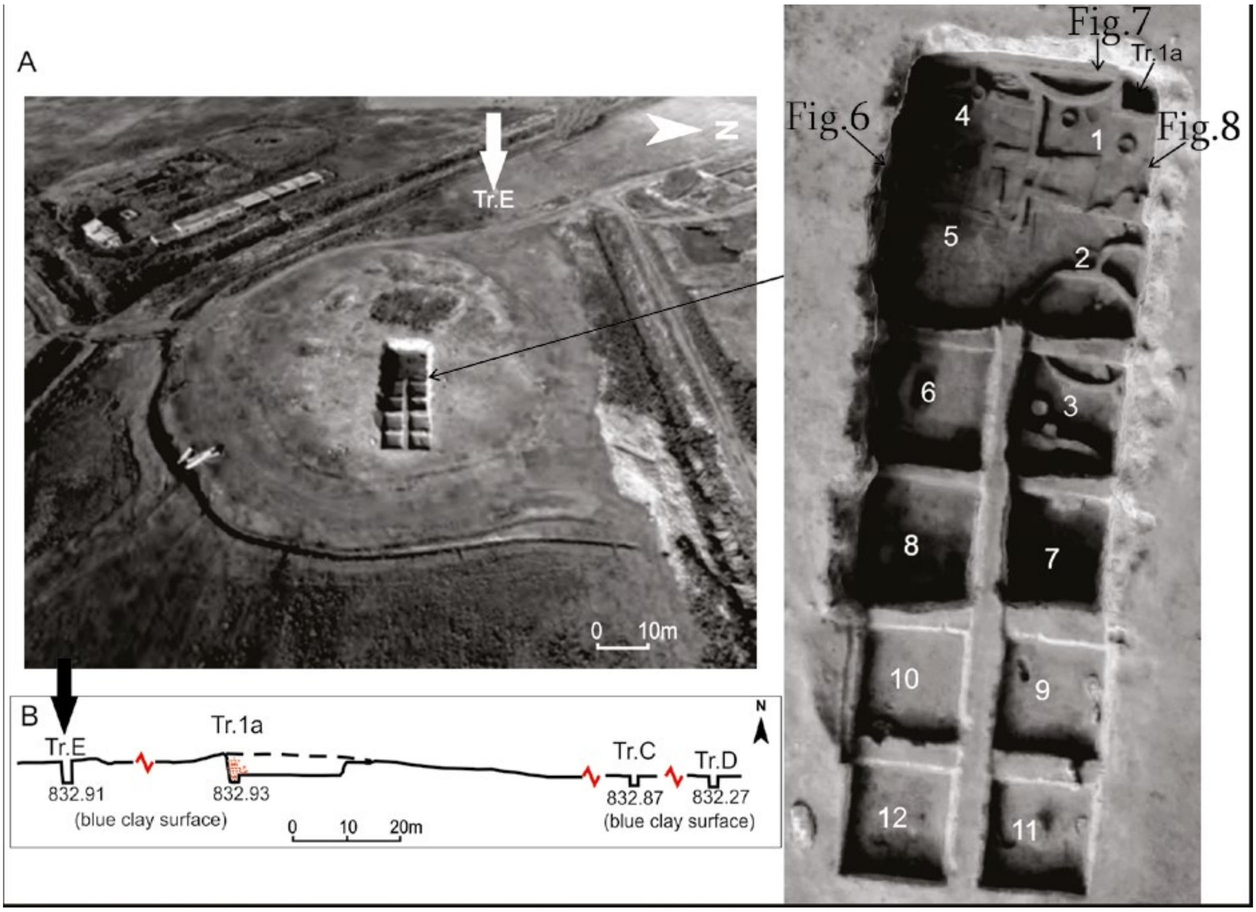

Figure 2. A. Excavations in the Aknashen settlement, the arrows indicating the locations of the trenches. The samplings and the corresponding figures are indicated; B. The four soundings at the archaeological site of Aknashen.

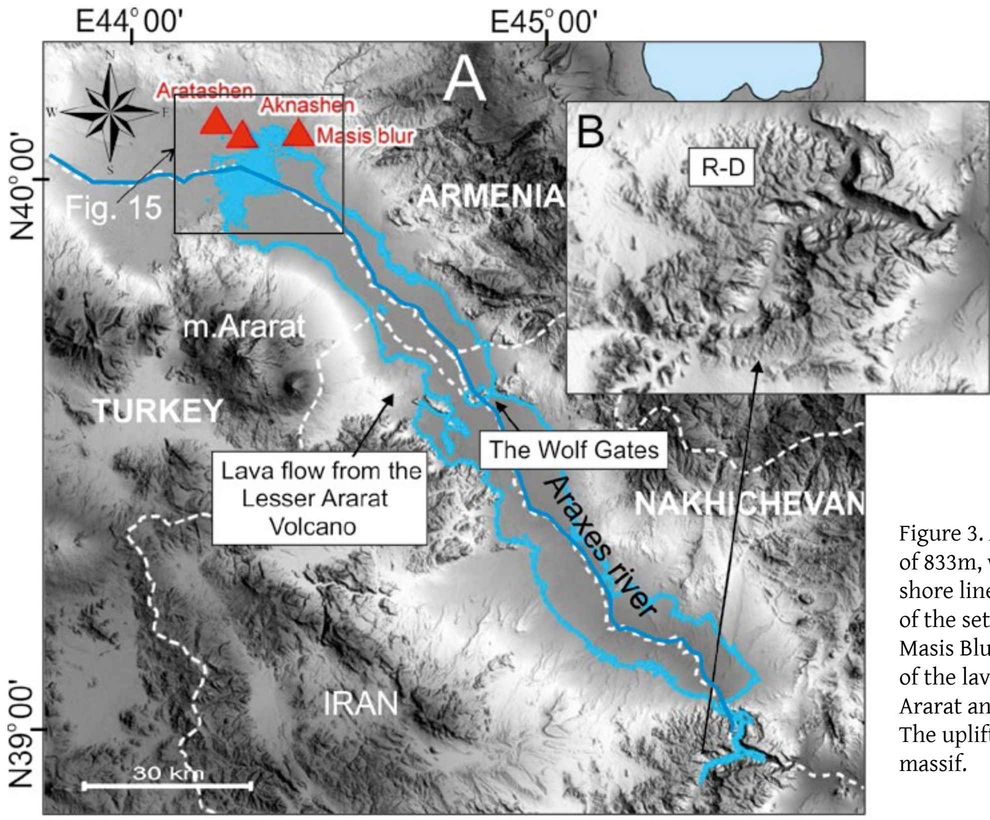

Figure 3. A. Relief elevation isoline of 833m, which follows the inferred shore line of the lake, the positions of the settlements of Aknashen, Masis Blur and Aratashen, position of the lava flow from the Lesser Ararat and the Wolf Gate uplift; B. The uplift of the Reshteh-Ye-Dagn massif.

wide, and in the narrowest part of the Wolf Gate it would have been 3.5km wide; thus the lake could not have been formed by a lava dam in the Wolf Gate area.

The lake modeled by the 833m elevation contour extended up to the junction of the borders of Iran and Nakhichevan, near the present-day large water reservoir of Aras - Govsaghunun. This present-day water reservoir may have inherited a part of the ancient lake floor. A large block of the Paleozoic basement, called Reshteh-Ye-Dagn, protruding above this part of the Ararat valley (R-D in Figures 1 and 3B), served as a natural barrier separating both the present water reservoir and the ancient lake. The Reshteh-Ye-Dagn massif is cut by deep V–shaped canyons, bearing evidence of intense tectonic uplift of the massif in the Quaternary and probably later, in the Würm. It is highly likely that the vertical rise of this massif was responsible for the creation of the dam that formed the lake in the Ararat valley (Figure 3).

Geo-archaeological and archaeometric studies at the Aknashen settlement

Materials and methods

On the top of the Aknashen mound, twelve squares were excavated (Trenches 1 to 12), 4.5m x 4.5m each, lying in two parallel series with the total length of 26.5m (along the west-east axis) and the total width of 10m (along the north-south axis) (Figure 2A). The recorded thickness of the cultural layer exceeded 5m, extending more than 2m below the present level of the surrounding plain.

For the lithostratigraphic and mineralogical study, continuous sampling was carried out from the lower parts of the southern (Trench 4) (Figure 4), western and northern (Trench 1) walls of these excavations (Figure 5) and from the sounding in Trench 1 (Trench 1a).

Blocks 37cm and 49cm in size were sampled by cutting directly from the face of the walls. Samples were taken for soil micromorphology and SEM analyses. Micromorphological analyses are used for landscape studies, and help to understand site formation processes, and how soils and sediments were affected or produced by humans within settlements.

An immersion method was used to study the content of the samples. Slides were prepared by scraping an approximately 0.5-1g sub-sample from each layer and mounting it on a glass slide; then the sample was covered by a slip of glass and a liquid of N 1.492 or 1.460 refractive index was added between the two glasses. This Refractive Index was chosen for the light fraction,

Figure 4. Excavations in the Aknashen settlement. The southern wall with the sampling location indicated; (a) dryland; (b) wetland; (c) water condition (see Figures 6 and 9).

Figure 5. Excavations in the Aknashen settlement. The western and northern walls with the sampling locations indicated; (a) dryland; (b) wetland; (c) water condition (see Figures 7-9).

because it approaches the indices of many light minerals and phytoliths. The percentage of minerals and phytoliths may appear overestimated, because of the small amount of the studied samples (0.5-1g). The size of minerals in most fractions corresponded to 0.02-0.1mm, rarely ranging up to 0.25-0.5mm. Objective lenses with magnifications of x20 and x60 and an *eyepiece* lens x8 were used. The geochemical composition was determined from bulk samples measured by ICP-MS, ALS CHEMEX.

The chronology is based on 14C ages (for more information see Badalyan and Harutyunyan in this volume; Chataigner *et al.* – Bayesian analysis – in this volume).

Lithostratigraphy

Based on our investigation of more than 4.5m log of sediments, we identified sedimentation of dryland, wetland, submerged and lake environments that contain seven archaeological horizons (AH).

The uppermost stratum of about 2.5m-thick deposits was composed of unconsolidated eolian sediments and relocated clay, silt material containing pebbles, pottery, obsidian artefacts, and animal bones with morphological changes, some of which were probably caused by heating. This uppermost stratum corresponds to AH V-I, which indicates dryland conditions. The lower part of AH IV/V, composed of relocated clay material, layers of limonitization horizons and hematite lenses, indicates the stage of pedogenesis, during which iron is released from primary minerals to form free iron oxides that coat quartz particles in soils with a thin reddish film. Dehydroxylation of the iron oxides bound to the clays might have resulted from a more or less sudden drying out of the environment (Duchaufour 1982; Figures 6-9).

A contrasting 0.5m–thick layer consisting of regularly alternating dark and somewhat lighter strata was observed below these layers, which is correlated with the AH VI (see Figures 6-9).We observed effects of hematitization, limonitization, rare calcium-carbonate crusts and numerous features of bioturbation such as wormholes and root-holes. According to our archaeologist colleagues, there were no remains of buildings, but a small amount of artefacts and animal bones were discovered in AH VI.

The layered sediments of white and brown silt-clay alternation the 'varve', formed in wetland conditions, were recorded in the southern, northern and western walls (Figures 6-9). Formation of varve sediments

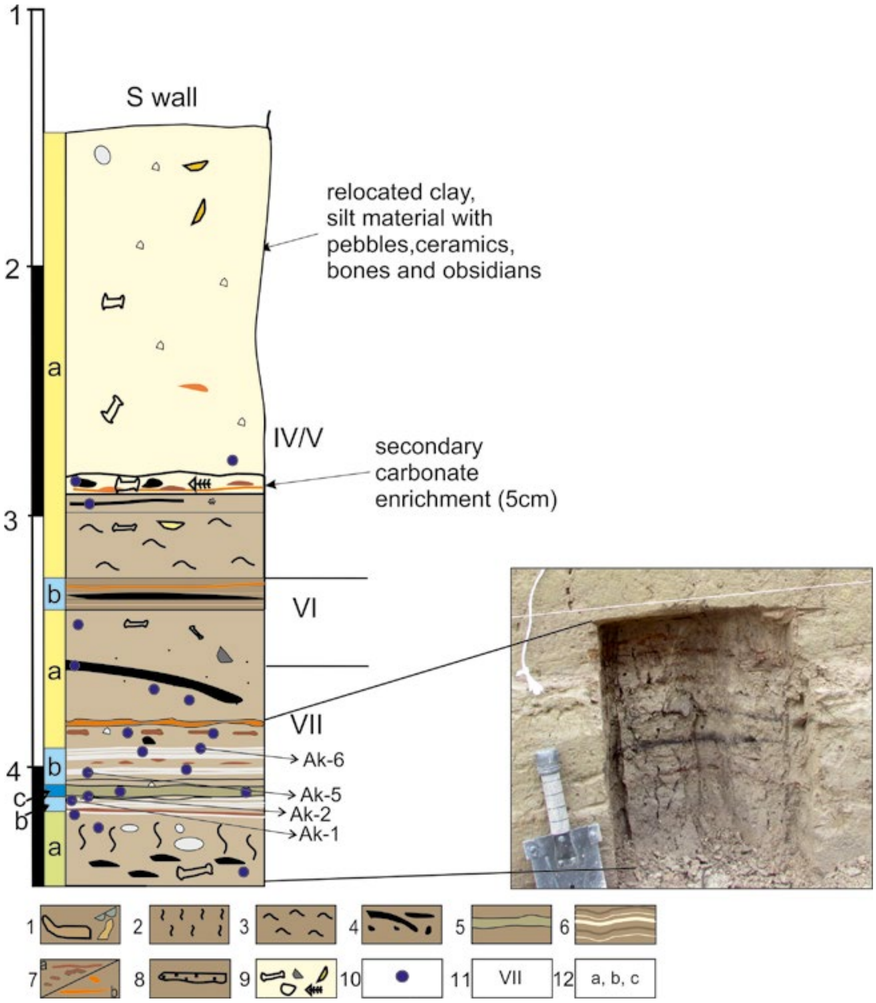

Figure 6. The southern wall of the Aknashen archaeological site. See figure 9 for the legend.

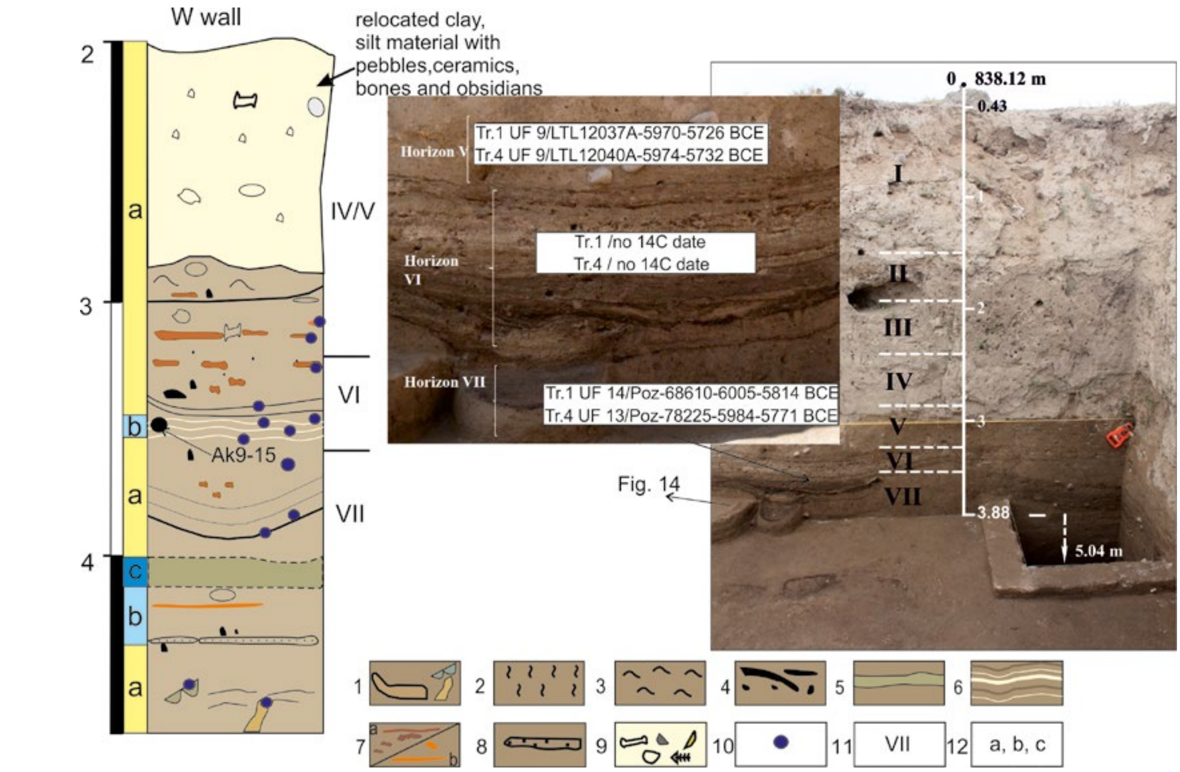

Figure 7. The western wall of the Aknashen archaeological site with the results of radiocarbon dating (14C) of the western wall V, VI and VII Horizons. See figure 9 for the legend.

depends on overall climatic conditions. The main controlling factor is the seasonal variability of temperature and precipitation.

Phytolith-rich sediments from the 'varve' section fill the white deposit (Figures 6-9). Particles of the white layers are more coarsely grained in comparison to the dark layers situated above and below. The regular alternation of the coarse-grained pale layers and the fine-grained dark layers suggests that these strata corresponded most probably to the summer and winter seasons, respectively. The ecosystem probably corresponded to that of a wetland, where after soil inundation anaerobic processes were prevailing, which in turn forced the biota, particularly the rooted plants, to adapt to the flooding. According to the phytolith study, grasses are the predominant taxon in the white layers of the 'varve' unit (AH VI); herbaceous plants, usually emergent through water and rooted in hydric soils, prevail in a wetland ecosystem (Keddy 2010).

In AH VII the pale-green layer (c in Figures 6-9) is composed of mostly weathered clayey minerals. Phytoliths were almost absent from this layer, and we suppose that comparatively deep water regime was present in that period with no plant growth. The thickness of the pale-green unit corresponds to 4cm and about 2.5cm in the southern and northern walls, respectively (Figures 6 and 8). The existence of this unit in the western wall can be just inferred because there is lack of continuous sampling (Figure 7).

The lithostratigraphic study shows that sand lenses in AH VII, composed of mostly weathered amphibole and quartz minerals, may indicate an event of transgression of some large water body (Figures 7 and 8).

To reconstruct landscape evolution and propose a model, we compared archaeological horizons of the northern, western and southern walls and demonstrated general palaeoenvironmental changes in Figure 9. The layer of green-blue clay of palaeo-lake origin is identified at an elevation of 833m (Figure 9), and is covered by deposits indicative of dryland conditions. A transgression event of a large body of water is indicated by the sandy lenses in AH VII.

Mineralogy and phytoliths

The mineralogical analysis of the collected samples shows that the major components of the Aknashen archaeological site are weathered minerals, opal, a minor quantity of quartz, plagioclase, amphibole, augite, diopside, biotite, hematite and limonite; a few volcanic glass particles are also present. Light microscope observations established that the opal is composed mainly of opaline phytoliths (Figure 10) and the assemblages show a significant share of phytoliths in all of the analyzed samples.

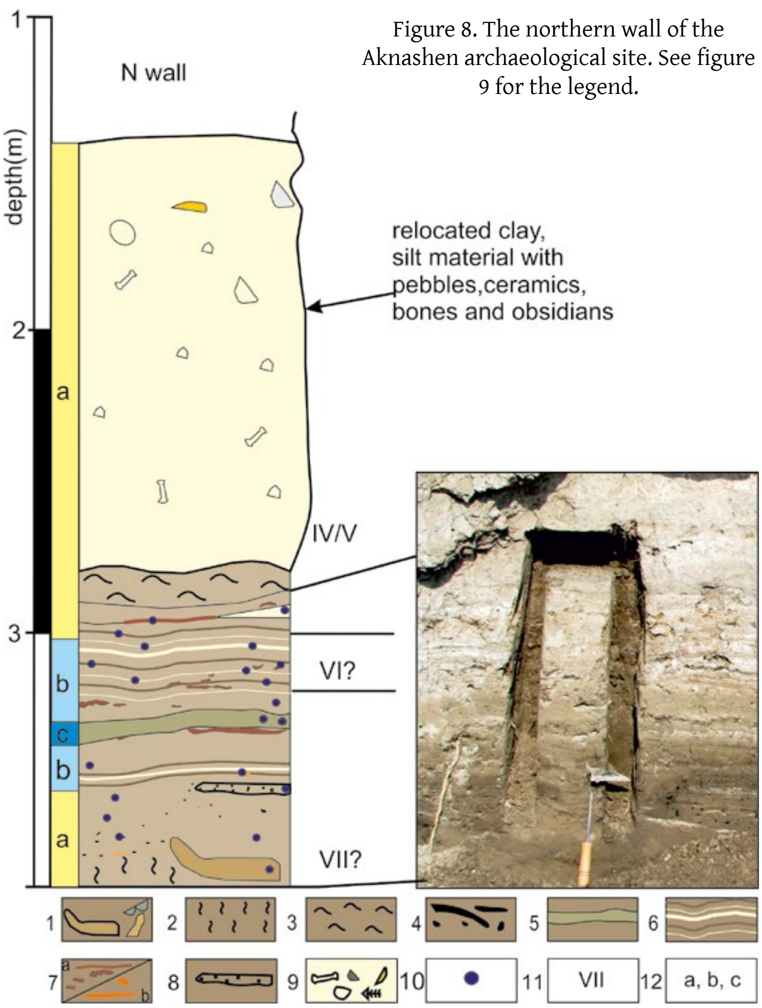

Figure 8. The northern wall of the Aknashen archaeological site. See figure 9 for the legend.

The first results of this study demonstrate a certain variability in the phytolith production. The irregularly shaped particles of phytoliths with protuberances are large and solidly silicified, which is diagnostic for woody tissue. Their colour varies from colourless or transparent through brown to yellow; the size is microscopic, and the refractive index (N) is less than 1,460. The morphology of each phytolith was examined based on the International Code for Phytolith Nomenclature 2005 (Madella *et al.* 2005) and the earlier publications (Twiss *et al.* 1969; Piperno 1988; Mulholland 1989; Twiss 1992; Alexandre *et al.* 1997; Albert *et al.* 1999; Delhon *et al.* 2003; Messager *et al.* 2011).

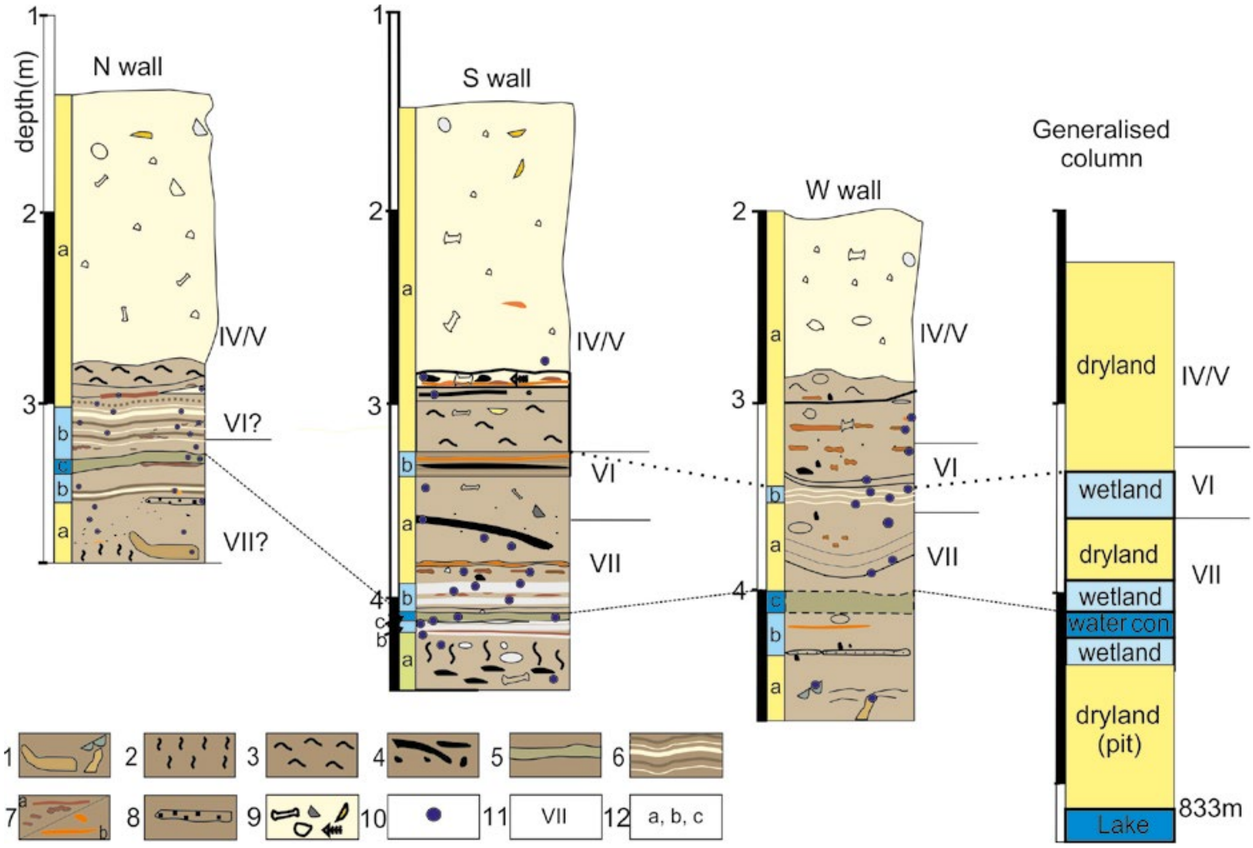

Figure 9. The northern, southern, and western walls of the Aknashen archaeological site.
1. Archaeological structures; 2. Bioturbation features of the burned material (charcoal); 3. Relocated clay material with dark, rounded clay materials; 4. Charcoal particles; 5. Pale-green horizon; 6. Wetland condition 'varves'; 7. a) Hematites; b) Limonites; 8. Lens of sand; 9. Animal bones, obsidian and ceramic artefacts, pebbles and fish bones; 10. Sampling points; 11. I-VII are the archaeological horizons; 12. a) dryland, b) wetland; c) water condition.

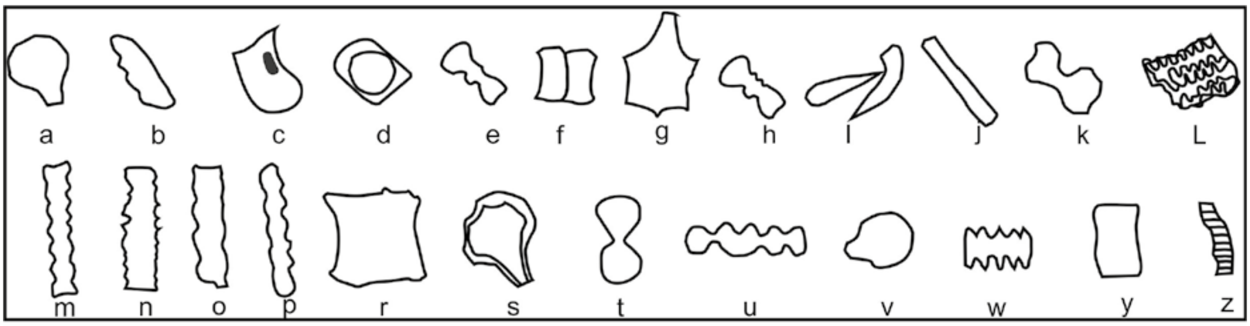

Figure 10. Outline sketches of the main phytolith morphotypes: a. cuneiform bulliform cells; b. cylindrical polylobate; c. bubble of cytoplasm; d. rondel phytoliths type; e. trapeziform polylobate phytoliths; f. bulliform cells in lateral view; g. Flabelolita; h. cylindrical polylobate grass cells; i. acicular hair cell; j. elongate-shape phytolith; k. Bilobate short cells; l. phytolith from a wheat husk (Christine 1998; Shillito, 2011); m-p. different elongated phytoliths; r. parallepipedal phytolith formed in bulliform cells; s. fan-shaped phytolith formed in bulliform cells; t. bilobate short cell (phytoliths characteristic of grasses); u. cylindrical polylobate; v. cuneiform bulliform cell; w. cylindrical sulcate tracheid; y. parallepipedal bulliform cell; z. vascular tissue.

In the lower part of the *northern wall* (Figure 8) mostly elongate-shape (diagnostic for wood) (Figure10j) and rare grass phytoliths are described (cylindrical polylobate, e.g. Figure 10e,h,u; bilobate, e.g. Figure 10k,t). An articulated wheat husk phytolith (Figure 10L) was found in the northern wall and in the western wall in Horizon VII. The wheat husk phytolith needs further investigation, but it is similar in appearance to those shown in Christine (1998) and Shillito (2011). In the same level, acicular hair cells (Figure 10i), and vascular tissue (Figure 10z) were found in low quantity.

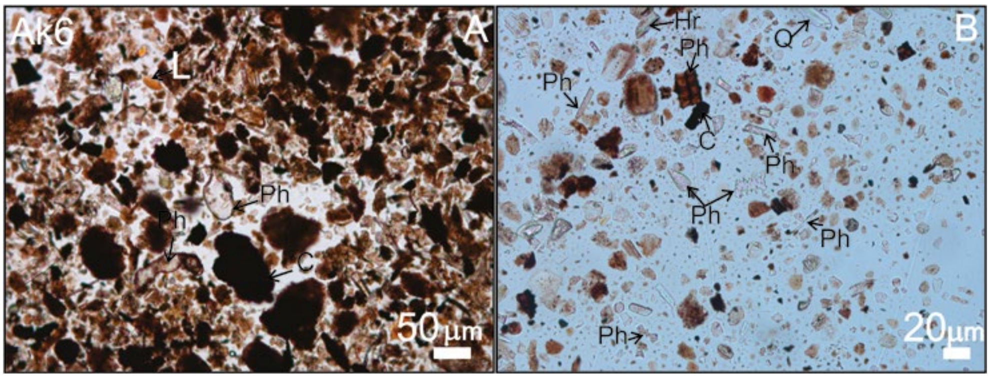

Figure 11. Microscopic photos of sample Ak6 (southern wall; Horizon VII). For the position of the sample, see Figure 6. Ph-phytoliths, Q-quartz, C-charcoal, Hr-hornblende, L-limonite.

Various forms were observed, including silicified phytoliths with grass affinity composed of long cells of different contours, hair bases, hooks, prickles, short cells. Considering the grass type (e.g. bulliform, long cell polylobate) and the frequencies and quantity of phytoliths, we suggest grasses growing under a water regime (wetland varves, Figures 6-9). Short-cell phytoliths from grasses tend to contain a small bubble of cytoplasm, which enables the identification of these phytoliths to be fairly straight forward (Mulholland 1989).

Samples from the green layer of the northern wall (water conditions) in Horizon VII were composed of 98% weathered-clayey minerals and 2% of elongate-shape phytoliths, microscopic in size.

Samples collected above Horizon VI in the northern wall are composed of strongly weathered minerals with observed signs of limonitization, indicating absence of water conditions (dry land, Figure 8).

The *southern wall* is very strongly weathered, its phytoliths are microscopic in size and broken, most shapes being unrecognizable. Phytoliths from charcoal samples are irregularly shaped and solidly silicified particles, which is diagnostic for woody tissue and related to the use of fire (Figure 6). Such particles are residue after plant materials are burned.

We have noted that some stratigraphic levels do not contain phytoliths (e.g. the pale-green layer of the southern wall in Horizon VII, c in Figure 9). Their samples also contain mostly weathered minerals, occasionally elongate-shape phytoliths up to 4% (diagnostic for wood) and minor bulliform types (diagnostic for grasses) indicating water conditions.

The content of phytoliths increased above the pale-green layer (Figure 6): most of them are typical for grasses. The relatively high concentrations of phytoliths in the white layers could have been produced in the wetland regime by forming varves. In the upper part of the block, limonitization indicates sudden drying out of the environment. Above this layer, the content of phytoliths is reduced.

Sample Ak6 from the southern wall (Figures 6 and 11) contains abundant phytoliths characteristic of wood that was used as combustible material for fire. Elongate-shape phytoliths (Figure 10m-p), acicular hair cells (Figure 10i), articulated wheat husks (Figure 10L) and minor fan-shaped phytoliths formed in bulliform cells (Figure 10s) are characteristic for the samples from this zone. Charcoal particles are also observed in sample Ak2 (see Figure 6).

The formation of phytoliths occurs by absorption from soil solutions and their composition depends on the environmental conditions and the content and type (chemical composition) of water. Our analysis revealed high quantities of *Al, Fe, Mg* and *Ti* (Figures 12 and 13).

A significant amount of *Fe* and *Al* was probably a result of secondary mineralization of decomposing plant tissue containing silicic phytoliths. In an environment of chemical weathering, the presence of *Al* and *Fe* oxides can affect the degree of survivability of phytoliths because they can reduce the amount of dissolved silica available in soils. Therefore, sediments studied at the archaeological settlement of Aknashen contain phytoliths of different types, but further investigation of their chemistry is requires to understand the presence of chemical elements in the soil and in each phytolith type.

Samples taken from the *western wall* and from the Trench 1a of the Aknashen archaeological site were also analyzed (Figure 5). It should be noted that for these strata the pale-green layer is only inferred by the presence of the sandy lens (Figures 7 and 9), which is related to a water environment of deposition. Additional sampling is required to collect accurate evidence related to the 'varve' unit in the western wall.

Discussion

It appears that the lake in the Ararat valley was contemporary to the period of human habitation at the Aknashen settlement. Several observations favor this hypothesis.

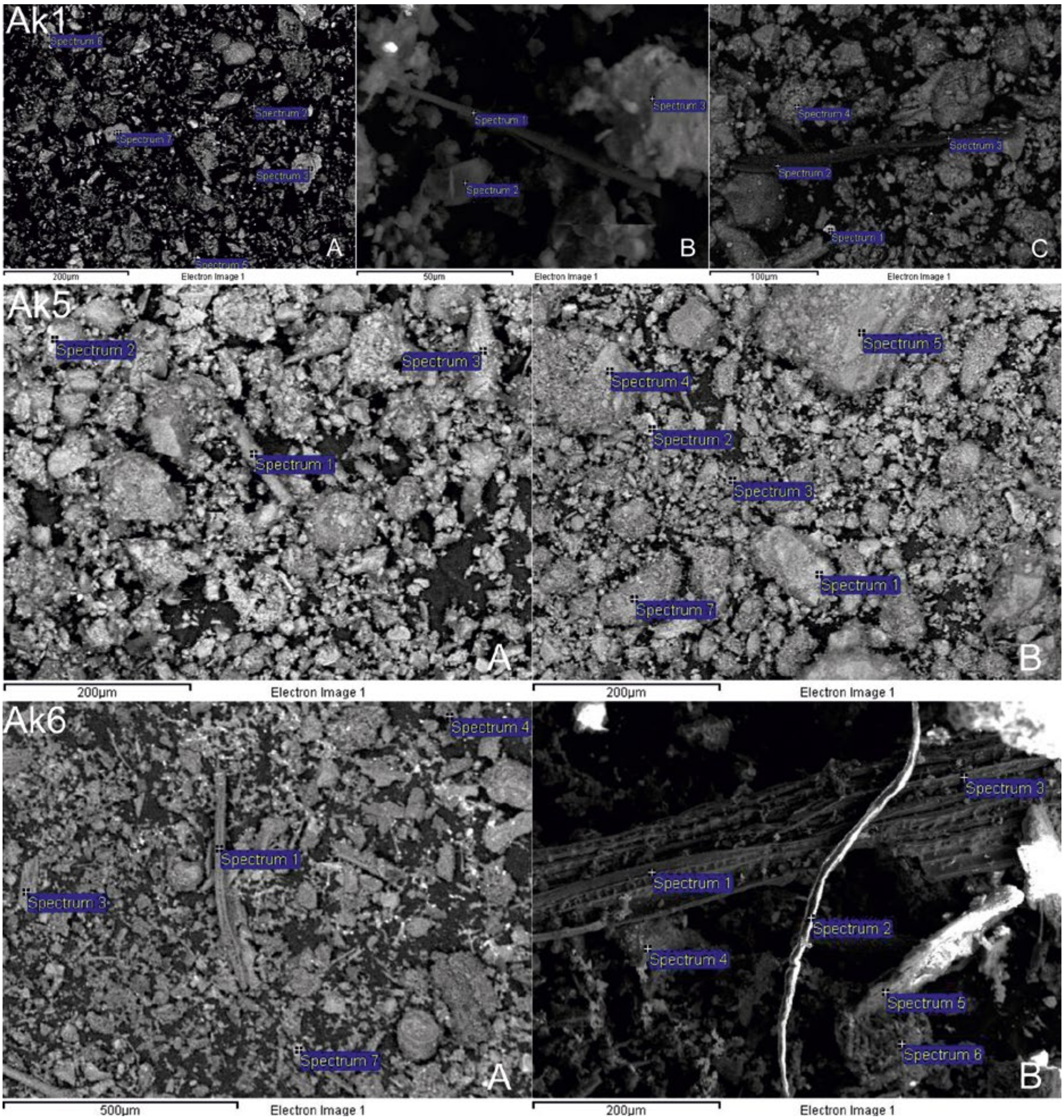

Figure 12. SEM analysis of samples Ak1, Ak5 and Ak6 (southern wall; Horizon VII).

Observation 1. There are clear signs of water sediments on the northern, southern and western walls of the excavation (Figures 6-9). The sediments are about 0.5m thick. Thin lenses of sand are observed in the lower parts of the section (the western and northern walls) suggesting transgression, then a deeper water basin (c in Figure 9), while the sediments prevailing in the upper parts of this layer are characteristic of a marsh (b in Figure 9). The archaeologists refer to them as Horizons VI and VII (Figures 6-9). Horizons V and VII contain artefacts and preserved remains of Neolithic structures, while Horizon VI contains no structure, but does contain a thin layer typical of a shallow water basin with stagnant water (Figure 9). Regularly alternating whitish and dark layers observed in this Horizon could be interpreted, respectively, as summer sediments (dryer climate, whitish strata) and winter sediments (more humid climate, darker strata).

Horizon VI could have resulted from the stage corresponding to lake transgression that forced people to abandon the settlement. Judging by the thickness of the sediments in Horizon VI (0.5m), the transgression took place over a short period of up to several decades and was followed by lake regression and re-habitation of the settlement.

N	elements	Si	Al	P	Mg	Ti	Fe	C	O	K	Na	Ca	Cl
Ak1 (A)	Spectrum2	52.66	15.51	2.96	5.81		14.30			3.15		5.62	
	Spectrum3	33.54	13.66		6.71	2.47	33.46			10.17			
	Spectrum5	6.04	1.63	30.56			2.18					59.59	
	Spectrum6	55.92	18.74		3.54		14.23			4.33		3.24	
	Spectrum7	55.52	10.82		3.76		19.53			6.26		4.11	
Ak1 (B)	Spectrum 1	63.14	7.78		8.30		9.78			3.86		7.12	
	Spectrum 2							95.51	4.49				
	Spectrum 3	0.32						94.47	5.21				
Ak1 (C)	Spectrum 1	3.21	6.93		5.40	4.93	79.52						
	Spectrum 2	5.42						92.68					1.89
	Spectrum 3	1.04						62.74	35.47				0.74
	Spectrum 4	34.95	10.86		2.65	21.60	24.79			2.62		2.53	
Ak5 (A)	Spectrum 1	64.60	13.29		3.38		10.94			4.82		2.97	
	Spectrum 2	11.73	5.65			16.24	66.38						
	Spectrum 3	57.72	11.47		3.08		17.10			6.85		3.78	
Ak5 (B)	Spectrum1	48.35	4.30		11.63		9.92			1.05		24.75	
	Spectrum2	3.51		25.83								70.66	
	Spectrum3	53.19	15.80		2.06		12.16			8.86		7.92	
	Spectrum4	59.07	20.40				2.63			2.40	4.61	10.88	
	Spectrum5	55.10	24.37				2.85				3.25	14.44	
	Spectrum7	49.64	13.86				18.63			13.07		4.80	
Ak6 (A)	Spectrum1	89.61		5.78								4.61	
	Spectrum3	69.83	4.44				7.37			4.26		14.09	
	Spectrum4	89.74	0.96		1.16					2.34		3.95	1.84
	Spectrum7		1.97	31.90								66.13	
Ak6 (B)	Spectrum1	91.37								5.25			3.38
	Spectrum2	1.01						67.28	31.71				
	Spectrum3	73.84	2.91	5.44	2.62		3.72			2.61		8.86	
	Spectrum4	57.20	10.94		3.54		11.31			17.01			
	Spectrum5	93.35	2.30									4.35	
	Spectrum6	45.31	5.34	13.56	1.94		3.97			1.94		24.80	3.14

Figure 13. The chemistry of samples Ak1, Ak5 and Ak6 (see the position of the samples on Figure 6).

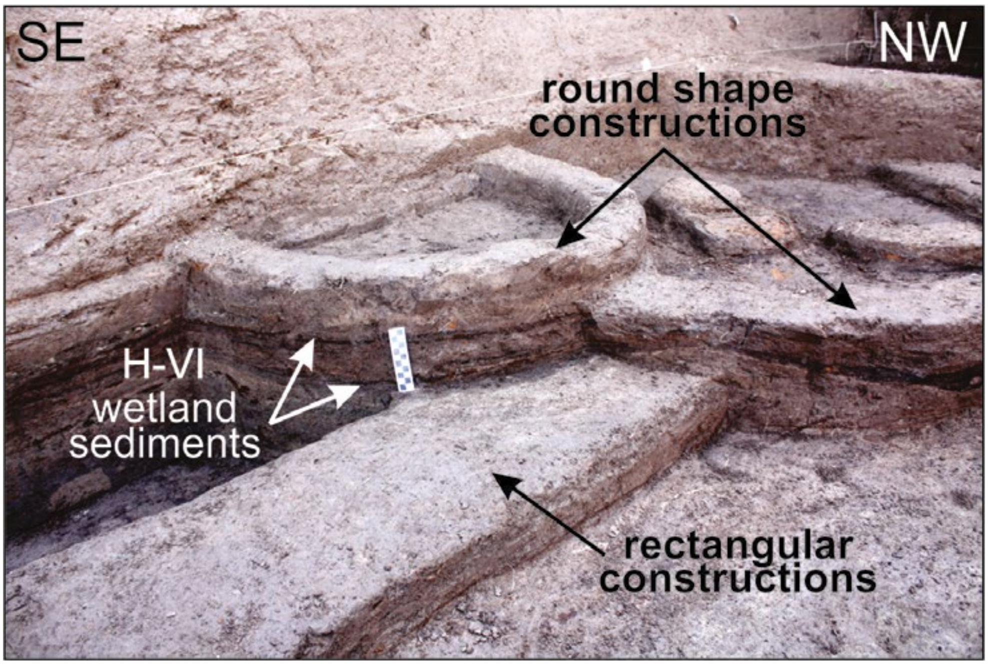

Figure 14. The settlement of Aknashen – the western wall with Horizon VII.

About 10cm-thick sediments of a shallow-water basin were also observed between the rounded and rectangular Neolithic structures on the western excavation wall in Horizon VII (Figure 14). They could indicate an earlier episode of lake transgression that was short in duration, according to the thickness of the sediments. In the meantime, it is important to observe that the lake transgression event probably separates the levels of the rectangular and rounded structures (Figure 14).

Observation 2. Many fish bones were found in Horizon V. As determined by Dr Valentin Radu, a portion of these bones could be related to the fish species *Cyprinus carpio, Capoeta capoeta, Tinca tinca, Silurus glanis, Barbus* sp. Fish of all these species can live in rivers, but also in large lakes periodically connected with rivers. Some of the fish bones could be related to *Cyprinus, Silurus, Tinca*, and *Barbus*. *Tinca* can also live in ponds with a low concentration of oxygen.

The lake contour modeled by GIS technologies locates the Aknashen settlement on the lake shore (Figure 15). Another Neolithic settlement, Masis Blur, would also have been located on the lake shore, while Aratashen, a settlement of the same period, would have been situated 9km E-NE of the lake shore. Fish bones were found in Aknashen and Masis Blur but not at Aratashen.

Observation 3. The elevation of the roof of Horizon VI, containing the water sediments, corresponds to 834.65m. If the water level is modeled according to this elevation, the lake would cover the Aknashen settlement, but Masis Blur and Aratashen would remain beyond the inundated area (Figure 15).

Thus considerable evidence suggests that a lake existed in the Late Neolithic in the Ararat valley and that its shore line varied in elevation between 833 and 834.65m. The settlements of Aknashen and Masis Blur would have been located near the shores of this lake and their inhabitants would have been able to fish in its waters. The Aknashen settlement could have been inundated when the water level rose (Horizon VI) in 6005-5814 BC (14C/AA-68561). It appears that there was yet another earlier episode of inundation of the Aknashen settlement (Horizon VII).

No clear evidence can establish how long the lake existed in the Ararat valley. However, there is an interesting account in Strabo (1964). Strabo mentions that '*as accounted, in the old times the torrent flow of the **Armenian Araxes** from mountains spread over the vast area of the lowland plains and, having no exit, created a sea. And **Jason** broke a cleft in rock like in the case of the **Tempe valley**, through which the river water now flows down to the **Caspian Sea**. This dried up the **Araxena valley** that chanelled the river up to its abrupt flow into the sea.*'

The Araxena valley corresponds to the Ararat valley which is closed in the southeast by the Reshteh-Ye-Dagn uplift, which could have dammed the lake tectonically and turned the Araxes river channel sharply towards the Caspian Sea. Potential maximum

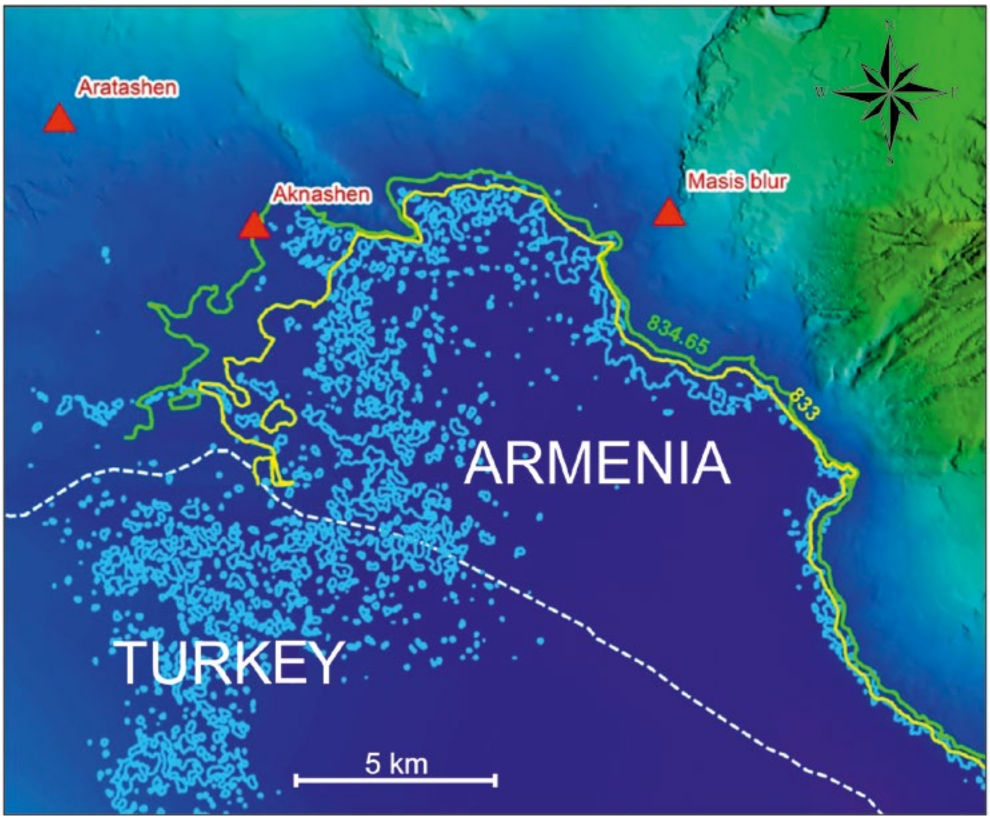

Figure 15. Relief elevation isoline of 833m, indicating the inferred contour of the lake shore line, and the contour at 834.65m, indicating the elevation of the shore line at the time of the transgression recorded in Horizon VI. The blue line corresponds to the DEM of 45 resolution, and the yellow and green lines correspond to the DEM with a resolution of 5m. The position of the area is shown in Figure 3.

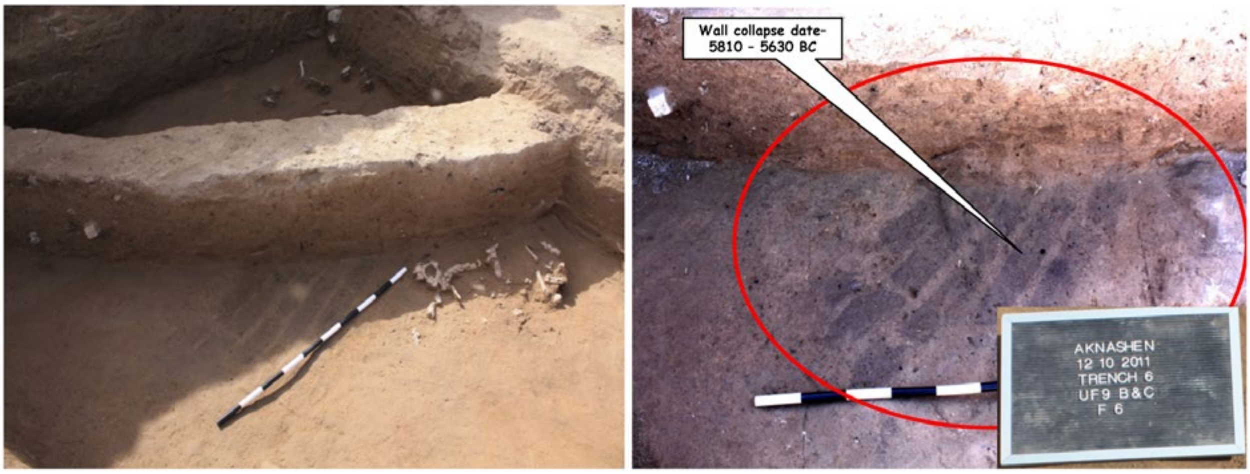

Figure 16. The mudbrick wall that had fallen, probably as the result of an earthquake.

earthquake magnitudes estimated for several active faults running near the Reshteh-Ye-Dagn massif vary in the range of 7.8 to 7.0. These faults include: the Maku Fault (M(max)=7.4, 37km from the dam area), the Siah-Cheshmeh-Khoy North-Tabriz fault (M(max)=7.8, 78km from the dam), and the Nakhichevan Fault (M(max)=7.1, 16km from the dam). It is suggested that an earthquake along one of these faults could have broken the dam in the Reshteh-Ye-Dagn massif and allowed the lake of the Ararat valley to flow catastrophically into the Caspian Sea. The level of water in the Caspian Sea changed by >150m in the Quaternary, by several tens of meters in the Holocene and by several meters in the last century (Leroy *et al.* 2020).

According to B. Helly (personal communication), there may be clear association between the reference to the Tempe valley in Strabo’s account and a strong earthquake in ancient Greece. The Tempe valley is located in Thessaly and tradition links its formation to an earthquake that enabled water to be emptied from the Thessalian trough.

A mud-brick wall discovered in Trench 6 during the excavations of 2011 at Aknashen had toppled to one side (Figure 16). We presume that this wall could have fallen as the result of an earthquake. The estimated age of this wall is in the range of 5810 to 5630 BC.

Thus we suggest that the earthquake that occurred in the Ararat valley between 5810 and 5630 BC destroyed walls in the Neolithic settlement of Aknashen. It is possible that earthquake epicentre was located on the active Yerevan Fault that runs 10km far from Aknashen.

Conclusion

The Ararat valley is a large basin about 220km long and 30km wide; it represents a tectonic depression formed during the stage of collision. The northern and southern parts of the depression are bordered by large Quaternary volcanoes of Aragats and Ararat. The recorded changes of geometry of the Araxes river channel are partially related to the tectonic activity in the Quaternary, including the historical period.

Geo-archaeological and archaeometric studies were conducted in the Late Neolithic settlement of Aknashen in the northern part of the Ararat valley. A detailed study of sedimentary layers (on the millimetric scale in some cases) was carried out to reveal evolution of the landscape and to propose a reconstruction model. The layer of green-blue clay that originated from the palaeo-lake is identified at the elevation of 833m a.s.l. and is covered by deposits of a dry-land environment. The flooding event is indicated by the sandy lenses in Horizon VI, which does not contain any remains of buildings.

Based on the study of the lithostratigraphy, mineralogy and the phytoliths observed in the walls of the Aknashen settlement excavation we suggest that the site had been exposed to effects for wetland and even water environments when grasses grew under water.

The collapse of the mud-brick wall in the settlement can be presumably related to an earthquake with an estimated age in the range of 5810-5630 BC. The earthquake epicentre was most probably located on the Yerevan Fault that was situated about 10km far from Aknashen.

Therefore, there is a considerable set of evidence to suggest that a lake existed in the Ararat valley in the Late Neolithic and its shore line varied in the elevation range of 833 - 834.65m a.s.l. The Aknashen settlement could have been inundated when the water level rose in 6024-5753 BC (14C). There is no clear evidence to estimate how long the lake had been preserved in the Ararat valley.

Acknowledgements

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The many geomorphic factors and responses in the reconstruction of the Aknashen landscape

Vincent Ollivier

Introduction

The site of Aknashen has been the subject of archaeological and geological analysis for many years (Badalyan *et al.* 2010; Karakhanyan *et al.* in this volume). One of the main questions concerning the site environment is that of the origin of the processes responsible for the development of a vast lake area covering much of the plain of the Araxes river between Aratashen and the gorge of the Reshteh-Ye-Dagn massif (Karakhanyan *et al.* in this volume). Another question concerns the reconstruction of the evolution of this lake system during the Neolithic occupation of the site. To complement the ongoing studies, the approach developed here is related more directly to the links between tectonics, climate changes and the possible impact of fluctuations during the Holocene of the relative level of the Caspian Sea, the natural outlet of the Kura-Araxes hydrosystem. In the case of this wide alluvial plain with a connected fluvial network flowing to the Caspian, these three main geomorphic and environmental parameters must be carefully incorporated into an integrated study.

Climate

The climate plays an important role, influencing the hydrological flow that supplies rivers and lakes, increasing or decreasing the efficiency of erosion processes and sediment transfers in the hydrosystems. Records of palaeofloods show that the magnitudes and frequencies of floods are highly sensitive to climate changes (Blum and Törnqvist 2000).

Base level

We recently reconstructed and highlighted the inland retroactive impact of the relative Caspian Sea level variations on landscape changes and alluvial terrace organization in the middle Kura valley and its tributaries over the past 40ka (Ollivier *et al.* 2015; 2016). Six phases of valley floor aggradation (i.e. 27,000-13,000; 11,000-3200; 2900-2100; 1600-1000; 400-150 cal. BP) and seven phases of fluvial incision (>37,000; 37,000-27,000; 13,000-11,000; 3200-2900; 2100-1600; 1000-400; 150-0 cal. BP) are recorded. The frequency, the speed and the magnitude of these changes significantly influenced the extent and intensification of flooding, as well as the physiography of the riparian contexts of the rivers connected to the Caspian Sea (notably the Kura and its tributaries, leading to enhanced rates of vertical accretion during transgressions and channel incision during relative falls in sea level).

Tectonics

Interfering in our case with an existing river network, lakes develop in local topographic lows sometimes formed by crustal tectonic deformation. Independently of the tectonic mechanism generating the tectonic barrier, the formation of a tectonic lake is coeval with fast vertical movements and its extinction coincides with slower or negligible tectonism and/or increased erosion power across the lake outlet. According to some modeling results (Garcia-Castellanos 2006), the evolution of lakes is sensitive to the initial geometrical configuration, lithology, tectonic uplift, and climate (precipitation and evaporation rates) to a similar degree, and each of these factors can change the timing of lake evolution by several orders of magnitude.

First results

At the site of Aknashen, our analyses were focused on the stratigraphy of trench E (Figure 1) and its relation to the archaeological layers and the environment of the site. Trench E is located a hundred meters west-northwest of the archaeological excavation. It provides information on the sedimentary dynamics of the site periphery. Some stratigraphic correlations have been made with the Neolithic units of the excavation.

Trench E has a total depth of 230cm. The succession of the stratigraphic levels enables a good reading of the local environmental variability. The sequence alternates between lake levels, wetland, levels at the periphery of the human occupation, flooding episodes and colluvial-eolian dynamics indicating drier environmental conditions. The succession of the sedimentary units is as follows (Figure 1):

Stratigraphic description of trench E

Level 1:
Olive green/brown silty-clayey level with compacted polyhedral structures. Some organic material laminations are visible. We can also observe very scattered fine sandy whitish particles.

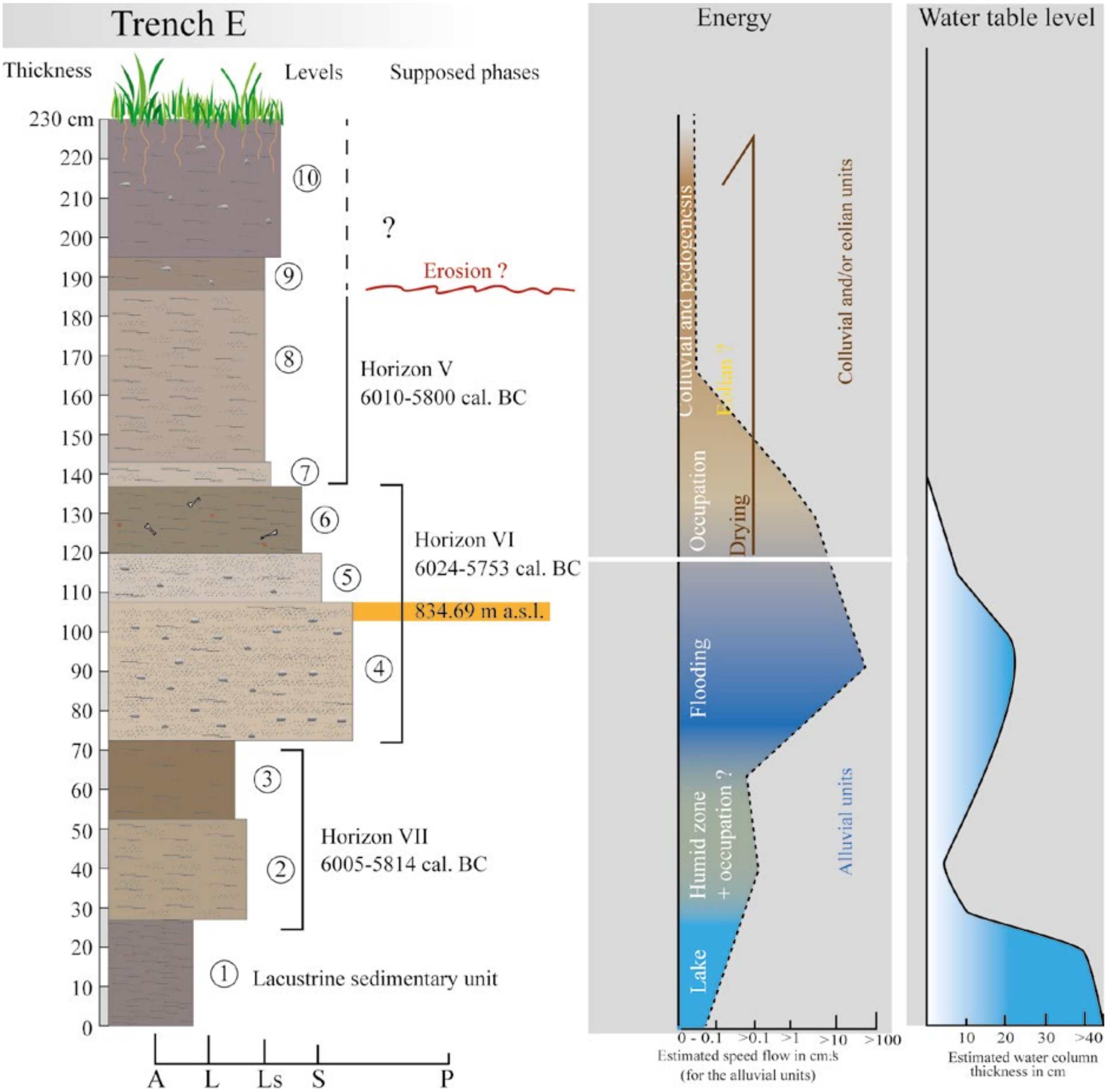


Figure 1. Stratigraphy and sedimentology of Trench E, including estimated speed flow and estimated water column.

Level 2:
Brown-green silty-sandy level with ferric oxidation halos and fine sandy whitish particles. Light polyhedral structures.
Level 3:
Olive green silty-sandy level, scattered white, gray and pink sandy particles.
Level 4:
Sandy-silty light brown-yellow level with scattered gravels.
Level 5:
Sandy-silty light brown level with small scattered gravels.
Level 6:
Silty-sandy brown/light brown level with bone fragments, micro-charcoal and gastropod fragments.
Level 7:
Light brown silty-sandy level with carbonate aggregates and micro-charcoal.
Level 8:
Dark brown silty-sandy level with isolated sand particles.
Level 9:
Brown silty-sandy level with polyhedral structures and scattered gravels.
Level 10:
Brownish arable soil.

According to the facies and the thickness of the sedimentary units described, some stratigraphic correlations with the levels defined in the archaeological excavation may be proposed (Figure 1).

Reading of the sedimentary sequence described in Trench E

Level 1 is a lacustrine unit widely observed in the Araxes valley in a number of trenches dug on some major archaeological sites such as Masis Blur (Karakhanyan *et al.* in this volume). The elevation of this level is widely considered to be positioned around the altitude of 833m a.s.l. (Karakhanyan *et al.* in this volume; Paffenholtz 1948). Levels 2 and 3 correspond to wetland facies (level 2) and a presumed level indicating the periphery of a human occupation (level 3). Both levels can be correlated to horizon VII of the Aknashen excavation (Figure 1). Levels 4, 5 and 6 correspond to horizon VI of the excavation. Levels 4 and 5 are flooding levels that include sand particles, gravels and small pebbles indicative of a growth in the local hydrodynamic as well as in the sedimentation rates. Level 6 is more representative of the impact of the human settlement of Aknashen on the sedimentation, as it contains bones, pottery fragments and charcoal. Levels 7 and 8, corresponding to horizon V, show a perennially dry environment with a sedimentary eolian component. Levels 9 and 10 are in discontinuity in the sequence due to a possible erosion phase.

An original approach to the sedimentary facies allows us to reconstruct the estimated speed flow and water column thickness of the stratigraphic sequence of trench E (Figure 1). According to experimental calculations from a dataset on sedimentation in artificial lakes (Maleval and Jigorel 2002), the lacustrine facies of level 1 suggests that it extended about 90 meters (into the lake) from the shoreline, the silty clay sedimentation accumulating to a thickness of 25cm per 20 years (calculations on median). The speed flow and the water column are estimated to be ≥ 0.1cm/s and >40cm respectively. The data for flood levels (Figure 1; Maleval and Jigorel 2002) with the detrital coarse sand located at the outlet of the tributaries (levels 4 and 5), the estimated speed flow at ≥100cm/s and the minimal estimated water column around 25cm are consistent with the stratigraphic sequential evolution. These data are also in agreement with the mapping by Karakhanyan *et al.* (in this volume).

Interpretation and discussion

Climate variations, base level changes and tectonics are considered for the particular evolution of the Araxes valley in the Holocene. The inland retroactive impact of the Caspian Sea relative water level changes is beginning to be well documented. The temporal and spatial extent of this influence was measured for the Kura valley and its tributaries in the Lesser Caucasus (Ollivier and Fontugne 2012; Ollivier *et al.* 2015; 2016). A comparison between the topographic profiles of the Araxes and the Kura was carried out to identify whether the base level changes had an impact on the environment of Aknashen (Figure 2). The uplift and subsidence rates of Mosar *et al.* (2010) are reported. Both the Kura and the Araxes rivers have a rain-snow regime. At the present time the Kura river has a length

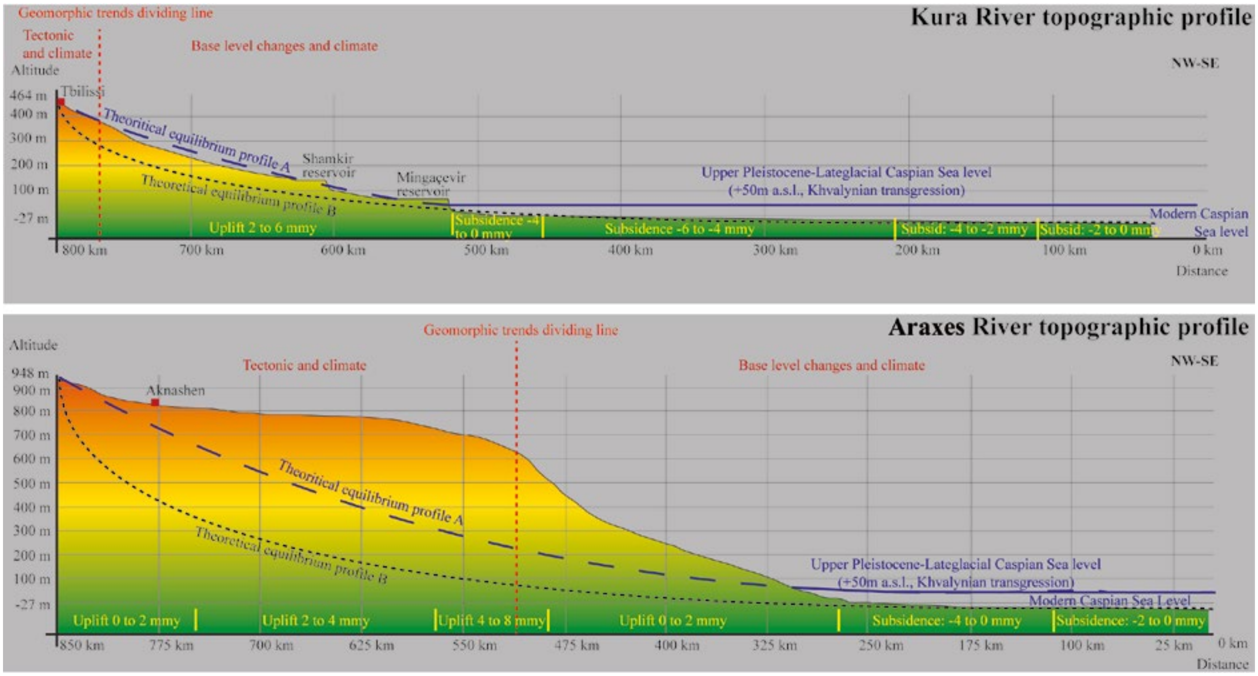


Figure 2. Topographic profiles of the Kura and Araxes rivers, with the uplift and subsidence rates.

of 1515km and a watershed of 218,906km^2 with an average flow of 551m^3/s. The Araxes river has a length of 1072km and a watershed of 102,000km^2 with an average flow of 285m^3/s. Upstream from the confluence with the Araxes river, the Kura river has a smaller watershed reaching approximately 86,000km^2 and an average flow of about 220m^3/s. These two rivers, forming one hydrosystem, have roughly comparable characteristics.

Caspian Sea base-level changes?

The topographic profile of the Kura river (see our previously published studies) shows, with an average gradient of 0.17% from the Georgian border to the shore of the Caspian, a large and relatively flat valley in which the relative sea-level variations can be presented on a broad spatial scale (Figure 2). Some studies point out that changes in relative sea-level induce long-range inland impact (e.g. 800km to 150km) for drainage area sizes comparable to those of the Kura (Blum and Törnqvist 2000). The mature topographic profile of the Kura, reaching a strongly rectified theoretical equilibrium profile, indicates the impacts of the erosive and sediment budgets controlled by changes in the relative level of the Caspian Sea since the Late Pleistocene. This dynamic is also supported by a limited impact of the tectonics (-2 to 6mm/year of vertical movement) compared to the high frequency and amplitude of the sea-level oscillations (varying from 150 to 10m during the Holocene) in the studied section. A geomorphic trend dividing line can be proposed (Figure 2) that spatially determines the respective impacts of climate, tectonics and changes in the base level. The influence of the changes in the relative level of the Caspian Sea has been determined to be perceptible 800km away from its current level shoreline and up to 400 meters of altitude on the main course of the Kura (these data are different for each tributary).

The topographic profile of the Araxes is very different from that of the Kura. The complete profile is immature with strong inclination following the first significant increases in uplift rates. According to the dividing line of the geomorphic trends, the impact of the Caspian Sea oscillations is only perceptible at about 500km inland and up to 600m for the Araxes valley. Millenary changes in the relative level of the Caspian Sea do not appear to have significantly affected the evolution of the environment of the site of Aknashen. This is probably due to the importance of uplift in the vicinity of the Reshteh-Ye-Dagn massif and of the Kura tributary status of the Araxes river during certain periods (as today). The record of the effects of feedback and delayed responses from the Araxes hydrosystem to changes in the base level have probably been buffered or erased by this important disconnection between upstream and downstream.

Climatic and/or tectonic event?

The Holocene is characterized by rapid climate change events (Mayewski *et al.* 2004), which are often associated with landscape changes. The most prominent Holocene climatic event in Greenland ice-core proxies, with approximately half the amplitude of the Younger Dryas, occurred ~8400 to 8000 years ago (Alley *et al.* 1997), often called the 8.2 ka event for short. This Holocene event brought generally cold and dry conditions to broad regions of the northern hemisphere, especially in winter, in response to a very large outburst flood that cooled the North Atlantic. The 14C dates obtained for the Neolithic horizons VII to V of the archaeological excavation, ranging between 7900 and 7600 cal BP (Badalyan *et al.* 2010; Karakhanyan *et al.* in this volume, notably), follow the 8.2 cal. ka event. In some recent studies on climate and vegetation dynamics in the Lesser Caucasus (Messager *et al.* 2013; Joannin *et al.* 2014), the development of in-situ water-dependent plants and of forests at lower altitudes at 8200 cal BP reflects the shift from an arid and cold Early Holocene to a more humid and warmer Mid–Late Holocene. In addition, fire history and sedge-based fen development provide records of drier phases at approximately 6400, 5300–4900, 3000, 2200–1500 and 400 cal BP (Joannin *et al.* 2014; Leroy *et al.* 2019).

This environmental and climatic succession is found in the stratigraphic sequence of trench E (Figure 1). It is recognized that the 8.2 climatic event was accompanied by a sustained wetter phase in the region, as in Turkey and Central Asia (Figure 3; Chen *et al.* 2008; Fleitmann *et al.* 2009; Ollivier *et al.* 2011). This could have enhanced the development of extensive wetland margins in floodplains and around lakes in poorly drained systems under strong base level pressure. This can also be driven by one or more stronger uplift phases affecting certain thresholds and disconnecting the upstream from the downstream part of the valley. Although the genesis and development of the lake system took place earlier than the Neolithic period, the post-tectonic extinction of large lakes was frequently and significantly delayed by flexural isostatic uplift occurring in response to erosion at the topographic barrier (Garcia-Castellanos 2006), which suggests a certain sustainability of the lake environment.

The stratigraphic sequence then shows a return to the initial alluvial conditions in the valley with better drainage (regressive erosion-regulating thresholds, erosion of the top of horizon V?) and decrease of the piezometric surface (this can also be due to tectonic or seismic activity; Leonardi *et al.* 1997), as well as a drier overall climatic trend with a strengthening of the wind parameters, recorded in the sedimentation. Both tectonic and climatic parameters appear to be the main factors responsible for driving the evolution

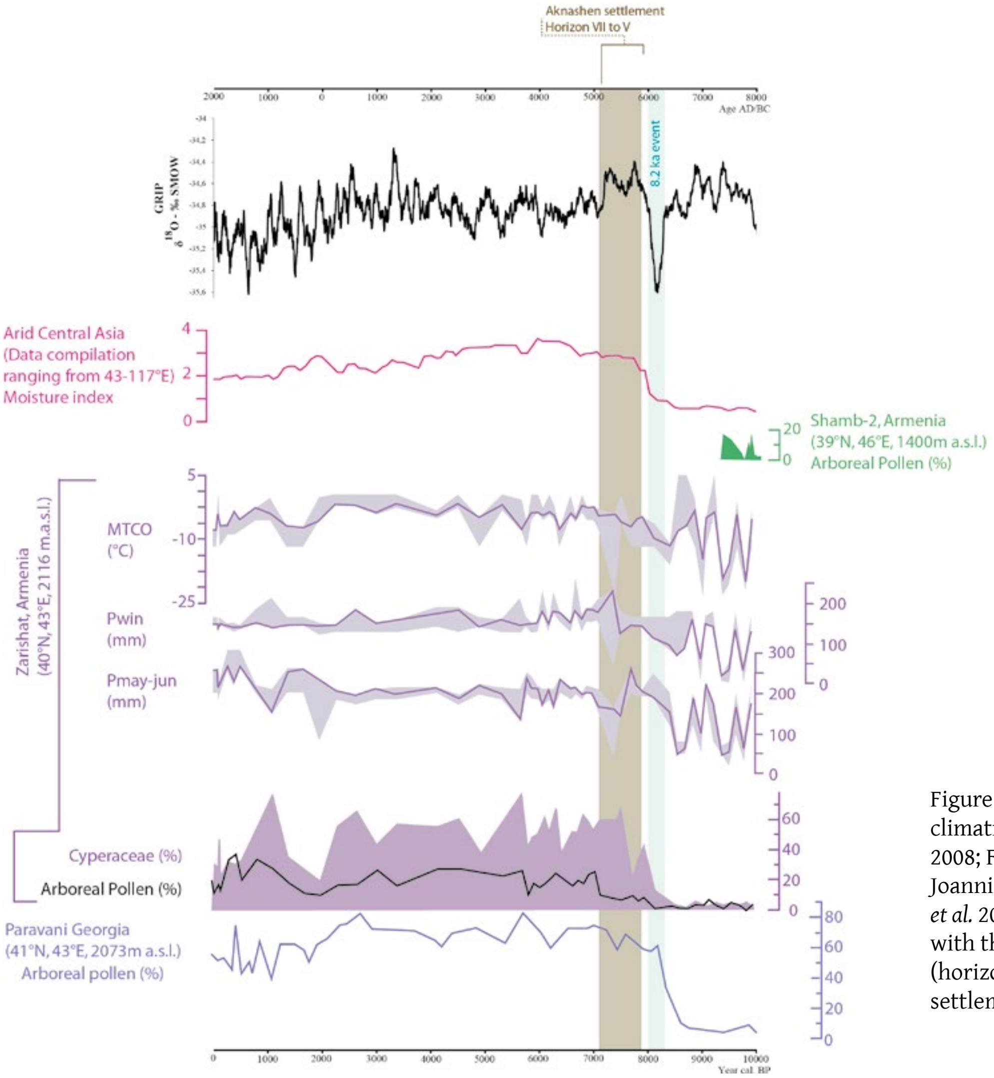


Figure 3. Regional and global climatic curves (Chen *et al.* 2008; Fleitmann *et al.* 2009; Joannin *et al.* 2014; Messager *et al.* 2013; Ollivier *et al.* 2011) with the stratigraphic sequence (horizons VII to V) of the settlement of Aknashen.

of the postglacial lake in the Araxes valley. However, the causes and expression of geomorphic responses to environmental variability are often more complex.

Other geomorphic factors?

The key variables affecting sediment transport are numerous, among them lithology, land cover conditions, availability of materials, rainstorms and intrinsic thresholds such as sediment caliber being the most significant. The catchment area, the elevation, the relief, the mean gradient, the runoff and the water discharge are also among the parameters most commonly examined to analyze the sediment flux. In the course of the Araxes river, some of these features are highly variable. Downstream from the Reshteh-Ye-Dagn massif and its threshold affected by the tectonics (see Karakhanyan *et al.* in this volume: Figure 1), as well as around and downstream from the Lake Agh Gol area, the Araxes river receives left bank tributaries that cross Pleistocene sedimentary stocks (fan and accumulation glacis) as well as a local geological series that are very responsive to erosion (limestones, sandstone and marl from the Palaeozoic and the Neogene). Badlands, fans and gully erosion are well developed. High rates of sediment yields are frequent for mountain rivers after rainstorm-triggered sediment supply and/or landslide episodes. This could have changed the balance between liquid flow and sediment load in this section of the river and led to gradual or rapid clogging of this last flat/depressed area before the embanked part in the canyon. Upstream, the flows are slowed and thus promote the development of a wide lake or a wetland area. In addition to the contribution of high-magnitude and low-frequency events to the overall sediment cascade, the importance of sediment storage for fueling rather than buffering high sediment transport rates must be considered. The highest sediment transport largely involves (re-) mobilization of this sediment storage, with most evidence occurring in tectonically active mountain belts and along passive continental margins (Korup 2012). A re-opening of the valley by a tectonic or climatic event (changes in the rainfall patterns) would then lead to a general linear incision trend and to normalized speed flows of the Araxes river.

Among these numerous parameters, the major volcanoes flanking the Araxes valley could have also played a role in the overall Holocene physiography (meandering, swampy area, etc.) and lake development. The double-peaked stratovolcano Mount Ararat appears to have been active during the Holocene and finally during the 3rd millennium BC (Karakhanian *et al.* 2002), but also in the form of a phreatic eruption with pyroclastic flow at the time of the July 1840 earthquake and landslide. The large andesitic-to-dacitic stratovolcano Aragats, dissected by glaciers, is of Pliocene-to-Pleistocene age. The youngest lower-flank flows are determined to have occurred between the end of the late Pleistocene and 3000 BC (Kharakanian *et al.* 2003). In addition, a line of craters and pyroclastic cones presenting young lava flows and lahars are considered to be characteristic of Holocene summit eruptions.

Besides the major damming of the valley by basaltic flows, well known during the Quaternary in Armenia (Ollivier *et al.* 2010) and which caused large lake areas to form, moderate or small subglacial eruptions and enhanced geothermal heat flux could have generated discreet melting of volcano icecaps and continuous fluxes of meltwater into the valley, without any need for the implication of a strong Holocene Rapid Climate Change (RCC; Mayewski *et al.* 2004). This theoretical digression is not intended to ignore occasional water inflows leading to lake formation in a favourable climatic or morphogenic context. As the geology determines the establishment of aquifers, it is also possible that during the more humid climate that occurred after the 8.2 ka event, the groundwater played a certain role in the increase of the surface water table and the formation of lakes. This must be further investigated.

Conclusion

This short and incomplete study, based only on fieldwork data and data correlations, is however rich in information, from local to regional level. The origin and evolution of the Araxes valley during the Neolithic is partly defined and new data are provided concerning water input, depth and speed flow at the time of human occupation at Aknashen. Also discussed are the interlocking links between tectonics, climate changes and the possible impact of fluctuations during the Holocene of the relative level of the Caspian Sea on the geomorphic response in the Araxes valley. The many bends and changes in the Araxes river beds through the millennia demonstrate the complexity of the phenomena and the strong relation between the drivers of the morphogenesis (tectonics, base levels and climate) and the responses of the fluvial geomorphology. The forcing associated with these changes could have been relatively small, implying the existence of underlying tipping points where self-propelling change - i.e. strong positive feedback- is triggered within the systems in question (Turney *et al.* 2016). The Araxes valley appears to have been highly sensitive to changes caused by the passing of tipping points within different components of the climate and the geomorphic system. In this context several aspects concerning the many geomorphic factors and responses in the landscape reconstruction are exposed. This ongoing study concerning Aknashen's past environments also enables better understanding of the impact of changes on the relative level of the Caspian Sea in this part of the Caucasus; these data may be applied to our research concerning its entire basin. Finally, a better understanding of the long-term evolution of the postglacial Araxes lake and its internally drained basin is crucial. These systems are climate-sensitive discontinuities in the sediment flow from orogens to basins, and therefore their sedimentary infill constitutes a record of climatic and tectonic evolution (e.g. Tiercelin 2002; Yan *et al.* 2002), which frequently impacted human occupation in prehistory.

Bayesian analysis of radiocarbon dates from Aknashen

Christine Chataigner, Ruben Badalyan and Armine Harutyunyan

The absolute chronology of the Late Neolithic of the South Caucasus was first sketched in the years 1970-1990 by 14C dating at sites in Georgia and Azerbaijan (Kavtaradze 1983; Kiguradze 1986; Narimanov 1987; Chataigner 1995), suggesting a global development during the 6th millennium. This corpus of 14C dates has been considerably enriched by excavations carried out since the early 2000s in the Kura basin, the steppes of Azerbaijan, and in the Araxes basin. It thus appears that the oldest Neolithic settlements in the South Caucasus were created during the transitional period between the 7th and 6th millennia and that almost all of the Neolithic sites were deserted in the last centuries of the 6th millennium (Nishiaki *et al.* 2015a).

In this corpus, the Ararat valley was known until now only by a small number of dates from Aratashen (Badalyan *et al.* 2007) and the upper horizons (V-I) of Aknashen (Badalyan *et al.* 2010). Therefore, the publication of data obtained to date on the lower levels of Aknashen fills a gap. The deepest strata have not yet been reached in all trenches and further dating will be carried out in the coming excavation seasons.

The objective of this chapter is to analyze the results of the 14C dating that has been carried out to date on the site of Aknashen, in order to establish a solid chronology that makes it possible to identify the evolution of the settlement and to specify the temporal context of its relations with neighbouring regions.

Material et method

Material

Radiocarbon dating was conducted on samples taken from each of the trenches excavated. The trenches that were first opened in the field work (Sond.A, Tr.1 to Tr.6) were the subject of the greatest number of dates, from 7 to 8 samples for each, and up to 13 for Tr.4, in which important architectural remains were concentrated; only Tr.5 has been dated only 3 times. Trenches Tr.7 and Tr.8, whose study began later, were dated 4 to 5 times each, but post-neolithic disturbances affected more than half of these dates.

The materials chosen were, where possible, samples with a short life cycle: charred seeds, unburnt animal bones or human bones. In other cases, charcoals from particularly reliable contexts were selected.

Seven samples, from the upper horizons (I-III) of Tr.2, Tr.6, Tr.7, and Tr.8, yielded dates indicative of modern, medieval, or Middle Bronze intrusions. Out of the 64 dates produced, 57 belong to the 6th millennium and make it possible to characterise the Neolithic occupation of Aknashen.

Method

Calibrated radiocarbon dates can be combined with archaeological prior information of various kinds (depth, association with a structure or feature...) to produce a combined chronology that should be more reliable than its individual components (Bayliss 2015). For this reason, in order to better define chronologically the evolution of the settlement of Aknashen, we carried out two series of Bayesian analyses:

- a ‘sequence’ analysis of the trenches: in each trench the thickness of deposits was subdivided into UFs (‘Unités de Fouille’ or Unit of Excavation) corresponding to layers, thus the analysis by ‘sequence’ enables testing the relevance of the 14C dates according to the stratigraphic data;
- a ‘phase’ analysis of the horizons: the UFs were grouped into seven horizons based on alternation between cultural levels and strata of erosion or natural deposits (Badalyan and Harutyunyan in this volume); the assumption is that, in each horizon, the radiocarbon dates from the various trenches are temporally related, thus the ‘phase’ analysis estimates the chronological limits of the horizons.

Bayesian analysis was conducted using the sequence and phase models of the OxCal calibration program (version 4.4) and the atmospheric curve of IntCal20. For this study on the Neolithic period, we have ignored the dates concerning intrusions related to the periods from the Bronze Age to the modern period.

Sequence analysis

The stratigraphic sequence (Figure 1) established during the excavations is given in the chapter ‘Stratigraphy and Architecture’ (Badalyan and Harutyunyan in this volume, Figure 4):

Horizon	Trench 1-1a	Trench 2	Trench 3	Trench 4	Trench 5	Trench 6	Trench 7	Trench 8	Trench 9	Trench 10	Trench 11	Trench 12	Sondage A	Sondage B
I	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1	UF 1
	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2	UF 2
	UF 3	UF 3	UF 3	UF 3	UF 3	UF 3			UF 3	UF 3	UF 3	UF 3	UF 3	UF 3
	UF 4	UF 4	UF 4	UF 4	UF 4	UF 4								
II	UF 5	UF 5	UF 5	UF 5	UF 5	UF 5	UF 3	UF 3	UF 4	UF 4	UF 4	UF 4	UF 4	
													UF 5	
III	UF 6	UF 6	UF 6	UF 6	UF 6	UF 6	UF 4	UF 4	UF 5	UF 5	UF 5	UF 5	UF 6	
							UF 5	UF 5	UF 6	UF 6	UF 6	UF 6		
IV	UF 7	UF 7	UF 7	UF 7	UF 7	UF 7	UF 6	UF 6	UF 7	UF 7	UF 7	UF 7	UF 7	
	UF 8	UF 8	UF 8	UF 8	UF 8	UF 8	UF 7	UF 7	UF 8	UF 8	UF 8	UF 8	UF 8	
V	UF 9	UF 9	UF 9	UF 9	UF 9	UF 9	UF 8	UF 8	UF 9	UF 9	UF 9	UF 9	UF 9	
	UF 10	UF 10	UF 10	UF 10	UF 10	UF 10	UF 9	UF 9	UF 10	UF 10	UF 10	UF 10	UF 10	
		UF 11	UF 11		UF 11	UF 11	UF 10	UF10					UF 11	
VI	UF 11	UF 12	UF 12	UF 11	UF 12	UF 12							UF 12	
VII	UF 12	UF 13	UF 13	UF 12	UF 13	UF 13							UF 13	
	UF 13	UF 14	UF 14	UF 13	UF 14	UF 14							UF 14	
	UF 14	UF 15	UF 15	UF 14	UF 15	UF 15							UF 15	
	(UF 15 Tr.1a)													

Figure 1. List of the UFs by trench.

For radiocarbon dates obtained from a series of samples that were excavated in stratigraphic order, the 'sequence' analysis enables determination of the degree to which the dates actually form a sequence and the degree to which this reduces the uncertainty (error) value of each date (McNutt 2013). In this study, the 'prior' information is provided by the succession of UFs in a given trench and, within each of these UFs, by the succession of depths from which the samples were taken. However, assessing the reliability of priors is not an easy task (Pettitt and Zilhao 2015) and the difficulties highlighted by Bayesian analysis can reside in a problem of stratigraphy (artefacts may be mobile between layers), in a technical problem linked to the dating (quantity and quality of the analyzed material) or in a statistical problem (notably the size of the studied corpus).

The results of the modelling are presented for each trench:

– two indices: A(model) provides a value for the agreement of the entire model, and A(overall) is a function of agreement indices of the individual dates (A)

– the 'Boundary Start' and 'Boundary End', which provide estimates of when the sequence started and ended

– the multiple plot of the analysed dates, with the agreement indices of the individual dates (A).

For the model indices, values less than 60 indicate that the chronological data and model are inconsistent, while those greater than 60 indicate consistency, the value of 60 being similar to 95% probability in a chi-square test.

If an individual agreement index (A) is less than the acceptable value of 60%, the sample is discussed (provenance, material, etc.). It is then considered to be an 'outlier' and the analysis is repeated. The outlier is not computed within the new overall analysis and no longer possesses an index A, but rather a probability (P) that this date is in the right place. On the plot, a question mark is added to its name. The plot shows the standard calibrations (unmodelled) as a light toned curve and the Bayesian (modelled) calibrations in darker tones.

Trench 1/1a

In Tr.1 and the deep sounding Tr.1a, seven samples distributed across UF14 and UF6 belong to the Neolithic period. These are six pieces of charcoal and a human bone (LTL-5734A; UF8) from the remains of the burial of a newborn, whose grave was disturbed. An eighth sample (UBA-16001; UF5) comes from the baulk between trenches 1 and 2 and is important, as it consists of charred wheat grains (*Triticum aestivum*) found *in situ* (Figure 2a).

The Bayesian analysis rejects no sample and the indices are good: A(model) = 84.3 and A(overall) = 87.3 (Figure 2b).

The start of the sequence is estimated to be 6089-5806 cal BC (95.4%) [5970-5848 cal BC at 68.2%; median 5918 cal BC].

The end of the sequence is estimated to be 5619-5389 cal BC (95.4%) [5610-5509 cal BC at 68.2%; median 5548 cal BC].

After the Bayesian treatment, the eight dates are kept.

Baulk Tr.1/Tr.2						
Lab No.	**Context**	**Depth (cm)**	**Material**	**BP**	**cal BC (95%)**	**Median cal BC**
UBA-16001	UF5	174	charred seeds (*Triticum aestivum*)	6597 ± 26	5616 - 5479	5538

Tr.1/Tr.1a						
Lab No.	**Context**	**Depth (cm)**	**Material**	**BP**	**cal BC (95%)**	**Median cal BC**
Poz-22745	UF6	190-212	charcoal	6910 ± 40	5889 - 5719	5788
LTL-5734A	UF8	—	human bone	6860 ± 45	5842 - 5655	5742
UGAMS-5802	UF9	296	charcoal	6940 ± 30	5894 - 5732	5812
LTL-12037A	UF9	311	charcoal	6936 ± 45	5969 - 5726	5813
Beta-363169	UF12	425	charcoal	6900 ± 40	5888 - 5714	5780
Poz-61366	UF13	444	charcoal	6905 ± 35	5883 - 5720	5782
Poz-68610	UF14	500	charcoal	7030 ± 40	6007 - 5803	5916

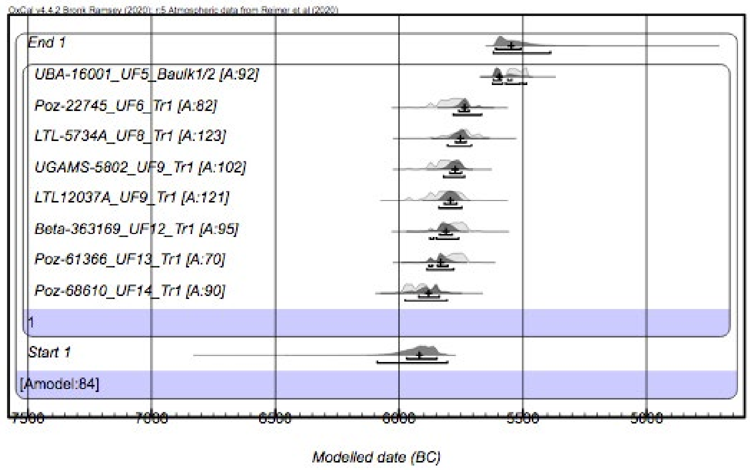


Figure 2. Trench 1/1a: a) Radiocarbon dates; b) Multiplot.

Trench 2

In Tr.2, six samples were radiocarbon dated; they are distributed between UF15 and UF9. Added to them is the sample (UBA-16001; UF5) from the baulk between Tr.1 and Tr.2 (Figure 3a).

Bayesian analysis highlights the problem posed by a sample (LTL-12038A) which is older than all of the underlying UFs. It was taken from a hearth (UF9 str.9) where a 'horned trapeze' was also found, a transverse arrowhead whose shape is characteristic of the lower levels of the site.

The UF9 sample was considered to be an outlier and Bayesian analysis then computed a modelling which does not reject any sample: A(model) = 89.8 and A(overall) = 91.3 (Figure 3b).

The start of the sequence is estimated to be 6082-5769 cal BC (95.4%) [5931-5806 cal BC at 68.2%; median 5878 cal BC].

The end of the sequence is estimated to be 5620-5334 cal BC (95.4%) [5608-5488 cal BC at 68.2%; median 5534 cal BC].

After the Bayesian treatment, six dates are kept and one (LTL-12038A) is rejected.

Trench 3

In Tr.3, eight samples were radiocarbon dated; they are distributed between UF12 and UF6 (Figure 4a). These are seven pieces of charcoal and a human bone, a fragment of an adult skull from a disturbed grave (LTL-13037A).

Bayesian analysis highlights the problem posed by the date determined for the deepest level (Poz-68612; UF12b), much later than the two dates from overlying levels (UF10); these were obtained from charcoal (Ly-10437) and from human bone (LTL-13037A) and are consistent. The sample Poz-68612 is probably intrusive. Two other samples have indices (A) <60%: UGAMS-2821 (UF7a) and LTL-12039A (UF9). These two samples must be considered to be outliers; then the Bayesian analysis shows correct indices: A(model) = 88.2 and A(overall) = 89.1 (Figure 4b).

The start of the sequence is estimated to be 6354-5762 cal BC (95.4%) [6016-5816 cal BC at 68.2%; median 5936 cal BC].

The end of the sequence is estimated to be 5476-4922 cal BC (95.4%) [5461-5271 cal BC at 68.2%; median 5342 cal BC].

After the Bayesian treatment, five dates are kept and three (Poz-68612; LTL-12039A; UGAMS-2821) are rejected.

Trench 4

In Tr.4, thirteen Neolithic samples, distributed between UF14 and UF5, were dated (Figure 5a). It should be noted that the four samples from UF13 show remarkable homogeneity, between 7010±50 BP and 6985±35 BP.

Baulk Tr.1/Tr.2						
Lab No.	Context	Depth (cm)	Material	BP	cal BC (95%)	Median cal BC
UBA-16001	UF5	174	charred seeds (*Triticum aestivum*)	6597 ± 26	5615 - 5484	5540

Tr.2						
Lab No.	Context	Depth (cm)	Material	BP	cal BC (95%)	Median cal BC
LTL12038A	UF9 str.9	324	charcoal	7031 ± 45	6011 – 5801	5915
LTL13038A	UF10 F19	337-351	charcoal	6938 ± 45	5970 - 5726	5815
BETA-394513	UF13a	420	charcoal	6890 ± 30	5876 - 5716	5768
Poz-68611	UF13c	435	charcoal	6950 ± 40	5971 - 5734	5826
Poz-110206	UF14		charcoal	6880 ± 40	5878 - 5669	5763
Poz-110207	UF15		charcoal	6940 ± 40	5968 - 5729	5815

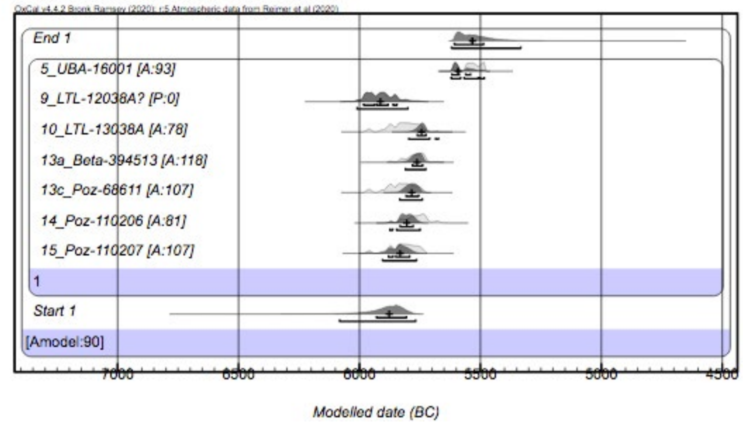


Figure 3. Trench 2: a) Radiocarbon dates; b) Multiplot.

Tr.3						
Lab No.	Context	Depth (cm)	Material	BP	cal BC (95%)	Median cal BC
Poz-22746	UF6A	215-232	charcoal	6420 ± 40	5475 - 5320	5400
UGAMS-2821	UF7a F7	232-240	charcoal	6740 ± 50	5730 - 5561	5654
UGAMS-4079	UF7b	243	charcoal	6640 ± 30	5627 - 5483	5574
UGAMS-4080	UF7b	262	charcoal	6590 ± 30	5616 - 5478	5534
LTL-12039A	UF9	299	charcoal	7005 ± 45	5988 - 5770	5890
Ly-10437 (SacA-34240)	UF10	342	charcoal	6960 ± 30	5969 - 5743	5836
LTL-13037A	UF10 F18	340-347	human bone	6970 ± 35	5975 - 5747	5850
Poz-68612	UF12b F25	388	charcoal	6630 ± 40	5625 - 5482	5563

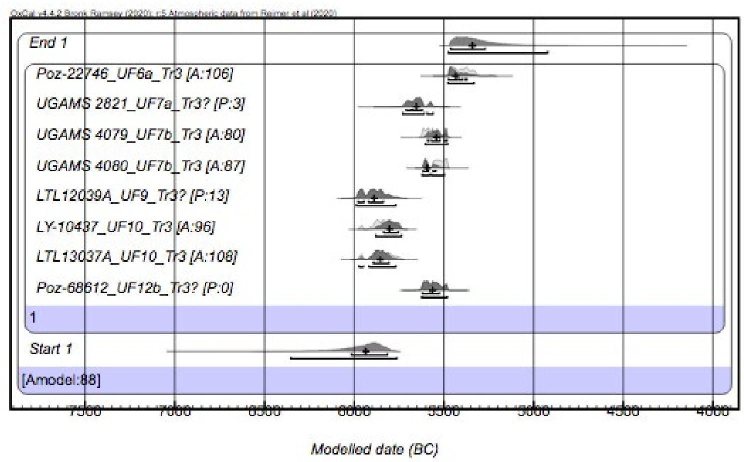


Figure 4. Trench 3: a) Radiocarbon dates; b) Multiplot.

Tr.4						
Lab No.	Context	Depth (cm)	Material	BP	cal BC (95%)	Median cal BC
UGAMS-6461	UF5	157	charcoal	6480 ± 30	5481 - 5371	5421
Poz-22747	UF6	157-167	charcoal	6790 ± 40	5736 - 5626	5683
UGAMS-5803	UF7a' str.8	237	charcoal	6800 ± 30	5731 - 5635	5688
UGAMS-6462	UF7c	232	charcoal	6770 ± 30	5722 - 5627	5672
UGAMS-6463	UF8a'	268	charcoal	6880 ± 30	5841 - 5674	5759
UGAMS-5804	UF8b	271	charcoal	6600 ± 25	5617 - 5480	5540
LTL-12040A	UF9a F18	337	charcoal	6949 ± 45	5972 - 5732	5826
LTL-13039A	UF10 F21	349	charcoal	6892 ± 35	5883 - 5713	5772
Poz-78211	UF13	410	charcoal	6985 ± 35	5980 - 5757	5868
Poz-78225	UF13 F32	415	charcoal	6990 ± 40	5982 - 5755	5873
Poz-78226	UF13	421	charcoal	6980 ± 40	5979 - 5750	5862
Poz-110262	UF13 F38		charcoal	7010 ± 50	5990 - 5757	5893
Poz-110208	UF14		charcoal	6910 ± 40	5889 - 5719	5788

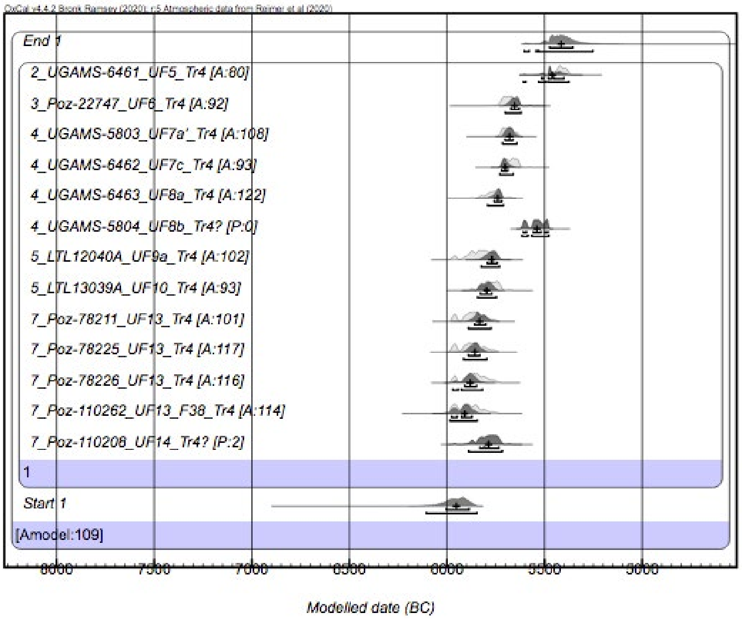


Figure 5. Trench 4: a) Radiocarbon dates; b) Multiplot.

The modelling rejects two samples: the charcoal from the deepest level (Poz-110208; UF14) and the charcoal from UF8b (UGAMS-5804). When they are considered as outliers, the agreement indices are quite high: A(model) = 108.5 and A(overall) = 109.1 (Figure 5b). This sequence, which includes the largest number of samples from different UFs, could be the most representative for Aknashen.
The start of the sequence is estimated to be 6107-5847 cal BC (95.4%) [6005-5887 cal BC at 68.2%; median 5953 cal BC].
The end of the sequence is estimated to be 5604-5254 cal BC (95.4%) [5476-5356 cal BC at 68.2%; median 5416 cal BC].
After the Bayesian treatment, eleven dates are kept and two (Poz-110208; UGAMS-5804) are rejected.

Trench 5
In Tr.5, only three samples were radiocarbon dated to the 6th millennium; they are distributed between UF13 and UF7 (Figure 6a).
Despite the similarity of dates between an early layer (UF13) and a late layer (UF8), no date is rejected and the Bayesian analysis validates the sequence: A(model) = 85 and A(overall) = 86.6 (Figure 6b).
The start of the sequence is estimated to be 6684-5760 cal BC (95.4%) [6043-5801 cal BC at 68.2%; median 5941 cal BC].
The end of the sequence is estimated to be 5715-4859 cal BC (95.4%) [5699-5472 cal BC at 68.2%; median 5560 cal BC].
After the Bayesian treatment, the three dates are kept.

Trench 6
In Tr.6, six samples were radiocarbon dated to the 6th millennium; they are distributed between UF12 and UF6b. These are 5 pieces of charcoal and a bone from the burial of a newborn (UF11 F15). In addition, there is a sample (Poz-56369; UF7 F1) from the baulk between trenches 6 and 8; it is a human bone from the disturbed grave of an adult (Figure 7a).

Tr.5						
Lab No.	Context	Depth (cm)	Material	BP	cal BC (95%)	Median cal BC
UGAMS-4081	UF7a	240	charcoal	6720 ± 30	5713 - 5564	5637
UGAMS-5805	UF8a F7	280	charcoal	6970 ± 25	5971 - 5755	5850
Poz-78227	UF13	429	charcoal	6950 ± 40	5971 - 5734	5826

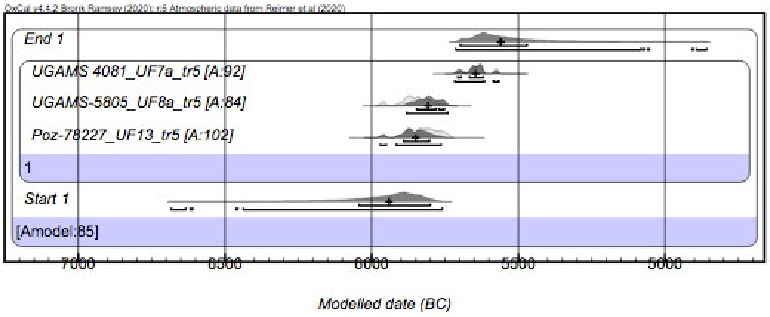


Figure 6. Trench 5: a) Radiocarbon dates; b) Multiplot.

Tr.6						
Lab No.	Context	Depth (cm)	Material	BP	cal BC (95%)	Median cal BC
UGAMS-2820	UF6b	207-236	charcoal	6690 ± 50	5714 - 5484	5607
UGAMS-4082	UF7a	234	charcoal	6560 ± 30	5611 - 5476	5516
LTL12041A	UF8a str.12	284	charcoal	6832 ± 45	5802 - 5631	5712
Poz-70153	UF11 F15	355	human bone	6730 ± 40	5720 - 5564	5647
Poz-89192	UF12		charcoal	6920 ± 40	5894 - 5721	5797
Poz-88796	UF12		charcoal	7010 ± 50	5990 - 5757	5893

Baulk Tr.6/Tr.8						
Lab No.	Context	Depth (cm)	Material	BP	cal BC (95%)	Median cal BC
Poz-56369	UF7 F1	245-258	human bone	6640 ± 50	5633 - 5480	5568

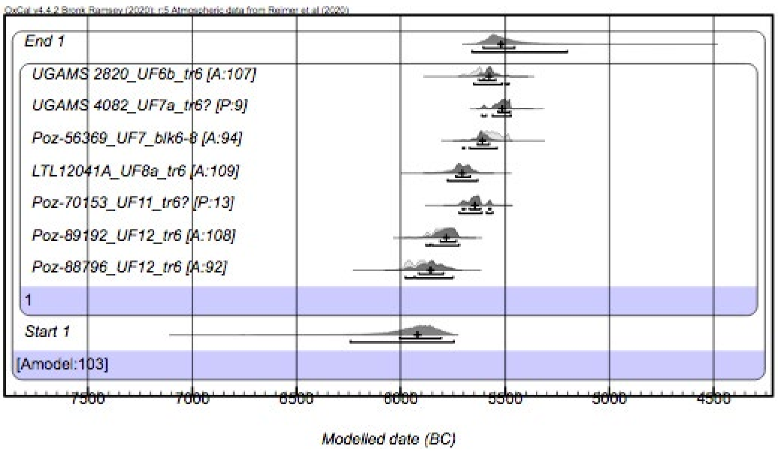


Figure 7. Trench 6: a) Radiocarbon dates; b) Multiplot.

The Bayesian analysis rejects a sample (UGAMS-4082; UF7a) which was considered to be an outlier. The analysis then validates the sequence, with indices: A(model) = 76.7 and A(overall) = 80.8.
The start of the sequence is estimated to be 6122-5745 cal BC (95.4%) [5963-5786 cal BC at 68.2%; median 5889 cal BC].
The end of the sequence is estimated to be 5648-5321 cal BC (95.4%) [5612-5491 cal BC at 68.2%; median 5539 cal BC].
In the modelling, the human remains of UF11 F15 present the lowest individual index (A = 69). The tomb could have been dug from a level later than UF11. If this sample is considered to be an outlier, the analysis validates the sequence with high indices: A(model) = 102.7 and A(overall) = 103.7 (Figure 7b).
The start of the sequence is estimated to be 6252-5752 cal BC (95.4%) [6007-5809 cal BC at 68.2%; median 5923 cal BC].
The end of the sequence is estimated to be 5660-5200 cal BC (95.4%) [5607-5456 cal BC at 68.2%; median 5521 cal BC].
After the Bayesian treatment, five dates are kept and two (Poz-70153; UGAMS-4082) are rejected.

Trench 7

In Tr.7, only two charcoal samples were radiocarbon dated to the 6th millennium; they come from UF7 and UF5 and represent the upper part of the Neolithic occupation (Figure 8a).

The Bayesian analysis validates this short sequence: A(model) = 90.6 and A(overall) = 91.9 (Figure 8b).

The start of the sequence is estimated to be 6281-5488 cal BC (95.4%) [5816-5522 cal BC at 68.2%; median 5674 cal BC].

The end of the sequence is estimated to be 5590-4659 cal BC (95.4%) [5550-5215 cal BC at 68.2%; median 5361 cal BC].

After the Bayesian treatment, the two dates are kept.

Trench 8

In Tr.8, only two samples were dated to the 6th millennium, a piece of charcoal and a child's bone from a disturbed grave, both belonging to UF8. Added to this is a human bone (Poz-56369; UF7 F1) which comes from the baulk between Tr.6 and Tr.8 (Figure 9a).

The Bayesian analysis validates this short sequence of the upper part of the Neolithic occupation: A(model) = 100.9 and A(overall) = 100.8 (Figure 9b).

The start of the sequence is estimated to be 5814-5484 cal BC (95.4%) [5644-5537 cal BC at 68.2%; median 5606 cal BC].

The end of the sequence is estimated to be 5619-5287 cal BC (95.4%) [5596-5468 cal BC at 68.2%; median 5514 cal BC].

After the Bayesian treatment, the three dates are kept.

Trial trench Sond.A

In the trial trench Sond.A, eight samples were radiocarbon dated. They are distributed between UF13 and UF6 (Figure 10a).

The Bayesian analysis pinpoints problems with samples AA-68559 (UF7) and UGAMS-2293 (UF8), as well as with sample AA-68561 (UF11). It is noticeable that two dates obtained by the laboratory of the University of Arizona (AA-68559 for UF7 and AA-68560 for UF10 F5) are concordant with the stratigraphy and that the date of UF10 is in agreement with that obtained for the same context by the Georgia laboratory (UGAMS-2292).

The samples (UGAMS-2293; UF8 and AA-68561; UF11) were therefore considered to be outliers and Bayesian analysis was carried out again. The agreement indices show that this modelling is quite good: A(model) = 119.1 and A(overall) = 116.8 (Figure 10b).

The start of the sequence is estimated to be 6330-5808 cal BC (95.4%) [6039-5855 cal BC at 68.2%; median 5969 cal BC].

Tr.7						
Lab No.	Context	Depth (cm)	Material	BP	cal BC (95%)	Median cal BC
LTL-13040A	UF5 str.2	235	charcoal	6506 ± 45	5606 - 5371	5445
Ly-10438 (SacA-34241)	UF7	293	charcoal	6650 ± 30	5630 - 5484	5580

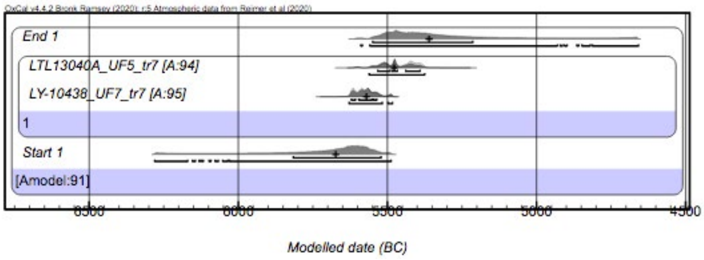


Figure 8. Trench 7: a) Radiocarbon dates; b) Multiplot.

Tr.8						
Lab No.	Context	Depth (cm)	Material	BP	cal BC (95%)	Median cal BC
LTL-13041A	UF8 F15	305-323	charcoal	6597 ± 45	5621 - 5478	5541
Poz-82221	UF8		human bone	6620 ± 40	5622 - 5481	5556

Baulk Tr.6/Tr.8						
Lab No.	Context	Depth (cm)	Material	BP	cal BC (95%)	Median cal BC
Poz-56369	UF7 F1	245-258	human bone	6640 ± 50	5633 - 5480	5568

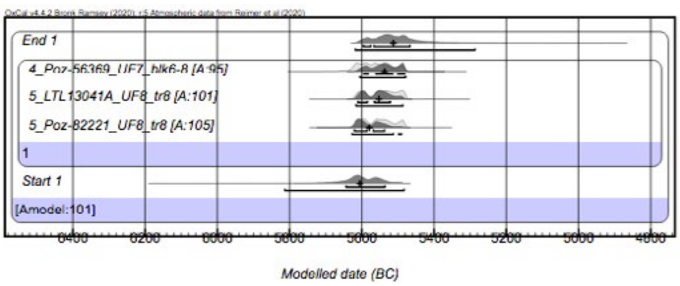


Figure 9. Trench 8: a) Radiocarbon dates; b) Multiplot.

Sond.A						
Lab No.	Context	Depth (cm)	Material	BP	cal BC (95%)	Median cal BC
Ly-13664	UF6	205-240	charcoal	6350 ± 70	5477 - 5130	5326
AA-68559	UF7	240-265	charcoal	6868 ± 40	5842 - 5664	5750
UGAMS-2293	UF8'	265-290	charcoal	6550 ± 50	5619 - 5383	5513
UGAMS-2292	UF10	315-348	charcoal	6900 ± 50	5895 - 5669	5784
AA-68560	UF10 F5	317-335	charcoal	6930 ± 44	5968 - 5723	5807
AA-68561	UF11	348-370	charcoal	7035 ± 69	6026 - 5746	5912
Ly-13665	UF12	370-390/400	charcoal	6920 ± 55	5976 - 5676	5803
UBA-9628	UF13	390/400-405/415	bone (*Ovis aries*)	7000 ± 29	5983 - 5795	5888

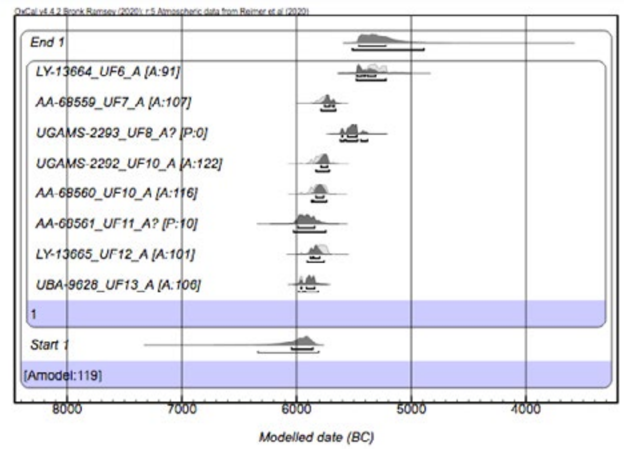


Figure 10. Trial trench Sond.A: a) Radiocarbon dates; b) Multiplot.

The end of the sequence is estimated to be 5509-4866 cal BC (95.4%) [5459-5216 at 68.2%; median 5307 cal BC].
After the Bayesian treatment, six dates are kept and two (AA-68561; UGAMS-2293) are rejected.

Trenches Tr.1 and Tr.4

The baulk between trenches 1 and 4 having been removed in order to clearly observe the architectural remains in the full area of the two trenches, a study of Tr.1 and Tr.4 together is possible. Out of 21 samples, Bayesian analysis rejects three, two being outliers in the analysis of Tr.4, the date of the third (Poz-22745; Tr.1 UF6) being aberrant compared to samples from the same UF or from earlier UFs (Figure 11).
The Bayesian analysis validates the sequence with very high indices: A(model) = 123 and A(overall) = 121.6.
The start of the sequence is estimated to be 6043-5863 cal BC (95.4%) [5984-5900 cal BC at 68.2%; median 5945 cal BC].
The end of the sequence is estimated to be 5603-5337 cal BC (95.4%) [5510-5398 at 68.2%; median 5452 cal BC].

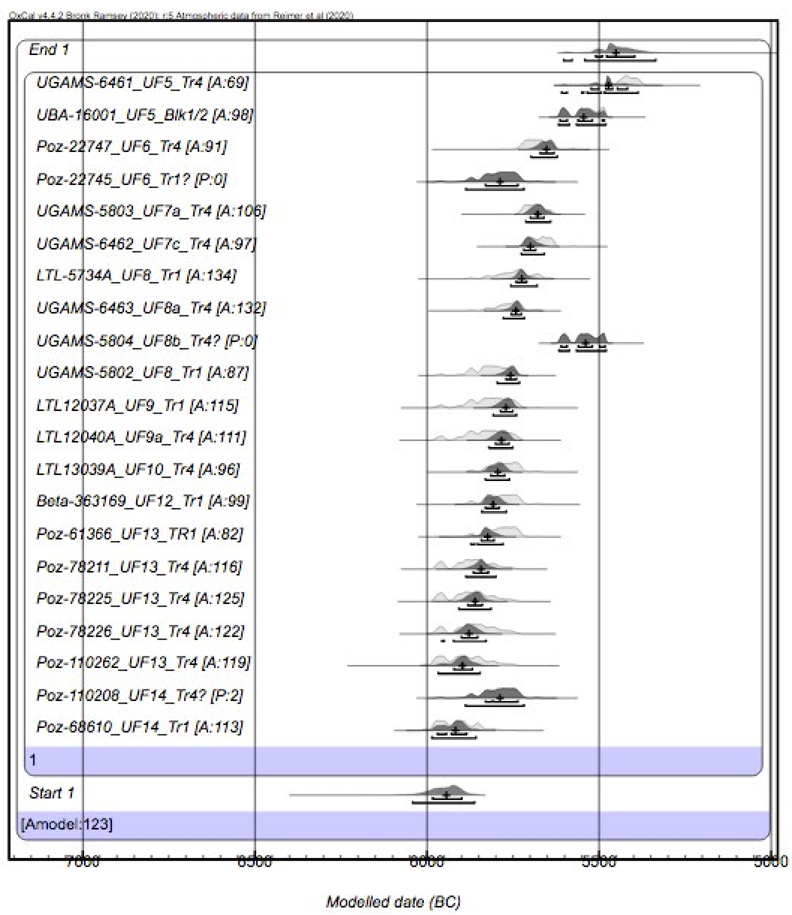


Figure 11. Multiplot of the radiocarbon dates from trenches 1/1a and 4.

After the Bayesian treatment, eighteen dates are kept and three (Poz-110208; UGAMS-5804; Poz-22745) are rejected.
This joint sequence of trenches Tr.1 and Tr.4 appears to be the most representative for Aknashen. It covers most of the occupation levels, between the lower horizon (VII) (but without reaching the deepest level UF15) up to horizon II, thus without including the upper horizon (I) which was very disturbed by posterior intrusions.

Conclusion on sequence analysis

As trenches 7 and 8 were only excavated in their upper part, most of the information on the occupation sequence of Aknashen comes from trenches 1 to 6 and from trial trench Sond.A.

The results of the different models obtained from these trenches can be summarised in Figure 12.

The median values of the beginning of the settlement of the site are highly concordant and suggest that the site was created at the very beginning of the 6th millennium, around 5950 cal BC. The median values of the late phase of the occupation, based on the dates of horizons III and II, provide a wider range situated between 5560 and 5310 cal BC.

Phase analysis

In order to define the stages in the development of the Aknashen settlement and to determine the chronological boundaries of the different horizons, we have carried out Bayesian analyses of 'multiple phases', using the 'contiguous' model which assumes that the phases succeed each other with no break or discontinuity between them. In order to better understand the succession of occupations at Aknashen throughout horizons VII to II (horizon I, very disturbed, has only produced modern dates), we carried out two analyses: the first on only those trenches for which the dates for horizon VII are known (Tr.1/1a, Tr.2, Tr.4, Tr.5 and trial trench Sond.A), the second on the assemblage of available data (Tr.1 to Tr.8 and trial trench Sond.A).

context	Boundary start (95.4%)			Boundary end (95.4%)		
	from	to	median	from	to	median
Sond.A	6330	5808	5969	5509	4866	5307
Tr.1	6089	5806	5918	5619	5389	5548
Tr.2	6082	5769	5878	5620	5334	5534
Tr.3	6354	5762	5936	5476	4922	5342
Tr.4	6107	5847	5953	5604	5254	5416
Tr.1+Tr.4	6043	5863	5945	5603	5337	5452
Tr.5	6684	5760	5941	5715	4859	5560
Tr.6	6252	5752	5923	5660	5200	5521

Figure 12. Boundary starts and boundary ends modelled for trenches 1 to 6 and Sond.A.

Chronological data

Seven stratigraphic horizons

At Aknashen, the UFs have been grouped into horizons (from VII, the earliest, to I, the latest) which correspond to the main phases of development of the settlement. These horizons were defined in part by the periods of abandonment that marked the history of the site and in part by the evolution of the material culture and architecture (see Badalyan and Harutyunyan, in this volume):

- horizon VII: overlying the virgin soil and ending in abandonment due to flooding; in the architecture, circular buildings and rectangular buildings coexist; in the lithic material, the most striking feature is the large quantity of bladelets/microblades, bullet cores, nuclei on pebbles and microliths.

- horizon VI: clayey-sandy deposits, brought by the flood. Horizons VII and VI are characterised by the absence of local pottery with mineral or plant temper and by the high amount (in comparison with overlying horizons) of imported pottery, monochrome or painted.

- horizon V: reoccupation of the site (level V-1), then abandonment marked by a layer of tamped earth that appears to be the result of the destruction of structures. In this upper level (V-2), for the first time, there are a few samples of local pottery with mineral temper (with a predominance of the Grit II group).

- horizon IV: reoccupation of the site and continuation of building circular structures. Several levels of floors in the habitations provide evidence of a long, rather homogenous occupation. The amount of local pottery with mineral temper sharply increases, the Grit II group still slightly predominates over the Grit I group.

- horizon III: the architecture is characterised by large rounded structures in cob comprising two sections. The number of pottery sherds doubles; the Grit I group is the most abundant and, for the first time, plant-tempered pottery appears.

- horizon II: disturbed by later intrusions, this horizon is characterised essentially by a clear reduction (in relation to horizon III) of structures and materials *in situ*. As for the pottery, the situation is similar to that of horizon III.

- horizon I, very disturbed, did not provide any 14C date for the Neolithic period. It is characterised by the complete dominance of pottery with plant temper. The number of microliths (transverse arrowheads) is highly reduced in this horizon, the end of a tendency that had begun in horizon V.

The sequence of lower horizons (VII to V) is thus based on a succession of occupation and abandonment phases. However, the dates obtained on these three horizons largely overlap: nine dates (out of twelve) of horizon V are included in the same time interval as the 15 dates of horizon VII (between 7030 ± 40 BP and 6880 ± 40 BP). In addition, samples from horizon VI (AA-68561, Sond.A UF11) and horizon V (LTL-12038A, Tr.2 UF9) provided dates earlier than all of horizon VII. Horizons VII, VI and V probably succeeded each other over a relatively short period of time.

While taking into account these difficulties, in an attempt to identify the chronological range of the different horizons defined by the excavators, Bayesian analyses by 'phases' were undertaken.

Radiocarbon dates

The radiocarbon dates for Horizons VI to II were presented in the chapter 'Stratigraphy and architecture' (Badalyan and Harutyunyan in this volume). As they form the basis of the Bayesian analysis by phases, they are presented again here, gathered in the same table and supplemented by the dates of Horizon VII (Figure 13).

The study of *horizon VII* in trenches 1-2, 4-5 and trial trench 'Sond.A' revealed the same stratigraphic succession: two levels of construction (circular buildings in the lower level, circular and rectangular buildings in the upper level) are separated in some places by deposits indicative of a marsh environment, which are evidence for a first transgression of the palaeolake; this transgression was limited in space, but also probably in time, given the thinness of the deposits (Badalyan and Harutyunyan in this volume). Horizon VII thus consists of two sub-phases that have been distinguished in the modelling.

Horizon V also comprises two strata: a lower phase (V-1) with constructions and an upper phase (V-2) indicative of the abandonment of a part of the site with the formation of a compact layer of clay resulting from the destruction of the buildings of the lower level (V-1). These two strata have also been distinguished in the modelling.

Horizon VII							
Sub-phase	**Lab No.**	**Context**	**Depth (cm)**	**Material**	**BP**	**cal BC (95%)**	**Median cal BC**
upper	Beta-363169	Tr.1a UF12	425	charcoal	6900 ± 40	5888 - 5714	5780
	Poz-61366	Tr.1a UF13	444	charcoal	6905 ± 35	5883 - 5720	5782
	Beta-394513	Tr.2 UF13a	420	charcoal	6890 ± 30	5876 - 5716	5768
	Poz-68611	Tr.2 UF13c	435	charcoal	6950 ± 40	5971 - 5734	5826
	Poz-78211	Tr.4 UF13	410	charcoal	6985 ± 35	5980 - 5757	5868
	Poz-78225	Tr.4 UF13	415	charcoal	6990 ± 40	5982 - 5755	5873
	Poz-78226	Tr.4 UF13	421	charcoal	6980 ± 40	5979 - 5750	5862
	Poz-110262	Tr.4 UF13	–	charcoal	7010 ± 50	5990 - 5757	5893
	Poz-78227	Tr.5 UF13	429	charcoal	6950 ± 40	5971 - 5734	5826
	UBA-9628	Sond.A UF13	–	bone (*Ovis aries*)	7000 ± 29	5983 - 5795	5888
lower	Poz-68610	Tr.1a UF14	500	charcoal	7030 ± 40	6007 - 5803	5916
	Poz-110206	Tr.2 UF14	–	charcoal	6880 ± 40	5878 - 5669	5763
	Poz-110207	Tr.2 UF15	–	charcoal	6940 ± 40	5968 - 5729	5815
	Poz-110208	Tr.4 UF14	–	charcoal	6910 ± 40	5889 - 5719	5788

Horizon VI						
Lab No.	**Context**	**Depth (cm)**	**Material**	**BP**	**cal BC (95%)**	**Median cal BC**
Poz-68612	Tr.3 UF12b F25	388	charcoal	6630 ± 40	5625 - 5482	5563
Poz-89192	Tr.6 UF12	–	charcoal	6920 ± 40	5894 - 5721	5797
Poz-88796	Tr.6 UF12	–	charcoal	7010 ± 50	5990 - 5757	5893
Ly-13665	Sond.A UF12	370-390	charcoal	6920 ± 55	5976 - 5676	5803

Horizon V							
Sub-phase	**Lab No.**	**Context**	**Depth (cm)**	**Material**	**BP**	**cal BC (95%)**	**Median cal BC**
upper (V-2)	UGAMS-5802	Tr.1 UF9	296	charcoal	6940±30	5894-5732	5812
	LTL-12037A	Tr.1 UF9	311	charcoal	6936±45	5969-5726	5813
	LTL-12038A	Tr.2 UF9 str.9	324	charcoal	7031±45	6011-5801	5915
	LTL-12039A	Tr.3 UF9	299	charcoal	7005±45	5988-5770	5890
	LTL-12040A	Tr.4 UF9a F18	337	charcoal	6949±45	5972-5732	5826
	LTL-13041A	Tr.8 UF8 F15	305-323	charcoal	6597±45	5621-5478	5541
	Poz-82221	Tr.8 UF8		human bone	6620±40	5622-5481	5556
lower (V-1)	LTL-13038A	Tr.2 UF10 F19	337-351	charcoal	6938±45	5970-5726	5815
	Ly-10437 (SacA-34240)	Tr.3 UF10	342	charcoal	6960±30	5969-5743	5836
	LTL-13037A	Tr.3 UF10 F18	340-347	human bone (skull)	6970±35	5975-5747	5850
	LTL-13039A	Tr.4 UF10 F21	349	charcoal	6892±35	5883-5713	5772
	Poz-70153	Tr.6 UF11 F15	355	human bone (tibia)	6730±40	5720-5564	5647
	UGAMS-2292	Sond.A UF10	315-348	charcoal	6900±50	5895-5669	5784
	AA-68560	Sond.A UF10 F5	317-335	charcoal	6930±44	5968-5723	5807
	AA-68561	Sond.A UF11	348-370	charcoal	7035±69	6026-5746	5912

Horizon IV						
Lab No.	**Context**	**Depth (cm)**	**Material**	**BP**	**cal BC (95%)**	**Median cal BC**
LTL-5734A	Tr.1 UF8	–	human bone (tibia)	6860±45	5842-5655	5742
UGAMS-2821	Tr.3 UF7a F7	232-240	charcoal	6740±50	5730-5561	5654
UGAMS-4079	Tr.3 UF7b	243	charcoal	6640±30	5627-5483	5574
UGAMS-4080	Tr.3 UF7b	262	charcoal	6590±30	5616-5478	5534
UGAMS-5803	Tr.4 UF7a' str.8	237	charcoal	6800±30	5731-5635	5688
UGAMS-6462	Tr.4 UF7c	232	charcoal	6770±30	5722-5627	5672
UGAMS-6463	Tr.4 UF8a'	268	charcoal	6880±30	5841-5674	5759
UGAMS-5804	Tr.4 UF8b	271	charcoal	6600±25	5617-5480	5540
UGAMS-4081	Tr.5 UF7a	240	charcoal	6720±30	5713-5564	5637
UGAMS-5805	Tr.5 UF8a F7	280	charcoal	6970±25	5971-5755	5850
UGAMS-4082	Tr.6 UF7a	234	charcoal	6560±30	5611-5476	5516
Poz-56369	Baulk6/8 UF7 F1	245	human bone	6640±50	5633-5480	5568
LTL-12041A	Tr.6 UF8a	284	charcoal	6832±45	5802-5631	5712
Ly-10438 (SacA-34241)	Tr.7 UF7	293	charcoal	6650±30	5630-5484	5580
AA-68559	Sond.A UF7	240-265	charcoal	6868±40	5842-5664	5750
UGAMS-2293	Sond.A UF8'	265-290	charcoal	6550±50	5619-5383	5513

Horizon III						
Lab No.	**Context**	**Depth (cm)**	**Material**	**BP**	**cal BC (95%)**	**Median cal BC**
Poz-22745	Tr.1 UF6	184/190-212	charcoal	6910±40	5889-5719	5788
Poz-22746	Tr.3 UF6a	215-232	charcoal	6420±40	5475-5320	5400
Poz-22747	Tr.4 UF6	157-167	charcoal	6790±40	5736-5626	5683
UGAMS-2820	Tr.6 UF6b	207-236	charcoal	6690±50	5714-5484	5607
LTL-13040A	Tr.7 UF5 str.2	235	charcoal	6506±45	5606-5371	5445
Ly-13664	Sond.A UF6	205-240	charcoal	6350±70	5477-5130	5326

Horizon II						
Lab No.	Context	Depth (cm)	Material	BP	cal BC (95%)	Median cal BC
UGAMS-6461	Tr.4 UF5	157	charcoal	6480±30	5481-5371	5421
UBA-16001	Baulk1/2 UF5	174	charred seeds	6597±26	5616-5479	5538

Figure 13. Radiocarbon dates from Aknashen, by horizon.

Phase analysis of Horizons VII-II in trenches 1-2, 4-5 and Sond.A

Trenches 1-2, 4-5 and trial trench Sond.A constitute the western part of the excavated zone and are the only ones that have provided dates for the deepest horizon (VII). This assemblage, coherent both horizontally (excavated sector) and vertically (stratigraphy), has provided 38 radiocarbon dates.

The six dates that were rejected during sequential analyses of the different trenches were considered to be outliers (Tr.2: LTL-12038A; Tr.4: UGAMS-5804 and Poz-110208; Tr.1 and Tr.4: Poz-22745; Sond.A: UGAMS-2293 and AA-68561). Of the 32 remaining dates, nine are rejected by the Bayesian analysis, because they are clearly either too early or too late in relation to other dates on the same horizon. The modelling is validated by very high indices: A(model) = 155.7 and A(overall) = 153.9. The results can be summarised in the following table (Figure 14a).

The 14C dates of the horizons and of the boundaries between horizons, modelled by the Bayesian analysis, are presented with their full probability distribution (95.4% confidence interval). However, in order to make transitions between horizons clearer, calibrated median dates have been added, even if they are only imperfect estimates of reality (Michczynski 2007).

The results of the Bayesian modelling suggest, as we had seen previously, that the occupation of horizon VII (according to the 14C dates currently available and which do not concern the deepest strata, UF15) began towards the middle of the first century of the sixth millennium.

In this *horizon VII,* the two phases of construction were separated by an episode of partial flooding of the site, which could have occurred around 5900-5880 cal BC.

The second episode of flooding, which concerned the entire site and brought quantities of sand and gravel, as well as deposits of marshy type *(horizon VI)*, probably occurred between 5850 and 5810 cal BC. The precise duration of this flood cannot be known, but the structure of horizon VI, which consists of annual varves, composed of light and dark seasonal layers, confirms that this episode would have lasted several years.

Directly on the surface of horizon VI, structures of the *lower level (V-1) of horizon V* were built. This phase of construction would have lasted about thirty years (between about 5810 and 5780 cal BC); then the area was deserted, as the *upper level (V-2)* consists of a compact layer of clay resulting from the destruction of the buildings of level V-1. The abandonment of this sector could have occurred over several years, as the surface of the compact clay layer is striated with cracks, which usually form during evaporation of water from torrential rains on the clayey deposits. The reoccupation of the site in this sector and the beginning of horizon IV would have taken place around 5750-5740 cal BC.

Horizon IV was thus formed after a more or less long abandonment of the village, which is also evidenced by the plan of the constructions, which differs from that of horizon V. This horizon, which includes several repair phases of the floors of the buildings, would date to between *ca.* 5750 and 5690 cal BC.

Horizon III would have taken place between *ca.* 5690 and 5630 cal BC. It should be noted that the dates of Horizons III and II modelled by the Bayesian analysis do not overlap, which could suggest a short abandonment of the site between *ca.* 5630/5620 and 5610/5600 cal BC. The fact that Horizon III presents evidence for an event, that resulted in the settlement's temporary abandonment between Horizons III and II, was mentioned in the chapter on ceramics (Harutyunyan in this volume).

Horizon II would have lasted up to 5450/5400 cal BC. However the disturbance to the latter level and the small number of dates available make the definition of the upper limit hypothetical.

Horizon I, 80 to 90 cm thick, which succeeded horizon II but did not provide any radiocarbon date, would thus have probably continued up to about 5350-5300 cal BC.

The 'multiplot' of this modelling (Figure 14b) reveals the concentration of the occupations over a short period of time, from the beginning of horizon VII up to the end of horizon IV. Horizon III differs from this assemblage in the high heterogeneity of its three dates. The two dates available for Horizon II fit into the continuity of Horizon IV.

Horizons	Modelled dates cal BC (95.4%)	Boundaries	Modelled dates cal BC (95.4%)	Medians cal BC
		Boundary end II	**5603 – 5281**	**5435**
II	5612-5380			
		Transition III/II	5686 – 5491	5599
III	5710-5626			
		Transition IV/III	5726 – 5645	5692
IV	5776-5667			
		Transition V upper/IV	5796 – 5719	5749
V-upper	5810-5735			
		Transition V lower/upper	5826 – 5746	5781
V-lower	5836-5755			
		Transition VI/V lower	5852 – 5761	5810
VI	5872-5781	flood		
		Transition VII/VI	5886 – 5801	5845
VII-upper	5908-5817			
		Transition VII lower / upper	5927 – 5837	5881
VII-lower	5976-5848			
		Boundary start VII	6063- 5844	5925

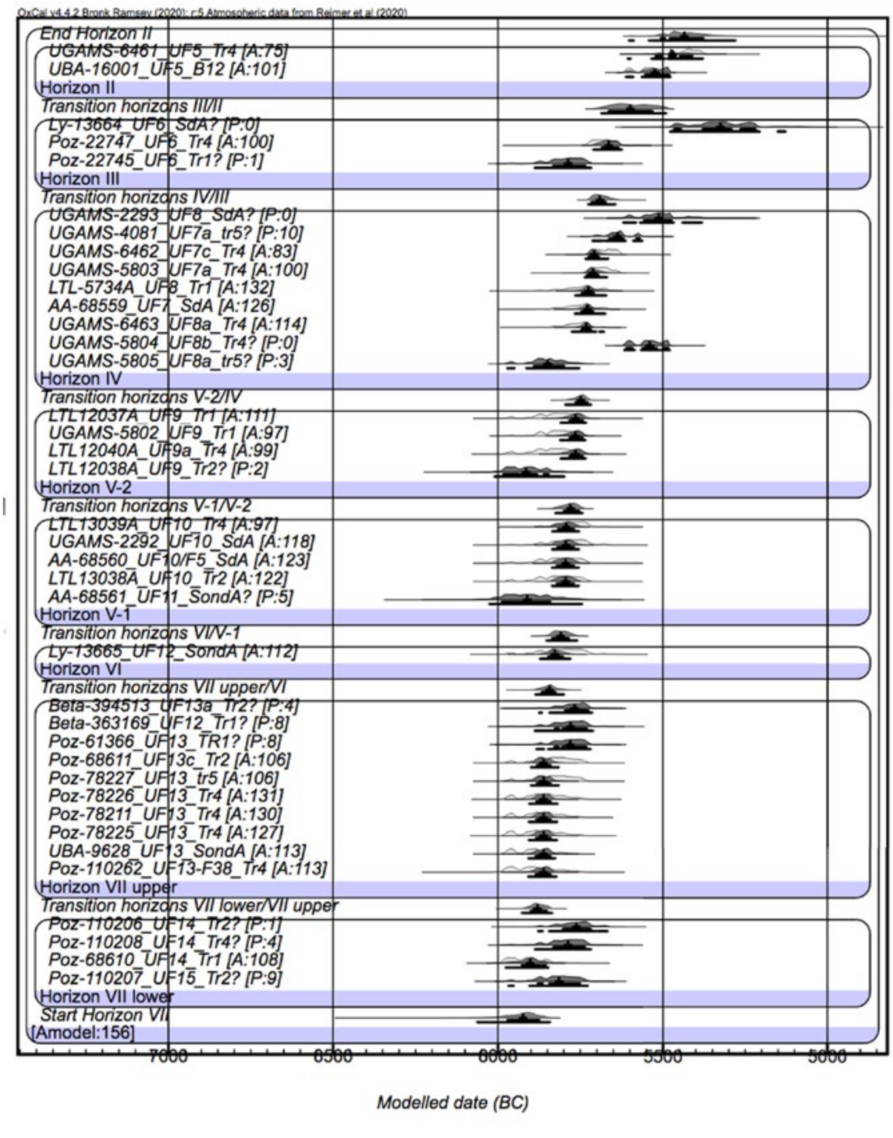


Figure 14. Phase analysis of trenches Tr.1-2, Tr.4-5 and Sond.A: a) Results; b) Multiplot.

Phase analysis of Horizons VII-II in trenches 1 to 8 and Sond.A

In a second stage, we have carried out a Bayesian analysis of 'multiple phases' on all the available data, except for the dates concerning the intrusions of the Bronze Age to the modern period. The corpus consists of 57 dates. As in the preceding stage, the dates that were rejected during sequential analyses of the different trenches were considered to be outliers. Besides the six samples mentioned in the preceding stage, this concerns three samples from Tr.3 (UGAMS-2821, LTL-12039A, Poz-68612) and two samples from Tr.6 (UGAMS-4082 and Poz-70153). Of the 46 remaining dates, the Bayesian analysis rejects 13 of them, nine for horizons VII to IV and four (out of five samples not yet rejected) for horizon III alone. The dates of horizon III all come from different trenches and further sampling in this horizon would be necessary.

The modelling is validated by very high indices: A(model) = 148.2 and A(overall) = 146.4. The results can be summarised in the following table (Figure 15a).

The results obtained by this modelling are very close to those of the first modelling, as much for the lower limit of horizon VII as for the five successive transitions between horizons VII and IV. However, they diverge beginning at the upper stratum of horizon IV. Indeed, as the 'multiplot' of this modelling shows (Figure 15b), horizon IV is composed of two groups of dates: the first situated around 5700 cal BC defined by the samples from trenches 1, 4, 5 and trial trench Sond.A, as well as by a sample from Tr.6, and the second situated around 5600 cal BC consisting of samples from trenches 3, 6, 7 and the baulk between trenches 6 and 8. The latter group provides the reason for the difference between the two results of modelling for the IV/III transition. The absence of this second group of dates in the western part of the excavated zone (Tr.1, 2, 4, 5 and Sond.A) raises questions which could be resolved, either by new dating of the upper strata of horizon IV, or by a thorough examination of the correlations between the different trenches.

Conclusion

The results proposed by the Bayesian modelling should be considered to be bases for reflection, as the excavation of the site continues. These results could be refined by the new dates obtained, especially from the deepest strata of horizon VII (UF14 and UF15) and from the upper horizons.

However, if the results obtained for Aknashen are compared with those from different sites of the Kura basin, which belong to the same Aratashen-Shulaveri-Shomutepe culture, similarities are noticeable (median values are used to allow comparisons with other sites):

- horizon VII of Aknashen (*ca.* 5950-5850 cal BC, median values) would be contemporary to the occupation of the site of Hacı Elamxanlı (*ca.* 5950-5800 cal BC, median values) (Nishiaki *et al.* 2015a); this contemporaneousness is confirmed by several parallels in their material evidence (see Badalyan *et al.* - Conclusion - in this volume)

- the upper stratum of horizon VII (*ca.* 5880-5850 cal BC, median values) would also be contemporary to

Horizons	Modelled dates cal BC (95.4%)	Boundaries	Modelled dates cal BC (95.4%)	Medians cal BC
		Boundary end II	**5539-5325**	**5454**
II	5553-5386			
		Transition III/II	5581-5486	5536
III	5597-5513			
		Transition IV/III	5609-5529	5577
IV	5780-5545			
		Transition V-2/IV	5804-5723	5757
V-upper	5815-5740			
		Transition V-I/V-2	5830-5751	5792
V-lower	5840-5764			
		Transition VI/V-1	5851-5769	5817
VI	5873-5790	flood		
		Transition VII/VI	5886-5806	5843
VII-upper	5906-5823			
		Transition VII lower / upper	5924-5838	5880
VII-lower	5974-5847			
		Boundary start VII	6055-5847	5923

Figure 15. Phase analysis of trenches Tr.1 to Tr.8 and Sond.A: a) Results;

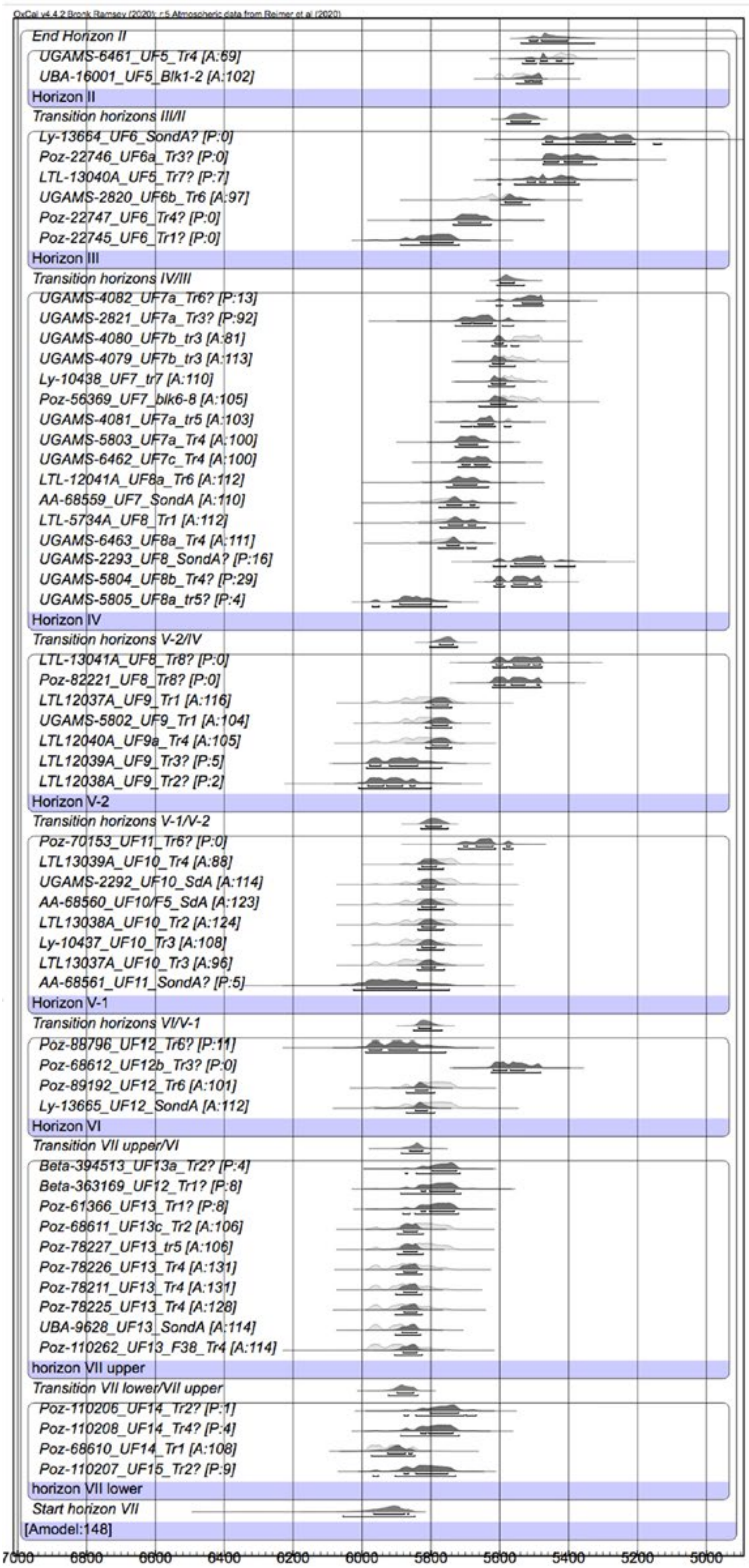


Figure 15: b) Multiplot.

the lower level of Gadachrili Gora (horizon 2; 5880-5840 cal BC, median values) in the Georgian basin of the Kura (Batiuk *et al.* 2017: fig. 4)

- the interruption in the occupation of Aknashen caused by the flood (horizon VI; *ca.* 5850-5810 cal BC, median values) is comparable to the temporary abandonment that has been observed at Gadachrili Gora where a thin sterile layer of green clay separates horizon 2 (5880-5840 cal BC, median values) from horizon 1 (5770-5460 cal BC, median values) (Hamon *et al.* 2016: 155) .

In the inundation level of Aknashen (horizon VI), blocks of obsidian from the Tsaghkunyats range were recovered (Gratuze *et al.* in this volume). These blocks were clearly brought by a strong flood from the river Kasakh, which upstream runs along the Tsaghkunyats range and downstream joins the river Sevjur, which flows near Aknashen. The climatic phenomenon of strong rains which caused this flooding and the overflowing of the palaeolake is part of the context of climate change that began towards the end of the 7th millennium in the Southern Caucasus (Joannin *et al.* 2014; Messager *et al.* 2017): the dry and cold climate of the early Holocene was followed by a milder and especially wetter climate with heavy rainfall in spring. It is therefore possible that episodes of very heavy rainfall correlated with the same climatic disturbance may have affected northern Armenia, where the Kasakh river originates, and the neighbouring region of southern Georgia, where Gadachrili Gora is situated.

Chronological comparisons with other Neolithic sites in the Kura and Araxes basins will be presented in the Conclusion chapter (see Badalyan *et al.* in this volume).

The pottery of Aknashen

Armine Harutyunyan

Introduction

The pottery of the Late Neolithic 'Aratashen-Shulaveri-Shomutepe' culture (dated to the first half of the 6th millennium BC) represents at present the earliest pottery-producing cultural horizon in the South Caucasus (Chataigner *et al.* 2014a). In particular, nearly 9,000 stratified pottery fragments from the Aknashen settlement, located on the Ararat valley, form the earliest known corpus of pottery in the region's material culture sequence. These materials were obtained in the course of the excavation of more than four metres of the cultural deposits of the site, divided into seven horizons. These horizons presented constructions in the cob technique and abundant archaeological materials associated with them (for details, see Badalyan and Harutyunyan in this volume). The radiocarbon dating of the lower six (VII -II) horizons falls within the range of 6000/5950 - 5450/5400 cal. BC (for more details see Chataigner *et al.* – Bayesian analysis – in this volume). The pottery material that was not re-deposited (upper level of horizon V - horizon II) is dated to 5780/5750 - 5450/5400 cal. BC.

The results of the material analyses presented below include not only stratigraphic and morpho-typological data, but also those of archaeometric research: petrographic, chemical and X-ray diffraction. These analyses were also carried out on clay samples from the vicinity. Some strictly preliminary results of these researches have been published elsewhere (Arutyunyan 2008; Arutyunyan and Mnatsakanyan 2010; Badalyan *et al.* 2010; Arutyunyan 2011; Harutyunyan 2014).

Before entering into the description and analysis of the ceramic material, it is important to note that the local population not only had a sound understanding of pyrotechnics and of clay characteristics (plasticity, formability, hardening, thermo-resistance and water resistance), but they also knew that the necessary raw materials were abundant in the Aknashen surroundings and in the wider Ararat valley. Fragments of fired clay, as well as bins built from clay with organic inclusions (cereal threshing products, spicules of oil plants, weeds) by means of coil-building or ring-building, were found in the lower horizons of the settlement. All the architectural constructions in the settlement were made of the same clay mixed with wild plants (for example *Alyssum desertorum)*, dung, threshing waste and straw from cultivated cereals. Moreover, by the time that local ceramic production emerged at Aknashen, its population was already aware of the potter's craft, as evidenced by fragments of imported painted vessels.

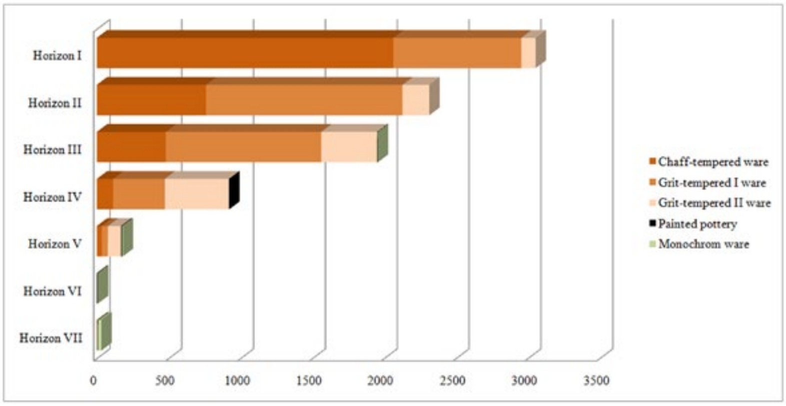
Pottery classification and stratigraphy

During the excavations of 2004-2015, 10,022 pottery fragments were found in the settlement that belong to the Neolithic-Chalcolithic period, to the Early, Middle, Late Bronze and Iron Ages, as well as to the medieval period. As much as 88% of the assemblage (n=8832) is from the Neolithic-Chalcolithic period. All excavated pottery was collected, as well as some non-stratified materials from collapsed baulks and walls. Despite the fact that this material can very easily be assigned to appropriate cultural horizons on typological grounds, non-stratified samples were nevertheless excluded from the statistical analyses, resulting in a sample of 8475 stratified fragments (Figure 1).

Previous typological and archaeometric analyses of the Neolithic-Chalcolithic pottery from the settlements of Aratashen (Palumbi 2007) and Aknashen (Arutyunyan 2008; Arutyunyan and Mnatsakanyan 2010; Arutyunyan 2011; Harutyunyan 2014) have made it possible to distinguish a few ceramic groups from the total corpus, differentiated by morphology and fabric composition. First, a visual inspection revealed two groups: pottery with organic inclusions ('Chaff-tempered'[1] ware) and pottery with mineral inclusions ('Grit-tempered' ware). Then, the pottery with mineral inclusions was differentiated into two sub-groups: 'Grit-tempered I' ware and 'Grit-tempered II' ware. Despite the fact that both grit-tempered groups contain mostly mineral inclusions, there are significant and visually discernible differences in the characteristics of the nonplastic materials, as well as in the technology of production and the surface treatment of the vessels. In addition, petrographic analysis has revealed pores resulting from burnt plant residues in the 'Grit-tempered II' ware.

Apart from the above-mentioned groups, our excavations at Aknashen also uncovered a small

[1] This group, designated 'Chaff-tempered ware', contains plant inclusions in the clay paste. We used the following notations after G. Palumbi, who first described the same pottery from the Neolithic settlement of Aratashen (Palumbi and Badalyan 2005; Palumbi 2007). But it has been noted that the fabric of the pottery from both Aratashen and Aknashen consists of cut plant stalks. Chaff remains (chaff consists of the remains of the envelope of cereal grains) were rarely found and only in small amounts on the outer surfaces of the bases. Moreover, dung was possibly used, but this hypothesis requires more research.



Horizons	Chaff-tempered ware	Grit-tempered I ware	Grit-tempered II ware	Painted pottery	Monochrom ware	Total
I	2064	891	100			**3055**
II	760	1368	187			**2315**
III	481	1081	390	4	1	**1957**
IV	114	360	446	3		**923**
V	35	43	91	7	6	**182**
VI	1			6	3	**10**
VII	1	2		5	25	**33**
Total by horizons	**3456**	**3745**	**1214**	**25**	**35**	**8475**
Unstratified sherds	210	125	21	1		**357**
Total	**3666**	**3870**	**1235**	**26**	**35**	**8832**

Figure 1. Distribution of the Neolithic-Chalcolithic pottery of Aknashen by horizons.

amount of painted and monochrome pottery sherds of high quality that were obviously imported, which is confirmed by clay analyses (see below). The latter are represented by two types: brown-black polished pottery with small sandy inclusions and light beige, reddish-pink fragments with organic temper. Figure 1 presents the distribution of Akanashen Neolithic - Chalcolithic pottery excavated between 2004 and 2015 according to groups and horizons:

- pottery with organic inclusions – Chaff-tempered ware – 3666 fragments (41.5% of total amount of the Neolithic-Chalcolithic pottery);
- pottery with mineral inclusions – Grit-tempered I ware – 3870 fragments (43.8%);
- pottery with mineral and organic inclusions – Grit-tempered II ware – 1235 fragments (14.0%).
- painted imported pottery - 26 fragments (0.3%).
- monochrome imported pottery - 35 fragments (0.4%).

In the determination of the stratigraphic distribution of the analysed pottery examined from the top (horizon I) to the bottom (horizon VII), it is important to note that the upper layers of the settlement mound are highly disturbed, in some places to a depth of 2 metres (horizon I, and II in part), by later intrusive burials and re-digging. Such disturbances partly distort the stratigraphy and, correspondingly, the statistics of pottery distribution in relation to the horizons. In general, all pottery groups are encountered across the full depth of the cultural layer. Still, it is clear that pottery with organic inclusions makes up an absolute majority only in horizon I (0 to 1.56m). In all the other horizons the quantities decrease sharply (Figure 1). Moreover, because of disturbance, the pottery of the Chaff-tempered group cannot be associated with any buildings or contexts. Only in Sond.B UF3 F1 was a large cone-shaped vessel preserved *in situ* with triple almond-shaped knobs along the outer edge of the rim (Figure 4: 12).

Sondage A produced the clearest stratigraphic distribution of pottery. A comparative analysis of the pottery in two parts of the sounding, one distorted by intrusive burials of the Late Bronze Age (A) and another undisturbed by intrusions (A'), observed from the top to the bottom, showed clearly that there was a smooth shift over time from organic inclusions to mineral inclusions. Also, and starting with UF6[2] (Horizon III) Grit-tempered II pottery begins to predominate. At the same time, as can be seen in Figure 2, there is a sharp decrease in pottery density at deeper levels. The proportionality of the excavated areas in Sond.A and Sond.A' ensures that the comparison is sound (Figure 2).

Beginning in Horizon II, the pottery with mineral inclusions starts to increase in relation to chaff. Horizon

[2] UF means 'Unité de Fouille' or 'Unit of Excavation'.

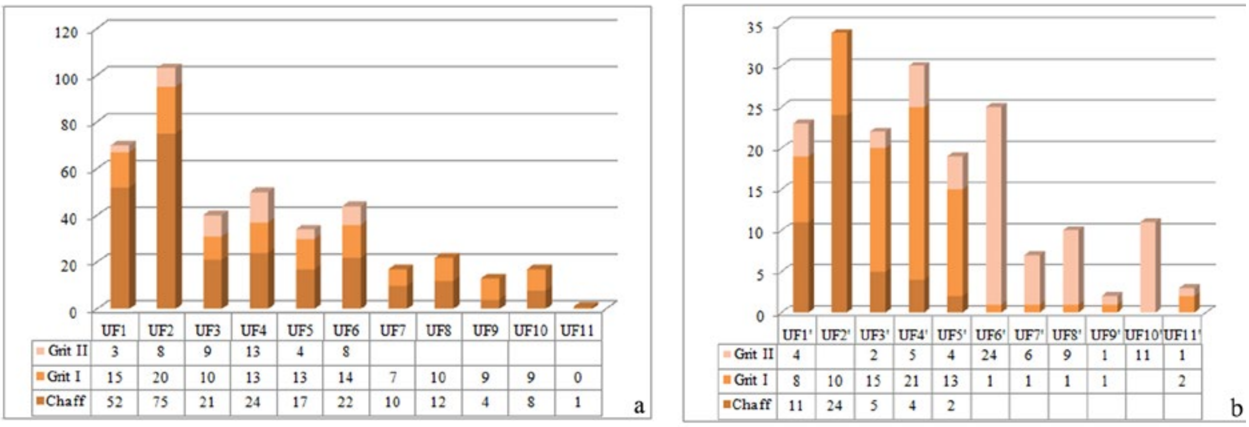


Figure 2. Distribution of pottery by UF-s: a) in Sondage A excavated in 2004-05; b) in Sondage A' excavated in 2006.

III occupies a special place in the settlement's history, as it presents evidence for an event that resulted in the settlement's temporary abandonment between horizons III and II. Widespread finds of examples of Grit-tempered I (Figures 7 and 8) and Grit-tempered II (Figure 9) groups, found *in situ* within destroyed mud-brick buildings, provide further evidence. The amount of pottery with mineral inclusions within that period sharply increases relative to Chaff-tempered ware, and by Horizon IV, pottery with mineral inclusions predominates. In Horizon IV, the density of the pottery found decreases by half compared to Horizon III; most fragments (generally Grit-tempered I to Grit-tempered II) are concentrated among the remains of mud-brick constructions. In Horizon V, the pottery was mostly concentrated in the final period of the horizon (UF 9). The sherds were found in association with thick clay deposits, probably natural, and collapsed constructions.

Horizons VI and VII are, with respect to pottery, crucially different from the horizons above; here, there is a sharp decrease due to the virtual disappearance of the local Grit-tempered II pottery. At the same time, although imported painted pottery is quite equally distributed across horizons III to VII, in horizons VI and VII it is dominant. And examples of monochrome pottery appear for the first time. Because of the small amount and size of the fragments, neither reliable cultural attribution nor layer-by-layer typological analysis is possible. Nevertheless, it is obvious that samples from Horizons VI and VII are different from the pottery of the horizons above them.

Analysis of the stratigraphic distribution of the pottery also takes into account sherd size and vessel representation. Thus, Chaff-tempered pottery found in the upper horizons is represented either by relatively large sherds or multiple sherds belonging to the same vessel, and thus probably belongs within that horizon, while small-sized sherds found in Horizon V are probably associated with animal burrows or other kinds of disturbance. Grit-tempered I ware is, as expected, well preserved in Horizons III and II. Grit-tempered II ware is more fragmented compared to other groups; most examples that can be restored are from Horizons III and IV. This pottery predominates in Horizon V.

In addition, we present a brief description of the above-mentioned groups of pottery identified according to their features (morphology, technique and technology, etc.).

Chaff-tempered ware

Pottery with organic inclusions ('Chaff-tempered' ware, Figures 3 and 4) is quite diverse and represented by bowls and basins with a round base and vertical or slightly excurved walls with a straight-cut or tapering edge, closed spherical jars, and pots with a relatively low neck and flat base.

Characteristics

These vessels were built by hand, either by spiral coiling or ring/slab-building technique.[3] Most vessels are well made, with slipped and polished surfaces. Interior and exterior surfaces have clear remains of burnt plant remains, but traces of hand modelling are difficult to find. There are rare examples of sherds that are broken at the joins between coils or slabs, making it possible to see either an overlapping of elements (an overlapping thickness of roughly one finger's width (Figure 12: 13) or directly abutting slabs that were then smoothed and plastered. Sherds often present traces of comb indentation, a particularity of Chalcolithic pottery of the region, which many researchers consider to be a type of decoration. I assume, following other researchers (Lyonnet *et al.* 2012, footnote 198), that, in addition to their decorative function, the comb marks are an aspect of surface refinement, serving to level

[3] It is very difficult to discern spiral coiling due to the fragmentary nature of the pottery, but this method of modelling is in evidence on a large jug from Aratashen (AR.00.K.82).

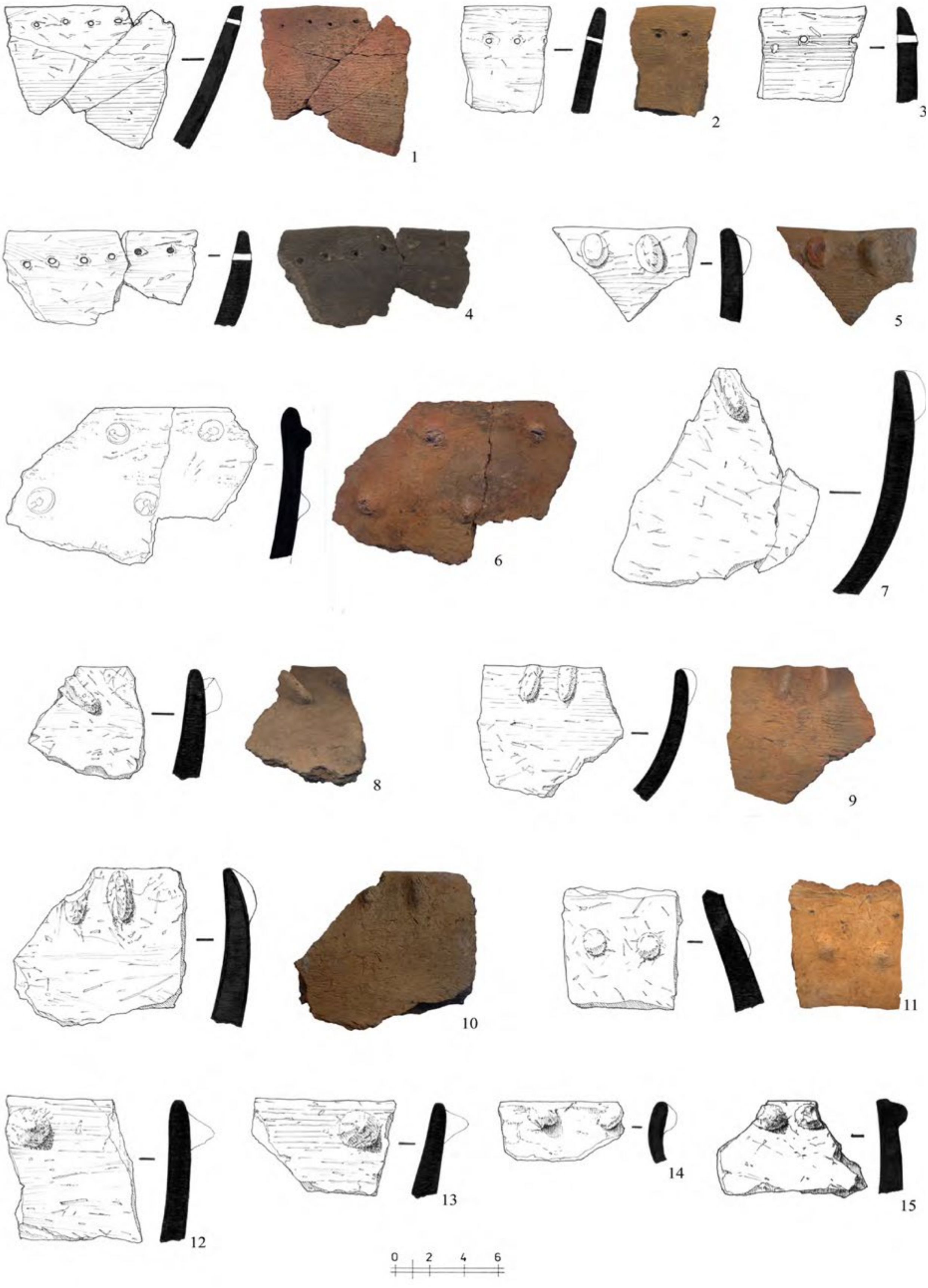


Figure 3. Pottery of the Chaff-tempered group: (1, 4, 7-8, 12-15) Horizon I; (2-3, 5-6, 10) Horizon II; (9) Horizon IV; (11) Horizon V.

Figure 4. Pottery of the Chaff-tempered group: (1-4, 6-12) Horizon I; (5) Horizon II.

and compact the surface of the vessel, after which it was polished and covered with a thin layer of slip. On the pottery of Aknashen it is often possible to see comb traces beneath an eroded slip. The only complete large vessel, the above-mentioned vessel found *in situ* in the layer that was later disrupted by burials, is decorated on the external edge of the rim with four groups of three almond-shaped knobs (Sondage B, Figure 4: 12). Preserved on the surface of this vessel, which was clearly fabricated using slab construction, there are traces of comb indentation and polishing.

The surface colours of vessels vary from different shades of pink-red to brown to grey, and more rarely, blackish. Colours on the interior tend to be brighter than those of the exterior. Bands within the fabric, visible in sherd sections, consist of one colour or several. The fabrics are more or less coarse-grained with many pores from plant remains (Figure 12: 9-12). Sherds with mottled surfaces and tri-coloured bands with grey-black cores seen in the fabric profile of sherd fractures indicate insufficient and uneven firing,[4] with temperatures reaching only 450 to 600°C, rarely as high as 800°C (Arutyunyan and Mnatsakanyan 2010: 217). No traces of kiln firing in the settlement were found. Apparently, firing was carried out in fire-pits outside the hill. For small vessels, firing could also have taken place in small pits/fireplaces dug indoors or outside and filled with ashy earth.

As mentioned above, there are two main vessel forms: bowls and pots. The bowls usually have thin walls (0.3 to 1.2cm thick), depending on the size, with round or flat bases. They are differentiated by size (from small cups to deep bowls) and the degree of openness of the rim (Figure 3: 1-10, 12, 13, 15; Figure 4: 10-12).

Short-necked pots, with necks that are almost cylindrical or widening outward, apparently have round bodies and flat bases, as shown by many fragmented parts of such pots (Figure 3: 11, 14; Figure 4: 1-2, 4, 7-9). Given that full vessel profiles are not available, overall morphological reconstructions are often partial. The correlation of bowls to pots remains stable regardless of the degree of layer disturbance or the quantity of analysed fragments (about 10% of the total assemblage). For example, as shown in Figure 6, the number of bowls found within four excavation units (Trenches 9-12) is almost four times higher than that of pots (77 to 87% and 23 to 13% respectively).

Apart from these shapes, there are some sherds from round closed vessels, the so-called hole-mouth jars (Figure 4: 3), and flat, thick plates or trays with polished inner surfaces and roughly processed outer surfaces. Sherds measuring between 2.5 and 2.8cm in thickness, belonging to huge storage jars, are rarely encountered.

Other examples that have not been previously recorded[5] at Aknashen were found along with the Chaff-tempered group in Sondages C and D, located outside the hill (Sondage C, 100m east from the top of the settlement mound, and Sondage D, 220 m), at a depth of 155-175cm below the modern surface, under a fully sterile layer. Sherds (n=125) that have plant and mineral inclusions in the fabric are represented by body fragments of thick-walled vessels, which, along with the organic inclusions contain large quantities of sand particles of average size. The colours of the vessels vary from different shades of pink-red to light brown. The few diagnostic fragments are sherds from flat-bottomed vessels (sometimes called 'pans') with perforations below the rim (Sondage D, UF 4, Figure 5: 3, 4) and rims with notches along their edges[6] (Sondage C, UF 4, Figure 5: 6). This pottery does not occur in the main part of the Aknashen settlement, but it is similar to pottery of the Chaff-Grit-tempered group in Aratashen (Figure 5: 7-12; Palumbi 2007: 68), which is concentrated mostly in horizon 0, being more rare in horizon I.

Some Chaff-tempered pottery, mostly bowls, are either decorated on the outer edge of the rim with conical, almond-shaped and pineal protuberances or knobs (Figure 3: 5-15; Figure 4: 12), or have perforations below the rim edge (Figure 3: 1-4). On two fragments, which apparently come from pots, such knobs are located on the shoulders (Figure 3: 11). Figure 6 shows the distribution of decorated pottery by horizon (the analysis is based on four trenches, T9 to T12). As shown in horizon I, where the largest quantity of pottery was found, bowl rims with knob decoration make up 10% of the analysed fragments, those with perforations beneath the rim edge 13%; in horizon II, bowl rims with knob decoration make up 5% and those with perforations beneath the rim 20%, while in horizon III the percentages are 15% and 30% respectively. However, it is not possible to reach any conclusions concerning the chronological sequence of the two types of decoration, or the development of the vessel shapes, because the available dataset is not complete, and because of disturbances in the upper layers of the site.

There are only two sherds with incised herringbone decoration on the shoulders (Figure 4: 2); in one case this decoration is combined with rounded knobs (Figure

[4] Different factors affect the colours on the surface and within the interior profile bands of the fabric. They can vary significantly within one jar, which is not atypical of open-air firing in which the gas environment is unstable (Volkova and Tsetlin 2015).

[5] More detailed analysis of the pottery from the upper horizons is needed, because among the samples of the 'Chaff-tempered' group that were selected for petrographic analysis, fragments containing very large quantities of small sand grains (calcite or limestone) are present. The firing temperature could have reached 800°C.

[6] The samples are too small to determine diameter, and none are perforated.

Figure 5. (1-6) Pottery of the Chaff-tempered group from the Soundings C and D; (7-12) Fragments of rims of vessels from Aratashen, with various notches along the edge.

	Total	Diagnostic sherds	Bowls	Pots	Sherds of bowls ornamented with knobs	Sherds of bowls ornamented with perforations
Horizon I	350	38	30	8	3	4
Horizon II	264	26	20	6	1	4
Horizon III	143	15	13	2	2	4

Figure 6. Chaff-tempered pottery excavated in the trenches 9-12 in 2015.

4: 6). There are also two rim fragments with notches of different shapes placed on the rim.

Petrographic description

Fifty samples of Chaff-tempered ware were subjected to petrographic analysis.[7] The main results are summarised below.

The clay contains organic inclusions, presumably chopped straw, crop-processing waste and animal dung. Both small and large tempering materials as well as sandy admixture were used for thin-walled vessels (0.3-1.2cm) and for medium and large vessels

[7] Petrographic analyses of the pottery from Aknashen were conducted in 2007–2008 (grant from Project Discovery, No. 2007-RC-004), and in 2011–2012 (grant from the National Committee of Science of the Ministry of Science and Education, RA 'The Origins and Development of the Ceramic Production in Armenia (the Neolithic period – Early Bronze Age)', 11–6a635). The analyses were carried out at the Institute of Geological Sciences of the National Academy of Sciences of Armenia.

(1.3-2cm). The content of organic temper is between 10-12% and 30-37% (rarely 45-48%). The content of macrofragmental sand inclusions is low (5-6% to 15-16%), but in rare cases is as much as 25-33%. In the composition of the sand fraction, cenotypal dolerites, dacites, andesites and small amounts of old rocks (granites, quartzites, epidozites, quartz porphyry) are predominant (Figure 11: 9-12; Figure 12: 9-12).The role of vitroclasts is comparatively small. These are fresh samples of volcanic glasses of acidic composition and form typical acute-angled shapes. The sources of these volcanic glasses are tuff-ignimbrites and unlithified tuff sands of the Aragats region. There are single fragments of fluidal obsidian among numerous vitroclasts. The limited amount of grog used as a sandy admixture is combined with palaeotypal lithoclasts (Arutyunyan and Mnatsakanyan 2010). The matrix contains an unbroken clay-ashy cryptofibrous aggregate with no traces of the transition of the clayey minerals into the glassy phase. The clay-ashy component contains numerous remnants of shells and diatom valves (*Stephanodiscus astraea, St. kanitzii, Melosira scabrosa, Diatoma niemale*) consisting of isotropic opal, numerous spicules and single flagellates. The isotropic opal in the matrix indicates that the firing temperature was 450-600°C. Some samples with cryptocrystalline calcite stand out. They are slightly welded and the initial disassociation of calcite indicates the higher temperature of firing (~800°C).

Grit-tempered I ware

The pottery of the 'Grit-tempered I' group is coarser in composition and shaping technique. It is represented by barrel-shaped and cylindrical vessels with flat wide bases and pronounced, bulging transitions to the walls, sometimes with rounded shoulders and simple, straight-cut, round or sharp rim edges (Figures 7 and 8).

Characteristics

The small and large vessels are mostly of the same type. The sherds are very compact, with bumpy surfaces and easily observed fragments of grog and rock debris surrounded by star-shaped cracks. The jars are constructed with clay coils or slabs, 2 to 10cm wide or more (depending on vessel size). They were built up from the bottom, the flattened edges forming the base for the next build-up of the coils. Imprints of small sand particles or plant remains (straw, chaff, seeds) are rarely visible on the outer surface of the bases. Apparently these materials were sprinkled over the surface as the vessels were shaped. Impressions of wicker (basket) on the bottoms, known from the Shulaveri material (Javakhishvili *et al.* 1975: Fig. 48: 6-7), exist on only two samples from Aknashen (Figure 8: 2). The coil/slab building technique is clearly visible at the junction of elements (there are visible traces of fingerprints from flattening; Figure 12: 14). The collection contains many fragments broken along joins, as well as sherds with cracks along the slabs. Wall thickness is more or less standard, at 0.5 to 1.0/0.9 to 1.2cm, regardless of vessel size. The exterior finish is rough, with no additional slip or polishing. Surface colours vary from pink to red-brown to grey and spotted black. In the section, sherds have a single colour, rarely two or three colours, including a grey core, the grain is average to coarse, lumpy, often containing large basalt inclusions, as well as grog particles (as much as 2 to 3mm) (Figure 12: 1-4). The firing temperature was 450 to 600°C. The pottery differs only in size, rarely in the absence of bulge on the bases or in the degree of concavity of the profile. There is no decoration. Some rims and bases clearly belong to oval-shaped vessels, which makes the reconstruction of their sizes more difficult. But unlike the pottery with organic inclusions, this group contains several complete or partially restorable vessels.

This pottery group is morphologically comparable to material on sites of the Kura and Araxes basins as well as on many Near Eastern sites. Any variation depends upon the nature of the nonplastic materials. In the north, in the Shulaveri-Shomutepe group (Javakhishvili *et al.* 1975; Narimanov 1987; Hansen *et al.* 2006; Lyonnet *et al.* 2012, Akhundov 2013), these are mineral inclusions, whereas in the south, in Nakhichevan Kültepe (Abibullaev 1982; Marro *et al.* 2019) and south-east, in the Kamiltepe area (Lyonnet *et al.* 2012: 37-47), chaff and other organic tempering materials were used.

Some large conical or cylindrical lugs (Figure 8: 2, 4-7), applied horizontally to the upper part of a body, bring a little diversity to the repertoire. Comparable material exists, particularly in the chaff-tempered pottery from Kültepe I (Abibullaev 1982: Plate X: 1; XI: 12), Chalaghantepe (Narimanov 1987: Fig. 46), Alikemektepesi (Masson *et al.* 1982: Plate XLV: 2), and in the pottery with mineral inclusions from Arukhlo (Chelidze and Gogelia 2004: Plate XXXVI: 2; Plate XXXVIII: 6,7; Hansen *et al.* 2006: Abb. 39; Hansen *et al.* 2007b: Abb. 26).

Petrographic description

Based on the quantitative petrographic examination of 50 samples, the paste of the pottery of this group contains macrofragmental sandy admixture (5-15%, 15-25%, 25-35%, 35-45%), sometimes very large in size (up to 0.5-0.9cm), which has caused the surface of the vessels to be covered with star-shaped cracks (Figure 12: 1-4; Figure 13: 1-4). In the composition of lithoclasts, palaeotypal andesites, acidic volcanic rocks (including tuffs), old granites, quartzites, as well as cenotypal olivine basalts, andesites, rhyodacites, vitroclastic tuffs have been observed (Arutyunyan and Mnatsakanyan 2010). Important among the tempers is the grog (Figure 12: 2-3; Figure 13: 2), the content of which is as

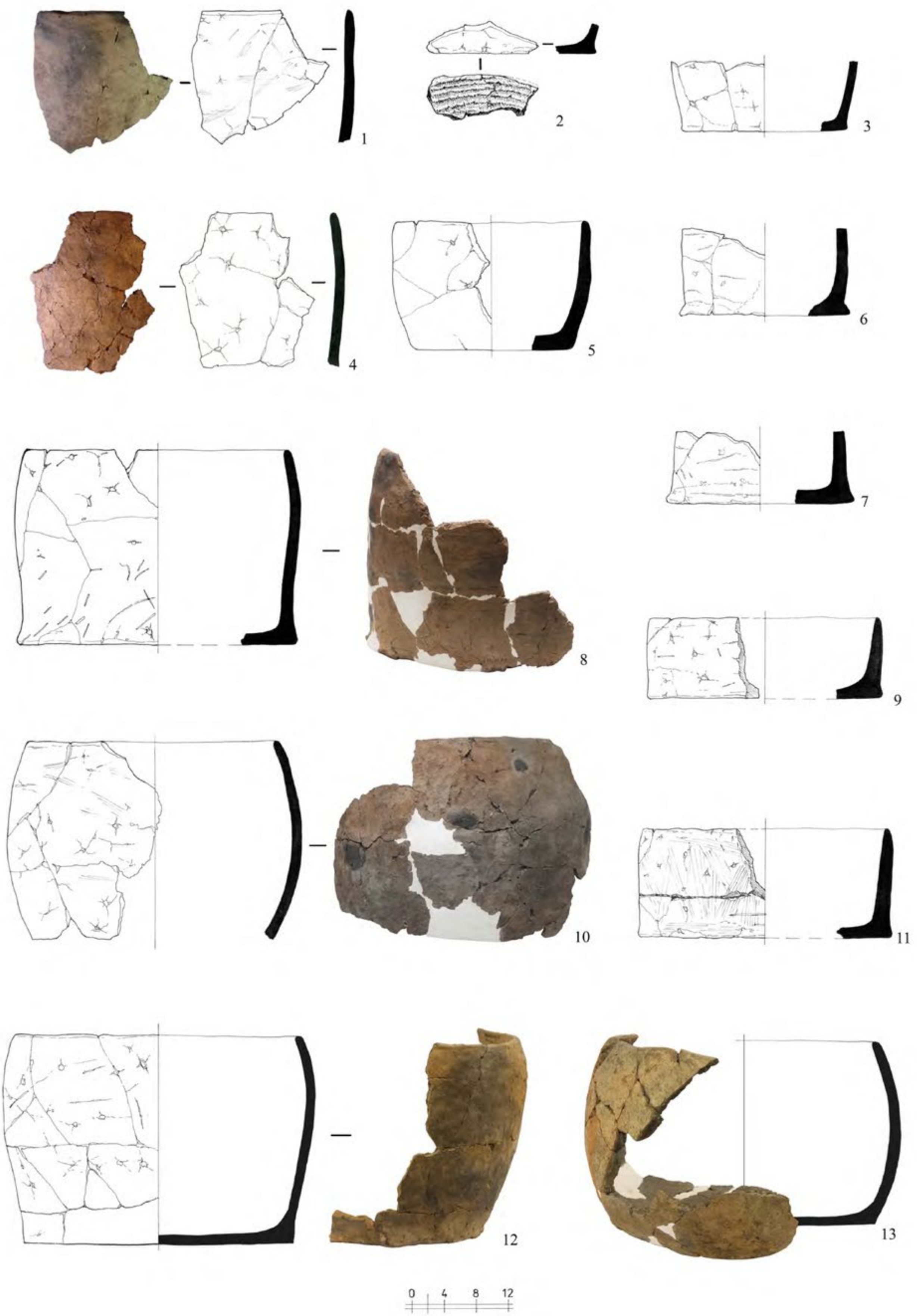


Figure 7. Pottery of the Grit-tempered I group: (1-5, 8, 11) Horizon II; (6-7, 9) Horizon I; (10, 12-13) Horizon III.

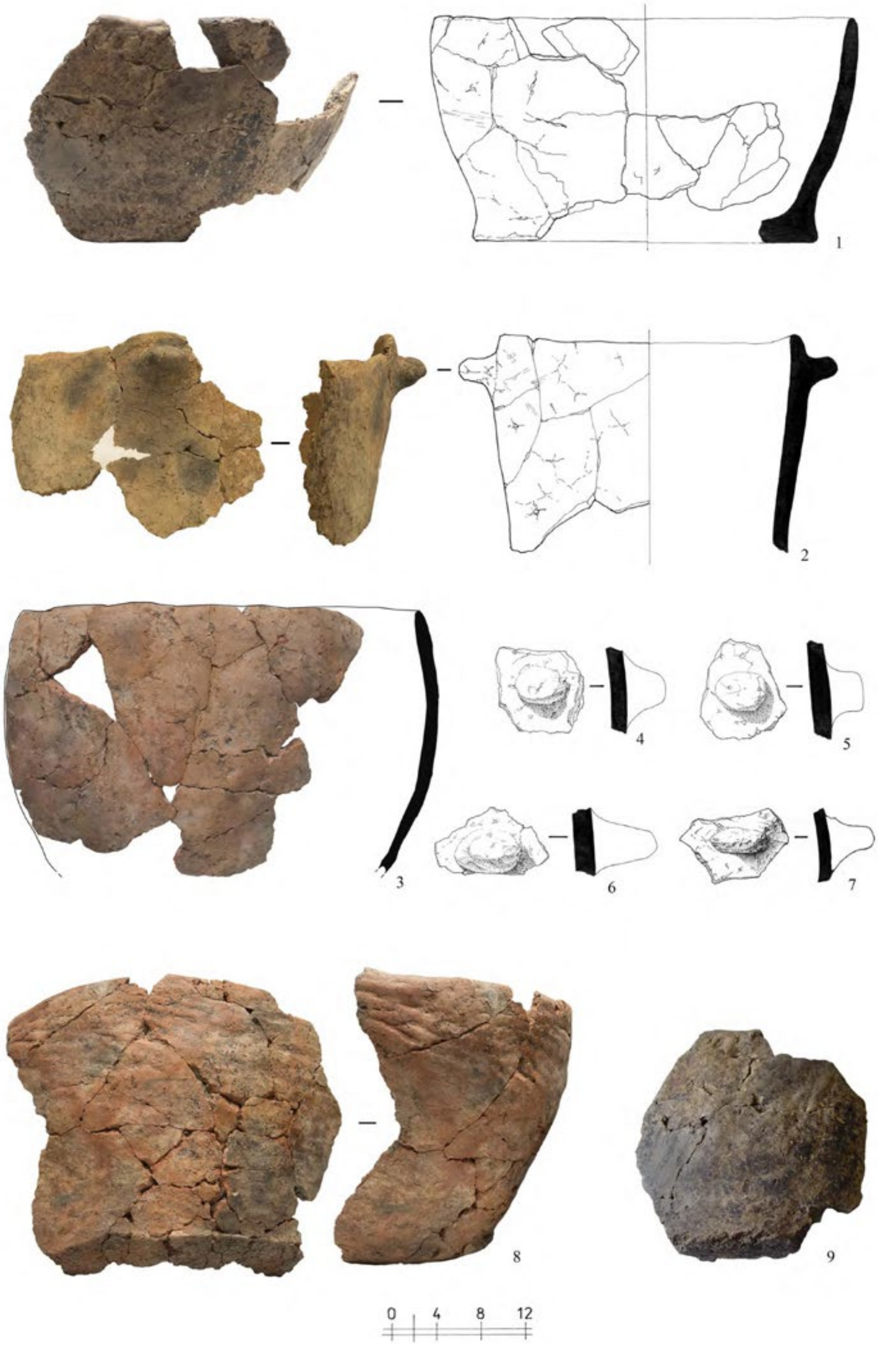


Figure 8. Pottery of the Grit-tempered I group: (1, 3, 9) Horizon III; (2, 4-7) Horizon I; (8) Horizon II.

much as 20-23%, sometimes 44-45%. In such cases, it is a substitute for macrofragmental sandy admixture. For the rock fragments the cohesiveness with the clay matrix is complete and the contacts are sharp, but the grog is almost always separated by fine cracks. Blurred boundaries, phenomena of resorption, corrosion, indicate a low temperature firing and the cracking that resulted from refiring (Glushkov 1996). It should be noted that 42% of the analysed samples contain a sand inclusion of 5-15%, which corresponds to the content of the natural admixture in the clay. Apparently, for groups with a higher content of tempering materials, a paste consisting of two kinds of clay was made. In the composition of crystalloclasts, plagioclase originated from geological formations of different ages, while old, palaeotype volcanic rocks predominate. Clinopyroxene and quartz are also present. The vitroclastic material is associated with widely developed coverings of acid ignimbrite tuffs which are interlayered with unlithified tuff sands in the region. The silty-argillaceous matrix has an unbroken clay-ashy cryptofibrous base as a result of comparatively slight thermal transformations over a short firing period. The abundant admixture of acidic ash material in the clay cement is a characteristic feature of this group. The admixture of organic material in the form of shells and diatom valves filled by fresh isotropic opal is also typical for the group (Figure 13: 4). The amount of pores in the group as a whole is small (5-12%). The pores are closed and surrounded by a thin band of oxidation, which characterises a lean-clay ceramic paste. Based on the texture of the clay cement, the fresh appearance of the crystalloclasts, the absence of neogenic cracks (and mineral phases) and the presence of numerous remnants of algae composed of isotropic opal, the firing temperature can be considered as not higher than 450-600° C since these values correspond to the beginning of dehydration for opal (complete dehydration of opal occurs at 700° C). In addition, the samples of this group are characterised by a short firing interval, when glass formation conditions are not yet achieved.

Grit-tempered II ware

Characteristics

The 'Grit-tempered II' group is represented by deep bowls, small bowls, cups of cylindrical form and hole-mouth jars with flat bases (Figure 9: 4, 6-11), low-necked jars with smooth transition from walls to neck, and simple straight-cut or tapering rims (Figure 9: 2-3, 5). In contrast to 'Grit-tempered I' ware, the bulge on the base is absent; the walls are rounded, transitioning smoothly to the base. This pottery is distinguished by finer workmanship. The fabrics are well-processed and cleaned of impurities. The surfaces are smoothed, covered with 'engobe' or slip (liquid clay of thinner composition) and well polished. The thickness of the fragments varies from 0.5-1.0 to 0.9-1.2cm. The surface colours are homogeneous, with mostly light exteriors in shades of red-yellow-brown colour and darker, grey-black interiors. The fracture is rough, with average to small-grained (1 to 1.5mm) inclusions and small multi-directional cracks. The section is often banded, with thin edges repeating the colour of the external and internal surfaces, and dark-grey cores (Figure 12: 5-8). The pottery appears to be coil-built, but unlike for 'Grit-tempered I' ware, it is very difficult to visually define the size of the coils/slabs. The most interesting find of this group is from horizon IV (Ak.2011, Tr.3, UF 8, F13, Figure 9: 1). It is a large vessel with an oval-shaped body (26.5 x 39cm in diameter, 11.8cm high) and a flat base. The walls of the slightly rounded body smoothly transition to the base. A horizontal spout is placed in the middle of the body on one side. While oval-shaped jars and bowls are known in the 'Aratashen-Shulaveri-Shomutepe' culture (Kiguradze 1976: 162; Fig. 39: 2; Fig. 40: 17), examples of pottery comparable and contemporary to this jar in the region are unknown to the author. Jars with spouts on the body are also known on Halafian sites, for example Yarim Tepe II in north-west Iraq (Munchaev and Merpert 1981: 237, Fig. 83: 4; Merpert and Munchaev 1973: pl. XLIV: 3, 7, 8) and Tell Zeidan in the Euphrates river valley of north-central Syria (Stein 2009-2010: Fig. 4). Similar spouted bowls and jars of chaff-tempered pottery were excavated at the sites of Ahrendjan Tepe and Qara Tepe in the Salmas plain in north-west Iran (Ajorloo 2016: Fig. 3). According to this last author, the pottery from these sites is closely related to the Hajji Firuz pottery tradition, in which, however, there are no spouted vessels. The author established a relation between the presence of spouted vessels and the production and use of dairy products (Ajorloo 2016: 152-153), in contrast to the husking trays, pithoi and wide-mouth jars common on Neolithic sites of northern Mesopotamia that would be related to agricultural activities.

Petrographic description

The pottery of this group (46 samples analysed) is characterised mainly by the brecciated structure of the clay paste, seen in the presence of fragments and separations of light dispersed clay (or hydromicaceous material) (Figure 13: 5-8). The matrix is mainly characterised by the opacitised hydromicaceous aggregate burned to various degrees. This aggregate has a cryptofibrous, flaky structure with a small portion of silt admixture, an almost complete absence of volcanic ash and no traces of vitrification. The natural sand fraction consists of crystalloclasts, lesser amounts of lithoclasts formed during the destruction and erosion of old granites, quartzites, lesser amounts of the newest obsidians and volcanic glasses. Another characteristic feature is the widespread presence (sometimes as much as 5-7%) of grog, present as a low-temperature form with indistinct, sinuous boundaries, and as a high-temperature form with clear boundaries and cracks along the contour (Figure 13: 6). The pottery contains a small amount of organic material which is very small in size, indicated by complex pores and voids (15-28%) corresponding to the outlines of plant remains. The remnants of diatoms, typical both for the natural clays of the region and for the entire pottery assemblage of the settlement, are rare in this group. The dissociation of opal, which together with other mineralogical criteria (e.g. initial vitrification, fluid phase) may suggest a higher firing temperature in the range of 600-650° C, in some cases 700-750° C, and the firing conditions could have been both reducing and moderately oxidizing, or reducing with a periodic moderate or low access of oxygen.

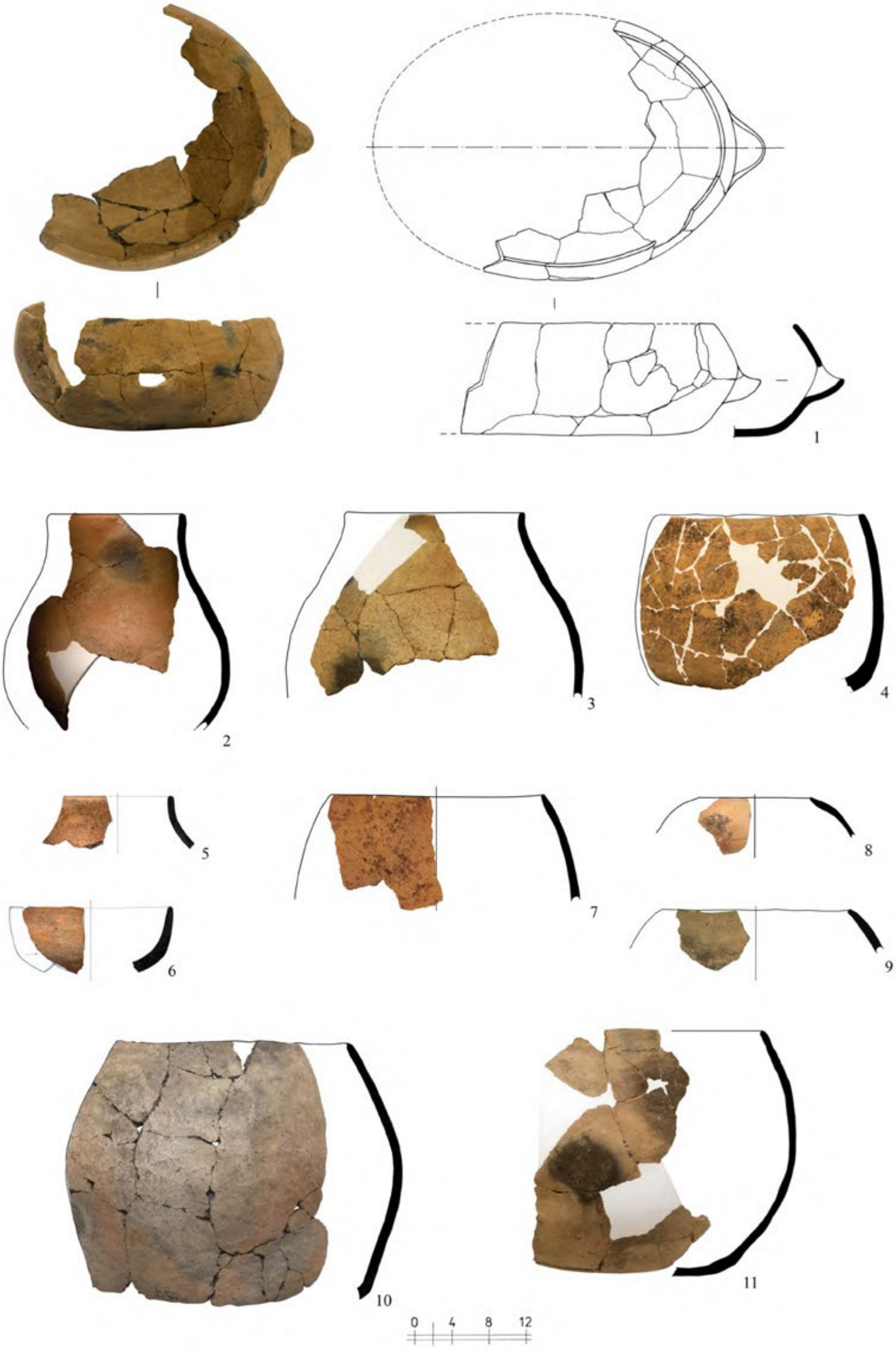


Figure 9. Pottery of the Grit-tempered II group: (1-2, 4) Horizon IV; (3, 9, 11) Horizon III-IV; (8, 10) Horizon III; (6-7) Horizon II; (5) Horizon I.

Imported pottery

Characteristics

The excavations produced 25 fragments of high-quality vessels. These differ from the overall mass of Aknashen pottery by their thinness, the homogeneity and purity of the fabric, the surface colour and the presence of painted decoration (Figure 10a). Another 30 high-quality fragments do not cluster with any of the groups of Aknashen pottery. This last group, in contrast to the previous one, is conventionally called monochrome. Its external features and the composition of the clay paste divide it into two sub-groups.

Figure 10b presents the distribution of painted pottery by horizon. As shown, painted pottery is found only in horizons III – VII, in similar amounts. But, as mentioned above, in horizons VI and VII painted pottery makes up a significant proportion of the corpus, at 60% and 15% respectively.

Even at first sight, the heterogeneity of the Aknashen collection with regard to colour and painted motifs (Figure 10a) is apparent. It would appear that the fragments belong to different cultural traditions. But because of the small quantity and size of the fragments, secure cultural attribution as well as typological analysis by layer are difficult. It is very likely that the vessels from horizons III-IV with red paint on a reddish-yellow background (Figure 10a: 2, 5) and those with black or dark-brown paint on a grey-beige and olive background (Figure 10a: 9-11) belong to the Halaf culture (Badalyan *et al.* 2010: 194). Considering that there are similar examples from Aratashen (Palumbi 2007) and Nakhichevan Kültepe I (Abibullaev 1982: 72-75; Masson *et al.* 1982: 117,120; Narimanov 1987), it is becoming increasingly clear that, among imported wares, the Halaf tradition dominates on sites along the Araxes river (Chataigner *et al.* 2014a). One possible source could be Tilkitepe, a settlement with clear connections to the Ararat valley, judging by group 3a obsidian from Aratashen (Badalyan 2010). Apart from this, some fragments are similar to painted pottery of the Samarra type (Figure 10a: 7, 8; Akkermans and Schwartz 2003: Fig. 4.21) in its later stages, when pottery of Samarra style was widespread not only in central Mesopotamia, but also in the wider region, from the

Hor.	Reference number	Surface colour	Paint colour	Description	Figure
III	Ak07.T3.UF6b	light gray 5Y 7/2	very dark gray 5Y 3/1	A fragment of the rim ornamented on the interior edge by combined triangles	10: 1
III	Ak08.T8.UF 4	reddish yellow 7.5YR 7/6	red 2.5YR 5/8	A fragment of the neck (?) ornamented with the crossed lines	10: 2
III	Ak08.T5.UF6	light brownish gray 2.5Y 6/2	black 2,5Y 2.5/1	A fragment of the body, decorated with 4 parallel oblique lines, 3.7-4.5 mm width	10: 3
III	Ak09.T1.UF6.str.4	white 5Y 8/1	very dark gray 5Y 3/1	A fragment of the body, decorated with 2-3 horizontal lines, 5 mm width	10: 4
IV	Ak08.T8.UF 5	reddish yellow 7.5YR 7/6	red 2.5YR 5/8	A fragment of the body/neck (?) ornamented with the crossed lines (possibly can be joined to AK08.Tr.8.UF 5)	10: 5
IV	Ak08.T7.UF5b	gray 2.5 6/1	black Gley 1 2.5/N	A fragment of the body ornamented with inscribed into each other triangles, partly hatched	10: 6
IV	Ak09.T2.UF8a	light gray 5Y 7/2	very dark gray 5Y 3/1; pale olive 5Y 6/4	A carinated body sherd decorated with direct hatching	10: 7
IV	Ak11.T5.UF8c/9c.F 9	ext.: pale yellow 5Y 7/3; int.: light gray5Y 7/2		Unpainted body sherd	-------
V	Ak11.T3.UF9	very pale brown 10YR 7/3		Unpainted body sherd	-------
V	Ak.14.T7.10	Ext.: pale yellow 2.5Y 7/3; Int.: pale brown 10YR 6/3	Dark gray 2.5Y 4/1	A fragent of the carinated body decorated with three rows of obligue zigzags filled of cross-hatching .	10: 8
V	Ak.14.T7.9	Ext.: reddish yellow 7.5YR 7/6; Int.: reddish yellow 5YR 6/6	Dark brown 7.5YR 3/2	A fragment of the shoulder decoreted with two or three parallel bands on the perimeter.	10: 9
V	Aĸ12.T5.10b	Ext.: very pale brown 10YR 7/3 Interior: pale brown 10YR 6/3	Exterior paint: black Gley 1 2.5/N Interior paint: light olive brown 2.5Y 5/3	A fragment of the neck with poorly preserved decoration of oblique hatching. On interior parallel vertical lines are visible.	10: 10
V	Ak11.T4.9a	Grayish brown – 10YR 5/2	Black – Gley 1 2.5/N	A fragment of the shoulder decorated with vertical lines, dots and fish-shape figure	10: 11

Figure 10a. Imported pottery: description (nos. 1-11).

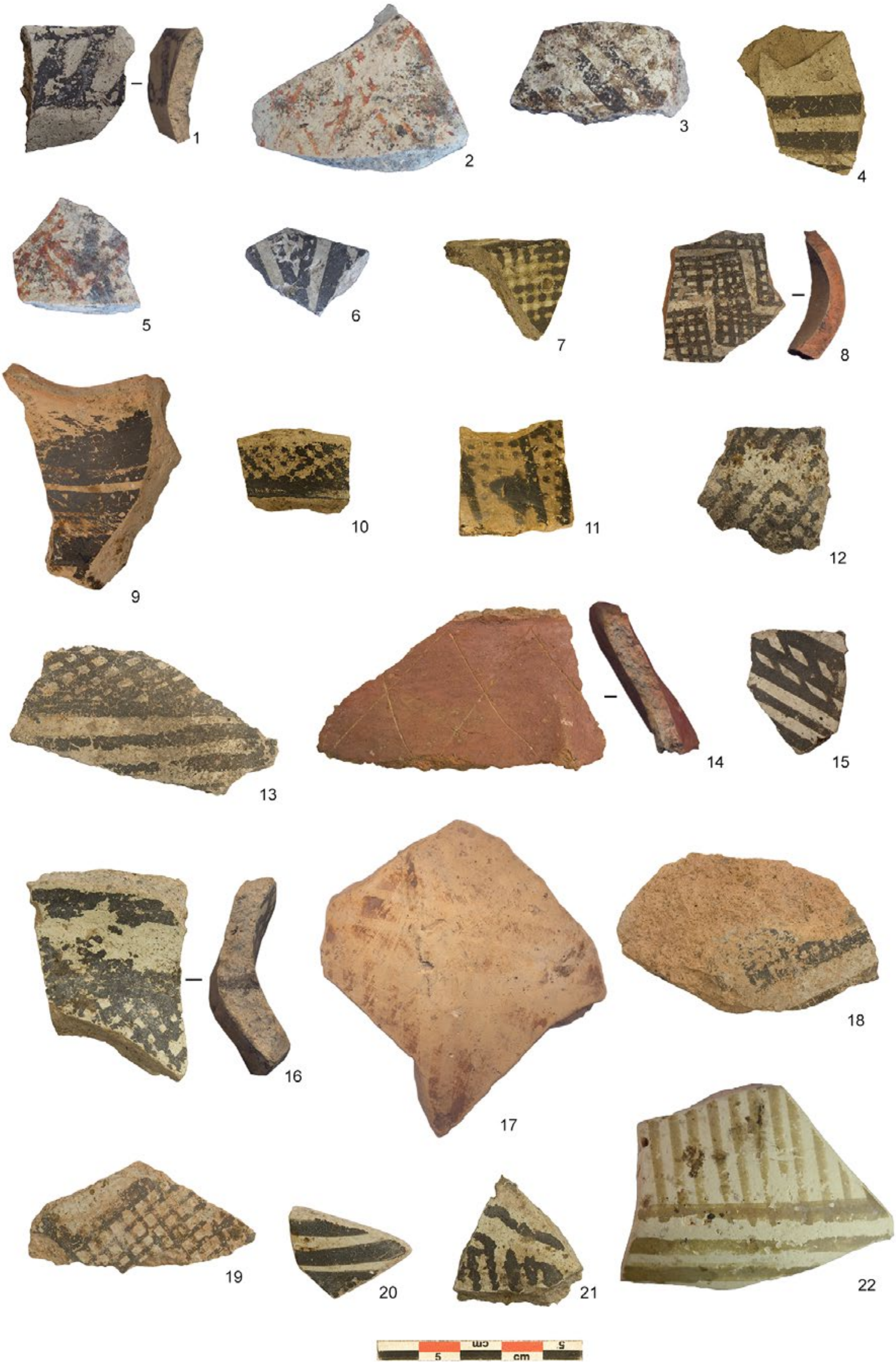


Figure 10b. Imported pottery: sherds.

Hor.	Reference number	Surface color	Paint color	Description	Figure
VI	Ak13.T4. UF11	Ext.: light gray 5Y 7/2;	Very dark gray 5Y 3/1	A fragment of the body decorated with obligue cross-hatching	10: 12
VI	Ak13.T2. UF12b	Ext.: light brownish gray 2.5Y 6/2	Dark gray 2.5Y 4/1	A fragment of the body decorated with two parallel lines, 4 mm width, and obligue cross-hatching.	10: 13
VI	Ak13.T1A. UF11	Ext.: weak red 10YR 4/4; Int.: reddish brown 5YR 5/4	-----------------	A fragment of the shoulder with almound shape knob and obligue cross-hatching, scratched after firing.	10: 14
VI	Ak.14.T3. UF12b	Ext.: pale yellow 2.5Y 7/3; Int.: pale brown 10YR 6/3	Dark gray 2.5Y 4/1	A fragment of the body decorated with 5 parallel bands, 2-4 mm width. Three of them in the middle filled of hatches.	10: 15
VI	Ak13.T1. UF11	Ext.: pale yellow 2.5Y 8/2; int.: light brownish gray 10YR 6/2	Very dark gray Gley 1 3/N	A base of the neck decorated with two row of triangles apex facing to each other. Below is obligue cross-hatching ornament.	10: 16
VI	Ak13.T5. UF12a	Est.: light brown 7.5YR 6/4; Int.: reddish yellow 7.5YR 6/6	Black Gley 1 4/N	A fragment of the body poorly preserved. Remains of a band 8 mm width are hardly visible.	-------
VII	Ak05.Sond.A. UF13a	pale yellow 2.5Y 8/3	Dark brown 7.5YR 3/4	A sherd of the body decorated with the crossed lines. Ornament poorly preserved.	10: 17
VII	Ak13.T5.UF13a	Ext.: light brown 7.5YR 6/3 with whitish thin coat; Int.: light brown 7.5YR 6/4	Dark brown 7.5YR 3/2	A fragment of the body decorated with poorly preserved chevron filled of obligue hatching.	10: 18
VII	Ak13.T5.UF13a	Ext.: light brown 7.5YR 6/3 with whitish thin coat; Int.: light brown 7.5YR 6/4	Dark brown 7.5YR 3/2	A fragment of the body decorated with chevrons filled of obligue hatching.	10: 19
VII	Ak13.T4. UF12	Ext.: light gray 2.5Y 7/2; Int.: pale yellow 2.5Y 7/3	Very dark gray Gley 1 3/N	A fragment of the body with tree paralel horizontal bands, 0.4 -0.8 cm width	10: 20
VII	Ak13.T1A. UF14	Ext.: light gray 2.5Y 7/2; Int.: light gray 2.5Y 7/2	Very dark gray Gley 1 3/N	A fragment of the body decorated with obligue band, 3 mm width, 0.5 cm from which is hatching	10: 21
VII	Ak06.Sond.A. cleaning	Ext.: pale yellow 2.5Y 8/2	Light olive brown 2.5Y 5/3	A fragment of body sherd decorated with three parallel horizontal strips on the body to bottom part and the vertical parallel stripes in extending to the shoulder part	10:22
VII	Ak05.Sond.A. UF12	pale yellow 2.5Y 7/3		Unpainted body sherd	13:15
VII	Ak05.Sond.A. UF13	pale yellow 2.5Y 7/3		Unpainted body sherd	13:16

Figure 10a continued. Imported pottery: description (nos 12-22).

Balikh in northern Syria to Khuzestan in south-western Iran and on the upper Tigris (Oates 2013: 407- 408, note 4; Tekin 2011: Fig. 7, Fig. 8: 1-5; Caneva 2011: Fig. 14; Miyake 2011: Fig. 20). A recently discovered settlement at Hacı Elamxanlı tepe in West Azerbaijan (Nishiaki *et al.* 2015a: 284, Fig. 3: f-g) is the northernmost point where such pottery is found.

On some sherds (Ak07.T3.UF6b; Ak13.T1A.UF14, Figure 10a: 1, 21; possibly Ak13.T1.UF 11, Figure 10a: 16), the paint may have been made from bitumen. The earliest use of bitumen for paint probably took place in Sabi Abyad (Connan *et al.* 2004). In the settlement of Mentesh Tepe, this technique was attested in the horizons dated to the Neolithic (5800-5650 cal. BC; Lyonnet 2017: 141-142), and mostly to the Middle and Late Chalcolithic periods (4800/4600 - 4200 cal. BC; Lyonnet *et al.* 2012: 99, 101-106).

Finally, a single Aknashen shoulder sherd, apparently from a pot, is painted dark red, with a knob and scratched decoration applied after firing (Ak13.T1A.UF 11, Figure 10a: 14); it most closely resembles Hassuna pottery.

As mentioned above, for the monochrome pottery two subgroups are differentiated: 1. Light beige, reddish-pink fragments with organic temper, pottery that differs from local clay in its lighter colour, smaller quantities of organic additives, firing quality, and surface processing; 2. brown-black polished sherds with small sand inclusions, totally different from the local pottery. In most cases, the small size of the sherds prohibits morphological reconstruction. Only among subgroup 2 sherds is it possible to identify two biconical jars (Figure 11). Morphologically identical jars are slightly different in overall production quality.

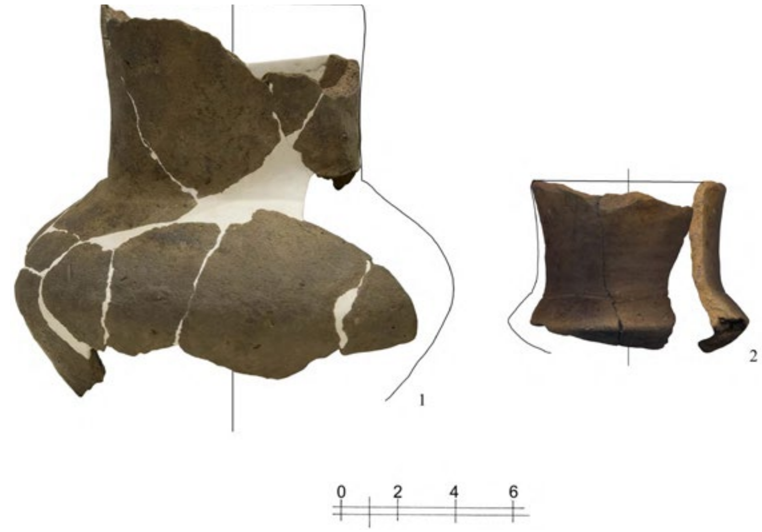


Figure 11. Monochrome ware (Horizon V).

Sample Ak.05.A.9 (Figure 11: 1; Figure 13: 17-18) is quite a large vessel with a high cylindrical neck, biconical body, grey-brown polished surface, and fine-grained sand inclusions. The second sample, Ak.12.T.8.8.str.6 (Figure 11: 2; Figure 13: 13-14), is a small, similarly shaped vessel with comparable characteristics, but the sherd has a more homogeneous composition with small organic and sandy inclusions in the paste.

In Marie Le Miere's opinion,[8] the latter sample (Ak.12. Tr.8.8.str.6) is quite similar to the Grey Black Ware type distinguished in the material of Tell Sabi Abyad (Le Mière and Nieuwenhuise 1996). Sample Ak.05.A.9 is similar to so-called Dark-Faced Burnished Ware, widespread throughout the Levant. DFBW pottery is also present on sites of the Tigris and Euphrates basin, at Til Huzur-Yayvantepe (Caneva 2011: Fig. 8-9), Salat Cami Yani (Miyake 2011), Hakemi Use (Tekin 2011: 154), Acarçay tepe (Özbaşaran and Duru 2011), and Mezraa-Teleilat (Özdoğan 2011). It is probable that, as the Aknashen assemblage grows, it will be possible to discern the DFBW group. It is worth noting that at all the listed sites, which are dated to the end of the 7th millennium BC (6200-6000 cal. BC), as at Aknashen Halafian and Samarra-related pottery is also found.

Petrographic description

For a comparative analysis, a petrographic study was made of four samples of pottery that differ in their external characteristics from the rest of the material. The selected examples belong to two different types:

1. two samples of undecorated pottery having yellowish-grey and beige-coloured clay (Ak.05.A.12, Figure 13: 15; Ak.05.A.13A, Figure 13: 16) are similar to the sherds of painted pottery;
2. two samples of biconical vessels (Ak.12.T.8.8.str.6, Figure 13: 13-14; Ak.05.A.9, Figure 13: 17-18) with a sherd dark brown in colour similar to the pottery conventionally described as monochrome.

The first samples are similar to each other both in appearance and in the composition of the debris and the clay matrix. This similarity consists of: 1. a low content of a macrofragmental impurity, which may be related to the sandy fraction of the original clay. Lithoclasts in these samples, except leucocratic granites and quartzites, contain cryptocrystalline limestones (and calcite in the composition of crystalloclasts); 2. the presence of grog up to 3%; 3. in both samples, the matrix for certain textural differences is composed of transparent isotropic dispersed clay.

Sample Ak.12.T.8.8.str.6 presents a very high content of large fragments and grog (up to 6 - 7%). The fragments are composed of limestones and calcite granules, but rarely arkose sandstones with calcic cement. The most important factor is the presence of algae and faunal remains (small foraminifera).[9] The clay matrix contains hydromica aggregate with a mixture of cryptocrystalline calcite (the original clay may have been calcic in composition).

Sample Ak.05.A.9 is distinguished by an exotic, unusual composition of lithoclasts (metamorphic schists), a high content of macrofragmental inclusions with a transition of the contact type of cementation. There is a high degree of sinterability of the clastic and clay fraction of this example (the firing temperature possibly exceeded 700° C).

[8] Personal communication based on Le Miere's examination of the Aknashen samples.

[9] Foraminifera - single-celled shells, mostly of marine organisms.

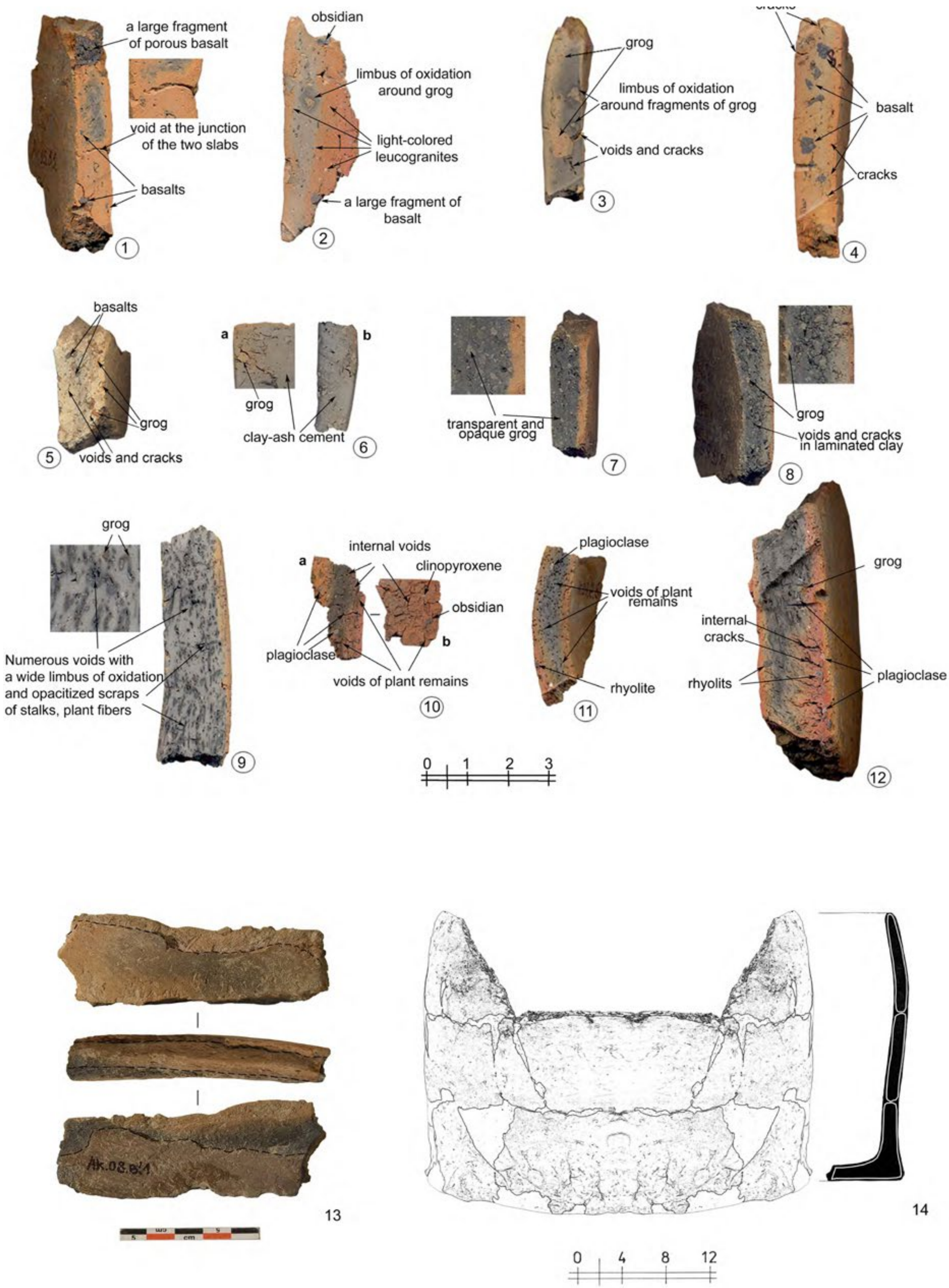


Figure 12. Samples of fractures at the sherds of pottery groups: (1-4) Grit-tempered I ware, (5-8) Grit-tempered II ware, (9-12) Chaff-tempered ware. Samples presenting crafting technique on the Chaff-tempered (13) and Grit-tempered I (14) pottery.

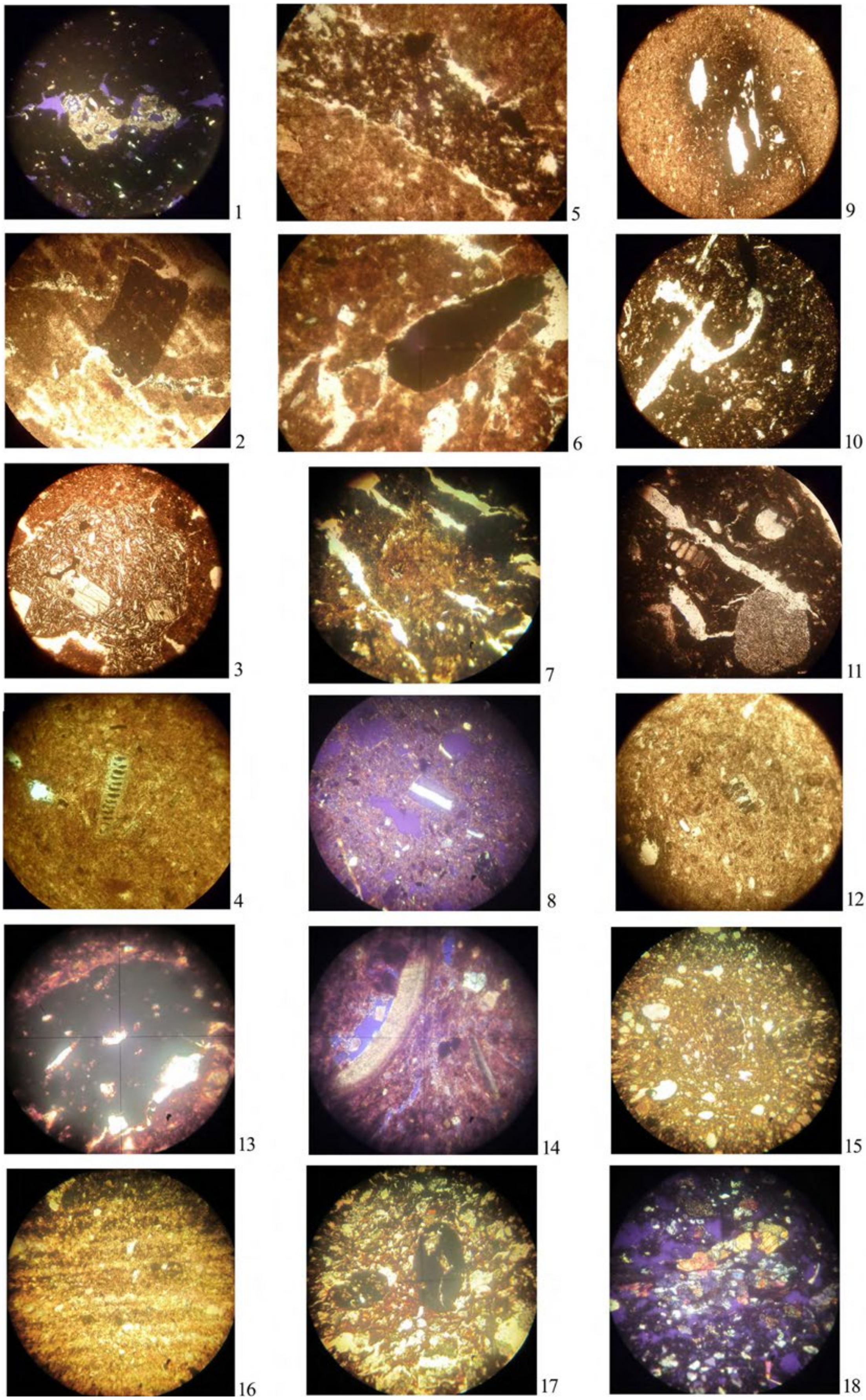


Figure 13. Photomicrographs of the petrographic thin sections of the local (1-12) and imported (13-18) pottery sherds.

1. No. 17 (2007-08). Ak.07.T2.5. Grit-tempered I ware. Criptocrystaline diagenetic calcite with an opal border. Magnification 9X, Crossed Nicols.
2. No. 24 (2007-08). Ak.07.T4.6. Grit-tempered I ware. Rectangular fragment of grog. Magnification 9X, Parallel Nicols.
3. No. 36 (2007-08). Ak.05.A.8. Grit-tempered I ware. Lithoclast of large porphiritic plagioclase-clinopyroxene basalt in the matrix. Magnification 9X, Parallel Nicols.
4. No. 30 (2007-08). Ak.07.T5.6. Grit-tempered I ware. Diatoms of cylindrical form in the matrix. Magnification 20X, Parallel Nicols.
5. No. 101 (2007-08). Ak.04.A.4. Grit-tempered II ware. Opaque clay in hydromica with crypto-fibrous structure. Magnification 9X, Parallel Nicols.
6. No. 112 (2007-08). Ak.06.A'.6. Grit-tempered II ware. A large fragment of grog in the hydromica matrix, separated by thin cracks. Magnification 9X, Parallel Nicols.
7. No. 30 (2011-12). Ak.11.Baulk 6/8.6. Grit-tempered II ware. Breccia texture in opaque mass. Magnification 9X, Parallel Nicols.
8. No. 39 (2011-12). Ak.11.T2.9.str.9. Grit-tempered II ware. Sand inclusions: crystalloclasts of plagioclase, quartz in hydromica crypto-scaly clay. Magnification 9X, Crossed Nicols.
9. No. 63 (2007-08). Ak.05.T4.4. Chaff-Tempered ware. Large voids. Burnt organic remains with strong oxidation on edges. Magnification 9X, Parallel Nicols.
10. No. 74 (2007-08). Ak.07.T7.1. Chaff-tempered ware. A large void in a curved shape after burnt organic remains. Magnification 9X, Parallel Nicols.
11. No. 80 (2007-08). Ak.07.B.1. Chaff-tempered ware. Large cylindric diatoma, near rectangular void and rounded lithoclast of rhyolite. Magnification 20X, Parallel Nicols
12. No. 62 (2007-08). Ak.05.T4.4. Chaff-tempered ware. A large diatoms of cylindrical form. Magnification 20X, Parallel Nicols.
13. No. 43 (2011-12). Ak.12.Tr.8.8.str.6. A fragment of grog in laminated matrix. Magnification 20X, Parallel Nicols.
14. No. 43 (2011-12). Ak.12.Tr.8.8.str.6. Fragment of cell of calcareous algae in cross-section. Magnification 20X, Crossed Nicols.
15. No. 44 (2011-12). Ak.05.A.12. A rectangular piece of grog size 1.2 mm (centre) in the laminated porous matrix. Magnification 9X, Parallel Nicols.
16. No. 45 (2011-12). Ak.05.A.13A. Laminated texture of the clay cement consisting of successive differently coloured strips with a width of 0.4 – 0.6 mm. The dark bands indicate opaque clay aggregate, the light ones indicate dispersed clay with visible thin microlites of plagioclase. Magnification 9X, Parallel Nicols.
17. No. 46 (2011-12). Ak.05.A.9. Fragments of smoothed grogs in the laminated matrix, composed of thin alternating layers of lenticular opaque clay, heavily impregnated with iron hydroxides. The matrix contains many small elongated pores. Magnification 9X, Parallel Nicols.
18. No. 46 (2011-12). Ak.05.A.9. Lithoclast of quartz-epidote schists in the matrix. Magnification 9X, Crossed Nicols.

Figure 13. Descriptions

Technological observations and the problem of the sources of raw materials

Thus, the data from the study of the clay samples and the archaeological pottery from Aknashen make it possible to presume that in the pottery production, both clays with natural original sand admixtures of lavas, crystals and volcanic glass (the Grit-tempered I ware group) and refined clays (Chaff-tempered Ware, Grit-tempered II ware) were used. In the Grit I group, several subgroups containing different amounts of sand inclusions were identified based on petrographic analysis. In these cases, it is possible that a granulometrically larger sand admixture from the same layers of lacustrine deposits was added. The quantitative and qualitative composition of the pottery with organic tempers suggests that the clay was subjected to more thorough processing - sieved, decanted, and then mixed with organic temper. The group with mineral inclusions in the composition of lithoclasts includes equally palaeotypal andesites, acid volcanic rocks (including tuffs) originating from old volcanic formations of the region, ancient granites, quartzites and cenotypal lava formations belonging to young, Middle Pleistocene formations of the Aragats volcano (olivine basalts, andesite, rhyodacites, vitroclastic tuff), but the group that includes organic tempering materials, cenotypal lithoclasts (dolerites, dacite, andesite) and rarely older rocks (granite, quartzite, epidozites, quartz porphyries) is predominant. A slightly different pattern of inclusions occurs in the Grit II group. There is no granulometrically coarse grain sand fraction, typical for the pottery of the Grit I group, but a very fine organic temper is present. A characteristic feature of pottery with a sandy admixture is the presence of grog, which in the Grit-tempered II ware comprises the main temper.

The analysis of the pottery, visually defined as imported, showed a complete difference between the clay component and inclusions and those of the local samples.

In order to determine the raw materials used for the fabrication of the local pottery, chemical[10] and X-ray analyses of clays from the vicinity of Aknashen and Aratashen were carried out. In addition, a petrographic study of the standard samples was made.

The studied samples were produced from clay/silt that originated in the vicinity of the sites. For Aknashen, this is a layer in the section of the drainage channel at the northern foot of the hill. Several samples of various clays were taken from the vicinity of the settlement of Aratashen. One of the sources is located 400-500m south-west of the site, and was used by local potters in the middle of the last century. Dry powder-like grey-beige clay was subjected to chemical and X-ray analysis. Bar-shaped samples made from local clay were fired at a temperature of about 600-700° C in a muffle furnace. Thin sections of the samples were then made and subjected to petrographic analysis.

All samples present a content of silty clay with an admixture of 12% to 16% sand material. The shape of

[10] Chemical and X-ray analyses of clays from the vicinity of the sites were carried out at the Institute of Geological Sciences of the NAS RA in 2008.

the particles is angular; the sizes vary from 0.5 to 1.3 - 1.5mm, sometimes up to 3-4mm. In the composition of the inclusions, the lithoclasts represented by andesites and plagioclase rhyodacites predominate. Crystalloclasts are represented by fresh/resorbed plagioclase and clinopyroxene, but rarely by amphibole, quartz or magnetite. The vitroclasts consist of obsidian with a fluid texture and a single fragment of pumice. The matrix in the section contains a fine mixture of a hydromica aggregate and glassy ash material with clusters of iron hydroxides; an unevenly distributed variety of the remains of diatoms is common. Chemical and X-ray analyses confirm the composition of clay minerals that correspond to the hydromica group (illite) (Deer *et al.* 1966), chlorite and a small amount of montmorillonite.

The above results enabled correlation of the examined clays with clays known in the region that are suitable for ceramic production and occur at shallow depths (up to 0.5m from the surface). The thickness of these clay deposits is from 2 to 5m (Mkrtchyan 1966: 91).

Situated in the south-eastern part of the village of Khoronk (formerly Lenughi), known in the literature as the Lower Aynali (Mkrtchyan 1966: 127-128), a deposit of plastic clays of the Lower Quaternary and the Holocene is composed of fusible clays interbedded with sands and gravel-pebble layers. The clay layer consists of two varieties: non-sandy and sandy, lying horizontally one above the other, with a thickness of 1.0 to 2.3m.

There is a deposit of fusible clay at the village of Norabats (formerly the village of Engija near the Neolithic settlement of Masis Blur) (Mkrtchyan 1966: 100-101). The clays having the same age as the above-mentioned alluvial-proluvial formations are represented by two varieties: a plastic clay with rare inclusions of gravel and a less plastic sandy clay. The thickness of the layer is 2.6 m.

Also located here is an area of sandy and ashy diatomitic clays of the Lower Quaternary, forming the well-known Paracar-Argavand group of deposits located 12 km south-west of Yerevan. They lie on the eroded surface of Oligocene sediments and are covered by Middle-Upper Quaternary (neo-Pleistocene) volcanic tuffs - ignimbrites of the Yerevan-Gyumri type (Mkrtchyan 1966: 446-458; Shirinyan and Avakyan 2005: 23-26).

Summarising the above, we emphasise once again that, judging by the results of the research, the painted pottery samples present a clear difference between their clay component and inclusions and those of the samples made in local clay. This points to the probability that they were imported. In turn, a comparison of the studied samples of the Chaff-tempered ans Grit-tempered I and II groups with samples in local clay indicated the identity of the clay component and the sandy admixture. Moreover, for production of the oldest pottery (Grit-temperd I), clay with natural sand admixture was used without any additional processing.

Aknashen pottery in its regional context

In the second half of the last century, in Georgia and Azerbaijan then in Armenia, the study of a new culture began. At that time, scholars agreed to distinguish two groups of sites in the Neolithic - Chalcolithic culture of the South Caucasus: the Shulaveri-Shomutepe group, characterised by pottery with mineral temper, and the Nakhichevan-Mil-Mugan group, characterised by pottery with plant inclusions. I. G. Narimanov presumed that both groups of pottery existed in the South Caucasus simultaneously, but that the first one prevailed in the central regions, in the middle course of the Kura river, where pottery with plant inclusions does not exceed 15-20% (in settlements like Shomutepe (Narimanov 1987: 117) or the upper horizons of Shulaveri and Imiris Gora (Masson *et al.* 1982: 111)), whereas the second group prevailed in the south, east of the Ararat valley up to the Caspian Sea (the Mil-Mugan group of sites), where mineral-tempered pottery is absent (Narimanov 1987: 129). Unlike him, R. M. Munchaev, one of the authors of the synthetic volume ‘Eneolithic in the USSR’ (Masson *et al.* 1982: 122), considered the central-Transcaucasian group of sites to be older than the South-Caucasian one, and he identified also a later group –Alikemektepesi (horizons 0-1), Kechili III, Sioni and Teghut. The last statement was accepted by all scholars.

Further research on this last group of sites and the latest research in the region confirm that these sites do belong to the Chalcolithic and it appears that they represent two traditions that simultaneously coexisted in the region. These are, first, sites of the Sioni type (Menabde and Kiguradze 1981; Kiguradze 2000; Kiguradze and Menabde 2004; Lyonnet 2018), characterised, in particular, by the presence of braziers or frying pans with a number of perforations below the edge of the rim, a combed surface, a decoration of rims with different kind of notches and a mineral admixture in the paste. The second tradition is that of Leylatepe, which reveals links with northern Mesopotamia (Narimanov *et al.* 2007; Museyibli 2011; Marro 2010). The pottery is reddish-pink/beige, characterised by the presence of plant temper in the clay paste (CFW), turning on a potter’s wheel and potter’s marks made before firing. Interestingly, the pottery of the Teghut Chalcolithic site shows parallels with both Sioni-type pottery (pans with perforations below the rim, a combed surface and mineral inclusions in the paste) and ‘Ubaid’ pottery (Torosyan 1976). The accumulation of data in recent decades makes it possible to state that in the initial stages, pottery with mineral inclusions[11] occurred

[11] The question of mineral inclusions or additives is reviewed in the section on petrographic analysis. Suffice it to say that in the initial stages raw clay was used without artificial additives.

on sites of the Kura basin (Shulaveri, Dangreuli Gora, Imiris Gora (Javakhishvili *et al.* 1975), Arukhlo I (Chelidze and Gogelia 2004; Hansen *et al.* 2006; 2007a; 2007b; Lyonnet *et al.* 2012*),* Gadachrili Gora (Batiuk *et al.* 2017), Shomutepe (Akhundov 2013), Hacı Elamxanlı (Nishiaki *et al.* 2015a), a small amount in Mentesh Tepe (Lyonnet *et al.* 2012) and Göytepe (Nishiaki *et al.* 2015b; etc.) and the Ararat valley (Aratashen, Aknashen, Masis Blur), while on the sites of the southern group, in the Nakhichevan Kütepe I and its sphere, mineral inclusions are completely absent; only pottery with plant temper is registered here (Bakhshaliyev 2014, 2016; Marro *et al.* 2019). Subsequently, pottery with organic inclusions became widespread across the region, whereas in the Shulaveri-Shomutepe group, even in the period of the Late Chalcolithic, pottery with mineral inclusions remained predominant (Hansen *et al.* 2006, 2007b; Akhundov 2013; Batiuk *et al.* 2017).

Both in terms of morphology and technological characteristics, the pottery of Aknashen with organic and mineral inclusions is typical for contemporary settlements of the region, in particular of the Ararat valley. The closest parallels are to be found at the nearby site of Aratashen.

The Chaff-tempered ware from Aknashen is the same as the pottery of layer 0 at Aratashen (Palumbi and Badalyan 2005; Palumbi 2007). Despite the small amount in the Aratashen collection, it presents significant variation in paste composition, morphology, and decoration. In the latest pottery at Aratashen, the Chaff-grit-tempered and Obsidian-tempered groups (Arutyunyan and Mnatsakanyan 2010; Palumbi *et al.* 2014) are separated. It should be noted that at Aknashen similar pottery (Chaff-grit-tempered group) is absent in the main excavation area; as mentioned earlier, it is found in a small amount only in sondages C and D outside the hill. A few fragments, decorated with incised notches on the rim edge (pottery of 'Sioni' type? Figure 5: 6), are also noted here. The above-mentioned materials would appear to date the Aratashen pottery assemblage of horizon 0 to a later period than horizon I at Aknashen.

Pottery with organic inclusions is common at Armenian sites, occurring throughout the entire Chalcolithic sequence. On the Ararat valley, it occurs at such settlements as Adablur/Kghzyak Blur (Areshyan 1991) (Figure 14: 2-4, 7-9, 12-13, 18), Tsaghkunk/Mashtots Blur (Figure 14: 1, 5-6, 10-11, 14-15), Armavir,[12] Artashat[13] (Khachatryan 1978: 58, Fig. 4), Metsamor[14] and a burial at Aknalich (Muradyan 2014). Unfortunately, little is known about the pottery assemblage of the Masis Blur settlement.[15]

The collections from Adablur and Tsaghkunk, housed in the Echmiadzin Historical and Ethnographic Museum (EHEM),[16] are characterised by the presence of fragments of very large vessels, such as *karases*, which often have decorative bands of applied clay decoration affixed to the upper part of the body (Figure 14: 1),[17] by pots with high cylindrical necks and sometimes with knobs at the rim edge (Figure 14: 12-15) and by bowls with knobs and perforations below the rim (Figure 14: 7-11).

Organic temper in the matrix is a feature of the pottery that unites all of the above sites; however, the morphology of the vessels, the nature of the surface treatment and the decoration reveal certain differences and make it possible to distribute the sites in time. The sites have been investigated to varying degrees, but even given the uneven datasets it is increasingly evident that horizon I of Aknashen was a relatively early settlement compared to its neighbors. It is the overall stylistic simplicity of the pottery that lends support to this view. A majority of the assemblage (80%) consists of plain, small bowls, occasionally decorated with knobs. This is in contrast to, for example, Aratashen level 0, where there are also pots with knobs on rim edges. And unlike the pottery from such sites as Adablur, Tsaghkunk and Artashat, there are no affixed clay band. Also absent are the perpendicular or diagonal notches, deep channels, holes, ripples, and tucks at the rim's edge, decorative features that are widespread on the pottery of sites of 'Sioni' type (Kiguradze 1976) such as the Tsiteli-Gorebi group (Varazashvili 1992*)*, features also present in Aratashen pottery (Fig. 5: 7-12; Palumbi 2007).

Common for the above-described pottery of the region is the conical, almond-shaped knob decoration, which was first recorded on pottery from horizon VI at Shulaveri (Javakhishvili *et al.* 1975: Fig. 11: 1, Fig. 17: 3) and is widespread among Shulaveri-Shomutepe sites

[12] Dr Inessa Karapetyan shared information on relevant surface materials from the territory of the site.

[13] Apart from the Chalcolithic layer on hill VII of Artashat (Khachatryan 1978), synchronous materials also come from hill VIII, I, and the valley between them. The distance between the hills is 100-200m, which makes it possible to presume the presence of a few small settlements (Zardaryan 2018).

[14] Pottery present in the exhibition at the Metsamor museum.

[15] Recently resumed work at Masis Blur (Martirosyan-Olshansky *et al.* 2013; Hayrapetyan *et al.* 2014) revealed Neolithic layers, contemporary to horizon V at Aknashen, where pottery is practically absent, except for 1 or 2 fragments in each trench, whose presence is most likely the result of disturbance (e.g. animal burrows). The virtual absence of pottery from a site contemporary to horizon V at Aknashen lends support to the view that the relatively limited pottery found in the later context is in all probability also the result of disturbance. At Masis Blur, a few fragments from surface collections attest to the presence of pottery with both mineral and organic inclusions.

[16] The EHEM collection includes material from early agricultural sites and surface material from nearby sites, including Tsaghkunk (R. Torosyan's excavations, collection #8), Adablur (S. Aslanyan's excavations, collection #32), Aratashen (S. Aslanyan's excavations, collection #14), Aknashen/Khatunarkh (R. Torosyan's excavations, collection #16), Teghut (R. Torosyan's excavations, collection #1). The material from the Adablur excavations is in the 'Erebuni' Museum-Reserve and in the History Museum of Armenia.

[17] It appears that similar clay band appear on relatively late Chalcolithic pottery.

Figure 14. Pottery from the sites of Tsaghkunk (1, 5-6, 10-11, 14-17, 19-20) and Adablur (2-4, 7-9, 12-13, 18) in Ararat valley: (1-15, 18) Chaff-tempered ware; (16-17, 19-20) Grit-tempered I ware.

(e.g. Imiris Gora) (Javakhishvili *et al.* 1975: Fig. 44-52), Arukhlo I (Masson *et al.* 1982: tab. XXXIV: 3, 6; Chelidze and Gogelia 2004; Hansen *et al.* 2006; 2007b; Lyonnet *et al.* 2012*)*, Gadachrili Gora (Batiuk *et al.* 2017, Fig. 14: 2-6), Shomutepe (Narimanov 1987: Fig. 10; Akhundov 2013), Göytepe (Nishiaki *et al.* 2015a, Fig. 3-c), Guseingulutepesi, Gargalartepesi, and Babadervish (Narimanov 1987: Fig. 38: 4; Fig. 35: 1; Fig. 33: 2; Fig. 27: 2; Akhundov 2013). This knob decoration persists into the Late Chalcolithic period, occurring on sites of the Tsiteli-Gorebi group, Sioni, Mentesh (Lyonnet *et al.* 2012, Fig. 143: 1-2), and persisting as late as the Early Bronze Age.[18] In the Eastern and Southern Transcaucasian groups, knobs occur more rarely. They are cone-shaped on pottery from Adsyztepe, Kechili, Kültepe I (Abibullaev 1982, Fig. IX : 6, 8; Marro *et al.* 2019: Fig. 15: 2) and from recently investigated sites in the Mil Plain (MPS4 and MPS5) (Lyonnet *et al.* 2012: 37-47) which dated to 5500 cal BC (Helwing and Aliyev 2017: 41). However, the earliest examples of knob decorations are still found on bowls (for example, at Aknashen, where 99% of the pottery with knobs are bowls); knobs decorate the edges of pots at a later date (Adablur) (Figure 14: 12, 13). On sites of the Kura basin, knob decoration is present on pottery with mineral inclusions (Akhundov 2013: 57), which directly correlates its morphological characteristics with the Grit-tempered I ware of Aknashen. Ongoing research at the Neolithic settlement of Arukhlo (Georgia), where excavations have uncovered a large quantity of pottery with knob and relief decoration, are providing new radiocarbon dates: 6451±40 BP (Bln-5949), 6369 ±46 BP (Bln-5950) (Hansen *et al.* 2007b: 19; Hansen *et al.* 2017: 291). While radiocarbon results do not always directly correlate with a certain pottery type, these dates make it possible to postulate that the upper layers at Aknashen, in which Chaff-tempered ware with knob decoration occurs, may date from the last quarter of the 6th millennium to the first quarter of the 5th millennium BC. Moreover, dark red-brown sherds from Aknashen with large whitish mineral inclusions differ significantly from the local pottery, but are comparable to pottery from Imiris Gora (horizons VII, V, IV-I, Javakhishvili *et al.* 1975: Fig. 43: 9; Fig. 44: 10; Fig. 46: 5; Fig. 51: 6), Khramis Didi Gora, Arukhlo I (Kiguradze 1986: Abb. 53: 7, 21; Abb. 68: 6, 11, 15; Lyonnet *et al.* 2012) and Gargalartepesi *(*Narimanov 1987: Fig. 27). The latest date for pottery with such decoration has been found in horizons I-IV at Imiris Gora – TB-27 6300±120 BP – *cal.* 5350 – 5085 BC (Chataigner 1995: 40-41, Table 1). An even more accurate dating for knobbed pottery is represented by the well-stratified and dated site in the Kura river basin, Göytepe, where this pottery is present in almost all construction horizons (Alakbarov 2018: Fig. 8-9). The site existed in the period *ca.* 5650-5450 cal. BC (Nishiaki *et al.* 2015a). Thus, neither plant admixture in the clay paste, nor applied ornament can serve as an unambiguous chronological marker. In addition to the above, the absence among more than 50 radiocarbon dates for Aknashen of a date earlier than 5400 cal. BC (based upon the availability of Bronze Age and medieval dates) suggests the possibility that the upper layer at Aknashen (horizon I), in which Chaff-tempered ware predominates, may date to not later than 5400 cal. BC. At the same time, we do not exclude the possibility of dating horizon I to the Early Chalcolithic, i.e. from the last quarter of the 6th millennium to the first quarter of the 5th millennium BC. This problem requires further research; perhaps new excavations of undisturbed parts of the upper horizon at Aknashen will clarify this issue.

The Grit-tempered I group of Aknashen is the most widespread type of Neolithic pottery of the Aratashen-Shulaveri-Shomutepe culture. It correlates, above all, with the same group present in layer I at Aratashen (Palumbi and Badalyan 2005; Palumbi 2007). However, at Aratashen the pottery is more fragmentary and there is no clear stratigraphy, unlike horizon III at Aknashen, where Grit-tempered I pottery was found *in situ*. Technologically, Aknashen pottery differs from the Aratashen materials in the more standard composition of the paste and the lower content of mineral inclusions. In the Aratashen pottery, there is greater variability in the paste composition, which is probably due to the high sand content of the natural clay in the sources that surround the site. Pottery similar to Grit-tempered I at Aknashen is also found in the Tsaghkunk (Figure 14: 16-17, 19-20) material. Particularly relevant is a large oval vessel (EHEM, #2068), whose fabric and surface treatment are similar to Grit-tempered I ware pottery from Aknashen.

Grit-tempered II pottery, which is present at Aknashen and found *in situ* in horizons III-IV, is rare in the Aratashen corpus (0, I layers), and the existing sherds are quite fragmentary. Clearly comparative material in the 'Aratashen-Shulaveri-Shomutepe' culture is not known to the author. The closest are a few examples from Arukhlo (Ware 3) (Bastert-Lamprichs 2017: 235; Hansen *et al.* 2006: Abb. 33; Hansen *et. al.* 2007b: Abb. 18) that are relatively similar in composition, shape and surface treatment.

Beyond the Ararat valley, pottery comparative to the Grit-tempered II group can be found in assemblages from the upper Tigris, such as Salat Cami Yani (Miyake 2011), Sumaki Höyük (Erim-Özdogan 2011a), Til Huzur-Yayvantepe (Caneva 2011) and Hakemi Use (Tekin 2011), as well as along the Euphrates at Akarçay tepe (Arimura *et al.* 2000; Özbaşaran and Duru 2011), or along the Khabur at Tell Seker al-Aheimar (Nishiaki and Le Miere 2005) and in the upper Tigris area at Çayönü (Erim-Özdogan 2011b). Despite the fact that all these sites pre-date Aknashen (the relevant material

[18] Among others, materials of the lower Kura-Araxes level at Gegharot in Armenia (publication in preparation)

from these sites dates to the second half of the 7th millennium BC), the overall technological trend from PPN to PN, from pottery with mineral inclusions to plant inclusions, is comparable to the transformations observed at Aknashen.

Distinctive local features in the Late Neolithic pottery of the 'Aratashen-Shulaveri-Shomutepe' culture are more evident in the vessel decoration than in the fabric. Thus, Aknashen and Aratashen pottery with mineral inclusions and Kültepe pottery with plant inclusions are equally undecorated, while relief decoration in the form of oval knobs and u-shaped, ring-shaped and zigzag-shaped patterns at the outer edge of rims is quite common in the pottery with mineral inclusions from the Kura basin; at Arukhlo, approximately one third of the sherds are decorated (Lyonnet *et al.* 2012: 77; Hansen *et al.* 2006; 2007b). Also on the pottery of Arukhlo, Imiris Gora, and Khramis Didi Gora are anthropomorphic relief elements created through *appliqué* (Lyonnet *et al.* 2012: 78-82, Bastert-Lamprichs 2017: 242). At Shomutepe, round and vertical knobs under vessel rims are only present on pottery with sandy inclusions. At the same time, comparable decoration is typical for Aratashen and Aknashen pottery from the upper horizons (I and II) that contain plant inclusions (Palumbi 2007; Arutyunyan 2008; Chataigner *et al.* 2014a), and semicircular relief decoration is virtually absent (except for the above-mentioned fragment in Figure 4: 5).

Conclusion

The 'Aratashen-Shulaveri-Shomutepe' pottery represents the earliest experiment in pottery production in the South Caucasus. On the Ararat valley, the process of its occurrence and development in the first half of the 6th millennium BC is clearly visible in the case of Aknashen and Aratashen. The technological trajectory can be briefly summarised as follows:

The lower layers at Aratashen (Level II b-d, dated to 5905-5775 cal. BC (Badalyan *et al.* 2007: 40) and Aknashen (Horizons VI and VII, 6000/5950-5850/5800 cal. BC, see more detail: Chataigner *et al.* – Bayesian analysis – in this volume) contain practically no pottery apart from a few imported fragments;

Pottery of coarse (Grit-tempered I ware) and relatively good quality (Grit-tempered II ware) then appears in small quantities in the upper layers of horizon V at Aknashen (dated to 5780-5750 cal. BC). Grit-tempered II ware includes vessels with reasonably well-processed sand- and grog-tempered fabric and polished surfaces (it occurs as single fragments at Aratashen);

In horizon IV (5750-5690 cal. BC) and III (5690-5600 cal. BC) at Aknashen, the quantities of Grit-tempered II pottery decrease in proportion to the increase of more crude pottery (Grit I) and pottery with organic inclusions (there is no similar layer at Aratashen). The distribution of pottery in horizon II (5600-5450/5400 cal. BC) is practically the same as in horizon III.

In horizon I at Aknashen, Chaff-tempered ware predominates entirely (there is no 14C date for this horizon).

Considering the fact that recent research in northern Mesopotamia, in particular in the Habur basin and the Jazira plain, has shown that the earliest pottery, the so-called Pre-Proto-Hassuna, contained mineral inclusions (Nishiaki and Le Miere 2005; Le Mière 2009), we can assume that the general trend in the technological development of pottery unfolded in similar fashion on the Ararat valley in the Late Neolithic.

Painted Aknashen pottery reflects direct or more probably indirect contacts between the populations of the Ararat valley and those of the Samarra and Halaf cultures to the southwest at the turn of the 7th to the 6th millennium BC.

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Aknashen: techno-typological and functional analysis of the lithic assemblage

Jacques Chabot, Cynthia Gosselin, Patrick Eid and Bastien Varoutsikos

Introduction

Since 2004, the excavations at the prehistoric settlement of Aknashen have yielded a rich lithic industry. The assemblage is largely made of obsidian (> 99%) but also includes various quantities of dacite, jasper, quartz and flint which are almost exclusively dedicated to the production of flake tools in the framework of an expedient strategy. In this paper, we present an overview of the material studied, including debitage, tools on blades and on flakes, amounting to 24,061 artefacts from the whole amount of 48,000 pieces of obsidian found at Aknashen during eleven field seasons. This assemblage covers every horizon identified at the site (I to VII) and is mostly represented by a blade industry. A careful analysis of this material sheds light on the activities carried out at the settlement and the role played by these artefacts in the daily life of the communities living at Aknashen. This study is an important step in providing a well dated cultural and behavioral sequence for the entire region, and will prove increasingly helpful as other assemblages from recently excavated sites across the Caucasus are published. The structure of the paper follows a logical order of the reconstruction of a *chaîne opératoire* (manufacture, use, discard).

Technology

Mostly three *chaînes opératoires* were identified, dedicated to the manufacture of flakes, bladelets and blades, the latter representing a much larger portion of the assemblage.

Figures 1a-b present debitage and cores from Aknashen, and Figure 1c displays unretouched blade blanks.

The first aspect that stands out is the relatively low proportion of debitage compared to the amount of blade blanks. Indeed, only 2076 whole debitage products were recovered while more than 6090 unretouched blade blanks were identified (along with 3441 blade fragments, 5142 tools on blades, and 1234 retouched blade fragments, see next section). Therefore, chunks, fragments and core put aside, 14.9% of the assemblage (13,901 artefacts) is made of debitage products, while 81% of the assemblage is represented by unretouched blade blanks and tools on blade (35.9%), with 2.5% of tools on flake.

Flakes

The *chaîne opératoire* dedicated to the manufacture of flake is best described as *ad hoc* and opportunistic, as found in several sites across the world (Inizan *et al.* 1995; Chabot 2002). This debitage is partially improvised as the knappers do not seem to have planned ahead a specific sequence of strikes and rather adapted to the new situation that each blow would create, then selecting a new striking platform. Using small nodules, the knappers can easily obtain flakes with no to little preparation using direct percussion (Figure 2a). They then adapt to the changing morphology of the core to knap off another flake. This multipolar method creates cores with no particular and recurring shape. Some flake cores seems to show a tendency towards the selection of the larger striking platform available and to look for ridges to obtain longer flakes but that is the limit of the strategy witnessed in this type of production. A few flakes identified in Tr.2 UF11 (Horizon V) could possibly represent a transition from exhausted or destroyed blade cores towards flake cores with the presence of parallel blade-like removals on their dorsal face. Furthermore, one bladelet core in UF11b shows an accident followed by the removal of flakes according to the strategy described above, suggesting the recycling of blade cores towards flake cores. In the use-wear section we will describe the use of one of these products (flake obtained for the recycling of a blade core).

The flake cores found at Aknashen are small and almost always exhausted. Indeed, this method generally exhausts the core fairly rapidly and only a limited amount of blanks can be obtained. All the cores found show negatives of removals widely overlapping each other. As mentioned, such method is found in many cultures across the world and it is not uncommon to find it practiced in parallel to more complex methods (Anderson *et al.* 2004) as it is the case in Aknashen.

So, flakes obtained according to this expedient method, have variable dimensions and could be used for various tasks, generally for a short period of time (a point we will address later in this study). In general, they were used raw or with minimal retouch so that most flake tools do not present any particularly stereotyped shape. Therefore, it is the morphology of the retouch itself (over their overall shape) that will provide the basis for the site's typology (see following section on morphological typology).

Horizon	Debitage	Apex (Pyramidions)	Microflakes (Bulbar microflakes)	Micro-fragments	Cores on flakes	Cores on blades (bullet cores)	Total	Fragments	Fragments of cores
I	165	3	5	27	5	3	208	285	16
II	306	1	8	94	5	3	417	882	22
III	434	5	35 (7)	66	5	6	558	1154	20
IV	629	15	83 (26)	359	18	6	1136	1417	70
V	271	7	9 (2)	10	1	4	304	386	19
VI	160	4	2 (0)	16	2	6	190	218	13
VII	111	5	9 (5)	6	2	4 (3)	145	293	8
Total	2076 (70,1%)	40 (1,4%)	151 (40) (6,5%)	578 (19,5%)	38 (1,3%)	32 (3) (1,2%)	2958 (100%)	4635	168

a) *Débitage* products and cores.

Horizon	Flakes (phase 1)	Proximal flakes	First flakes	Crest blades	Preliminary flaking	Accidents	Rejuvenation	Burin spalls	Total
I	63 (2)	63	3	0	3	14	3	14	165
II	167 (1)	67	1	1	1	17	5	46	306
III	218 (2)	86	0	1	1	28	0	98	434
IV	283 (9)	193	1	3	3	49	3	85	629
V	169(8)	43	1	0	0	14	0	36	271
VI	109	20	0	0	0	17	2	12	160
VII	67(1)	20	0	0	0	8	0	15	111
Total	1076(23) (52,9%)	492 (23,7%)	6 (0,3%)	5 (0,2%)	8 (0,4%)	147 (7,1%)	13 (0,6%)	306 (14,7%)	2076 (100%)

b) *Débitage* details.

Horizon	Proximal	Proximal mesial	Mesial	Mesial distal	Distal	Complete blade	Total	Fragm. blades
I	29	80 (6)	161 (20)	31 (2)	23	0	324 (28)	211
II	59 (1)	218 (7)	389 (44)	71 (4)	36	8	781 (56)	491 (9)
III	103 (2)	402 (10)	650 (61)	126 (11)	48 (1)	11	1340 (85)	1018 (14)
IV	209 (3)	642 (15)	993 (104)	148 (13)	95 (6)	12 (2)	2099 (143)	1107 (19)
V	37	182 (4)	258 (16)	49 (8)	18	6	550 (28)	210 (3)
VI	26 (2)	74 (4)	130 (9)	22	5	0	258 (15)	129 (1)
VII	44 (2)	85 (8)	173 (17)	42 (8)	3	1	348 (35)	229
Total	507 (10) (8,4%)	1684 (54) (28,5%	2754 (271) (49,7%)	489 (46) (8,8%)	228 (7) (3,9%)	38 (2) (0,7%)	5700 (390) (100%)	3395 (46)

c) Raw (blanks) laminar elements and, in brackets, lamellar elements.

Figure 1. Technology: a) Debitage products and cores; b) Debitage details; c) Raw (blanks) laminar elements (and lamellar).

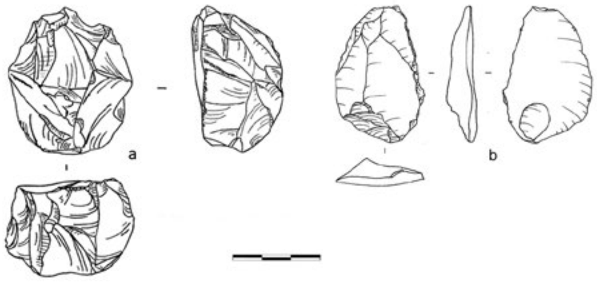


Figure 2. Flake debitage: a) Flake core, Horizon II (Sond.A UF5); b) Typical flake, Horizon VI (Sond.A UF11) [drawings: a) C. Gosselin; b) J. Leclerc].

From a technological perspective, these flakes are obtained through direct percussion and show common attributes. They have a plain butt that is large and thick, with a prominent and wide bulb, no lip, an impact mark generally easily identifiable, and marked ripples (waves) (Figure 2b).

However, despite some specific features, it remains difficult to identify precisely the products of this *chaîne opératoire* (cores aside) and to replace them within the production sequence. Therefore, many fragmented flakes could as well originate from the shaping of the blade cores. Flakes connected to the blade industry may have been produced on the site itself, or brought from an external workshop. The people at Aknashen seem to be only looking for flakes with a sharp edge that could be adapted to various tasks, unrelated to their geographic or technological origin. Flake production at Aknashen has been the focus of very little technical investment and represent, numerically, a weak portion of the assemblage compared to the blade products.

Blades

Three different techniques connected to the production of blade blanks have been identified at Aknashen: pressure with a crutch (N = 69 diagnostic pieces), pressure with a lever (N = 49 diagnostic pieces), and indirect percussion (N = 20 diagnostic pieces).

It might appear surprising at first that so few technically diagnostic pieces have been identified in an assemblage of more than 10,000 blanks. However, we should remember that those standardized blanks have generally been modified for functional purposes. We find them as small fragments (often too small to be diagnostic) which were often hafted in composite tools. Some pieces were found broken, while others were used to an extent that made the identifications of critical features impossible. Furthermore, the goal of this kind of analysis is not to diagnose all pieces but to reach a statistically satisfactory amount in order to identify the use of different techniques by this population, hence being able to understand their technological progress (know-how).

Pressure with a crutch (standing position)

Diagnostic artefacts connected to the technique of pressure with a crutch amount, so far, to 69. These pieces are well preserved and show clear characteristics of this technique (Figure 3a-f).

The identification of pressure flaking relies on three criteria: extremely regular edges and ridges, straight profile and lightness of the section (a wide but not particularly thick section) (Tixier 1984; Pelegrin 2002; Pelegrin 2012b). Our recent work on archaeological material allowed us to identify these three criteria simultaneously represented on assemblages from the Near East and the Caucasus (Anderson *et al.* 2004; Chabot 2002; Chabot 2015; Chabot and Eid 2007; Chabot and Eid 2010; Chabot and Pelegrin 2012).

The dominant morphological features of the blades manufactured by pressure with a crutch is their finesse and thinness. Due to functional imperatives, they are rarely found un-fragmented since their curved distal end was generally removed. The length of these artefacts ranges from 44 to 150mm (proximal-mesial specimens). The widest blade connected to this technique reaches 22.7mm although average width is at 15.3mm.

This technique can generally allow the manufacture of blade up to 28mm wide (Chabot and Pelegrin 2012). About forty other blade segments have shown width ranging from 24 to 28mm but it is not possible to identify precisely which pressure technique they are related to since they present mixed characters. Finally, blades characteristic of the crutch technique at Aknashen have an average thickness of 3.7mm.

The technical characteristics of the crutch techniques can first be seen in the proximal part: small contact area (punctiform, linear, or plain butt) and small, high and short, prominent bulb. These butts are connected to pressure carried out as close to the edge of the core as possible in order to facilitate the detachment of the blade. The body of the blade is wider that the proximal end of the blade. The pieces have a thin, rectilinear profile with a smooth ventral surface (witness of the stability of the knapping system), and curving of the blade only initiated in its distal end. The dorsal surface shows very parallel edges and mostly rectilinear ridges.

Pressure technique, whether with a crutch or a lever, has a functional advantage of producing long, standardized, regular blades that can be fragmented into several parts. This is particularly relevant to Neolithic groups as a large portion of these blanks seems to have been intended to be used into agricultural composite tools such as sickles or threshing sledges (see functional analysis).

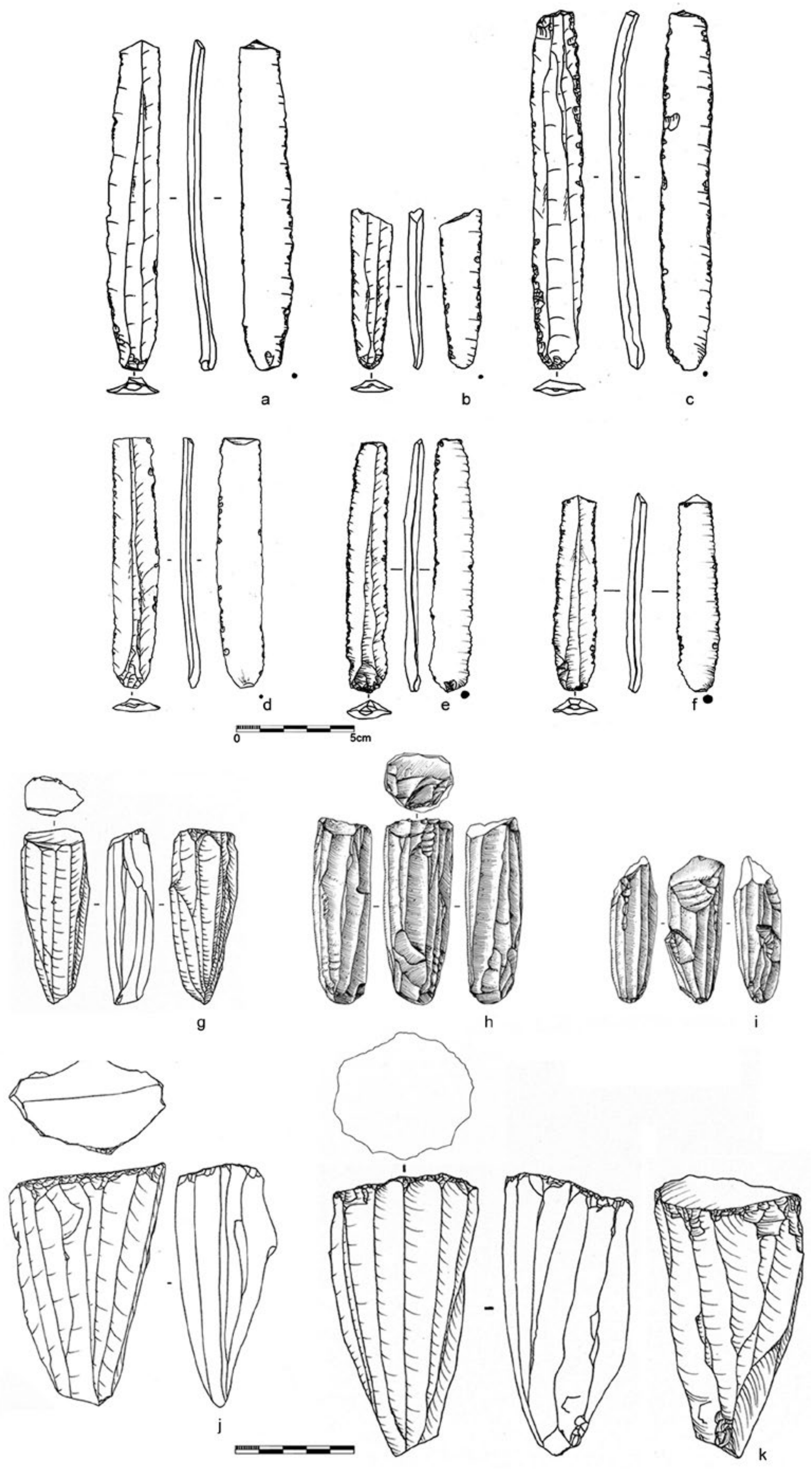


Figure 3. Pressure with a crutch (standing position): a-f) Segments of blades; g-k) cores.
Segments of blades: a) PM, Horizon II (Tr.2 UF5); b) PM, Horizon I (Sond.A UF2); c) PM retouched, Horizon III (Tr.5 UF6); d) PM fine tooth, Horizon IV (Tr.1 UF7b); e) PM, Horizon IV (Tr.4 UF7a); f) PM fine tooth, Horizon V (Tr.6 UF7b) [Legend: P = Proximal; M = Mesial; D = Distal]
Cores: g-i) Bullet cores, Horizon VII (Sond.A UF12, Tr.1a UF14, Tr.2 UF13); j) Prismatic core, Horizon II (Tr.6 UF5); k) Prismatic core, Horizon VI (Sond.A UF11)
[drawings: a-d, g, j-k) J. Leclerc; e-f) M-M. Leclerc; h-i) G. Devilder].

Although no long blade cores connected to the crutch techniques were retrieved, some smaller cores have shown features associated with this type of pressure. Here shown in 3 bullet cores (Figure 3g-i), and 2 slightly larger prismatic cores (Figure 3j-k). Bullet cores are only seen in Horizon VII and have all be knapped using pressure with a crutch and were all fairly well preserved. These cores were made by rotating or semi-rotating debitage (blades detached all around and not frontal only) and mostly regular and allow production of small blades to bladelets. Some elements may have been detached by direct percussion, but the bullet core shows clear evidence of pressure technique as well. We see evidence of thin and regular removals but the pressure platform has either been removed to trim the core, or partly destroyed, keeping us from studying the proximal end of the negatives. Despite this, the cores were associated to pressure with a crutch technique based on the regularity of the debitage, following a rotating method. Taking into account the limitations mentioned above, we can estimate that the blanks thus produced reached 70mm length and 7 to 10mm width.

The prismatic core that was found in Horizon II (Figure 3j) is slightly longer than the bullet cores described above. It shows a frontal debitage but some features suggest it was broken at some point of its use history. This core was trimmed as it shows several blade scars with no proximal end (counter-bulb). The removals are very thin and regular, suggesting the use of standing up pressure with a crutch. The longest blank associated with that core must have reached 100mm by 15mm.

Finally, the prismatic core from Horizon VI (Figure 3k) is the longest and still shows a pressure platform. It was knapped following a turning method and the counter-bulbs identified are high and prominent. However, products from this core seem less regular compared with previous cores, especially on one side of the artefact. The longest product was 115mm in length and 16mm in width.

Despite the crutch technique suggested by these cores, it seems that the blanks they produced were mostly smaller than the large majority of the blades that were obtained using the same technique. Such products are most likely connected to earlier stages of the core, when it was much larger, before making those prismatic and bullet-cores the final stages of a *chaîne opératoire* that was oriented towards the optimization of raw material management.

The connection between standing pressure with a crutch and other techniques is difficult to identify. Were they carried out independently from each other or simultaneously, possibly even complementing each other? For instance, pressure with a crutch would take over when the core became too small as the debitage went on. The lack of intermediate cores makes it difficult to discuss these questions and identify the connections between long and short blades.

Pressure with a lever

At Aknashen, 49 artefacts have been diagnosed to the pressure with a lever technique, including 22 proximal-mesial segments, 19 mesial segments, 4 mesial-distal segments, and 3 complete blades of 150mm in length, thus remaining fairly small for such technique. It is not surprising to witness a large representation of proximal-mesial and mesial sections in the assemblage as the mesial parts of these blanks has an extremely rectilinear profile (functionally optimal) and the proximal parts only has a fairly discrete bulb that does not constitute a real functional impediment when compared to other techniques such as indirect percussion. With this pressure technique, the maximum width of the blade is quickly reached in the proximal portion of the blank right after the end of the bulb, so the mesial part is very rectilinear and flat.

Overall, blade fragments associated with this technique have a width ranging from 24.5 to 34.7mm for an average length of 300mm, and an average thickness of 5.4mm (Figure 4a-h). Although no cores specifically associated to this technique were recovered, we can extrapolate an average core length of 250 to 300mm.

Pressure flaking with a lever was described in several publications (Pelegrin 2012b; Chabot and Pelegrin 2012; Pelegrin 2002; Anderson *et al.* 2004). In order to reach the final stage of debitage, this method require the core to be first roughed out using hard direct percussion, and regularize through indirect percussion. Only after such stages is the core ready to be exploited with the lever technique, generally being fixated in a system such as a dugout tree trunk. The point located at the end of the lever arm can be manufactured in a piece of wood reinforced with a copper point or a cervid tine or punch (Figure 4i; see also Pelegrin 2012b). It is important to mention that this complex knapping technique has been re-discovered thanks to the experimental work of J. Pelegrin.

Whether a copper or an antler point was used can be determined by a careful examination of the butt or of the junction of the butt and the ventral surface. For instance, a cracked butt would suggest the use of a metal point whereas the use of a antler point would instead create a small lip (Pelegrin 2012a; Pelegrin 2012b; Pelegrin 2002; Chabot and Pelegrin 2012; Chabot 2002).

Thus the artefact represented in Figure 4d shows a small lip and no crack suggesting use of a antler. On the other hand, pieces 4b and 4e have a small crack located

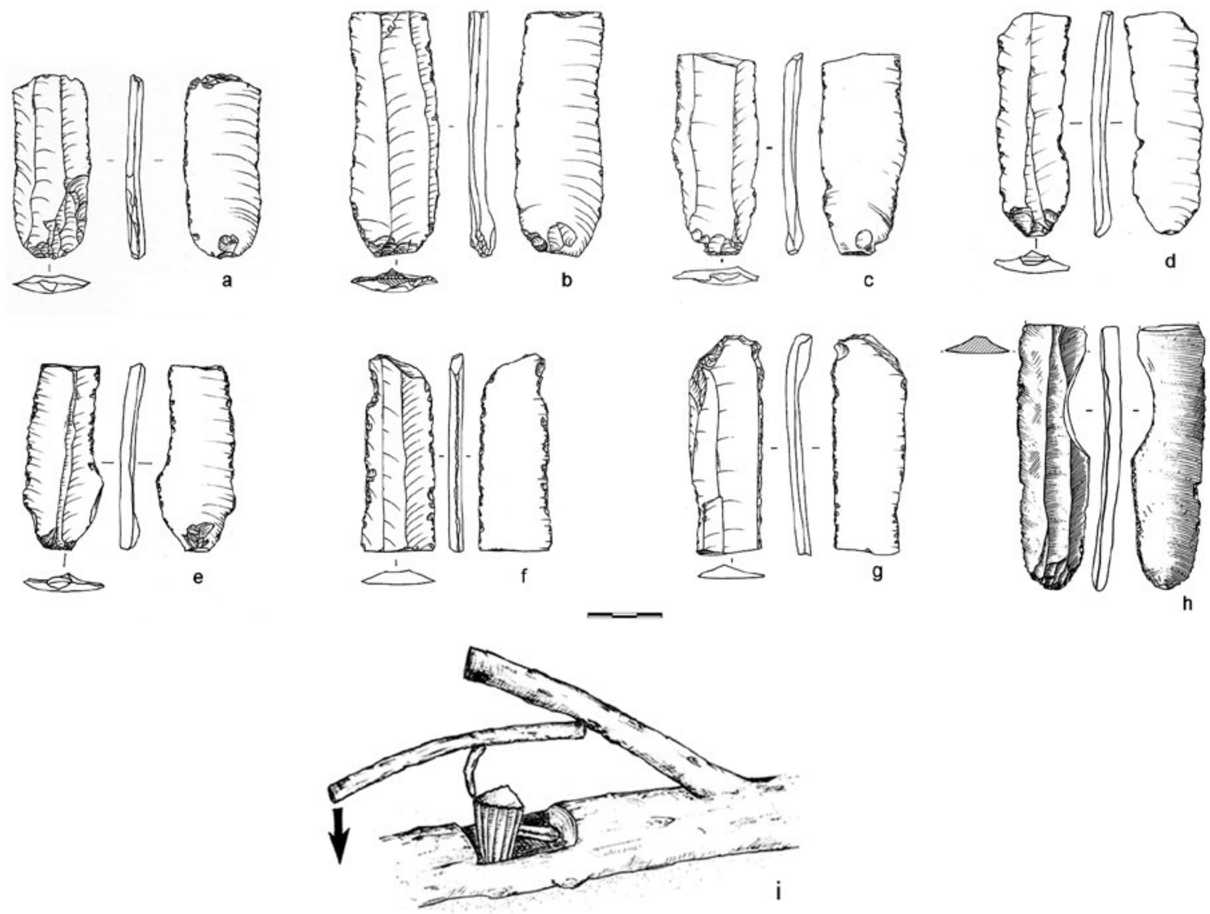


Figure 4. Pressure with a lever: a-h) Segments of blades; i) Experimental system designed by J. Pelegrin [drawing: P. Eid]. Segments of blades: a) PM, Horizon I (Tr.2 UF3); b) PM, Horizon III (Sond.A UF6); c) PM, fine tooth, Horizon II (Tr.2 UF5); d) PM, fine tooth, Horizon III (Tr.1 UF6); e) PM, fine tooth, Horizon II (Tr.5 UF5b); f) M, notch, Horizon II (Sond.A UF5); g) MD, Horizon III (Sond.A UF6); h) PM, retouched, Horizon I (Tr.11 UF3) [drawings: a-c, f-g) J. Leclerc; d-e) M-M. Leclerc; h) G. Devilder].

on their butts suggesting the use of a point probably made of copper. These features were identified in several pieces of the assemblage, and the use of copper points and antler was as well attested on the material of the neighboring site of Aratashen (Chabot and Pelegrin 2012) as well as on many Near Eastern Canaanean blades assemblages (Chabot 2002; Anderson *et al.* 2004).

The three criteria used to identify pressure with a crutch are also found on the blades associated with the lever technique. The use of the lever allows a multiplication of the strength used on the core (up to 300kg), in order to obtain longer, wider products, with fairly similar pressure flaking features (other than the striking platform). Other characteristics typically associated with this set of techniques are also witnessed: prominent, high and short bulb, flat and smooth ventral surface, and distal curving.

Furthermore, all butts found on these blades are plain, and slightly larger than the ones obtained with a crutch even though the proximal ends are still narrower than the body of the blade. The overhang is abraded on some pieces but not systematically. The regularity and rectilinearity of those blades is also seen on mesial and mesial-distal (slightly curved) segments shown here (Figure 4f-g).

Blades manufactures by pressure with a lever show many parallels with the ones made with a crutch. The lever (Figure 4i) allows a technical improvement leading to the procurement of longer, sturdier blanks with a similar regularity and rectilinearity. They preserve the sturdiness of indirect percussion (see next section) while adding the regularity that only pressure techniques allow. The overlaps between the varying pressure techniques exist both in their morphometry (between 24 and 28mm wide) and technical features such as butt aspects (small), as seen in 40 artefacts that can only be attributed to the broad category of pressure flaking.

It is not a coincidence that such complex techniques are witnessed on obsidian. The intrinsic characteristics of this particular raw material (volcanic glass) can only allow pressure techniques in the manufacture of such regular, thin, standardized product that could not be obtained with other techniques such as direct percussion (Chabot and Pelegrin 2012).

Indirect percussion

Twenty artefacts have so far been associated to indirect percussion. Their average width is 31mm, and average thickness 6mm. Almost all segments are proximal-mesial (N=18) with only 1 mesial and 1 mesial-distal. Among these sections of blades, even the short ones present clear characteristics allowing their attribution to this technique. Although indirect percussion probably had a marginal role in the blade *chaîne opératoire* (mostly in shaping the core and possibly to trim it in the later stages), some of the products obtained in this process were good potential tools. It is therefore not surprising to find some of those artefacts voluntarily fragmented. Consequenthly, this implies that the overall number of unbroken blades remain fairly small, the same phenomenon being observed at Aratashen (Chabot and Pelegrin 2012) as well as on other sites where we carried out parallel analysis on similar technological material (see for example: Chabot 2015, 2002; Chabot and Eid 2010, 2007).

On the other hand, it is also possible that blades connected to indirect percussion were obtained from workshops where pressure techniques were not known or mastered. But it is more likely that they are part of a *chaîne opératoire* involving all pressure techniques and contributed to shaping the core in its early stage of exploitation. Therefore, although they cannot be considered *plein débitage,* some of these blades were still transformed into tools.

There are several characteristics allowing the identification of indirect percussion (Figure 5a-d). They often show a plain, long and wide butt, so that the proximal end is as wide as the body of the blade.[1] This often gives a square aspect to the proximal end of the blank. The bulb is large, spread and prominent. The curving generally takes place as early as the mesial part. Several bumps can be seen on the ventral surface, suggesting these artefacts come from a less stable knapping method. Edges and ridges are fairly regular but not as much as with the pressure techniques. However, more regular edges can be obtained on smaller nodules or fragments. The blade's section is broad and thick and products generally have a more robust aspect as shown in the thickness of the blades. Therefore, although such blanks are fairly regular, the three criteria defining pressure flaking are never found all together on one artefact.

From a functional perspective, the curving on the mesial part limits the fragmentation of the blade into flat sections, which could explain why indirect percussion may have been less important in the blade industries of Aknashen.

To summarize, the indirect percussion blade production is carried out on large, long cores with a rotating exploitation mode. There is little evidence of the initiation of the exploitation of the core itself, which tends to support the hypothesis that most of them were brought on site in the early stages of the blank production, or at the end of the core preforming sequence. Large, flat, and irregular blades removed, are more likely associated with these stages. Five of those blades show scars of large, transferal removals on the dorsal surface, connected with the preparation of the flaking surface (for instance in Tr.4 UF11 / Horizon VI).

Direct percussion

In the course of the most recent excavations, several pieces, differing from the main *chaînes opératoires* identified at the site, were found in the lowest horizons (VI and VII). Two cores (Figure 5e-f) seem indeed connected to the production of small blades or bladelets, not as a result of the reduction of a long standardized blade cores, but as an independent *chaîne opératoire* targeted specifically towards the manufacture of smaller, less regular blanks.

These two cores are carried out on small nodules and show negatives of irregular bladelet-like removals. Bladelets were detached using soft direct percussion. The two examples found still have a cortical area and the flaking surface is present on 50 to 80% of the perimeter of the core. The striking platform is carefully managed although very little preparation seem to be involved in the process which, associated to the overall irregular aspects of the blanks, seem to suggest a rather expedient type of production.

Only a limited amount of material associated with these cores could be studied. Both cores are carried out on gray obsidian, and only a few flakes associated to a similar colour and texture were found in those layers, including some cortical flakes but no tools. Although it is difficult to draw specific conclusions regarding the overarching goal of this production and further analyses are required, it remains clear that this *chaîne opératoire* is exclusive to the lowest layers of the site and signals a new type of archaeological behaviors not well documented in Aratashen-Shulaveri-Shomutepe context.

Stratigraphic distribution of diagnostic pieces

Figure 6 presents the vertical distribution of the three techniques used to knap long regular blades across the

[1] Experiments of J. Pelegrin have shown that the butts of these kind of blades are at least 0.8mm long and at least 3 ou 4mm deep (Pelegrin 2012b).

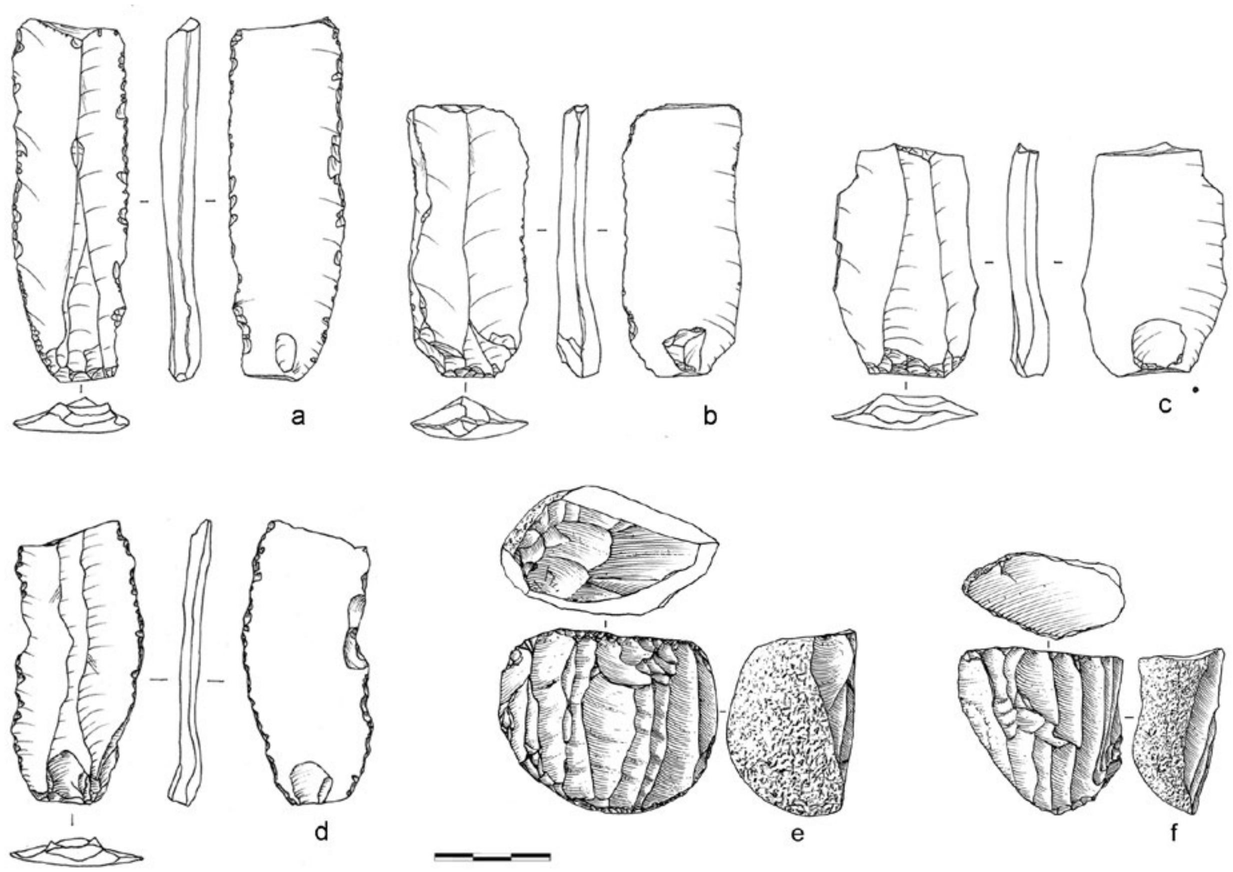


Figure 5. Percussion: a-d) Segments of blades knapped by indirect percussion; e-f) Bladelets cores knapped by soft direct percussion.
Segments of blades: a) PM, fine tooth, Horizon II (Tr.3 UF5); b) PM, Horizon IV (Tr.1 UF7a); c) PM, Horizon VI (Sond.A UF11); d) PM, denticulate, Horizon IV (Tr.7 UF5b).
Bladelet cores: e) Horizon VI (Tr.5 UF12b str.19); f) Horizon VII (Tr.1a UF14)
[drawings: a-c) J. Leclerc; d) M-M. Leclerc; e-f) G. Devilder].

Figure 6. Knapping techniques of long blades identified at Aknashen.

Techniques / Horizons	Pressure with a crutch	Pressure with a lever	Pressure (lever or crutch)	Indirect percussion	Total
I	2	9	3	0	14
II	13	8	5	4	30
III	8	13	11	6	38
IV	26	14	11	8	59
V	4	2	3	0	9
VI	3	1	1	1	6
VII	13	2	6	1	22
Total	69	49	40	20	178

stratigraphy of the site. The first result is that indirect percussion is the only technique not represented in every horizons of the site. This can be connected to an identification bias, considering the low representation of such technique, the limited number of proximal ends present across horizons, and the ambiguous characteristic present on mesial parts.

The diagnostic pieces are logically more represented in Horizon IV, those layers having yielded the highest amount of material.

This chart also highlights the omnipresence of the pressure techniques across the occupation of the site. As early as 6000 cal BC, the groups who settled in this location already carried with them this knowledge and *savoir-faire*, suggesting that this skill was mastered long before.

Area of knapping activity

Tables 1 and 2 display the presence of various products connected to knapping activities across the site. However, such elements are found in small quantities and are not concentrated in one location that could be identified as a knapping area (see Badalyan and Harutyunyan in this volume).

For instance, only very few cortex removal flakes were found at Aknashen. They are not found associated with other by-products, or together in a stratigraphic unit. The same is seen for the 6 first flakes (*entames*) found at the site, or large shaping flakes and crested elements. The few crested blades identified are not long preparation blade but generally fragments of flakes showing evidence of crests. These are indeed evidence of knapping activities but they were most likely not found in primary context. The overall distribution of products and by-products across the site could suggest that such objects were moved towards other areas, possibly connected to the cleaning of knapping areas. The same phenomena was observed at Aratashen (Badalyan *et al.* 2007).

Microdebitage is sometimes found here and there on the site but there are two areas of particular interest. An important concentration of microdebitage was found in UF 7b trench 2 (Horizon IV), made of 18 bulbar microflakes, 71 microflakes, and 260 microfragments, associated with 523 obsidian artefacts among which only 5 by-products (full debitage flakes), 22 unretouched elements of blades, and several tools (11 retouched, 2 fine tooth, 1 denticulate). This concentration is interesting but the lack of by-products (debitage) and cores renders difficult any interpretation.

Another concentration was found in Tr.4 UF6 /T4W3-T4W1 (lower part of a wall), associated with Horizon III. Among the 363 artefacts, there were 7 bulbar microflakes, 21 microflakes and two microfragments. No cores were associated to the findings. Numerous raw segments of blades (103) were found, along with 19 retouched segments of blades, 3 notches, 1 denticulate, and 11 fine tooth on blades, one fine tooth on flake and one retouched flake. Here again, only 18 debitage by-products and a few flake fragments have been found (12 *plein débitage*, and 6 proximal flakes/these raw flakes might have been there to be used). Despite the microflakes, it is difficult to describe this location as a knapping area.

Taking into account the information available to us, it seems that preparation and shaping of the cores did not take place on the site, or that they were carried out in a yet unexplored area of the settlement; even if the identification of some products suggests however that parts of the *chaîne opératoire* took place *in situ*. Indeed, let us point out that, in the case of a properly executed systematic blade-making sequence, the by-products are few in number (also, weak proportion of first stage flakes-products with cortex). Therefore, it is likely that the very first stages of the sequence were carried out at (or near) the source in order to facilitate transportation of the nodules and that they were brought to the site ready for blade production at the full debitage (*plein débitage*) stage.

From what we can 'read' on the products, long blades were unidirectionally removed following a diacritical scheme largely based on 2-1-2' although some occurrence of 1-2-3 are also found. Whether this is controlled or not, there appears to be a regularity in the removal of longer, slightly overshot blades every 4-5 blades, which could be a strategy to preserve, during the blank production, an appropriate convexity of the volume without having to engage in more complex core management operations. For both pressure techniques (with a lever or a crutch), preparation of the striking platform remains minimal. Also, several flakes, core fragments, or overshot blades show traces of abrasion on their distal part, marks of an immobilization device, necessary for any pressure knapping technique.

Furthermore, the absence of large blade cores could be explained by the progressive decreasing of their size during the *chaîne opératoire* and their recycling towards cores more adapted to smaller pressure flaking technique for the manufacture of thin blades and bladelets, or eventually flake cores. It is therefore possible to suggest that small pressure cores represent the latest stages of exploitation of large blade cores, knapped with a crutch or a lever, that have produced the large majority of blanks found at Aknashen. The presence of core trimming elements on the site supports this hypothesis and makes sense from the perspective of raw material optimization.

Finally, several evidence of knapping accident can be found in the assemblage. These artefacts are also spread across the settlement and do not seem to be closely associated with other debitage by-products. Those are generally small and short fragments of hinged (*réfléchie*) blades, a few fragments of small overshot blades, siret flakes and tongues (*languettes*). Some flakes also highlight some attempts to solve some of the accident by cleaning of knapping surface, or attempting to trim a pyramidal cores. Some of those operations can be attempted by knapping off smaller flakes or bladelets from an *ad hoc* opposed platform or a large flake perpendicular to the axis of debitage although the latter might be associated with the beginning of a flake *chaîne opératoire*.

Typological morphology

Flake tools

Figure 7 presents flake tools found so far at Aknashen. As mentioned above, the quantity of tools on flake remains low (6.5% of the tools). This count does not take into consideration unretouched blades (Figure 1c) that were intentionally fragmented and, for a large majority, have been used unretouched or have been stored awaiting to be used.

Some types of tools don't account many specimens but that is not the case with retouched flakes which compose the majority of this part of the assemblage (71%, Figure 8a). These flakes show a few limited retouch with no systematic type or position, although they generally are non-invasive. If we add to this the flakes showing fine tooth (retouch connected to their use, Figure 8b), we see that up to 82% of the flake tools at Aknashen have little to no preparation.[2] The nature of the tool-making process is thus closely connected to the *ad hoc chaîne opératoire* of flake blank manufacture. One type which shows more systematic retouch (front) are the end-scrapers (Figure 8c) but they are very limited in quantity. We will discuss further about this type of tool in the use-wear section.

Horizons	Retouched	Denticulates	Notchess	Fine tooth	Burins	Pointed	End-scraperss	Scrapers	Total
I	23	2	2	8	0	0	2	1	38
II	46	1	9	9	6	1	3	0	75
III	54	0	2	7	0	0	1	0	64
IV	51	2	5	7	2	3	4	0	74
V	41	1	6	2	0	1	4	0	55
VI	18	0	0	1	0	0	1	0	20
VII	20	0	2	3	2	1	1	0	29
Total	253	6	26	37	10	6	16	1	355

Figure 7. Inventory of the tools made on flakes at Aknashen.

The vertical distribution of flake tools is limited by the amount of material analyzed, but it seems so far that flake tools are equally represented across layers (though a little less in the most recent and the oldest horizons).

Blade tools

Figure 9 displays the total list of blade tools identified at Aknashen so far. Blade tools make up the large majority of the tool assemblage of the site, not accounting

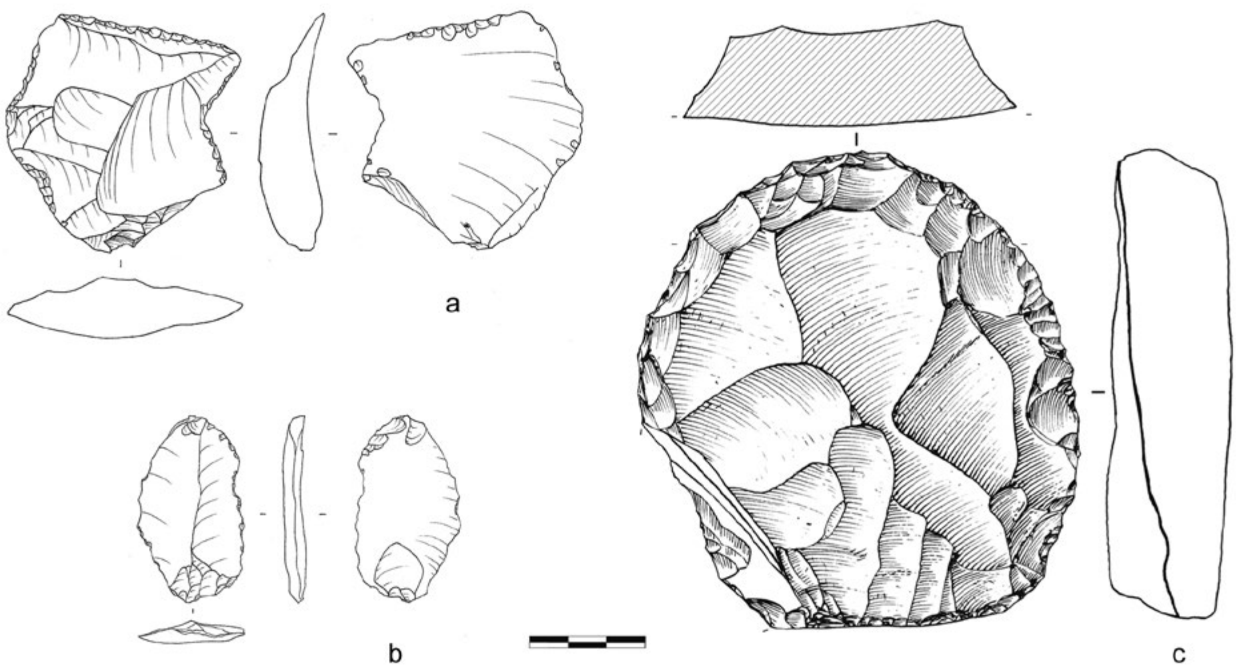


Figure 8. Flake tools: a) Retouched flake, Horizon I (Sond.A UF2); b) Fine tooth flake, Horizon IV (Tr.4 UF8b); c) End-scraper on flake, Horizon IV (Baulk2/5 UF8 F2) [drawings: a-b) J. Leclerc; c) G. Devilder]

[2] Flakes or blades that show a series of fine teeth created when they were used (chipping utilization retouch and not intentional knapping retouch) (Chabot 2002).

Horizons	Retouched	Denticulates	Notches	Fine teeth	Burins	Truncated	Pointed	End-scrapers	Scrapers	Micro-liths	Esquillées (wedge)	Total	Retouched fragm
I	186 (2)	14	24	33	33	3	4	3	1	4	0	**305 (2)**	62
II	422 (8)	32	62	159 (1)	54	11	6	3	0	10	3	**762 (9)**	219
III	662 (8)	67	94	392 (1)	61	9	5	5	0	17	0	**1312 (9)**	286
IV	826 (15)	74	117	338	57	11	12	3	2	44	1	**1485 (15)**	394
V	294 (4)	19	32	68	17	6	1	0	0	92	0	**529 (4)**	112
VI	254 (4)	9	16	34	10	5	1	1	0	12	1	**343 (4)**	80
VII	225 (5)	22	26	41 (2)	31	3	2	1	0	5	0	**356 (7)**	81
Total	2869 (46)	237	371	1065 (4)	263	48	31	16	3	184	5	**5092 (50)**	1234

Figure 9. Inventory of the tools made on blades and, in brackets, bladelets at Aknashen.

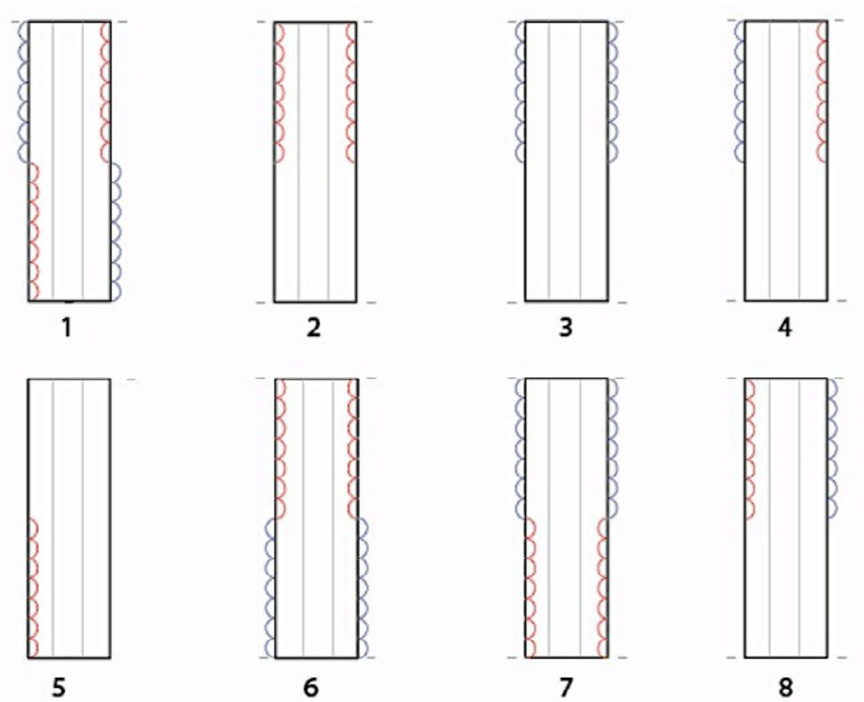


Figure 10. Retouch patterns on blade tools. • Type 1 is the so-called X-retouch, which is characterized by an alternation of the retouch on both sides of the blank. • Type 2 is opposite parallel retouch carried out on one half of the blank. • Type 3 is inverse retouch carried out on one half of the blank. • Type 4 is direct-inverse retouch carried out on one half of the blank. 215 • Type 5 is a direct retouch on one edge carried out on one half of the blank. • Type 6 is a direct retouch on two edges on the distal side, and inverse on two edges on the proximal side, while • Type 7 is the opposite. • Type 8 is an inverted type 4.

for a large amount of blade blanks probably used unretouched. As functional analysis have identified that such unretouched blanks could be used in various plant processing activities, these artefacts could represent up to 6000 additional tools. Therefore, the retouched blade (57%) and fine tooth (20%) constitute a category of unformalized artefacts representing 77% of the tool assemblage. This is consistent with the Neolithic behaviors identified in other sites where artefacts with little to no retouch are mostly used for agricultural activities, as experimental archaeology shown that unretouched blanks can be as efficient as retouched pieces.[3]

Concerning the retouched segments of blades, nevertheless it has been possible to observe some recurrent patterns. Typically, the proximal part will show direct retouch on one side, and inverse on the other. The pattern is then reversed for the distal part. This particular retouch organization might be connected with specific hafting technique, and may also explain the higher proportion of 2-edge retouch on bladelet (as opposed to the normal distribution in blades, which can more easily be used and kept in hand). Eight types of retouch patterns (Figure 10) have been

[3] Three of the authors of this chapter did participate to experimental programs on agricultural tools directed by P. Anderson (Research director at the CNRS-Nice). These experiments took place from 1999 to 2002 and in 2011.

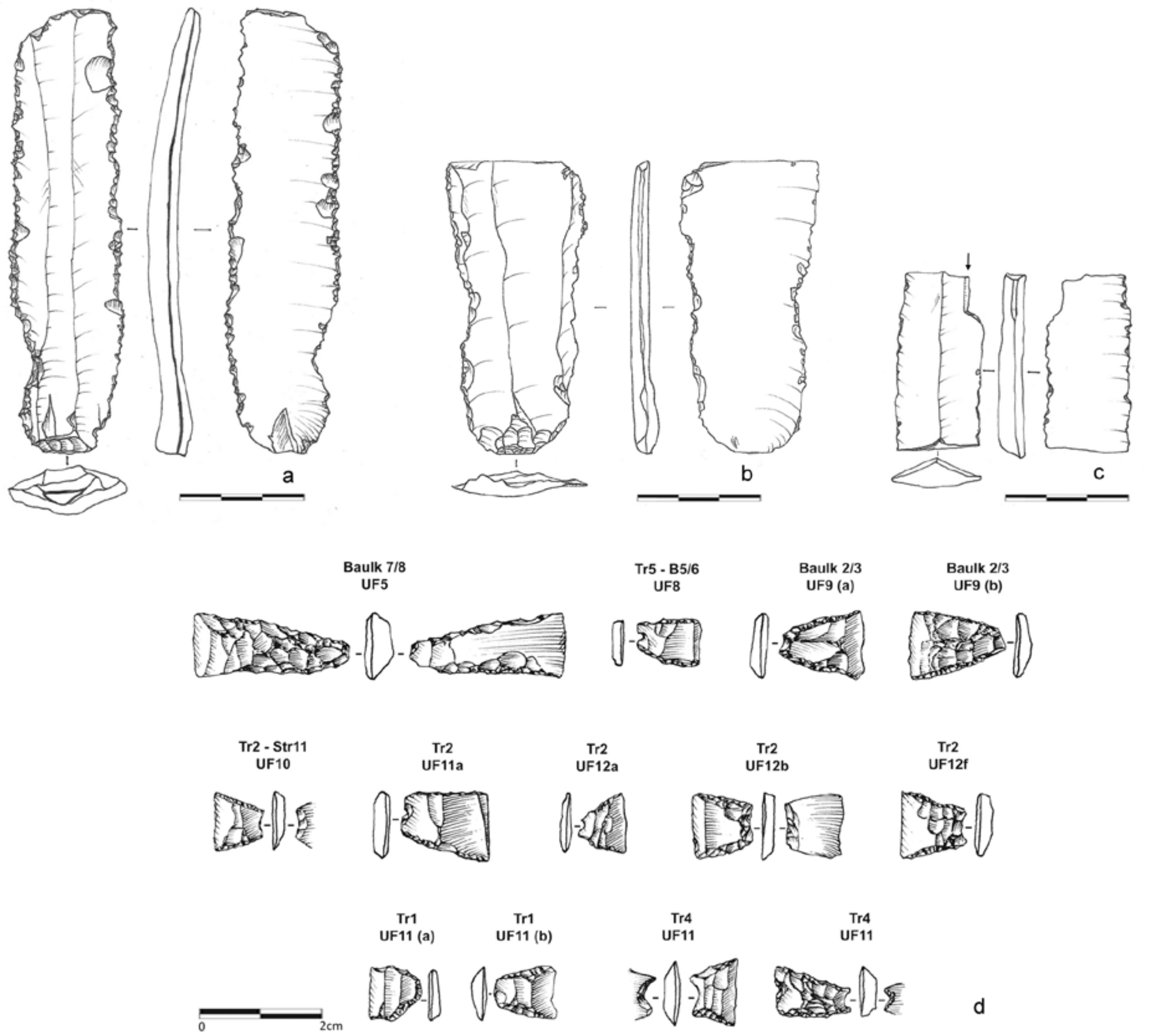


Figure 11. Blade tools: a) Notch on blade (PM), Horizon III (Tr.1 UF7b); b) Denticulate on blade (PM), Horizon VI (Sond.A UF11 F8); c) Burin on blade (M), Horizon III (Tr.5 UF6); d) Various microliths found at Aknashen (Tr.1 UF11, Tr.2 UF12a, Tr.2 UF10 str.11, Baulk5/6 UF8, Tr.4 UF11, Tr.2 UF12f, Baulk2/3 UF9, Tr.2 UF11a, Tr.2 UF12b, Baulk7/8 UF5) [drawings: a-c) M.-M. Leclerc; b) J. Leclerc; d) G. Devilder]

identified, not taking into account the variations in the retouch themselves. This approach did not yet allow to identify any specific patterns of tool distribution.

The high number of such tools (partially retouched and fine tooth blades) suggest that they played an important role at the site. Furthermore, the lack of parallels with classic prehistoric typologies is typical of agricultural settlements (Anderson *et al.* 2004). This limits the role and impact of morphological typology, since three-quarters of the tools show minimal transformations. This phenomenon was also witnessed in the neighboring site of Aratashen (Chabot and Pelegrin 2012; Badalyan *et al.* 2007) and other Near Eastern sites. Therefore, the standardization is not identified in the tool typology but in the techniques and methods of knapping carefully implemented to make them, as well as their functions. Indeed, as we saw above, the aim of the blade technology at Aknashen was to obtain regular and standardized blanks that were destined (for the majority) to be used, retouched or not, in specialized activities, in particular agricultural ones (see next section).

Still concerning this typology, four categories of formal tools (retouched) are represented in significative proportions: notches (7.2%; Figure 11a), denticulates (4.6%; Figure 11b), burins (5.1%; Figure 11c) and microliths (3.6%; Figure 11d). Burins spalls are found across the site and one concentration (N=18, burin spall) is found in Horizon III (Trench 5 UF 6), along with 6 burins on blade, that may have been manufactured in this area.

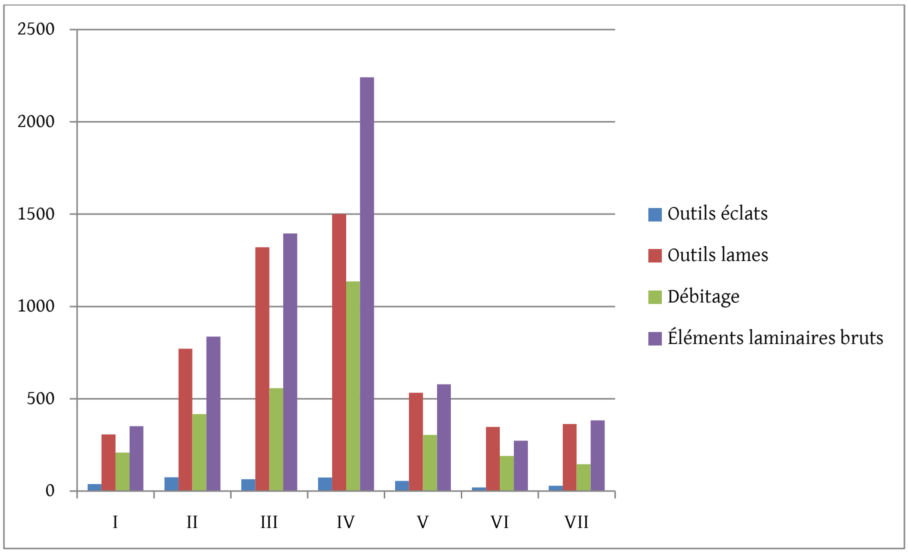


Figure 12. Evolution of the tools (on blades and on flakes), debitage and raw blades (blanks) at Aknashen.

Tool distribution across layers show a good representation on horizon III (25.7%) and IV (29.2%). Besides the microliths (that are more represented in Horizon V), most tool types are more numerous in horizons III and IV. However, such data could evolve since excavations are still ongoing.

Microliths are present in every horizons of the site. So far their presence is more discrete in both the oldest and the most recent level. 50% are concentrated in horizon V and 24% of them were found in level IV.

From a morphological point of view, microliths were made of various shapes and forms (many specimens are not typical geometrics); they were made on small fragments of blades, the most common form being the trapeze with direct retouch on both 'proximal' and 'distal' ends.

Figure 12 summarizes interrelations of tools, debitage, and unretouched blanks. It is interesting to notice the high proportion of blade (blanks and tools) compared to debitage. This suggests that only a portion of the knapping activities by-products have been found and that the excavated areas did not yield any workshops.

We observe a regular increase of debitage from horizon VII through IV and a progressive decrease from horizon III through I. We see a similar trend with blade tools except for a slightly superior representation in horizon VII (tool blades remaining more represented than debitage). The same phenomenon is seen for the unretouched blank fragments, more represented in VII than VI, and then slowly increasing in IV before decreasing progressively in the more recent horizons. Flake tools remain modestly represented across all horizons. Blades constitute a majority of the material in every horizon (blade blanks which are potential tools and tools on blades, put together) and occupy always more than 60% of the total amount of lithic artefacts (over 70% in horizon VII and III), hence it is in these two horizons that debitage is lower in proportion.

From a global angle, if we look at this assemblage from horizon VII to I, the lithic material is the same, both from a typological and technological point of view. As far as lithic is concerned, every level seems to belong to Neolithic culture. So far the amount of material is less in horizon I compared to some other horizons, but it is also the same ordinary amount in horizon V. Although level VII shows some different artefacts, so far it concerns only some objects and it is too early to discuss further about this since we will have to wait (work in progress) to see if this is anecdotic or really an important difference. For example the presence of small cores is interesting but the fact that we don't have such cores elsewhere is not the proof that they didn't have them, since similar products (like bladelets) are present everywhere. About level VII we definitely need more material to ascertain or not if there are some important difference in the technology.

Functional Analysis

Functional analysis of stone tools is done by high magnification traceology (use-wear analysis). This kind of analysis makes it possible to identify the function of an artefact thanks to the microtraces of use left on its active part. These traces can be observed by an attentive examination made with a metallographic microscope. Our analyses have been made at 200X and 100X magnification using a Zeiss Axioscope 2 MAT and an Olympus BX41M both equiped with Nomarski prisms (Differential Interference Contrast). Traceology is the only proven method to diagnose the true function of stone tools (Anderson *et al.* 2004; Yerkes and Kardulias 1993). It is by comparing the traces observed on the archaeological objects with an experimental reference frame that the diagnosis could be posed. Morphology (typology) and function are not always linked and it is frequent that an object classified in such or such typological category proves to have been used for another function. Consequently, it is always necessary to remain very careful when it comes to the supposed function of a given artefact, because it is only in the course of an high magnification examination that it will be confirmed or not (Gurova and Chabot 2007; Keeley 1980; Van Gijn 2010). Also, it is not rare to note (as we will see) that an artefact had more than one function on the same active part (edge) or on two different zones. Eighty-three artefacts from every horizon have been analyzed so far (eight come from Horizon I, ten from II, fourteen from III, fourteen from IV, twenty one from V, five from VI and eleven from VII) . Here we present the results of the analyses which we carried out on the two *chaînes opératoires* identified at Aknashen.

Use-wear analysis of the tools on flakes from Aknashen

Generally, few use-wear analyses have been carried out on the expedient tools, even if this kind of material is present in almost every cultural area around the globe (Chabot *et al.* 2014). This is possibly due to the fact that this material of ordinary appearance (flakes of various forms) offer a limited potential from a technological point of view, because as we saw, it belongs to a semi-improvised *chaîne opératoire*, whereas from a functional point of view, as they are tools used for a short time, the analyses are very difficult to make, because these artefacts carry little traces and those are very difficult to read and require long analyses. Also such flakes are often found on sites where exist also a more spectacular *chaîne opératoire* which hold more the attention of the researchers.

However, since many years (Chabot 2002), like other researchers (let us mention for example: Dionne 2013; Van Gijn 2010; McCartney 1996), we have showed the importance of these 'tools of the moment' which relate to the practice of small specific tasks, which explains why they were the object of little preparation, that they do not have a stereotyped aspect and that they were briefly used. They are thus witnesses of the everyday life and of short time work and their presence proves that they played a role for those who made them.

Thus in order to document these obsidian artefacts, within the framework of a wider program that we launched in 2013 on raw materials of North America (Chabot *et al.* 2017), we benefitted from it to carry out experiments on the obsidian of Armenia (experimental artefacts manufactured starting from blocks collected at Arteni and Gutansar volcanos). These experiments which related to the work of various materials (bone, antler, hide, plants etc.) used during short periods, helped us much to get the results which we present here. The universal problem that presents *ad hoc* tools concerns their short time use which makes so that their microtraces of use are most of the time at an initial stage of development. Also, many of these flakes did not serve yet, whereas others were used but so little that it is very difficult to identify their function.

To add to this difficulty, little polished is to be formed (especially in a so short period of use) on the Armenian obsidians because they are not matt, such as for example the obsidian of Sardinia which at some point is closer to flint (cryptocristalline) (Hurcombe 1992), whereas this one is made up of microcrystals and react like glass.

We selected archaeological flakes according to their potential as tools, i.e. for example, flakes who presented a good gripping and a well localised cutting-edge or who showed a series of retouch or fine teeth potentially associable with use of that given flake. We present here the specimens which revealed the most traces and we offer a summary of some other identified potential functions, but of a more tiny and hypothetical nature (lower degree of confidence of the diagnosis). The selected flakes are typical material of Aknashen, since they present little or no retouch (partial retouch, fine teeth or raw flakes).

Scraping hide and harvesting: rejuvenation flake (Horizon I, Trench 3, UF3)

This artefact is interesting, because it is a debitage product (rejuvenation flake of a striking platform) which was used. Thus, it is a nice proof that any object with an efficient cutting edge could be considered as a potential tool and used. Consequently, the active part of this artefact, made of a raw cutting edge presents evidence of scraping hide (Figure 13). In addition to a modest wear of the edge, we can also notice in the same area, the presence of short lines of which some are rather deep and without particular orientation (about perpendicular and/or oblique). This artefact also seems possibly to have worked plants during a short period. This is noticeable on a short zone (edge) located on its ventral face which presents an overall flat aspect and the formation of characteristic striations (that might be associated with harvesting activities). We will discuss in details of traces related to plant working in the next section devoted to the use-wear analysis of blades. This flake underwent a short time of use and seems to have two functions, the second one being not enough developed to let us go further than the recognition of the contact material (plants).

Scraping hide: retouched flake (Horizon II, Trench 4, UF5)

This retouched flake presents also traces of hide working (Figure 14), but these are more discreet than the previous example. It is still about a very short

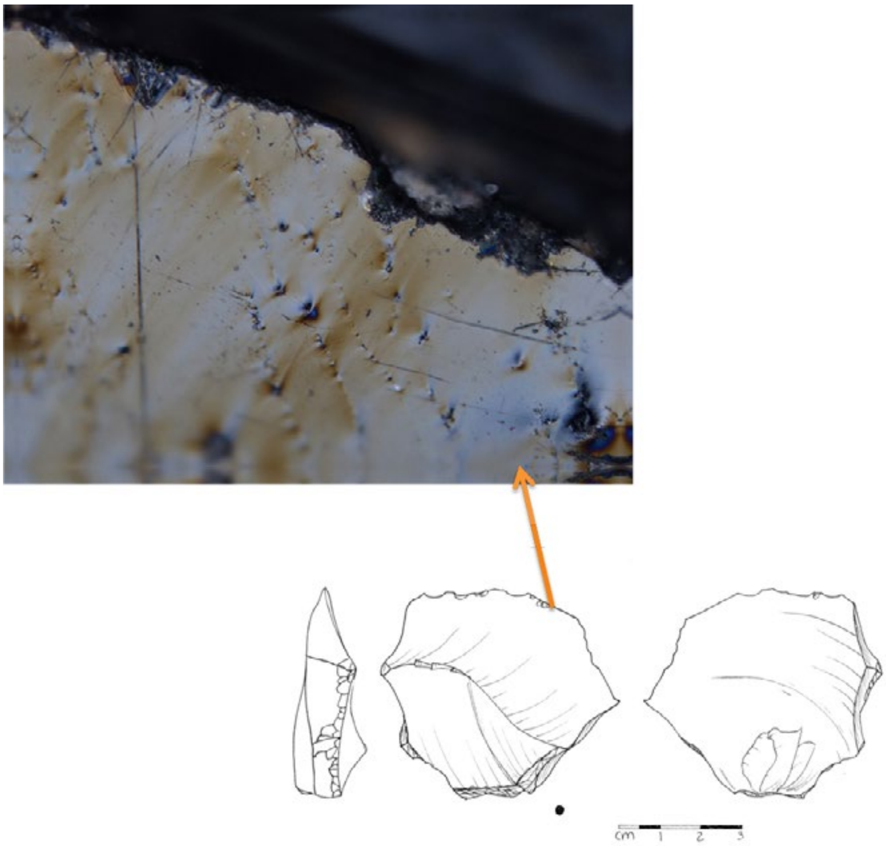


Figure 13. Use-wear, traces of hide working: Rejuvenating flake, Horizon I (Tr.3 UF3) (200X) [drawing : J. Leclerc].

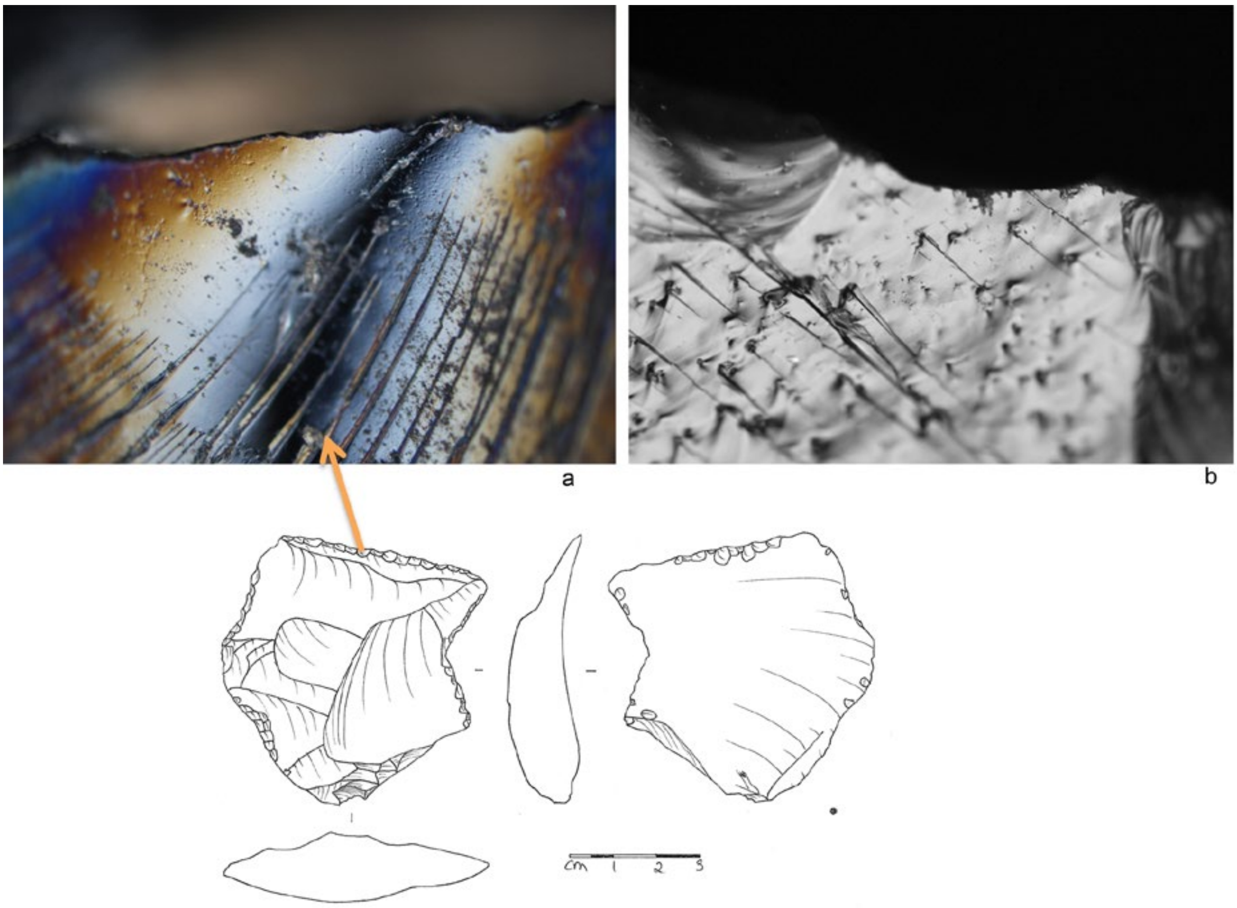


Figure 14. Use-wear, hide working: a) Retouched flake, Horizon II (Tr.4 UF5) (200X); b) Experimental microtraces (100X) [drawing: J. Leclerc].

time use where the traces are not very deep and still in 'formation'. Several elements made it possible to recognize this function in its beginning stage, in particular thanks to the experiments of short times that we carried out and who showed several very subtle but similar aspects. Thus, at some spots, we can observe the development of small traces of abrasion in the form of small dots. Also the beginning of wear of the cutting-edge presents a fine aspect, sign of the beginning of a similar rounding. The presence of some discrete removals that we do not see in the course of hard material work was also noted.

Scraping bone: denticulate on flake (Horizon II, Tr.5 UF5)

On the distal part of this flake made of a small denticulate, one can see traces which seem to attest that this object was probably used to scrape bone. This is noticed by the shape of the cutting-edge which lost its linearity; it is scattered with small wrenchings detached by the pressure exerced by the tool on a rough material such as bone (Figure 15a). Moreover, we can notice the beginning of a development of fine perpendicular lines located directly under the cutting-edge. Another type of traces, so characteristic of the work of the bone is present: it concerns a kind of abrasion which is developed in periphery of the cutting-edge and which was formed when the hard matter penetrated inside the surface of the artefact and then was released leaving a typical scar on the obsidian (Figure 15b). This kind of abrasion is noticeable by the presence of small white spots inside the brand of abrasion. Such traces were reproduced in the course of our experiments on bone.

Working hide: retouched flake (Horizon IV, *Sondage* A UF7)

This retouched flake has a particular morphology since the arrises seen on its dorsal side show than it was knapped from the remains of a blade core. The traces of use are observable on its right edge (Figure 16) where one can see some characteristics in link with the work of hides: mainly the presence of rather deep but short lines localised close to the cutting-edge but which do not leave necessarily from it and which do not have a clear orientation (some perpendicular, some oblique). The cutting-edge presents also an initial stage of rounding and some removals, having a termination sometimes rounded, sometimes squared, hence attesting this tool would have been used to scrape hides. Moreover, below the cutting-edge, several small points are visible and they are sign of primary stage of abrasion. It is important to note that all the microtraces present on this flake are found close to the cutting-edge. Outside the active zone of the tool, there are few traces.

Cutting plant- double use: fine tooth flake (Horizon IV, Tr.4 UF8b)

This flake presents fine teeth, signs of its use. Its active edge testifies a double utilization related to plant working, that is to say: stripping (Figure 17a) and threshing (Figure 17b). These kind of microtraces are usually more the prerogative of tools made on blades (as we will see), but the morphology of this flake which possess a rectilinear cutting-edge allows this kind of use. Wrenchings close to its edge seem to confirm that the logical order would have been to initially use this tool for stripping and then to thresh in a sledge (*tribulum*). These functions are discussed more in details in the following section which address several types of functions related to harvest treatment.

Some other examined flakes do carry microtraces, but those are even less developed and to associate them with a function is difficult. These flakes may have been used for some minutes only. Others show traces under development ascribable to a general category. Thus some flakes carry traces possibly caused by the work of plants and others by bone working (to scrape and/or groove).

In addition, the site of Aknashen contained a modest quantity of end scrapers. Two scrapers on flakes presenting a well-made end-scraper front were submitted to the metallographic microscope. One came from horizon II and the other from horizon IV (Figure 17c). However, for these artefacts also, the traces which they carry are too thin to come to a diagnosis. There exists a formation process/loss of traces on this kind of object. Thus dependently of the state of the front of the end scraper, traces can be visible and readable or on the opposite, the artefact can be at the end of a phase of retreat of the front (loss of the traces) and its microtraces are then very difficult to 'read'.

Use-wear analysis of the blades of Aknashen

As we saw previously, while flakes of Aknashen have variable forms obtained by semi-improvised knapping technique (and were used to various short time functions), the industry on blades was the object of a search for standardization thanks to the implementation of very precise techniques. As we will see it here, this seems to raise a functional goal, namely work of the plants. Such a fact is not surprising considering we are studying a Neolithic population for which the cultivated cereals were to occupy a fundamental place in their economy.

Harvesting

On the blades which were observed under the metallographic microscope, fourteen carried traces of

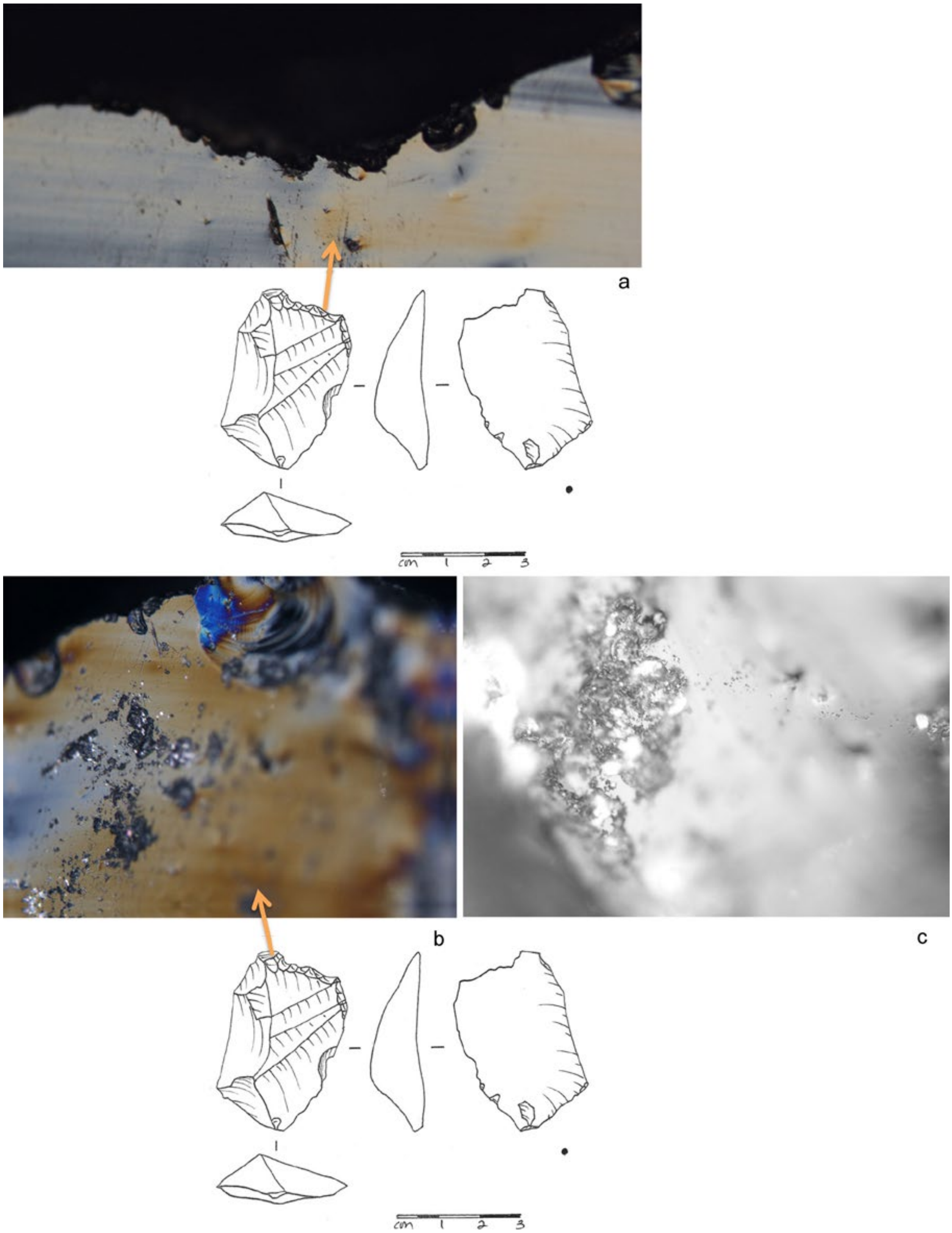


Figure 15. Use-wear, scraping bone: a) Denticulate on flake, Horizon II (Tr.5 UF5) (100X); b) Comparison: scar-like abrasion, on denticulate on flake, Horizon II (Tr.5 UF5) (200X); c) Experimental scar-like abrasion (500X) [drawings: J. Leclerc]

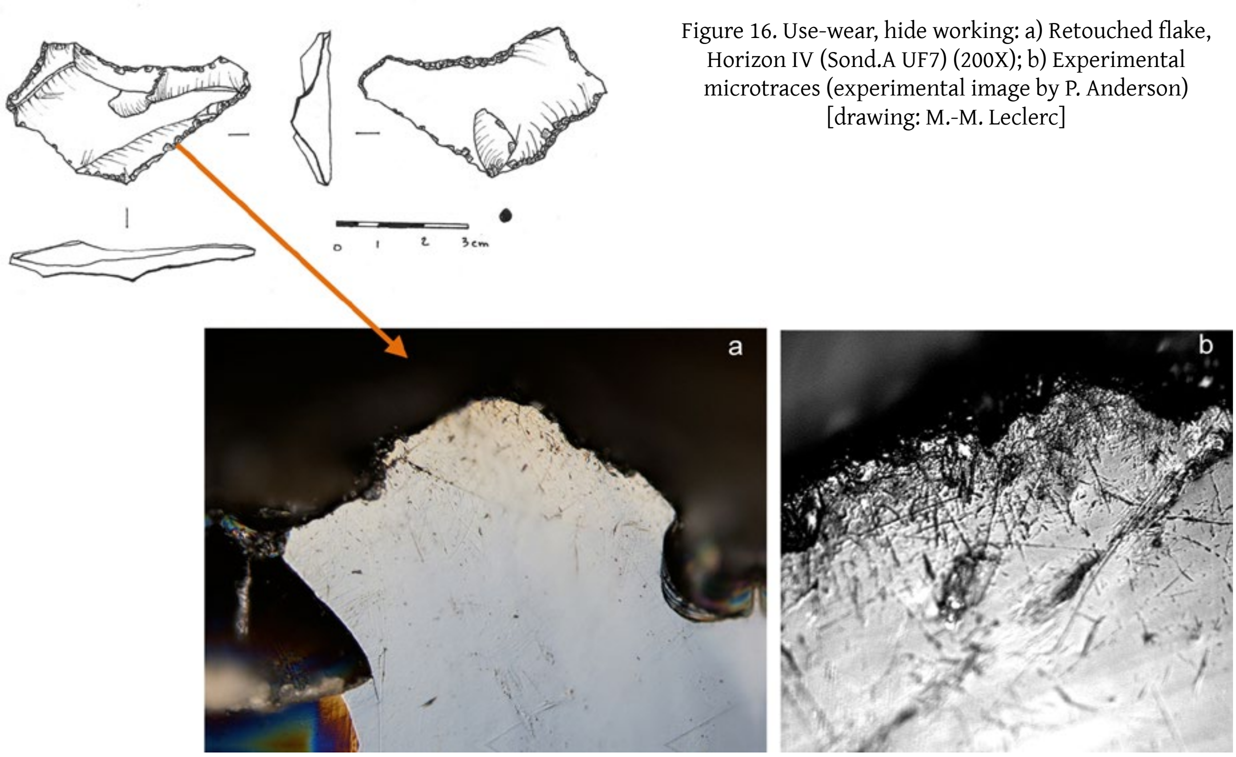


Figure 16. Use-wear, hide working: a) Retouched flake, Horizon IV (Sond.A UF7) (200X); b) Experimental microtraces (experimental image by P. Anderson) [drawing: M.-M. Leclerc]

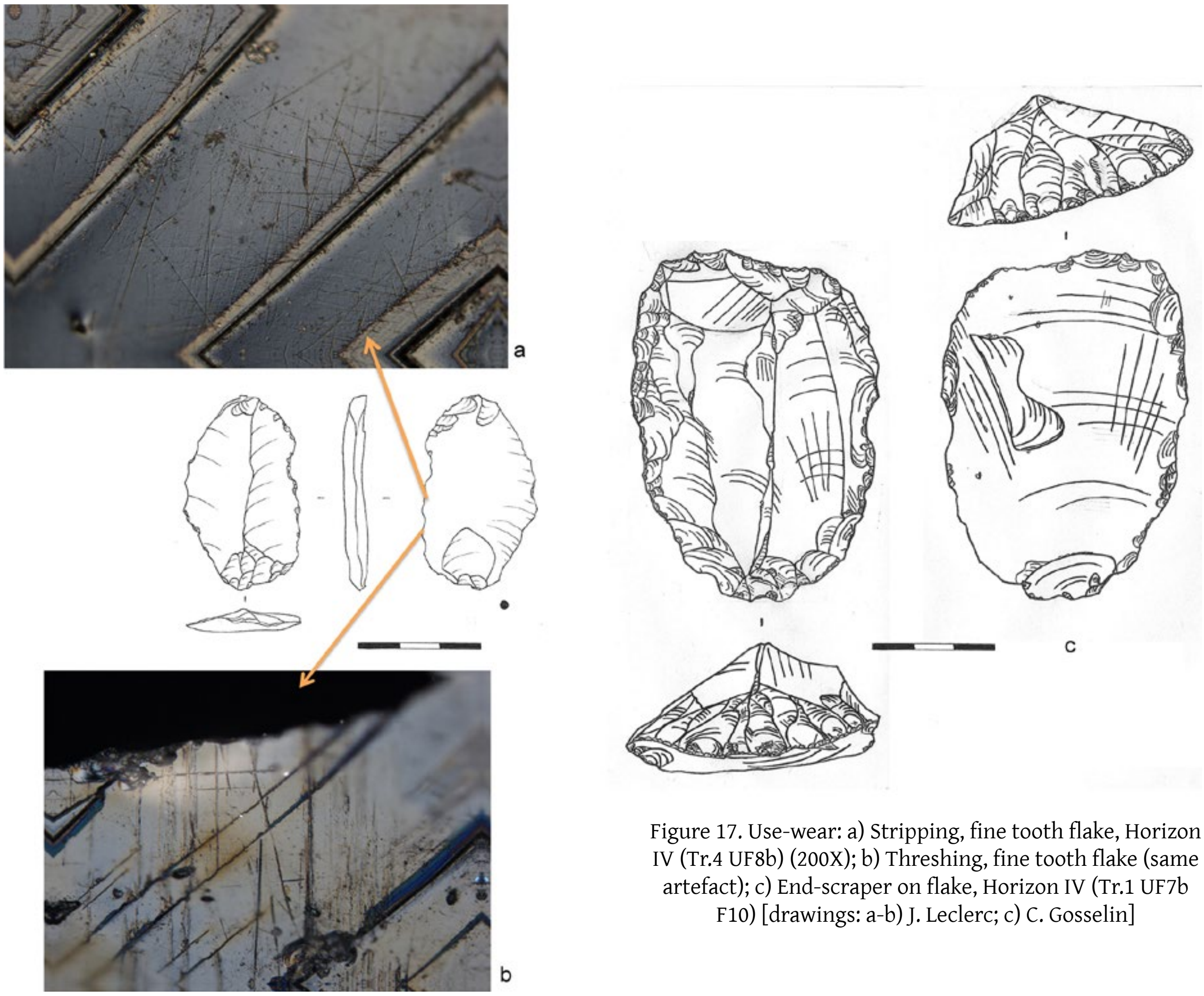


Figure 17. Use-wear: a) Stripping, fine tooth flake, Horizon IV (Tr.4 UF8b) (200X); b) Threshing, fine tooth flake (same artefact); c) End-scraper on flake, Horizon IV (Tr.1 UF7b F10) [drawings: a-b) J. Leclerc; c) C. Gosselin]

harvest. Other similar artefacts, that we will discuss in a forthcoming section, had been used to two functions including harvesting.

Among the artefacts for which harvesting was the only function identified, four of them showed such microtraces on both their cutting-edges. So, for these segments of sickle blades it seems that once one edge has been used it was returned and hafted on the other side in order to use its second cutting edge.

Sickle blades were identified (for the moment) in every horizon, except in the most recent and the most ancient one. This doesn't mean that they didn't practice this activity (research in progress). Furthermore, in Horizon I, another type of harvest activity is present that we will examine in the next section. As for Horizon VII, some double-used segments of blades were identified, including sickle blades used on both edges to harvest.

Another interesting fact is that six segments of blades used to harvest were manufactured by standing up pressure with a crutch, four by pressure with a lever, three more were also knapped by pressure but we cannot discriminate between small or big pressure, and the last one was obtained by indirect percussion.

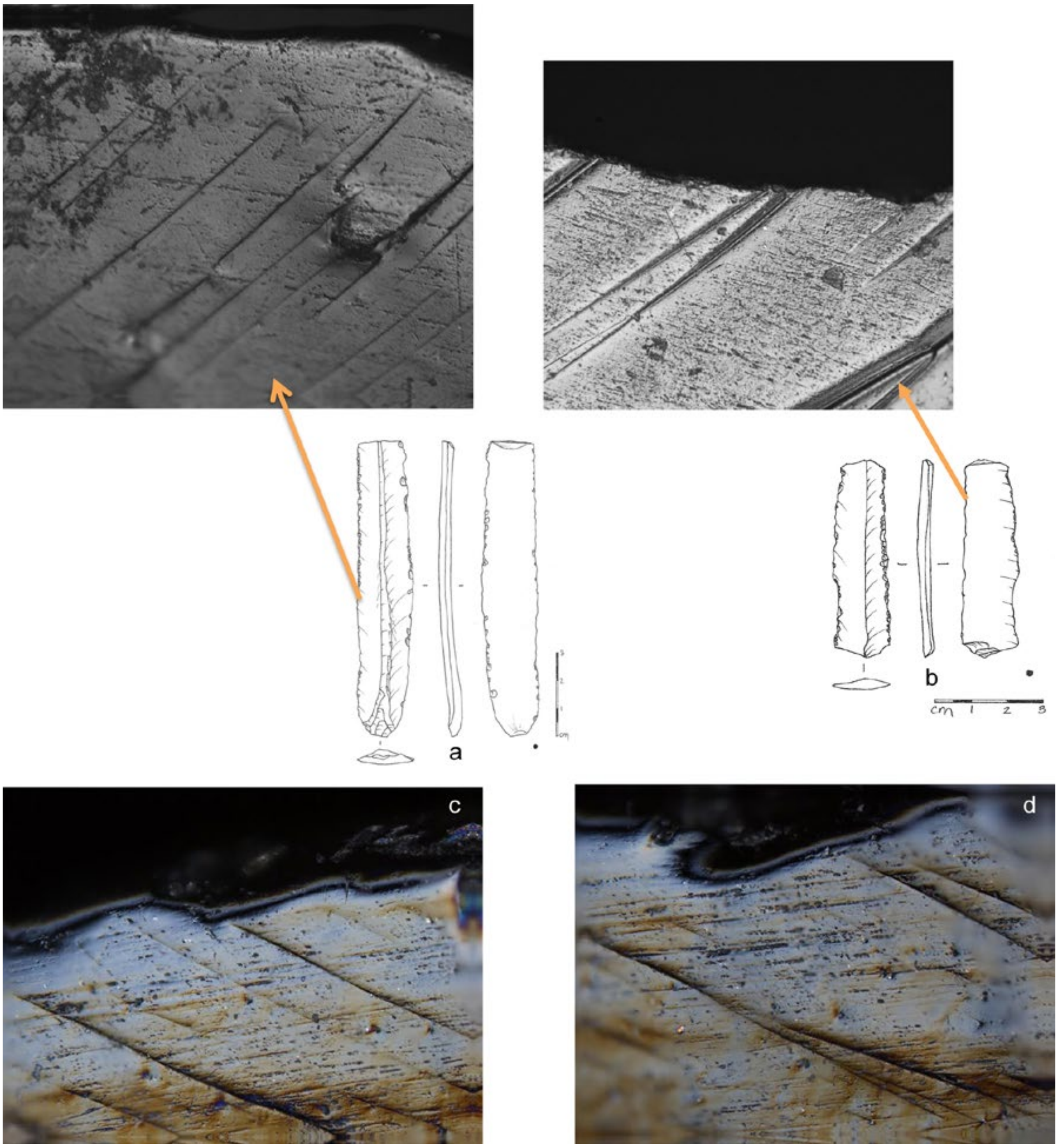


Figure 18. Use-wear, harvesting: Fine tooth blades made by pressure with a crutch: a) Horizon IV (Tr.1 UF7b) (200X); b) Horizon VI (Sond.A UF11) (200X); c-d) Experimental microtraces (200X) [drawings: J. Leclerc]

With regard to the parts of the blades used, nine are mesial sections and five are proximal-mesial parts. The types represented by these tools are as follow: five are raw segments of blades, six fine tooth, two notches and one is retouched. It is thus very interesting to note that eleven of the fourteen sickle elements do not have intentional retouch (except for used retouch for the fine tooth). This fact goes largely in the direction already discussed where to work plants, retouch are not necessary and which shows well that any sharp blade is a potential tool.

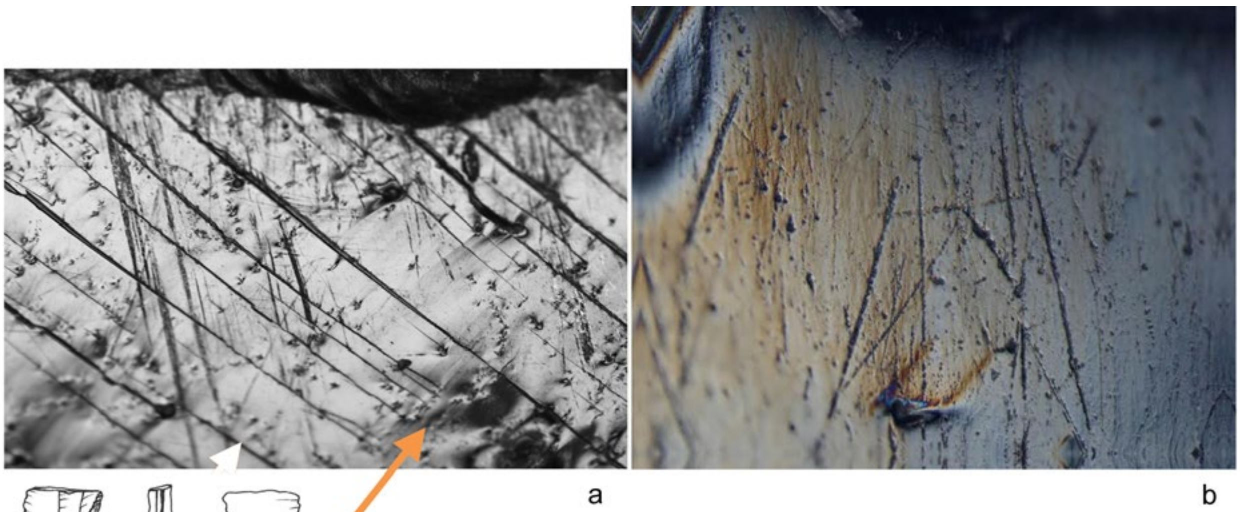
Concerning microtraces associated with this function, they are very well marked and uniform from a blade to another (Figure 18a-b): the general aspect is flat, the traces are concentrated near the cutting edge which is often rounded and can present a 'glazed' aspect. Fine striae (lines made of dots), parallel to the edge, which are typical of harvest activity (Anderson *et al.* 2004) are omnipresent. Sometimes isolated striations without orientation (intermittent scratches) can also be observed.

Stripping

Another way of harvesting is to do it by hand using a section of blade. The stripping traces are caused by the collected plants and a motion comprised of the harvester firmly wedging the seed head between his thumb and the blade in hand, then pulling it toward himself; this way all the kernels are detached. There exists in only a few types of plants a seed head fragile enough to be collected this way : einkorn wheat, emmer wheat, and hulled barley (Méry *et al.* 2007). The last two types were identified at Aknashen (Hovsepyan and Willcox 2008).

The experiments made it possible to define the characteristic traces which will be found on artefacts that were used to stripped. Thus, series of lines perpendicular to the cutting-edge and rather deep and concentrated will be observed. These traces are concentrated on the edge, but their form and their orientation are different from harvesting with a sickle. But since this is about a sort of harvest, some aspects might be alike, thus rounding of the edge (and glazed aspect) can be observed.

For the moment, in Aknashen, three artefacts have been identified with well marked traces of stripping (this does not include tools with double functions). Some other artefacts possibly served this way, but are not marked enough in order for us to diagnose it. The segments of blades which were used for stripping come from horizons I, V (Figure 19) and VII. Thus this work seems attested from the start to the end of the occupation of the site. The blades from Horizon I and V were manufactured by standing up pressure with a



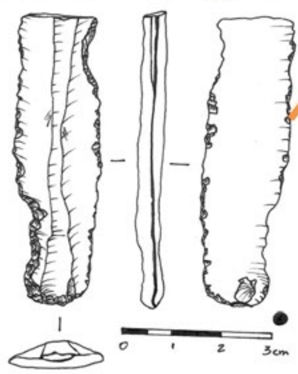


Figure 19. Use-wear, stripping: a) Notch on blade, Horizon V (Sond.A UF10) (200X); b) Experimental microtraces (200X) [drawing: M.-M. Leclerc]

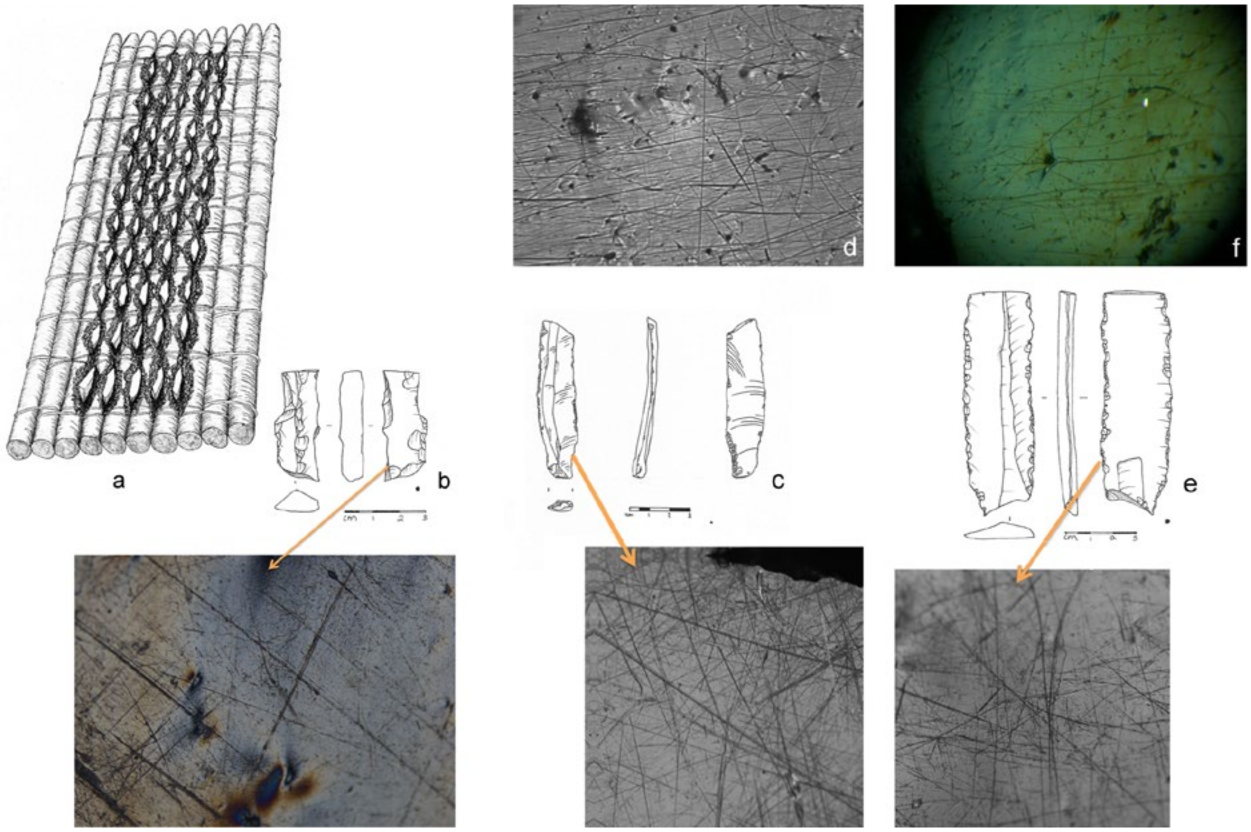


Figure 20. Use-wear, threshing: a) Reconstitution of a threshing sledge (after Anderson *et al.* 2004); b) Burin made on blade, Horizon VII (Sond.A UF12) (100X); c) Notch on blade, Horizon VII (Sond.A UF14a) (200X); d) experimental microtraces (200X); e) Fine tooth blade, Horizon I (Tr.3 UF3) (200X); f) experimental microtraces (200X); [drawings: a-b, d) J. Leclerc; c) C. Gosselin]

crutch, whereas the technique of knapping of the blade from Horizon VII could not be diagnosed because it presents a mixture of characters. From a morphological point of view, it is interesting to note that these tools correspond to three different types: one raw mesial section, one notch and one blade with partial retouch.

Threshing

Another known agricultural function starting from the Neolithic era, threshing, consists in chopping the harvested plants using a composite tool: the sledge or *tribulum* in which were embedded sections of blades (Figure 20a). This agricultural 'machine' was drawn by an animal (for example a bovid) and this action made it possible to separate the grains from their envelope and to chop the straw. We abundantly described this work in several other publications (see for example: Anderson *et al.* 2004; Chabot 2002). As it was also the case with Aratashen (Badalyan *et al.* 2007), this work is also attested at Aknashen.

Artefacts which show developed traces of this use were identified in horizons I (1), V (2), VI (1) and VII (3). This shows that this practice was in use throughout the occupation of Aknashen. Though it is fairly possible that this task was performed in every horizon. Moreover, as mentioned above for other functions, the absence (for the moment) of diagnosed tools linked to this work in such or such horizon, does not mean that threshing was in use, but those, either did not reveal such objects yet, or have artefacts with such traces but not developed enough to attest it with a high degree of certainty. This section does not either address blades with double agricultural use which we will treat in the next section and who also concern, as we will see, threshing activities.

Noteworthy, all these blades were obtained by pressure knapping techniques: two by standing up pressure with the crutch, one by pressure with a lever and four by one or the other technique (segments for which we cannot diagnose because possible characters for the two techniques are present). The types of segments chosen are still mesial parts (4) or proximal-mesial (3). As we already mentioned, the type of bulb created by pressure techniques (high and short), is not an awkward asperity from a functional point of view.

From a morphological point of view, once more we notice that different types can have the same function. Here the elements of *tribulum* consist of: three retouched segments, two notches, one fine tooth and one raw mesial segment.

Threshing microtraces (Figure 20b-c) testify that these tools were used with great intensity. Several elements contribute to create these traces: pressure put on the blades by both the weight on the sledge and the ground, cut plants themselves and occasional contact with the ground itself and of small stones which it contains. The nature of this work is much harder than harvesting and a great quantity of deep scratches (in all directions) will be observable on the cutting-edge, but also in periphery of the edge. Opposite to harvesting, the microtraces will tend to fade little by little in periphery. Sometimes on certain types of obsidian, tearing of polished (abrasion) in the shape of comets can be observed, as it is very often the case on such elements when they are made of flint (Anderson *et al.* 2004; Chabot 2002), but this was not seen yet on blades from Aknashen even if abrasion marks are present.

As we have just seen, these tools on blades, in a general way, were not transformed (no retouch or rare partial ones). But there exist examples of formal tools which also seem to be linked with threshing activities; this is the case for two burins on blades. One comes from Horizon V (Figure 20d) and the other one from Horizon VI. No other function was identified for the latter, which once more force a reflection about the link between tools' morphology and their identified function; here the 'burin blow' was probably performed after this tool was first used to cut plants. On the other hand, concerning the tool from Horizon V, the interior of the burin shows some scattered points of abrasion and linear traces of wear, but it is not developed enough in order for us to link these traces with a precise function such as those seen during the experiments we carried out.

Double-use related to plant working

So far, five segments of blades revealed traces of two functions related to plant working. Two seem to have harvested and then threshed (Figure 21a), whereas three seem to have been used to strip and then were used on a sledge (Figure 21b).[4] One of these blades came from Horizon V while the others are from Horizon VII. These blades with double function are certainly not the only specimens of that kind present at Aknashen.

About the technology used to make these blades, one was knapped by standing up pressure with a crutch, one by pressure with a lever whereas the three others were also obtained by pressure, but we cannot discriminate in favor of a technique or the other. Four are proximal-mesial segments and one is mesial. Four are retouched blades and one is a denticulate.

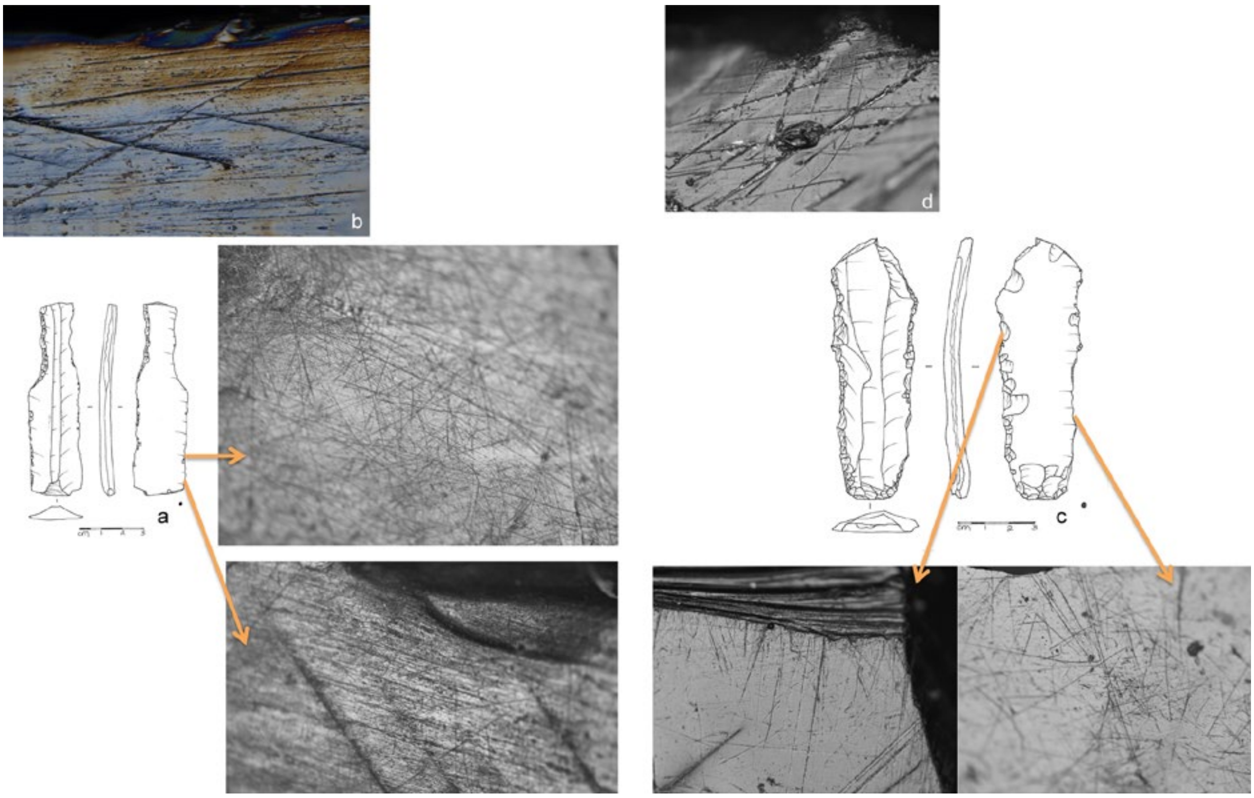


Figure 21. Use-wear, double-use: a) Harvesting and threshing, retouched blade, Horizon VII (Sond.A UF12) (200X); b) experimental microtraces (200X); c) Stripping and threshing, retouched blade, Horizon V (Sond.A UF10) (200X); d) experimental microtraces (200X) [drawings: J. Leclerc]

[4] In order to be able to understand and document those blades which showed double-use traces, we underwent special experiments in 2011 to observe how the formation of microtraces occur when a given blade is first used to harvest or strip and then recycled in a threshing sledge.

The vast majority of the tools on blades of Aknashen seems to have been used for plant working. On some rare segments of blades, other functions were identified.

Working hide

A end- scraper (from Horizon III) carries traces related to hide scraping (Figure 22a). We can observe that its end-scraper front is quite used. It presents traces of rounded random removals and rather deep striae which start from the front. The general aspect of the traces remains somewhat different from usual hide work, this possibly testifies that what we see here is an initial stage of hide soften (tough state).

Still in Horizon III, a burin presents localised microtraces of wear (at the junction between the end of the burin and the edge of the blade) which also seem to attest of hide working (Figure 22b). This tool also seems to have had a second function, because it presents light traces of plant working on its edges.

Grooving bone

A small end-scraper on blade coming from horizon III was used to scrape hard material, but its traces are at an early stage (located close to the front): partial breaks on the edge, some abrasion marks and non-oriented scratches do not enable us to identify which matter it is. In addition, as it is the case on many tools, this artefact seems to have had two functions. Thus, during our recent experiments, we carried out several tests concerning grooving antler, wood and bone. So this tool presents traces similar to those produced by bone grooving (Figure 22c). It's edge is still sharp except for some scarce removal and we can see the presence of characteristic long trails parallel to the edge.

Discussion

Why pressure with a lever?

Theoretically, manufacturing blades by pressure with a lever was not essential (Chabot and Pelegrin 2012), because, as we have just seen, it was also possible to obtain regular blades by standing up pressure with a crutch and rather regular and robust blades by indirect percussion. Consequently, why did they invest so much time and energy in order to make these technological complicated blades? This brings us back once more to the context of the Neolithic and Chalcolithic when such blades were present in northern Mesopotamia and in southern Caucasus. The invention and the progressive development of agriculture which gradually extended to a wider territory while becoming the base and the primary way of subsistence of these societies is perhaps part of the explanation. Harvesting activities and especially plant treatment by threshing that followed required excellent standardized tools in order to design balanced threshing sledges.[5] Those were made of logs tied together with leather strings and thus the sharp elements were to be embedded between the logs and had to be standardized in terms of dimensions so that the sledge would be balanced (this has been notably demonstrated by numerous experiments made by P. Anderson : Anderson *et al.* 2004). It is hardly surprising that such a narrow link exists between technology and functional purposes (two fundamental stages of the *chaîne opératoire* of an artefact).

Moreover, we have already evoked that such blades obtained by pressure, offered another advantage related to the function, namely the possibility of extracting from each blade several rectilinear sections, since only their distal part was curved. All in all, pressure with a lever knapping made it possible to obtain blades with regular proportions and to maximize their length (in order to obtain more segments). Furthermore, pressure with a lever offers products as regular as pressure with a crutch, but the products are more robust and of greater dimensions (width). Perhaps there are other causes of the presence of this sophisticated knapping technique, but this is possibly the beginning of an explanation.

Still from a functional point of view, it should also be noted that the fact that the majority of blades seem to have an agricultural vocation probably explains why these artefacts carry such a small amount of retouch. As we mentioned, retouch are not necessary to cut and chop plants properly since rough cutting-edge remains more effective for these tasks.

Origins of pressure detachment by lever

An important aspect concerning this industry of long blades in the Caucasian Neolithic era, is its origin. Indeed, since the first neolithic populations settled on the Ararat valley around 6000 BC, with their 'neolithic package' already made up, this means that their knowledge of pressure knapping (attested in Horizon VII) goes back to older periods. This is a topic on which more research will have to be done in the years to come, in order to precisely determine the origins and the roads (spreading) taken by these complex techniques of knapping. However, we can issue some elements based on other recent technological research carried out on the territories of northern Mesopotamia and of Anatolia (Astruc *et al.* 2007; Binder 2007; Pelegrin 2012b; Altınbilek-Algül *et al.* 2012) which seem to be the only places known to date to hold comparable obsidian blades, at earlier dates.

[5] Functions identified here and also in our previous use-wear analyses (Badalyan *et al.* 2010).

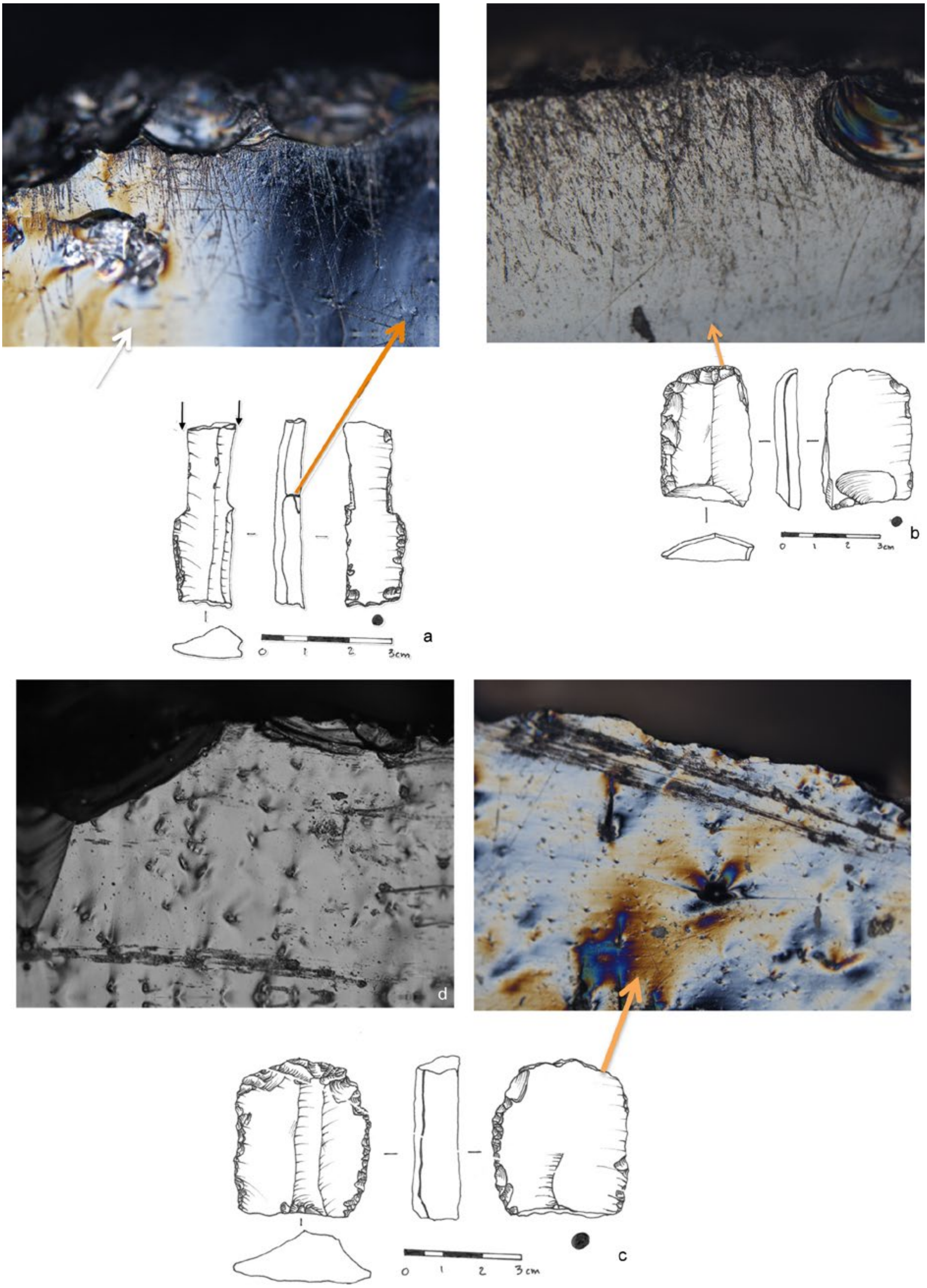


Figure 22. Use-wear: a) Working hide, burin on blade, Horizon III (Tr.7 UF4) (200X); b) Scraping hide, end-scraper on blade, Horizon III (Tr.7 UF3) (100X); c) Grooving bone, end-scraper on blade, Horizon III (Tr.7 UF3) (200X); d) experimental microtraces (200X) [drawings: M.-M. Leclerc]

Thus, concerning these 'neighboring' cultures located west of the Caucasus, although pressure with a crutch is attested since the second half of the 9th millenium (Pelegrin 2012b) and was identified on several sites of Syria and Turkey (Altınbilek-Algül *et al.* 2012), these older specimens concerned bladelets obtained by sitting pressure with a short lever (Pelegrin 2012b) and it is only from 7340-7080 BC that specimens of long obsidian blades obtained by pressure have been identified at Cayönü (Altınbilek-Algül *et al.* 2012). Among this material, one almost complete blade, and some fragmentary elements of blades could also be associated with pressure with a lever (Pelegrin 2012b). Ten similar artefacts were also discovered at Sabi Abyad in northern Syria in levels dated of 6200 BC (Pelegrin 2012b). The latter were made on exogene obsidian and when it comes to the artefacts of Cayönü, it is not known exactly from which workshop they came from. At Cayönü as well as in Sabi Abyad, the examination of the preserved butts does not show any fissuration, which tends to show that pressure with an antler point was preferred, whereas in Aknashen (and also at Aratashen; Badalyan *et al.* 2007), the two types of points were probably used (antler and copper).

An important difference between these industries made by pressure with a lever and those of the southern Caucasus lies (for the moment) in the proportion of identified specimens and in the origin of the workshops. Indeed we still don't know exactly where the large blades of the Near East were made; they seem to be exogenic at both Cayönü and Sabi Abyad (Pelegrin 2012b) and more work will be necessary in order to properly characterize their origins.

At Aknashen, even if the precise localization of the workshops is still to be found, everything seems to indicate that the knapping happened close to the site and even partly on the site (for the last phases). At the very least, it took place relatively close to the primary sources identified, where the majority of the obsidian artefacts came from. That explains why at Aknashen, inventory is definitely larger (compared to older blades identified in Turkey and Syria).Thus as we saw, 157 blades could be associated to pressure knapping, including 48 to pressure with a lever and 40 other blades for which we cannot be sure if they were made with a lever or with a crutch. This number is going to increase with the continuation of this research. The abundance of material places Aknashen among the oldest witnesses of an industry on long standardized blades.

As we already mentioned elsewhere (Chabot and Pelegrin 2012), it is very possible that the origin of the pressure knapping of southern Caucasus is to be sought in the communities of the Upper Tigris region that lies about 250 km southwest of the Araxes basin and where pressure was known, but we don't know how much time this technique was practiced in this area and especially if pressure with a lever was still in use there towards 6000 BC (Altınbilek-Algül *et al.* 2012).

Origins of this Neolithic culture and aim of this lithic industry

The Neolithic era of the south of Caucasus is a region rich in obsidian, but still little known regarding the Mesolithic and the Neolithic periods. At Aknashen, we observe a full (plain-pied) Neolithic from the very beginning of the occupation of the site (6000 cal BC). Consequently, the Armenian Neolithic's origin remains to be determined. The objects made out of obsidian thanks to a great technological know-how, do not seem to have come out of the southern Caucasus.

As we saw, Aknashen contained thousands of lithic objects. However, one is in right to wonder why this modest site, following the example of another neighboring village (Aratashen), contained as much lithic material; especially that this locally manufactured industry's purpose seemingly was not dedicated to exportation.

Conclusion

In order to understand the origins of the Neolithic culture of Aknashen which includes influences from both northern Mesopotamia and Caucasus, the continuation of technological studies of this lithic material could constitute a key element. Indeed, the high degree of technological know-how identified here in order to carry this pressure knapping can constitute an important cultural marker (Inizan 1991). This shows how important it is to work in order to understand these technological innovations, datable via the archaeological context from where they come from, and to find the 'roads' which they took. Thus, in this case, the pressure with a lever could constitute a significant element to define from where the inhabitants of Aknashen may came.

Moreover, on a site like Aknashen, lithic material is abundant, hence the technologies which we can study are part of a large collection and are not marginal. However the choice they made about pressure with a lever was an option rather than an obligation (Chabot and Pelegrin 2012), which adds even more to the cultural value of this manifestation and to the importance to retrace it (knowledge, know-how), which makes it possible to link this phenomenon to a culture and to a moment of its existence (Soressi and Geneste 2011), as well as, from a wider point of view, to the history and the evolution of techniques ('phylogeny' of the techniques) (Chabot and Pelegrin 2012).

On the other hand, as it is often the case in the Neolithic, intermixing of ideas, exchanges and borrowing of various techniques make so that cultures like Aknashen, very often will present hybrid features whose various origins remain very complex to relate (Cauvin 1989). In archaeology, it is often in the details that the answers are. So the study of these state-of-the-art technologies, work of specialists, in an early agrarian society which will keep on specialize itself, remains certainly a very important key to reach a better understanding of these cultures and their interactions.

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Aknashen lithic tradition in a regional context: blade-making and neolithization of the Southern Caucasus

Bastien Varoutsikos and Artur Petrosyan

Introduction

The mechanisms underlying the development of food-producing societies in the Southern Caucasus constitute the focus of about a dozen international projects across the region (Badalyan *et al.* 2010; Guliyev and Nishiaki 2012; Hansen *et al.* 2013; Hamon *et al.* 2016, Martirosyan-Olshansky 2015; Varoutsikos *et al.* 2018; Arimura *et al.* 2018). The presence of a rich variety of cultural remains associated with pre-Bronze Age farming settlements is a testimony to both the scale of the processes that took place from 6000 cal BC onwards and the archaeological potential of the region to shed light on more than 3000 years of agricultural development.

The site of Aknashen is located in the middle part of the Araxes river valley (Figure 1), an area that has been the focus of intermittent research on early farming since the 1970s. The settlement is associated with the first clear manifestation of agricultural behaviors in the Southern Caucasus known as the Aratashen-Shulaveri-Shomutepe culture (Chataigner *et al.* 2014a: 8). This culture appears shortly after 6000 cal BC in the Kura and Araxes river valleys with fully developed food-producing strategies. Yet, the rarity of 7th millennium sites in this region begs several questions regarding the origins of the agricultural behaviors in the Southern Caucasus.

The excavations carried out at Aknashen since 2004 have provided a large amount of well dated information through careful analysis of architecture, faunal and botanical remains, and chipped stone assemblage.

As one of the most ubiquitous archaeological remains, chipped stone artefacts have the potential to help explore a variety of socio-economic processes. The techno-typological study carried out by Chabot *et al.* (in this volume) has presented the main characteristics of the assemblage and provides the basis to address issues connected to the origin and nature of the Aratashen-Shulaveri-Shomutepe culture.

In this paper, we compare the assemblage of Aknashen with lithic productions at different levels, local (Araxes valley, within the Southern Caucasus and the

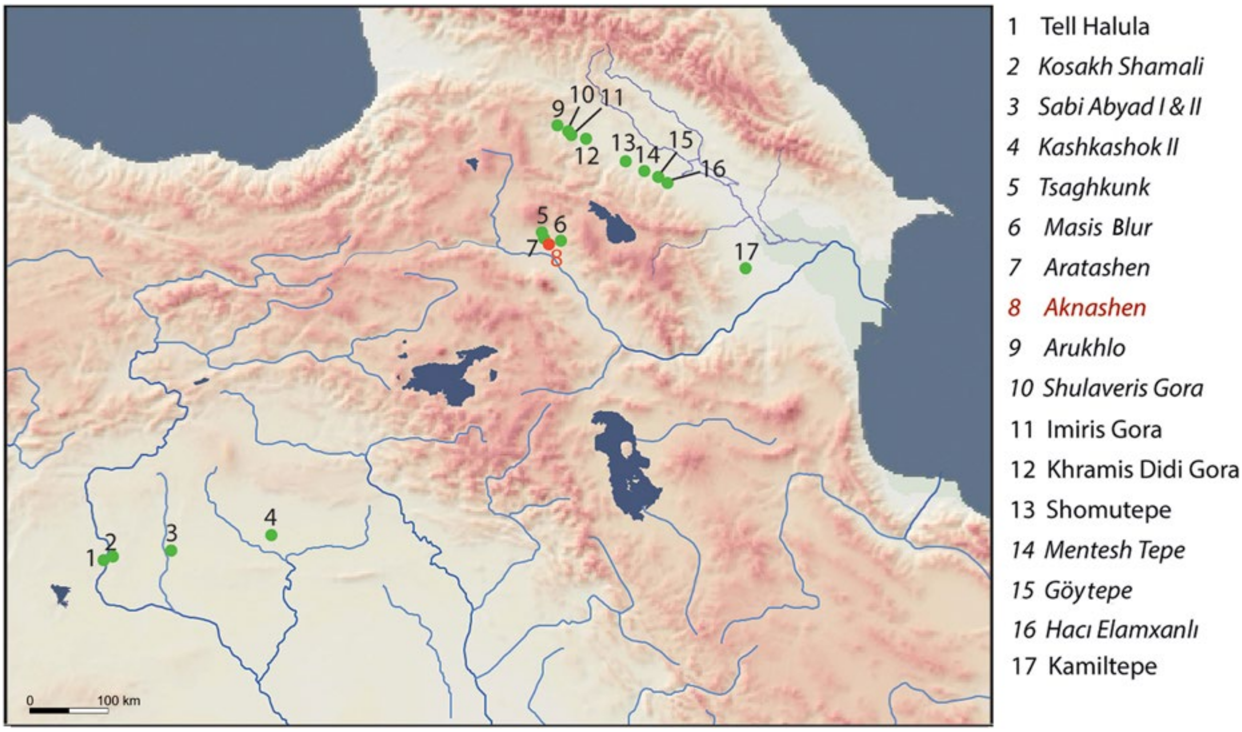


Figure 1. Map of sites mentioned in the text [in italics, collections studied].

Aratashen-Shulaveri-Shomutepe culture) and regional (Near East). Each level allows us to shed light on various processes from local organization of the lithic production within the valley to the neolithization of the Southern Caucasus.

Background

Regional setting: the Southern Caucasus and beyond

Described as a natural *cul-de-sac* between the Black and Caspian Seas and the Greater Caucasus, the Southern Caucasus, a term that commonly refers to the modern republics of Armenia, Azerbaijan, and Georgia, lies at the crossroad of Europe and Asia. This particular geographic location has helped defined the role of the 'Trans-Caucasian Corridor' (Fernandez-Jalvo *et al.* 2010; Egeland *et al.* 2014: 370) as an important destination and passage for human populations throughout the Palaeolithic into historical times.

The modern Republic of Armenia is shaped by a complex combination of mountainous ranges, volcanic massifs, deep valleys, and high plateaus. Its location along the Araxes river valley makes it a critical component to understand the Neolithic settlements of the southern Caucasus and beyond (Figure 1).

Chipped-stone industry at Aknashen

In the course of 11 excavation seasons at Aknashen-Khatunarkh, about 48,000 chipped stone artefacts were found, 99.6% of which were in obsidian. Although the proportions differ slightly in the upper horizon, obsidian remains largely represented across all layers. Other raw material recovered were flint, jasper, quartz and dacite (Chataigner *et al.* 2014a: 11; Chabot *et al.* in this volume).

The majority of the tools are manufactured on long blades, the production and/or use of those blanks representing an important part of the socio-economic activities of the site (Chabot *et al.* in this volume). Scrapers are largely carried out on blades with only a few examples on flakes. Other main tool categories include burins, retouched blades, large round scrapers and trapezes/transverse arrowheads (Figure 2).

Overall, we observe a decrease in knapping activities in the upper horizons (possibly Chalcolithic), probably connected to the decline of technical traditions also identified in the limitations of the taxonomic composition. Cores, fragmented cores and debitage products found at the site show evidence of indirect percussion and pressure techniques (both with a crutch and with a lever), and Chabot *et al.* (this volume) suggest that lever pressure cores could also be used for crutch pressure in the later stages of the *chaîne opératoire*. No significant concentration of waste debitage and by-products could be identified, possibly implying that knapping took place outside of the site, or in yet unexacavated areas of the settlement (Badalyan *et al.* 2010: 195). However, this could also be connected to the small amount of waste produced by the pressure techniques, especially if cores were brought in the *plein débitage* stage to the site. Some blades were selected for usewear analysis and showed traces connected to various agriculture-related activities such as harvesting, stripping, and threshing.

The obsidian industry at Aknashen was dedicated to the manufacture of long blades basically used in agricultural activities. The degree of skill and standardization achieved by the groups living at Aknashen is characteristic of the Aratashen-Shulaveri-Shomutepe culture and was also seen in the neighboring sites of Aratashen (Badalyan *et al.* 2010: 196, 217) and Tsaghkunk (Figures 3 and 4).

Aknashen in a regional context

The rich material culture found at Aknashen provides a chance to address some crucial questions in the socio-economic development of the region from 6000 cal BC onwards.

Over the course of the past century, several hypotheses have been suggested to explain the development of farming societies in the Southern Caucasus. First, a scenario of independent domestication gathered a broad consensus among soviet academics who largely based their hypothesis on the archeobotanical work carried out by Vavilov, Prischepenko, Zhukovsky, and Lisitsyna from the 1930s onward (Vavilov 1926; Zhukovsky 1964; Lisitsyna and Prischepenko 1977). Another approach to the question underlines the possible role of near eastern influences, whether seen as the main motor of agricultural development (Masson *et al.* 1982) or a wave of new cultural behaviors, possibly following an independent, local innovation (Korobkova 1987; Kushnareva 1997).

Closely connected to issues of Neolithization processes is the nature of the relationship between the two Aratashen-Shulaveri-Shomutepe regions, the mid-Kura and mid-Araxes river valleys. Although both areas appear to have emerged from the same cultural background, some differences are seen both in terms of material culture and economic behaviors (Chataigner *et al.* 2014a).

Each aspect will be addressed through the comparison of Aknashen's lithic industry with selected assemblages in order to provide specific insights into the role of the site at the sub-regional and regional levels.

Figure 2. Aknashen obsidian assemblage: (1, 14-16) blade-bladelet cores; (2-5) blades; (6-11) trapezes / transverse arrowheads; (12-13) round scrapers [photos: V. Hakobyan].

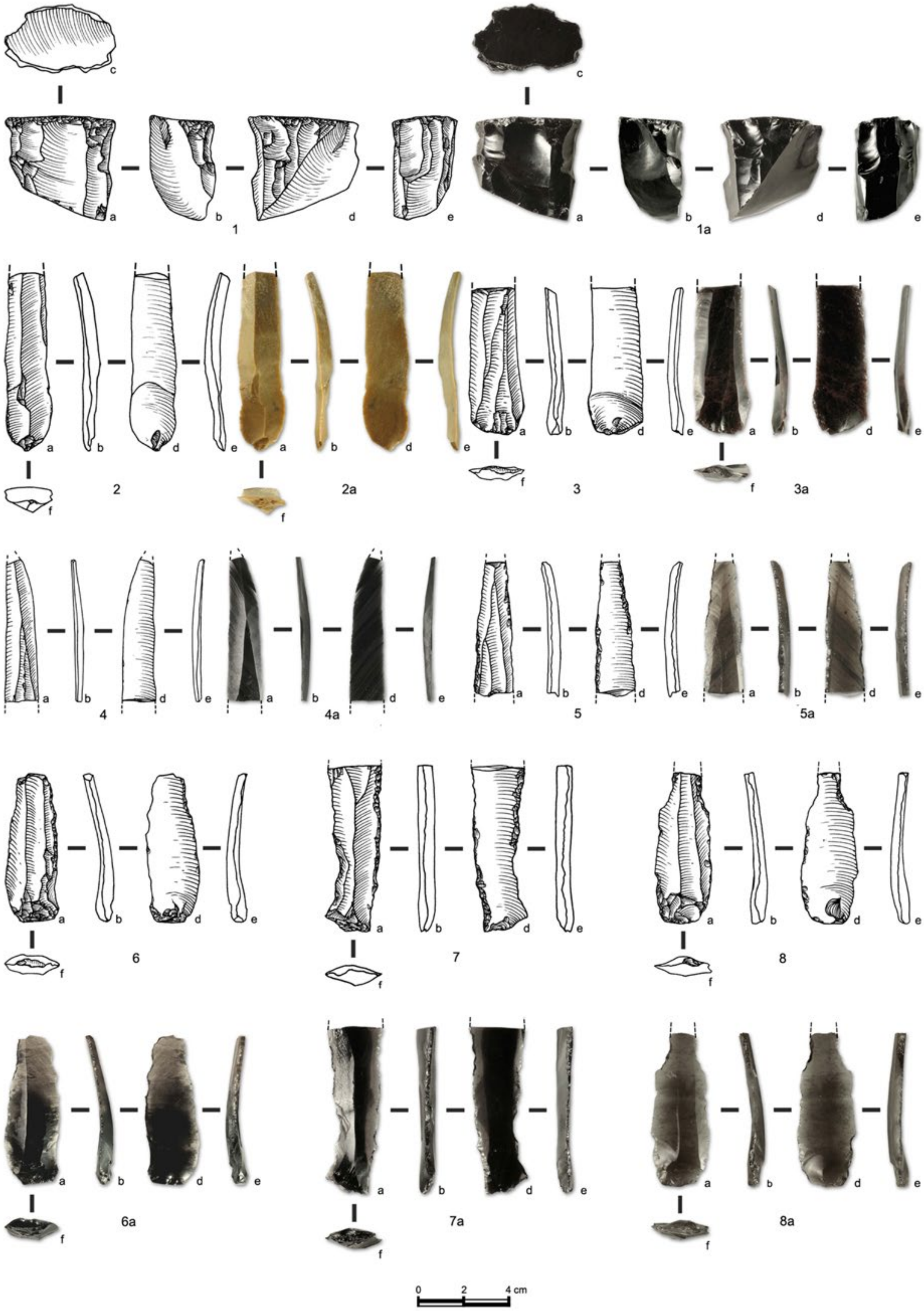


Figure 3. Tsaghkunk: (1) Core; (2-4) Blades; (5-8) Retouched blades [1, 3-8: obsidian; 2: flint] [drawings: G. Prveyan; photos: D. Arakelyan; editing: B. Gasparyan].

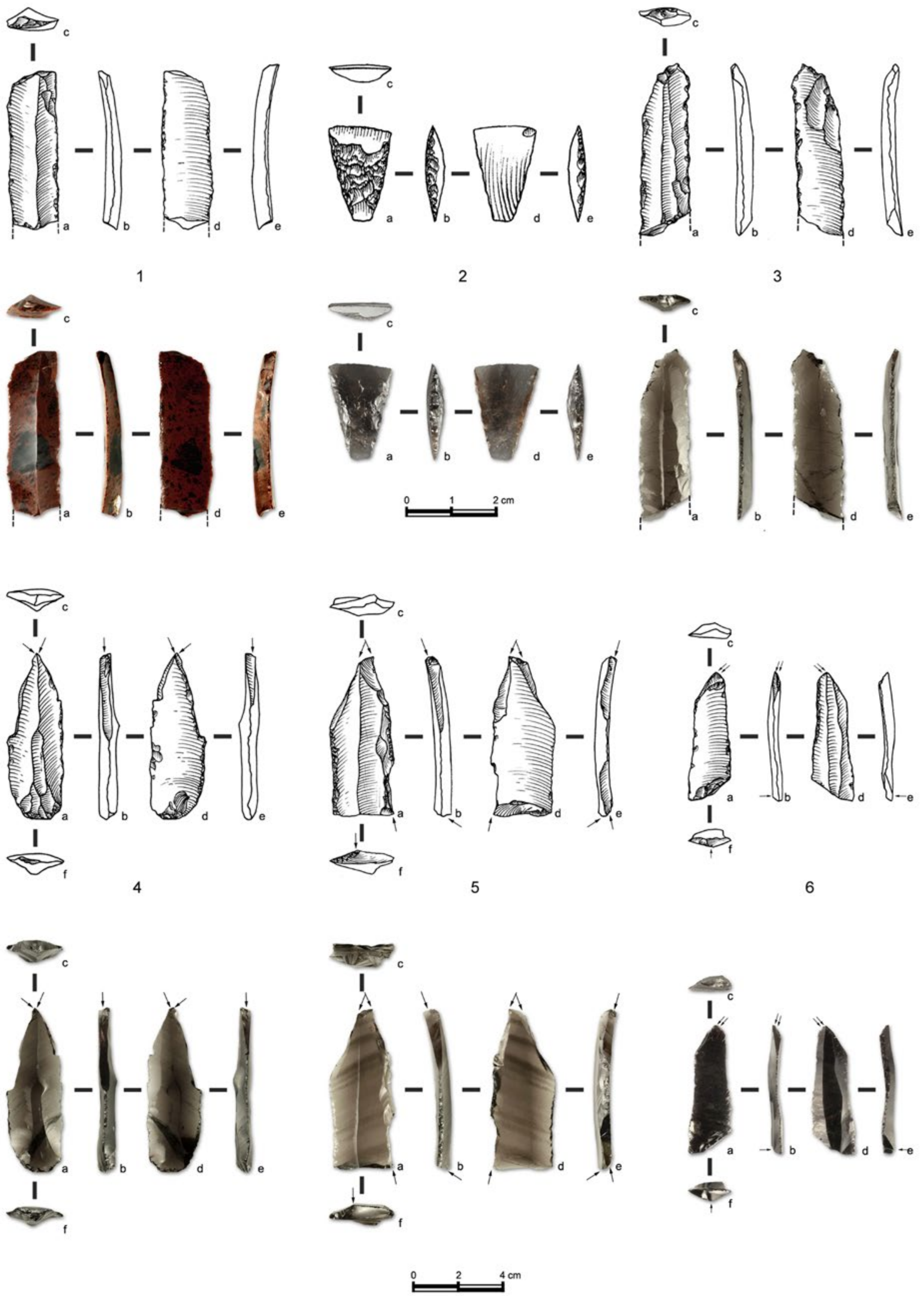


Figure 4. Tsaghkunk tools: (1) End scraper; (2) Transverse arrowhead; (3) Point; (4-6) Burins [1-6: obsidian] [drawings: G. Prveyan; photos: D. Arakelyan; editing: B. Gasparyan].

Material and methods

Quantitative approaches to inter-assemblage comparison in Archaeology have been carried out on tool types, morphometric attributes, relative proportions, on Middle and Upper Paleolithic assemblages and more seldom on Neolithic sites.

However, the goal of this study is not to identify specific patterns in lithic production as much as to highlight qualitative parallels in the manufacturing process in order to place the lithic assemblage of Aknashen back within a local and regional context. Furthermore, the territory covered by this study and the variation in data available for the assemblages studied require a methodological framework that is both analytically inclusive and behaviorally significant.

Therefore, we have defined several categories of characteristics that can be compared between assemblages in order to identify potential parallels and infer presence/absence of group interaction and cultural contact, and phenomena of technological borrowing:

- technique (pressure flaking, percussion) and typology (truncation, microburin)
- cores (conical, naviform, prismatic)
- blank type (flake, blade-like flake, irregular blades, regular blades, bladelets)
- projectile points type (trapezes/transverse arrowheads, tanged points).

Although no quantitative inferences can be extracted due to the variability in data availability, we can attempt to draw parallels and assume various extent of contact between cultural entities based on shared technologies and *chaînes opératoires* and, only within this framework, use tool type as an additional potential marker.

Local scale: Aknashen and the Aratashen-Shulaveri-Shomutepe culture

The Aratashen-Shulaveri-Shomutepe group is an archaeological culture associated with the first fully agricultural societies in the Southern Caucasus as early as 6000-5900 cal BC. It is characterized by villages of round mudbrick and cob houses, a subsistence pattern relying on the exploitation of domesticated crops (hulled barley, naked wheat) and animals (goat, sheep), and a lithic assemblage partly based on the production of long obsidian blades from prismatic cores (Figure 5: 7; Figure 6: 1-5, 10-13).

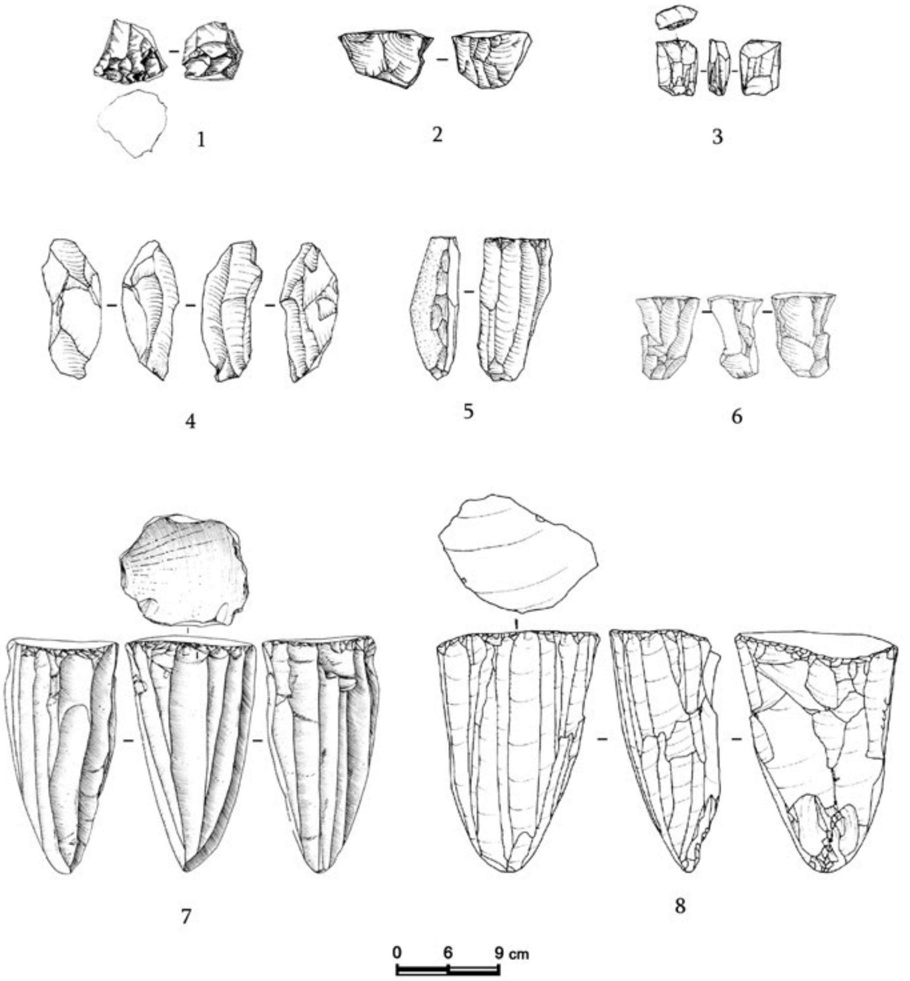


Figure 5. Cores: (1) Flake core, Sabi Abyad, Level 11 (Neolithic) (Copeland 1996: fig. 4.1: 1); (2) Single-platform flake core, Kosak Shamali, level 8, Sector B (Neolithic) (Nishiaki and Matsutani 2001: 221); (3) Bladelet core, Hacı Elamxanlı (Kadowaki *et al.* 2016: fig. 3: 2); (4) Naviform core, Kosak Shamali, Level 17, Sector A (Neolithic) (Nishiaki and Matsutani 2001: 222); (5) Blade core, Kosak Shamali, Level 18, Sector A (Neolithic) (Nishiaki and Matsutani 2001: 220); (6) Single platform core, Kosak Shamali, Fill (Chalcolithic/ Neolithic) (Nishiaki and Matsutani 2003); (7) Prismatic core, Aknashen, Tr.5 UF8a [drawing: G. Devilder]; (8) Prismatic core, Hacı Elamxanlı (Kadowaki *et al.* 2016: fig. 3: 6).

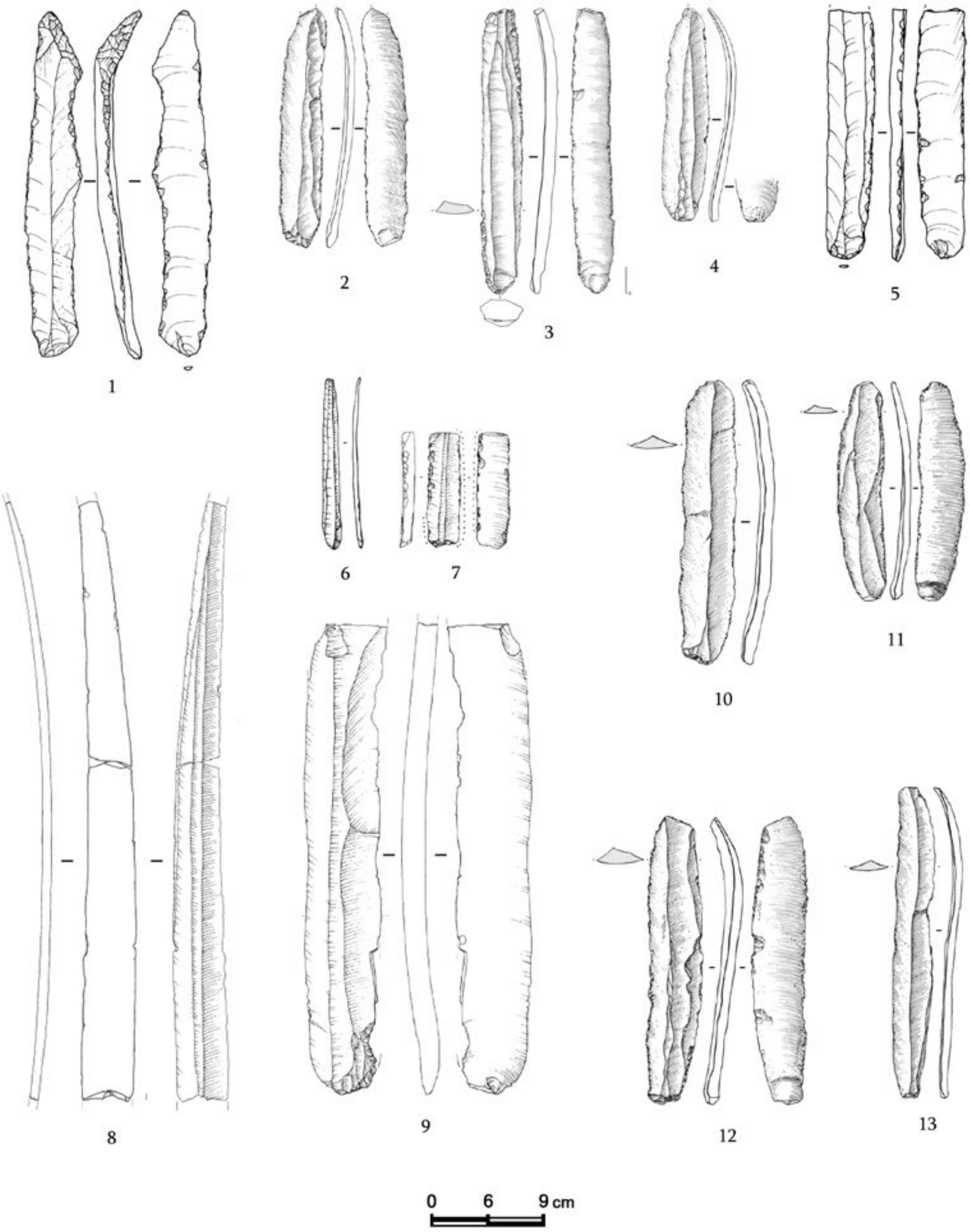


Figure 6. Blades: (1) Hacı Elamxanlı (Kadowaki *et al.* 2016: fig. 5: 12); (2-4) Aknashen (Tr.5 UF106, Tr.8 UF7, Tr.5 Str.2) [drawings: G. Devilder]; (5) Hacı Elamxanlı (Kadowaki *et al.* 2016: fig. 5: 11); (6-7) Seker al-Aheimar (Nishiaki and Le Mière 2005: 60); (8) Sabi Abyad I (operation 2) (Altinbilek-Algül *et al.* 2012: 166); (9) Çayönü, Large Room Building sub-phase (Altinbilek-Algül *et al.* 2012: 162); (10-13) Aknashen, Tr.4 UF10 [drawings: G. Devilder].

It is possible to divide the distribution of Aratashen-Shulaveri-Shomutepe sites into two areas or 'oases' (Chataigner *et al.* 2014a): the mid-Kura Valley, including the sites of Shulaveri, Imiris Gora, Arukhlo, Gadachrili Gora, Khramis Didi Gora in Georgia, and Shomutepe, Göytepe, Hacı Elamxanlı, Mentesh Tepe in Azerbaijan; and the Araxes river valley where the sites of Aknashen, Tsaghkunk, Aratashen, Masis Blur in Armenia and Kültepe in Nakhichevan have been identified and partially excavated (Sardaryan 1967; Kushnareva 1997; Badalyan *et al.* 2007; Badalyan *et al.* 2010, Marro *et al.* 2019).

Although these two regions seem to emanate from a single cultural entity, some distinctions exist, which can be interpreted to provide elements of answer regarding both the mechanisms underlying the development of this culture in the Southern Caucasus, and the organization of the groups composing it at the regional level.

Aratashen (level II: ca. 5850-5550 cal BC)

The site of Aratashen, located 6km northwest of Aknashen, is positioned in a loop of the Kasakh river, which flows into the Araxes a few kilometers to the south.

Excavations of the site have enabled the recovery of a large obsidian industry, which consists of more than 20,000 artefacts. Only 26 pieces of the lithic industry (about 0.1%) are in flint, quartz, secondary quartzite, silicified limestone, mudstone or serpentine (Badalyan *et al.* 2007: 43).

The obsidian industry is morphologically and technologically characterized by a predominance of long standardized blades (up to 20cm long). Blade tools make up 97.7% and flake tools 2.3% of the assemblage. The types of tools on flakes (end-scrapers, fine-denticulated, notches, side-scrapers and burins) account for only a minor part of the assemblage (Badalyan *et al.* 2007: 43; Chabot *et al.* 2009: 154).

Tools were carried out on whole blades, and especially on proximal and mesial segments. The retouched blades predominate (72.9% of the blade tool assemblage and 71.3% of the total tool assemblage). These tools are in fact blades, on which partial and non-invasive retouch was carried out. Notched blades amount to 10% of the total tools and are represented through various sub-types: simple notch (67%), symmetrical double notches with two notches opposite each other on each edge of the blade (13%), asymmetrical double notches (9%), multiple notches (9%) and finally, double notches on the same edge (2%) (Badalyan *et al.* 2007: 44). Other tool types are: denticulates on blades (2.1%), fine-toothed tools (6.98%) and burins (5.3%). Truncation, pointed blades, end-scrapers, retouched bladelets and side-scrapers are less frequent (less than 1% of the assemblage) (Badalyan *et al.* 2007: 44).

Various techniques were used in the course of the production: pressure with a crutch (N=64), pressure with a lever (N=24) and indirect percussion (N=29). All the diagnostic blades came from well-preserved Neolithic levels (Chabot *et al.* 2009: 154-155; Chabot and Pelegrin 2012: 184-190; Pelegrin 2012a: 475-477).

The 50 blade nuclei found at Aratashen all present features connecting them to the pressure with crutch technique (Figure 5: 7). It is likely that some of those cores were originally exploited through lever technique, then crutch technique to produce smaller blanks. Indeed, the length of these nuclei varies from 10 to 18cm, with an average of 12cm (Badalyan *et al.* 2007: 46).

In general, these unipolar nuclei present plain pressure platforms, with frequently abraded cornices and a 'semi-rotating exploitation'. Only a few examples of nuclei have a beveled edge - this modification keeps the blades from plunging, which is otherwise frequent with this technique. Most prismatic nuclei discovered could still have provided a large quantity of blades.

The industry on flake is represented by 81 nuclei (61 fragments). Small nuclei have varying dimension and show many striking platforms indicating no systematic debitage strategy. These nuclei are nearly exhausted and are between 5 and 7cm long and 4 and 6cm wide (Badalyan *et al.* 2007: 46).

Masis Blur (ca. 6200-5400 cal BC)

Masis Blur is located 11km east from Aknashen, southwest of the Norabats village, and about 2km north of Masis. The upper layers date back to the beginning of the 6th millennium cal BC (Hayrapetyan *et al.* 2014: 182-184).

Several thousand lithic artefacts have been unearthed during the excavations and the study of the lithic assemplage is still ongoing (Martirosyan-Olshansky 2015; 2018b). Preliminary observations already suggest that the chipped stone industry is targeted towards the production of long regular blades and is largely dominated by obsidian (over 99%) (Hayrapetyan *et al.* 2014: 182).

Only a few cortical artefacts were found in the site and, although some river-rolled obsidian pebbles from the Hrazdan were identified, their small size (<4cm) suggests they were not collected to be knapped (Martirosyan-Olshansky 2015).

So far, no particular knapping areas could be identified and the general rarity of initial by-products suggests that cores were brought to the site already shaped and partially exploited. Preform could have been collected during the summer in the course of transhumant exploitation of highland pastures and brought to the settlement at the end of fall along with the folks of sheep and goat (Martirosyan-Olshansky 2015). Indeed, evidence collected from various Late Neolithic sites in the area suggest that these societies were mobile and familiar with the various obsidian sources in their region.

Overall the industry at the site presents obvious parallels with the Late Neolithic materials from settlements of Aratashen and Aknashen, ranging from the technology to the typology with the presence of several trapezes in the assemblage.

Tsaghkunk (ca. 6000-5200 cal BC)

The settlement of Tsaghkunk is located 7.5km northwest from Aknashen, on the left bank of the Kasakh river at about 871m asl. After an initial survey carried out by Mnatsakanyan, Torosyan investigated the settlement during 1960-1968 but the results remain unpublished (Kushnareva and Chubinishvili 1970: 386; Torosyan *et al.* 1970). The material (728 samples) is currently stored in the Echmiadzin historical-ethnographic museum and was reassessed for this publication by one of the authors (Petrosyan *et al.* 2018).

The chipped-stone industry is mostly represented by obsidian artefacts (up to 99% of the assemblage). Despite the large number of by-product (296 pieces), only two cores were found (Figure 3: 1). Among the 10 blades identified, only two are complete. Overall, the truncated blades constitute the largest group of the collection (308 pieces). Taking into account the retouched blades, the tool category amounts to 13.5% of the whole assemblage and burins dominate the tool-kit (32 pieces; Figure 4: 4-6).

The assemblage also includes one arrowhead made on a blade (Figure 4: 2). This example can be classified as a transverse type, which is characterized by a broad, sharp edge formed from a lateral edge of the blade blank. Both lateral edges are generally truncated by abrupt retouches. The ventral face of the arrowhead is covered by pressure retouches. This arrowhead type was first attested at Mesolithic (or so-called 'aceramic') sites such as Apnaghyugh 8 (Kmlo 2) (Arimura *et al.* 2009: 18); the described type subsequently became a prevalent arrowhead type in the following pottery Neolithic such as at Aknashen (Badalyan *et al.* 2010: 217), Masis Blur (Martirosyan-Olshansky 2015) and other sites of Aratashen-Shulaveri-Shomutepe culture (Nishiaki *et al.* 2015b: 14; Kadowaki *et al.* 2016: 716) as well as at certain Chalcolithic sites (Tsaghkahovit; Arimura *et al.* 2012). This arrowhead type was in use for millennia and is attested at several pottery Neolithic sites such as Çayönü (Özdoğan 1994), Değirmentepe (Balkan-Atlı 2003: 373-384, fig. 3.11), etc. Additional similar specimens date to the Late Chalcolithic at Norşuntepe (Schmidt 1996). In other regions, a similar evolution of transverse arrowheads may be observed.

At this stage, it is difficult to determine the exact chronological boundaries of the settlement. The assemblage is clearly represented by regular blades, some of them manufactured through pressure flaking, in a way similar to Aknashen. The collection includes many objects which are characteristic of different chronological phases of the Armenia's Late Neolithic and Chalcolithic.

Mentesh Tepe (level I: ca. 5900-5600 cal BC)

Mentesh Tepe is a Late Neolithic settlement located in the mid-Kura valley in western Azebaijan. The mound is 45m in diameter and yielded an occupation ranging from the Late Neolithic to the Early Bronze Age (Lyonnet *et al.* 2016). As with other Aratashen-Shulaveri-Shomutepe settlements, the Neolithic level yielded circular structures ranging from 2 to 4.6m in diameter with plano-convex mudbricks and/or *pisé*, sometimes found along several post-holes. One of the main features of the site is the presence of several Neolithic burials, one involving 31 individuals. Faunal remains show the presence of domesticated ovicaprids, cattle, pig and dog, along with a few occurrences of wild species such as goitered gazelles and boars (Lyonnet *et al.* 2016).

Ongoing study of the material from the 2012-2013 excavations focuses on assemblages dated from 5700 cal BC and shows several interesting features (Lyonnet *et al.* 2016; Guilbeau *et al.* 2017). The Neolithic industry is largely carried out on obsidian, followed by flint, jasper, and chalcedony. The assemblage analyzed so far amounts, 692 lithic artefacts from secured layers have been analyzed. Main tool categories involve burins, sickle blades, two trapezes/transverse arrowheads, retouched blades, along with several types of scrapers. Non-obsidian industry is focused towards flake and *ad hoc* blade productions. On the other hand, the obsidian production is targeted towards the acquisition of long standardized blades, in their large majority manufactured through pressure flaking, possibly with a crutch and a lever, with a good representation of flat butts with preparation that is focused on the debitage surface.

Göytepe (ca. 5650-5450 cal BC)

The site of Göytepe is a Late Neolithic settlement located in the Middle Kura valley excavated by an Azerbaijani-Japanese team between 2009 to present (Guliyev and Nishiaki 2012). The *tell* is located in a region where a high density of Neolithic settlements (Shomutepe, Mentesh Tepe, Hacı Elamxanlı Tepe) has been identified in the course of the 50s to 80s (Narimanov 1987) and has produced a continuous sequence of occupation ranging from early to middle 6th millennium cal BC (Nishiaki and Guliyev 2019).

The site revealed features typically associated with Aratashen-Shulaveri-Shomutepe settlements such as agglomerated circular structures built in plano-convex mudbricks, a pottery assemblage rarely decorated with an increased density of sherds in upper levels, abundance of bone tools such as spatulas, hoes or awls and the production of long standardized blades occasionally using pressure techniques, mostly dedicated towards the production of sickle-type elements.

Lithic analysis of the site is ongoing and little quantitative information is available so far. However, several interesting features and general trends can be highlighted. A total 4465 lithic artefacts have been studied so far (Nishiaki and Guliyev 2019). As with other Aratashen-Shulaveri-Shomutepe assemblages, the production is targeted towards the manufacture of standardized blade blanks, here again mostly carried out on obsidian, in order to use with or without retouch. Blades are most likely produced using pressure and indirect percussion techniques. Tools are in majority manufactured on obsidian blade blanks that, along with some flint flake blanks, are manufactured into sickles, hafted in jagged ways on bone or wood handles. Obsidian is also used to produce trapezes/transverse arrowheads, some of them crafted using bi-lateral flat pressure retouch parallel to the ones identified in Northern Syria at the same time (Copeland 1996).

Hacı Elamxanlı (ca. 5950-5800 cal BC)

The mound of Hacı Elamxanlı is a Neolithic settlement in western Azerbajian (Nishiaki *et al.* 2015b). Excavations are carried out by Guliyev and Nishiaki and have identified four Neolithic layers, each characterized by typically Aratashen-Shulaveri-Shomutepe circular structures and material culture, yielding some of the earliest dates for agricultural occupations in the region. The pottery assemblage is composed of mineral-tempered and chaff-tempered ware, which are overall poorly represented when compared to the abundant lithic assemblage, and decrease in proportion in the lower layers. The assemblage also includes a very small amount of plain coarse pottery and two imported painted sherds (Nishiaki and Guliyev 2019: 471).

Analysis of the lithic assemblage have so far focused on levels 1 through 3. Across the 3 levels, raw material representation shows in sieved layers an important proportion of obsidian (between 44.7 to 57.3%) compared to other material (various types of flint, tuff, rhyolite).

The rich assemblage includes several types of technical pieces (core trimming elements [CTE], cores, cortical flakes) and suggest an overall strategy here too dedicated towards production of blade and bladelets (most likely, continuously as suggested by the distribution of width/thickness ratio) for obsidian, and flake blanks on non-obsidian raw material. The obsidian cores are found exhausted or in the process of being reduced, generally following semi-circular or circular mode, along with some re-used cores as well. The authors even point out the presence of a core belonging to earlier stages of the *chaîne opératoire*. Overall, all cores show a unipolar debitage, although traces of a bidirectional management of the volume seem to have been attested. Most blade butts are flat with preparation (abrasion or batter) focusing on the debitage surface.

Tool types are equally consistent with a good representation of burins and retouched blades (Figure 6: 1) (in 2012-2013 respectively 27-37.5% and 9.6-12.5%) (Nishiaki *et al.* 2015b; Nishiaki and Guliyev 2019). Other characteristically Aratashen-Shulaveri-Shomutepe tool types include trapezes (Figure 7: 7-9) on prismatic blades with lateral back as well as some examples including bi-lateral flat retouch such as the ones identified in Göytepe, sickles, and large round scrapers.

Arukhlo (ca. 5800-5300 cal BC)

Arukhlo is located about 50km southwest of Tbilisi at the western end of the village Nachiduri. The *tell* is approximately 6m high. The features of Iron Age settlements such as deep storage pits have disturbed and destroyed the Neolithic layers (Hansen *et al.* 2013: 387).

A total number of 4582 lithic artefacts have been recorded and analyzed. The entire collection consists of obsidian pieces. The assemblage includes several categories: cores, cortical flakes, crested pieces, debris, blades and retouched tools. There is a high frequency of flakes (up to 15%) and debris probably linked to *in situ* tool manufacturing and tool use. Blades and blade fragments (497) are also largely represented in the collection (Gatsov and Nedelcheva 2008: 39; Gatsov and Nedelcheva 2017). The blade assemblage is characterized by artefacts with irregular edges and trapezoidal cross section. About 35.2% of these artefacts have convergent and divergent edges. The obsidian blade industry is targeted towards blades production. As a whole, the blade category is largely heterogeneous especially regarding overall morphology and sections. There is a low frequency of full blades and a clear domination of proximal and mesial blade fragments, showing a low level of standardization.

Finally, retouched tools are characterized by different types of end-scrapers, perforators, drills, retouched blades, retouched flakes, splintered pieces, burins (Gatsov and Nedelcheva 2008: 40). Overall, the industry at Arukhlo I is represented by a high frequency of typological tools and flakes, burins and microliths tools (trapezes), with retouched blades being the most represented type, with sub-types such as irregular marginal continuous or partial retouches on one or the two edges and specimen with alternated retouches, blades with retouched notches and denticulated ones.

Shulaveri (throughout the 6th millenium B.C)[1]

The site Shulaveri is located on the Marneuli plain in the Kvemo-Kartli region. Shulaveri and other neighboring sites of this culture such as Imiris and Khramis Didi Gora were originally excavated the National Museum

[1] Batiuk *et al.* 2019: 56.

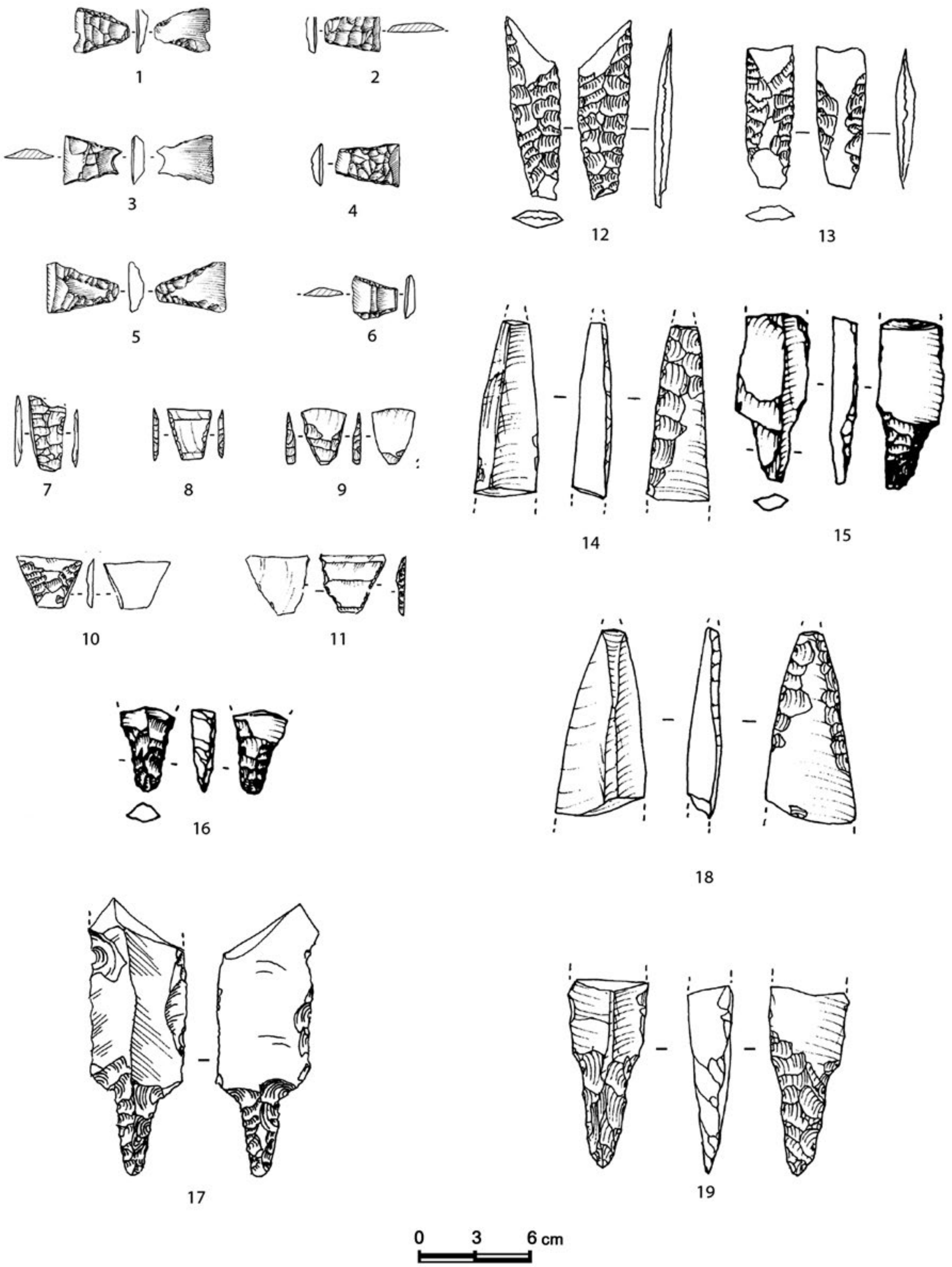


Figure 7. Arrowheads: a) Transverse arrowheads: (1-6) Aknashen (Baulk 6/8 UF6, Tr.3 UF9, Tr.2 UF9, Tr.8 UF8b, Tr.8 UF7, Tr.3 UF8) [drawings: G. Devilder]; (7-9) Hacı Elamxanlı (Kadowaki *et al.* 2016: fig. 4: 9 and fig. 4: 1-2); (10-11) Sabi Abyad, level 4 (Neolithic) (Copeland 1996: fig. 4.17: 14-15); b) Other arrowheads: (12-13) Sabi Abyad, level 5 (Neolithic) (Copeland 1996: fig. 4.17: 1-2); (14) Kosak Shamali, Byblos type, Sector A, Level 13 (Nishiaki and Matsutani, 2001: 222); (15) Kashkashok II, Type 2, H-12 (Nishiaki and Matsutani 2003: pl. 72); (16) Kashkashok II, Type 1, M-12 (Nishiaki and Matsutani 2003: pl. 72); (17) Sabi Abyad, Level 10-8 (Neolithic) (Copeland 1996: fig. 4.3: 1); (18-19) Kosak Shamali, Byblos type, Sector A, Level 13 (Nishiaki and Matsutani 2001: 222).

of Georgia, under the direction of by O. Japaridze, A. Javakhishvili, T. Kiguradze and M. Menabde.

Its sequence was organized into nine constructional horizons (Kiguradze 1976: 151). Despite the rich sources of flint located close to Shulaveri, inhabitants of the settlements used mainly obsidian. Indeed, this raw material represents 82% of the lithic industry of level IX and 98% of level I, while artefacts made on flint constitute only 2.5% of the overall assemblage (Hamon 2008: 91).

In phases I to III, the blade industry is relatively standardized, as shown by the high quantity of conical cores and long, wide parallel macroblades found on the sites. Full blades can reach up to 15cm (Hamon 2008: 91). In phase IV, flake production increases to become predominant in phase V. A few geometric microliths, generally trapezes, are present in phases IV and V (Lombard and Chataigner 2004). In the assemblage from Shulaveri, half of the lithic artefacts are tools, and more especially chisels, scrapers and splintered pieces. The agricultural activities are represented by sickle blades, adzes (Kiguradze 1976: 158).

Aknashen and the Near East

When the Aratashen-Shulaveri-Shomutepe culture develops in the Southern Caucasus, the Near East sees its own dramatic evolution. During the 7th millennium BC takes place the end of the Pre-Pottery Neolithic and the development of the Pottery Neolithic. This change is accompanied by a shift in settlement and subsistence strategies, increased mobility, with a territorial reorganization eventually leaving large PPN centres such as Jerf el 'Ahmar, Abu Hureyra, or Dja'de el-Mughara, empty.

The influence of Late Neolithic Near Eastern groups have been suggested as one causes of the development of agricultural societies in the Southern Caucasus (Masson *et al.* 1982; Varoutsikos 2015). The timing and mechanisms underlying this influence have not yet been properly identified but some evidence point towards possible interactions somewhere around the late 7th and early 6th millennium BC. The continuity of such interactions in the course of the 6th millennium have not been supported by any evidence so far. Near Eastern sites presented in this study have been selected on the basis of chronology, geographic location, and availability of lithic analyses.

Kashkashok II (Layers 3-4: first half of the 6th millennium BC)

Tell Kashkashok is a series of four large mounds located in the Upper Khabur valley in northern Syria. The site of Tell Kashkashok was discovered in 1985 and excavated by the University of Tokyo between 1987 and 1988, the Japanese team focused on Kashkashok II, a mound that yielded rich deposits of Hassuna and Ubaid layers (Matsutani 1991). Layers 3 and 4 lie right above the bedrock and show strong parallel with the level Ia of the Hassuna eponymous site in Iraq, and which radiocarbon dates consistently associate with the first half of the sixth millennium BC (Nishiaki 1992).

The lithic assemblages from layers 3 and 4 are represented by two types of flint, fine-grained, and coarse-grained, and to a lesser extent, by obsidian (39% in controlled samples), originating from the Bingöl area (Nishiaki 2000).

Flint assemblage is divided between two types of raw material. On one hand, fine-grained flint assemblage is only represented by finished tools (burins, and arrowheads) and blades with little of debitage taking place *in situ* although besides traces of bipolar or bidirectional knapping. On the other hand, coarse-grained flint is partly knapped on site and only associated with unipolar flakes. Flint is used for the production of non-standardized blades, flakes and several types of cores (blade core, flake core, discoidal, and unipolar). Tools come in majority from fine blades whereas crude blades where used unretouched. Overall, tools only account for 10 to 25% of the artefacts in non-controlled samples.

The most represented tool type is the scraper (end-scraper, side-scraper, round scraper, nosed scraper) generally on thick flakes, sometimes made on a reused core trimming elements not unlike some examples found at Aratashen. There is an overall small proportion of arrowheads (4.5%), mostly represented by Byblos points (Figure 7: 15). Other arrowheads include pieces with lateral retouch using pressure flaking. Several Byblos points are found on blade blanks with possible bidirectional or even bipolar debitage. Only a limited proportion of sickle blades have been carried out on flints, generally showing evidence for truncation or snapping. Other tools include borers, microliths on blade with lateral retouch, burins (both dihedral and angle burins) and notches are seen along retouched blades of several types, one including fine pressure flaking retouch on both dorsal and ventral surfaces.

The obsidian assemblage shows very few cores, described as unipolar blade cores and 'irregular bullet'. Blades were knapped off following preparation of the platform by abrasion on cortical, linear, plain and punctiform butts. It seems that at least some cores were brought as preform as shown by presence of cortical flakes and neo-crested blades. However, the proportion of obsidian tool is much larger, making up about 50% of the controlled sample, and 60 to 80% of the uncontrolled one. Tools are mostly carried out on parallel to sub-parallel blade blanks and the most represented tool is the corner-thinned blade (CTB) (60%). Other tool categories represented are burins, truncations, knives, along with trapezes (trapezoidal blade segments with truncated distal and proximal ends), backed pieces, and Cayönü-like tools (blade with abrupt retouch on lateral edges through pressure flaking, striation on dorsal surfaces, and notches to create a strangulation on one end).

Overall, features of this assemblage such as blade production, tool types (trapeze, strangulation, CTBs) are said to be fairly consistent with other Hassuna Ia collections such as the ones from Tell Sotto, Kül Tepe, and Umm Dabaghiyyah (Nishiaki 2000).

Sabi Abyad I (7th and 6th millennium BC)

Sabi Abyad is an ensemble of two sites involving several operations carried out by the University of Amsterdam and the National Museum of Antiquities of Leiden under the direction of Akkermans since the 1980s. Both sites include rich and well documented 7th and 6th millennium BC layers. Sabi Abyad I ranges from the late PPNB to the Halaf period, Sabi Abyad II has rich Middle to Late PPNB layers, along with some early PN occupations (Verhoeven and Akkermans 2000), and Sabi Abyad III yielded late PPNB and early PN occupations (Akkermans 1989).

At Tell Sabi Abyad I, 11 layers span 400 years of occupation. Level 10 through 8 are attributed to Late Neolithic and range from 6200 to 6000 cal BC, levels 7 through 4 are Transitional and date back to 6000-5900 cal BC, and finally layers 3 to 1 are dated to 5900-5800 cal BC and associated with the early Halaf.

In all levels, the main raw material is local flint, which nodules were used extensively. Throughout the occupation debitage techniques, tool types and obsidian use (amounting to less than one quarter of the total in each assemblage) remain consistent (Copeland 1996: 286).

Flint debitage includes four different types of cores (Figure 5: 1), with a flat flaking surface, two flaking surfaces, prismatic cores, and pyramidal cores dedicated to the production of irregular and continuous production of blades and bladelets, this type of blanks accounting for 14% of the total flint assemblage, most likely obtained through soft and hard hammer percussion.

Flint tools are represented by heavy duty tools, arrowheads (such as Byblos (Figure 7: 17), typical of the 7th-early 6th millennium BC, along with Ubaid or desert types), as well as transverse arrowheads (Figure 7: 10-11, Copeland 1996: 337). The assemblage of Sabi Abyad I also yielded several pressure flake points, blades (Figure 6: 8), sickle elements, tile knives, and burin (angle and dihedral), along with borer, beaks, and denticulates.

The debitage in obsidian yielded very few cores, generally flat and pyramidal. Few debitage seem to have taken place in situ for the Operation I, except for the production of tools through retouching of blanks. On the other hand, elements from operation III suggest that obsidian was obtained as small nodules and knapped on site. Overall, blade and bladelets are more represented in obsidian than flint, broadly focused towards flake blanks. Several blade, complete and fragmented, have been found in operations 2 and 3, with layers associated to 6500 to 6200 cal BC, possibly detached by pressure flaking with a lever (Altınbilek-Algül *et al.* 2012). Obsidian tools are represented by slightly different types of arrowheads (Byblos), pressure flake pieces, Çayönü-like tools, corner-thinned blades (CTBs, blade fragment where an inverse removal scar on the corner of the snapped blade can be found, most likely associated with specific hafting method), truncation, side-blow blade flake (SBBF, blade segment with bi-truncation 'to form a sliver-like artefact', found at Jarmo, as well as in Hassunan context (Copeland 1996; Altınbilek-Algül *et al.* 2012).

Although material culture across the four levels is fairly similar, some differences can be highlighted on both types of raw material. In level 11, techno-typological traits generally associated with the Pre-Pottery Neolithic have been abandoned, a trend also seen at other sites such as Tell Halula (Borrell and Molist 2007). Only a few blades have been found, no naviform cores, and CTBs become increasingly represented. Levels 10 through 7 see the apparition of Byblos points and pressure flaked pieces on obsidian, with, in level 6, the first Cayönü-like tools and SBBFs (possibly connected to use of anvil (see Altınbilek-Algül *et al.* 2012) along with tile knives present in the assemblage. Overall, production of blade seems to decrease towards the end of the 7th millennium and the beginning of the 6th millennium cal BC.

Kosak Shamali (pre-Halaf layers: second half of the 7th millennium BC)

Kosak Shamali is a medium size settlement mound located at the confluence of the Nahar Sarine tributary and the Euphrates. The site, excavated by the University of Tokyo in the mid-1990s, has yielded cultural remains ranging from Paleolithic to the Chalcolithic periods. Neolithic layers are found in level 18 in Sector A and level 8 in Sector B. In both situations, the preservation of architectural remains is fairly poor, and the material culture identified led the excavator to attribute those layers to the Late Neolithic period (most likely pre-Halaf). However, one radiocarbon sample from these layers yielded an uncalibrated date of 6140 BP.

The Neolithic assemblage from both sectors is fairly limited (Nishiaki and Matsutani 2001). Sector A yielded 140 pieces, all flint, with only 6 cores, flat and prismatic, at a semi-flaked or abandoned stage (Figure 5: 4-6). One of the prismatic cores displays evidence of preparation of a crested ridge, as well as a possible bidirectional management of the volume, most likely to avoid overshots. Only four retouched tools are found, one arrowhead (tanged point close to the Byblos type (Figure 7: 18), a retouched blade, and two sickle elements with abrupt backing and/or truncating retouch with gloss.

Sector B yielded 69 flint artefacts among which 10 are cores of types similar to sector A. Only two tools were found, a sickle and a retouched flake. All the obsidian at Kosak Shamali was found in disturbed context, and show tools such as SBBFs (the westernmost distribution of this tool type (Nishiaki and Matsutani 2001) and arrowhead fragments.

Overall, the nature of tools and cores seem to emphasize a production of blanks largely oriented towards flake, through single platform cores obtained from slam flint pebbles. These cores were rotated several times before being abandoned. The production of blade is however limited and rather occasional.

Near Eastern lithic assemblages from 7th to 6th millennium BC

Review of the data available for the Late Pottery Neolithic and early Halaf in the 7th to 6th millennium cal BC allows us to highlight specific features and trends. The evolution of raw material procurement, tool types and technology have changed greatly in the course of this millennium, an evolution possibly connected to the socio-economic changes underwent by the northern Mesopotamian societies then.

Raw material procurement towards the end of the PPN shows an emphasis on good quality material, exogenous, imported generally as core preforms (Nishiaki 2000) seen at Abu Hureyra, or Tell Halula. This behavior is witnessed all the way into the Late Neolithic, where new procurement types are witnessed around 6200/6000 cal BC at sites such as Kashkashok II or Damishliyyah I, where flint especially is transported and stored as unworked pebble (Copeland 1996; Altınbilek-Algül *et al.* 2012).

Tool types typical of Late Neolithic assemblages are represented by CTBs and SBBFs, generally on obsidian, along with tile knives on flint, at Tell Kashkashok II and Damishliyyah I. There is a decrease in burins, progressively replaced by amorphous flake tools (Copeland 1996) such as denticulates and notches. Arrowheads, manufactured on blades during the late PPNB, become rarer and replaced by transversal arrowheads (Figure 7: 10-11).

The end of the PPNB still reinforces a division between two areas, a naviform *chaîne opératoire* in the west, and single platform pressure flaked technology on prismatic cores in the east (Figure 5: 1-2, 4-6). In the latter, pressure flaking technique can involve a lever, a technique seen until 6200-6100 cal BC in the Near East based on the fragments identified at Sabi Abyad 1 and 2 (Altınbilek-Algül *et al.* 2012). Copeland (1996) suggests a technology characterized by flake blank productions, with blades generally accounting for less than 10% of debitage. This is for instance the case in the Halafian layer of Tell Halula, with the abandonment of naviform technology and the use of single platform cores for the production of sickle elements on flakes (Borrell and Molist 2007).

Overall, both in tool type and technology used, the very end of the 7th millennium BC shows dramatic change in lithic assemblages, with a change identified around 6200-6100 cal BC (Nishiaki 2000). During the 6th millennium, assemblages in the Jezireh are mostly flaked-based, and production of long blade through pressure knapping with lever or a crutch seems to disappear in the Near East until the Canaanean blades of the Bronze Age (Chabot and Pelegrin 2012).

Results and discussion

Along with the analysis provided by Chabot *et al.* (in this volume), an overview of the industries of the 7th to 6th millennium in the Southern Caucasus and the Near East allows us to present characteristics and intersite variations within the Aratashen-Shulaveri-Shomutepe groups, and draw some conclusions regarding the nature of parallels between these two regions.

The Aratashen-Shulaveri-Shomutepe lithic industry

Throughout the assemblages known in the Southern Caucasus Late Neolithic, several techno-typological features are fairly consistent.

Overall, obsidian is the raw material of choice, with proportions ranging from 50 to 99% of the total assemblages, even in sites distant from obsidian sources such as Hacı Elamxanlı or Mentesh Tepe, both located in Azerbaijan. Other local material (flint, jasper, dacite) are used more rarely for production of flakes as well as tools (mostly scrapers).

Aratashen-Shulaveri-Shomutepe industries are oriented towards the production of long standardized blades and bladelet blanks (Figure 6: 1-5, 10-13). These blanks are obtained through a combination of pressure techniques (lever and crutch), and indirect percussion (Chabot *et al.* in this volume). Blades generally have flat-smooth butts with marked bulbs (Aratashen, Aknashen, Arukhlo, Mentesh, Göytepe, Hacı Elamxanlı). Until recently, no operational sequence associated to the production of smaller product – i.e., bladelet – had been identified, suggesting that such blanks resulted from the continuous production of blade in the same core. However, some elements from Aratashen and Aknashen Horizon VII and possibly at Hacı Elamxanlı suggest a *chaîne opératoire* identified for the production of smaller blanks quickly organized a striking platform on smaller and sometimes cortical flakes to obtain regular to irregular bladelets (Chabot *et al.* in this volume; Nishiaki *et al.* 2015b). However, this particular sequence seems to disappear after 5800-5700 cal BC.

Overall, the *chaîne opératoire* is only identified during or immediately following the opening of the striking platform, and the initiation of the blade flaking. Only very little cortex is associated with Aratashen-Shulaveri-Shomutepe sites and the technical pieces generally identified support the knapping on site of a core already preformed and preliminarily exploited. Indeed, a large amount of undated debitage is found on the several sources across Armenia and Georgia, some of them being 'flake of opening' or resulting from the shaping of a preliminary crest.

The tool types represented in all assemblages also show some consistency with, a high presence of 'retouched blades' (involving retouched and used blade), burins, and an extremely large majority of tools being carried out on blade blanks rather than flakes. Other tool types such as notches and denticulates are also largely represented, along with a specific type of trapeze microliths sometimes defined as 'transverse arrowheads', truncated and/or backed trapeze-shaped blade fragments (Figure 2: 6-11; Figure 7: 1-9). Another characteristic tool is the large round scraper, carried out on a big flake sometimes detached from the debitage surface of a blade core then retouch on up to 80% of its circumference.

However, despite those parallels, differences exist in proportions and representations across sub-regions. For instance, the general proportion of unretouched vs retouched blade changes from one site to another with larger representation of unretouched blanks in Aknashen tools than Mentesh (Figure 2: 2-5, Figure 6: 1-5, 10-13). This also impacts the proportion of tool within the assemblage, with high proportions (up to 50%) in Shulaveri, while Aknashen and Aratashen only reach amounts up to 15% of the total. The representation of various stages of the *chaîne opératoire* also slightly varies from one site to the other, with later stage cores seemingly brought to sites such as Mentesh or Göytepe in comparison to Aratashen. Finally, tool-type representation also varies. For instance, differences at Hacı Elamxanlı, burins and retouched blade represent around 34% and 11% of the tools whereas they account for around 5% and 55% in Aknashen (all levels).

Several of the differences highlighted above could be connected to sample variations or other variables such as raw material accessibility. However, overall lithic assemblages from Aratashen-Shulaveri-Shomutepe settlements show remarkable consistency in tool type and production techniques across the Southern Caucasus, that is, a production that is first and foremost oriented towards the manufacture of long standardized blades.

Standardized blade production and pressure techniques in the Near East and the Caucasus

Production of long standardized blades in the Southern Caucasus is strictly associated with the Late Neolithic (Figure 2: 2-5, Figure 6: 1-5, 10-13). Use of the pressure technique (using a lever and/or a crutch) has been suggested at sites such as Arukhlo, Aratashen, Aknashen, Hacı Elamxanlı and Mentesh Tepe (Figure 2: 1, Figure 5: 7-8). The omnipresence of this method in Aratashen-Shulaveri-Shomutepe sites could be connected to various factors ranging from good production dedicated to exchange, or itinerant craftsmen.

Production of standardized blade in the Near East during the PPN is seen under two main forms. One, traditionally connected to 'western' tradition (Central Anatolia, western Levant) is the naviform core (Wilke and Quintero 1995) involving a complex shaping of the core and *chaine opératoire* to obtain pre-determined blade through percussion, which technique is largely exported all the way to Cyprus and the Southern Levant (Balkan-Atlı and Binder 2012). The other, associated with an eastern tradition is mainly seen in pyramidal/conical/long-barrel cores using pressure flaking techniques, at sites such as Cayönü or Cafer Hoyuk (Altınbilek-Algül *et al.* 2012). With the disappearance of the naviform technology towards the end of the PPNB-PPNC, only the latter mode of blade-making seem to persist into the Late Neolithic, especially at sites such as Sabi Abyad 2 or Damishliyyah I, (Altınbilek-Algül *et al.* 2012). Naviform technology is said to be less sustainable as the Near East experiences a breakdown of some of its distribution networks. This production of standardized blade seems to go on until the end of the 7th millennium BC and is not seen again in the Near East until at least the very end of the 6th millennium BC. Indeed, Copeland (1996) highlights the switch towards flake-based production taking after 6200-6100 cal BC in the Near East, at sites such as Sabi Abyad 1 and Kashkashok II, or Tell Halula (Nishiaki 2000; Borrell and Molist 2007).

It is therefore particularly interesting not only to find a few centuries later in the Southern Caucasus a flourishing and fully-developed blade-making tradition in Aratashen-Shulaveri-Shomutepe context, but also that those practices and techniques associated with this production continued throughout the Halafian period of Upper Mesopotamia (Nishiaki 2018). Despite some differences with Near Eastern *chaînes opératoires* (especially in the preparation of the striking platform), the implications of an introduction and persistence of blade production in the Southern Caucasus are interesting when considering other parallels found between those two regions in architecture, domesticates, or ceramics. Kiguradze (1976) finds, in the beads from Shulaveris Gora's earliest layers, some correlations with those found at Haçilar in Turkey. The several anthropomorphic figurines of Khramis Didi Gora are reminiscent of the Hassuna, Halaf, and Samarra cultures (Hamon 2008: 88). While the early layers of Aratashen-Shulaveri-Shomutepe sites reveal almost no pottery, some painted sherds are clearly associated with Halaf culture, an analogy that can also be applied partially to the bone and antler tool industry, as much in technique as in typology. Furthermore, studies show the relations between shards and architectural features associated with early layers in Mentesh Tepe with ceramic and building production from the Iranian plateau (Lyonnet *et al.* 2016).

Tool type parallels

Within limited chronological and geographic boundaries, typological parallels can help support specific hypothesis regarding cultural transmission processes. Some parallels are observed between the Near East and the Southern Caucasus beyond blade production (Figure 6). Some are connected to more general shift in Neolithic took-making (Binder and Perles 1990) that involve a standardization of the blanks and use of little retouching to transform them into implement suitable for multifunctional tasks, leading to a variety of retouched blades without clear retouching patterns. Other are found in more specific tools types. This is for instance the case of the large roundscraper, typical of the Araxes valley sites, while rarer on the Kura valley settlements. It is also found in the Near East at site such as Kashkashok II (Nishiaki 2000). One particularly interesting example shows the re-use of a large flake originating from the flaking surface of a blade-like core, which is also attested at Aratashen (Figure 8). Regarding the arrowheads, there are no evidence for Byblos-type point in the Southern Caucasus when they are found at Sabi Abyad or Kosak Shamali. Instead, trapeze/transverse arrowheads in the Aratashen-Shulaveri-Shomutepe sites are carried out on blade fragments, generally on snapped mesial part, either slightly backed or with a bilateral flat retouch on its surface (Chabot *et al.* in this volume; Nishiaki *et al.* 2015b). Such type of microliths are also found in Sabi Abyad I (level 5 and 4) (Copeland 1996), Kashkahok II and Damishliyyah I (Nishiaki 2000).

However, several key tool types seem to be missing. First are the CTBs and SBBFs (Figure 9). Found across the four near eastern sites of this study, and generally presented as typical of Late Neolithic assemblages in Mesopotamia (Copeland 1996), these elements do not seem to be present, or have not yet been identified in Aratashen-Shulaveri-Shomutepe collections. Second are the Cayönü/('Apnagyugh' (Kmlo) tools (Gasparyan and Petrosyan 2016). This particular tool type is found at Çayönü during the PPN on long regular blades ('Çayönü' tools) and thick blade or elongated flakes ('Apnagyugh' (Kmlo) tools), and again in Late Neolithic sites such as Kashkashok II (Nishiaki 2000). Yet, it is totally absent from the Aratashen-Shulaveri-Shomutepe assemblages. In the southern Caucasus, this type of tools is first identified in the site of Apnagyugh-8 (Kmlo-2), a small cave site on the Kasakh river (Arimura *et al.* 2009, 2010, 2012; Chataigner *et al.* 2012; Petrosyan *et al.* 2014; Arimura 2019). According to 14C dates, prehistoric occupations at this site are divided into four phases (Phase I is Medieval). Phase V, the earliest occupation, is situated during the end of the Pleistocene to the beginning of the Holocene (12th–10th millennia cal. BC) and characterized by obsidian microliths such as backed bladelets and scalene triangles. Early Holocene occupations Phases IV–III could date to the 10th–8th millennia cal. BC. These phases produced numerous obsidian tools, including microliths and a specific new tool class, the 'Apnagyugh or Kmlo tools', named after the site. Phase II is a Chalcolithic occupation, coupled with a new tool type of transverse arrowheads (Arimura *et al.* 2009; Petrosyan *et al.* 2014; Gasparyan and Petrosyan 2016; Arimura 2019). There are sites with these kind of tools' recorded in Kabardino Balkaria (Sosruko, Alebastroviy Grot), in North Ossetia (Chorniy Grot), in South Ossetia (Pichigin, Nagutny-1-2, Zura-Akho, Gijoeti, Tsipleti, Jermukh), in Svanetia (Paluri, Lebikvi, Nakuraleshi), in Adjaria (Beshumi), in Upper Imereti (Burghnari), in the Kura river basin, on the slopes of Papakar mountain chain (Damjili-1), on the Akhalkalaki Plateau (Chataigner *et al.* 2012: 56; Gasparyan and Petrosyan 2016: 24). The same tool is also found in Neolithic context at Bavra-Ablari (Georgia) (Varoutsikos *et al.* 2018). The absence of that tool type in *tell* sites can be interpreted in technical terms (lack of knowledge to produce such tool), functional term (no need for the function generally attributed to the tool), but we have to note that this tool is characterized by pressure-retouched edges and in some cases has visible abrasion traces on the surface, that were probably caused by use against mineral materials. The excavations at Apnagyugh-8 (Kmlo-2) opened a new research field, the Early Holocene period, which was poorly understood in Armenia until the early 2000s. After the Apnagyugh-8 (Kmlo-2) excavations, sites that could be dated to the Early

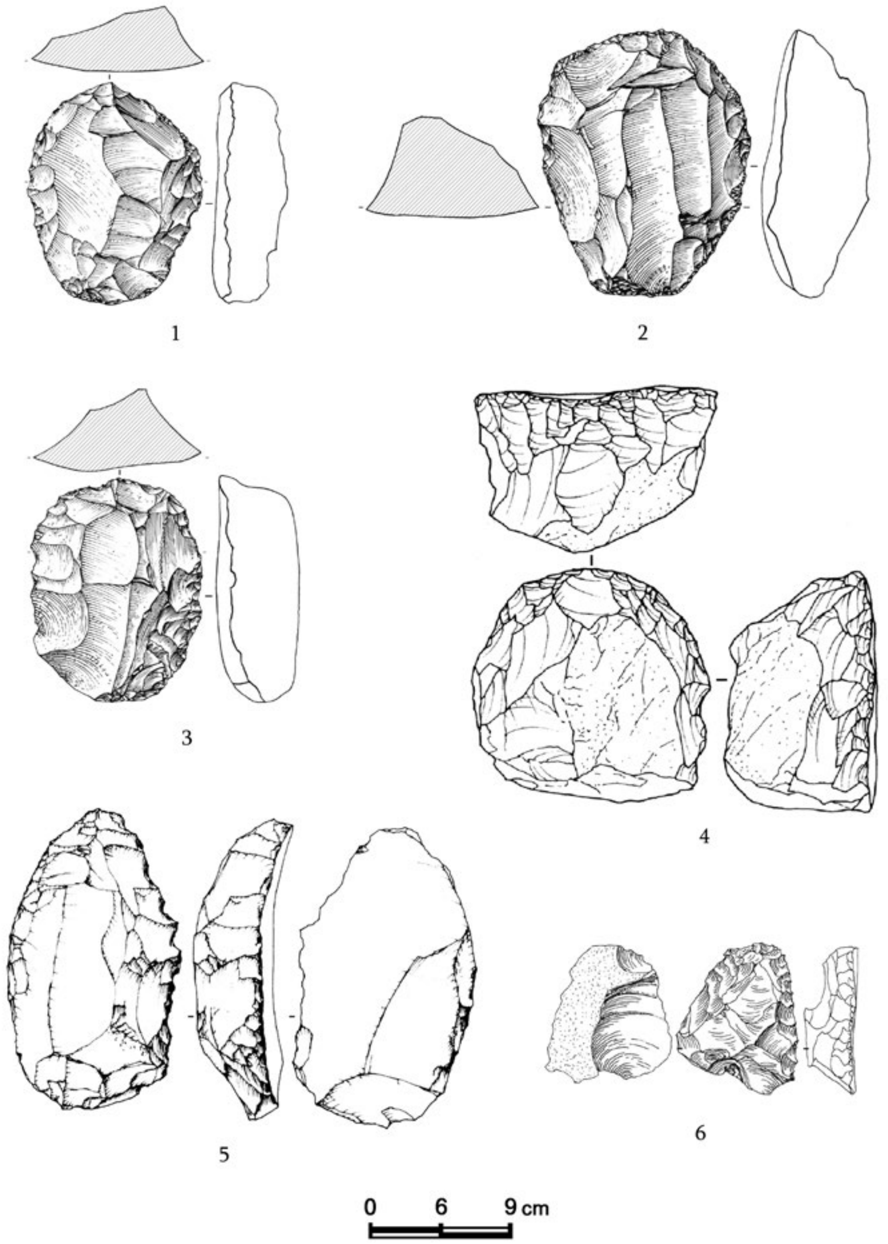


Figure 8. Large Round Scrapers: 1) Aknashen (Tr.8 UF8a) [drawing: G. Devilder]; 2) Aratashen (Sond. P-H UF 293) [drawing: G. Devilder]; 3) Aknashen (Tr. 4 UF7 T4W4-T1W2) [drawing: G. Devilder]; 4) Hacı Elamxanlı (Kadowaki *et al.* 2016: fig. 5: 13); 5) Kashkashok 2, Scraper 'type 4', M12-mixed (Nishiaki and Matsutani 2003: pl. 73); 6) Sabi Abyad, Level 6 (Neolithic) (Copeland 1996: fig. 4.12: 1).

Holocene period were found and excavated including Kuchak-1, Gegharot-1 and Yenokavan-2 (Arimura *et al.* 2014; Petrosyan *et al.* 2014). All sites have yielded similar obsidian assemblages, characterized by a blade/bladelet-dominated industry, microliths and 'Apnagyugh or Kmlo' tools. Moreover, several additional archaeological sites with 'Apnagyugh/Kmlo tools' were discovered through general surveys. All of these excavated and surveyed sites are small caves/rock shelters or open sites and are distributed in the mountainous area. It should be noted that no site having lithic materials comparable to the Early Holocene industry outlined here has yet been found on the lowland Ararat valley. Sites of the Early Holocene period are likely restricted to the mountainous area surrounding the Ararat valley, while Neolithic Aratashen-Shulaveri-Shomutepe sites are only found in the plain (Petrosyan *et al.* 2014; Arimura 2019).

Conclusion: Aknashen Lithic industry and the Neolithization of the Southern Caucasus.

In the light of the information gathered from almost a dozen sites throughout the Caucasus in the past twenty years, several hypotheses have been suggested with regards to the processes that led to the development of agricultural society in that area. These hypotheses take into account all cultural and economic developments that occurred following the beginning of the Holocene, but they generally rely mostly on our ability to identify changes in subsistence patterns and contact between groups.

Whatever the nature of the Aratashen-Shulaveri-Shomutepe phenomenon, it occurred quickly. There is currently no evidence for pre-Aratashen-Shulaveri-

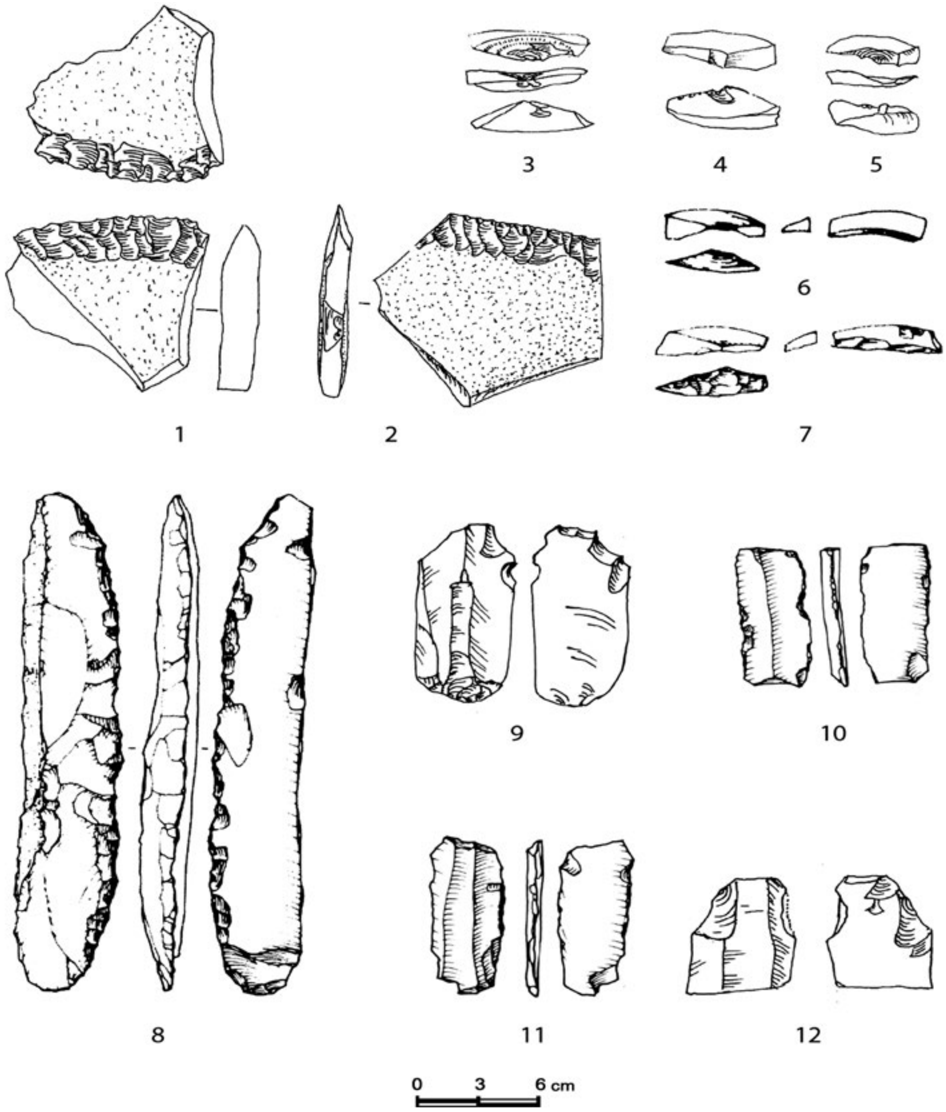


Figure 9. Other tools: (1-2) Tile knive, Sabi Abyad, Level 6 (Neolithic) (Copeland 1996: fig. 4.9: 3 and 1); (3-5) SBBF, Sabi Abyad, Level 6 (Neolithic) (Copeland 1996: fig. 4.12: 6-8); (6-8) SBBF, Kashkashok, P9 Fill and K10-mixed (Nishiaki and Matsutani 2003: pl. 77); 9, 12) CTB, Sabi Abyad, Level 11 (Copeland 1996: fig. 4.2: 2 and 7); 10-11) CTB type 1, Kashkashok, D8 Pit fill and E7-3 (Nishiaki and Matsutani 2003: pl. 77).

Shomutepe agriculture in the Southern Caucasus. Until recently the Early Holocene sites of the Kura and the Araxes river basins were not known and discussions of the question of Neolithization here were based only on the study of Late Neolithic-Chalcolithic settlements grouped into the Aratashen-Shulaveri-Shomutepe tradition, located in the valleys and plains. Fieldwork activities implemented during last 20 years brought to the discovery of series of Old and Early Holocene sites in Armenia, Georgia and Azerbaijan distributed by stratified cave and rock-shelter as well as open-air sites and settlements, filling the gap between the 10th and early 6th millennium BC (Petrosyan *et al.* 2014: 135-136; Arimura *et al.* 2018: 1-3). Even though the excavations and study of the Early and Middle Holocene sites is pending and there is much left to do in this direction, the accumulated information allows looking at the process on Neolitization in the Kura and the Araxes river basins from a new perspective. The data allows dividing the Early Holocene archaeological sequence into two chronological groups or steps. Group 1 or Step 1 with chronometric dates between 10.000-7300 cal BC is distributed by seasonal hunting and habitation camps on higher elevations (between 1700-3200m asl) organized inside of the caves and rockshelters in combination with artificial structures in front of them as well as short-term open-air activities. Some shifts in the economic lifeways (storage pits) and technological production of tools (so-called 'Apnagyugh' or 'Kmlo' tools) is obvious even though many similarities can be noticed with the lifestyle of the Late Pleistocene hunter-gatherers (Apnagyugh-8/Kmlo-2 cave, Kuchak-1 rockshelter, Edzani and Zurtaketi rock-shelters, Kotias Klde and Damjili caves). The chronometric dates for Group 2 or Step 2 span between 7300-6200 cal BC, when in parallel with the cave sites (Areni-1, Areni-2 and Damjili unit 5) first settlements (Lernagog-1, Paluri) appeared (Petrosyan *et al.* 2021; Nishiaki *et al.* 2019b: 1-16; Arimura *et al.* 2021). Sites with ritual function (Geghamavan-1 and Areni-2 caves) also exist (Gasparyan *et al.* 2020: 150; Khechoyan and Gasparyan 2014). Lernagog-1 settlement located on the southmost fringes of Mt. Aragats, closer to its junctions with the Ararat valley and dated with late 8th first half of the 7th millennium BC has similar architectural features with the settlements of the Ararat valley, meanwhile the lithic productions still remains with the dominance of the 'Apnagyugh or Kmlo' tools. This is allowing to hypothesize that the origin of the early farming culture in the Araxes river valley is local even though there is noticeable influence from the southern cultural centres (Arimura *et al.* 2018). Unfortunately, the questions of plant and animal domestication are still open and need additional research. Although some sites such as Apnagyugh 8 (Kmlo-2) or Bavra Ablari might be able to provide some evidence of occupation during the hiatus (Arimura *et al.* 2009 ; Petrosyan *et al.* 2014; Varoutsikos *et al.* 2018), the current state of our knowledge seem to point towards a weak density of pre-Aratashen-Shulaveri-Shomutepe sites.

In this context, some aspects of this study are particularly interesting. The consistency of type tools and technology across the Aratashen-Shulaveri-Shomutepe sites on one hand, and the absence of such technology in the contemporaneous Near Eastern settlements fit a scenario that other pieces of evidence are starting to hint at. Indeed, both linguistic and genetics studies (Dvorak *et al.* 1998; Nasidze *et al.* 2003; Chataigner *et al.* 2014a) support a connection with the Near East and emphasize the potential role of the SE Caspian area in the Neolithization of the Caucasus. One scenario presented earlier (Varoutsikos 2015) has suggested a movement of Late Neolithic groups away from the northern Mesopotamian area, possibly in response to the 6.2ky cal BC event, movement leading some of such groups to enter the territory of the Southern and North Caucasus following main river axes (Kura and Araxes) and the Caspian shores towards Dagestan and the site of Chokh (Amirkhanov 1982). In the light of this scenario, such groups could hold the technology of standardized blade-making using pressure flaking techniques explaining the transfer of such technology from the Near Eastern to the Southern Caucasus area between 6200 to 5900 cal BC. With the increase of newly excavated Early Holocene sites, it is becoming possible to test hypothesis about local origins for Aratashen-Shulaveri-Shomutepe phenomenon in the geographical frames of the Armenian Highlands (Petrosyan *et al.* 2021).

As an increasing number of Southern Caucasus Neolithic settlements monographs are being published, further analysis of well dated lithic assemblages will help clarify the technological landscape of the Aratahen-Shulaveri-Shomutepe culture. However, the speed and nature of the mechanisms involved already make the Neolithization of this area a precious case study to understand development of farming societies around the world.

Acknowledgements

The authors of this paper would like to acknowledge Anzhela Tadevosyan director of Etchmiadzin historical-ethnographic museum for providing access to the Tsaghkunk assemblage, Boris Gasparyan for his help in reviewing the text and for the tables for Tsaghkunk collection.

The provenance of the obsidian used at Aknashen

Bernard Gratuze, Ruben Badalyan and Christine Chataigner

Introduction

Obsidian is an essential raw material for Neolithic sites of the Ararat valley: 99% of Aknashen's lithic industry (Chabot *et al.* in this volume) is made of this volcanic glass, 99% of Aratashen's (Badalyan *et al.* 2007: 43), and 97% of Masis Blur's (Martirosyan-Olshansky 2018a: 21). In order to determine the provenances of obsidians found at Aknashen, a series of analyses was carried out; they showed the multi-source character of supply, pinpointed the geographical area of the volcanoes whose obsidian was exploited, and distinguished the main sources from the secondary ones.

The data from similar studies on the sites of Aratashen (Badalyan *et al.* 2007; Badalyan 2010; Chataigner and Gratuze 2014b) and Masis Blur (Badalyan 2010; Martirosyan-Olshansky 2018a) have shown similarities and differences in the models of obsidian procurement, but have also highlighted the dominant tendencies and the main directions of the supply network.

A first group of obsidian Neolithic artefacts from Aknashen – 10 non-stratified samples – was analysed by J. Blackman via the neutron activation method (INAA) at the National Institute of Standards and Technology (in Maryland, USA) (Badalyan *et al.* 2010). A second group, comprising 40 artefacts originating from horizons V-III, was analysed by Kh. Meliksetian and E. Pernicka at the Curt-Englehorn-Zentrum Archëometrie (Manheim, Germany), also by using INAA (Meliksetian *et al.* forthcoming). Finally, A. Juharyan (Institute of Archaeology and Ethnography, Armenia) studied, through portable XRF (pXRF), 118 samples from undisturbed contexts of horizon III (Azatyan and Juharyan forthcoming).

In the present study, 109 samples were analysed, originating from horizons IV (40 artefacts), V (26 artefacts), VI (13 artefacts) and VII (30 artefacts). In each horizon, some contexts (UFs/Features) have been selected and, among all the obsidian artefacts of these contexts, a selection has been made in proportion to the visual characteristics (texture, colour).

Methods

Two analytical methods were applied at the IRAMAT / Centre Ernest-Babelon for sourcing the obsidian artefacts from Aknashen. The first one is based on Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS), and the second one on a non-destructive Energy Dispersive X-Ray Fluorescence approach (ED-XRF). All the 109 studied artefacts were analysed using both methods to check the potential of XRF method for analysing obsidian artefacts directly on archaeological sites.

Laser Ablation Inductively Coupled Plasma Mass Spectrometry analysis (LA-ICP-MS)

Analyses of obsidian objects conducted at the Ernest-Babelon Centre of the IRAMAT (Orléans) were carried out with an Element XR mass spectrometer from Thermo Fisher Instruments (Gratuze 1999; Chataigner and Gratuze 2014a). This system offers the advantage of being equipped with a three-stage detection device: a dual mode (counting and analog modes) secondary electron multiplier (SEM) with a linear dynamic range of over nine orders of magnitude, associated with a single Faraday collector (faraday mode), which allows an increase of the linear dynamic range by an additional three orders of magnitude. This feature is particularly important for laser ablation analysis of lithic samples, as it is possible to analyse major, minor, and trace elements in a single run, regardless of their concentrations and isotopic abundance.

The measurements were carried out in peak jump acquisition mode, taking four points per peak in the case of counting and analog detection modes, and ten points per peak when using Faraday detection. Automatic detection mode was used for most of the elements; only sodium, silicon, aluminium and potassium were systematically measured with the Faraday detector. Silicon was measured with its isotope ^{28}Si, and was used as an internal standard. A total of 38 elements (see the table of compositions in the Appendix) were recorded. With our analytical parameters, the scanning time needed to measure the selected isotopes was about 2 seconds. As most of the isobaric interferences encountered could be dealt with by working on non-interfered isotopes, all the measurements were carried out in low resolution mode.

Two series of analysis were carried out. For the first one (79 artefacts), we used a VG UV-laser, generated by a Nd YAG pulsed beam and operating at 266nm wavelength, 3-4mJ power and 7Hz repetition rate. An argon stream (1.15-1.35 l/min) carried the ablated material to the plasma torch. For the second series (30 new artefacts, 5 already analysed during the first campaign), a Resonetics RESOlution M50e ablation device was used. This is an excimer laser produced by argon fluoride at 193nm wavelength, and operated at 4mJ and 10hz. A dual gas system with helium (0.65 l/min) released at the base of the chamber, and argon at the head of the chamber (1.1 l/min) carried the ablated material to the plasma torch. For both series of analyses, ablation time was set to 70 seconds: 20s for pre-ablation, so that potential surface contaminations could be removed, and 50s for collection time. Spot sizes were set to 100µm. Blanks were run every 10 samples. Only one area was sampled during both series, however; when, during analysis, element-spikes due to the presence of inclusions were observed, results were discarded and a new site selected. In some cases, the signal showed some heterogeneity, and up to four different areas were sampled in the case of some artefacts. All the collected data (a total of 120 analyses have been carried out) are given in the table in the Appendix.

Calibration was done by using 3 reference-standard glass materials: NIST610, Corning glass B and D, which were run periodically for correction in case of instrumental drift. ^{28}Si was used as internal standard to normalise the measured signal for each element, and the final percentage composition was calculated from the response coefficient (k) defined from the reference material (Gratuze 1999). Standard glass materials NIST612 were analysed independently of calibration, to provide comparative data and check for accuracy and precision. For the major elements, the analysed values were within 5% relative to all elements. Most trace elements were within 10%. Coefficients of variation for all major elements were <5%. For the minor and trace elements, most were <5% and all <10%.

X-Ray Fluorescence analysis (XRF)

A systematic qualitative X-Ray Fluorescence approach (XRF) was also applied to all the artefacts. X-rays were generated with a tungsten tube operating at 45kV and 0.8 mA. Analytical parameters were as follows: acquisition time of 1200 s, no beam filter, beam collimator diameter 1.5 mm, and energy domain for elemental analysis 0-50 keV. The instrument used was an ARTAX portable µ-XRF Spectrometer from Bruker. The net signal measured 11 minor and trace elements present in obsidian: K, Ca, Ti, Mn, Fe, Rb, Sr, Y, Zr, Nb and Ba were systematically recorded.

Geological samples, from sources located in Armenia, Georgia and Turkey, and archaeological samples were jointly analysed. The net signals measured for each element were plotted using simple binary diagrams following normalisation by the Lα tungsten X-ray.

Source	Number of artefact	% of artefacts	Sub-source	Number of artefact	% of artefacts
Arteni	53	48.6%	Arteni 1	2	1.8%
			Arteni 2	7	6.4%
			Arteni 3	42	38.5%
			Arteni 4	1	0.9%
			Arteni ?	1	0.9%
Gegham	10	9.2%		10	9.2%
Gutansar	10	9.2%		10	9.2%
Hatis	3	2.8%	Zerborian	2	1.8%
			Akunk/Kaputan	1	0.9%
Meydan Dağ	3	2.8%		3	2.8%
Pasinler	1	0.9%		1	0.9%
North Sarıkamış	5	4.6%	N 1	1	0.9%
			N 2	1	0.9%
			N 3A	2	1.8%
			N 3B	1	0.9%
South Sarıkamış	10	9.2%	S 1A	1	0.9%
			S 1C	3	2.8%
			S 2A	3	2.8%
			S 2B	3	2.8%
Tsaghkunyats	11	10.1%	Damlik	5	4.6%
			Ttvakar	1	0.9%
			Kamakar/Aikasar	5	4.6%
Yağlıca Dağ	3	2.8%	Yağlıca South	2	1.8%
			Yağlıca Summit	1	0.9%

Figure 1. Distribution of the analysed obsidian artefacts according to their provenance.

However, it should be remembered that results obtained with this technique are very sensitive to surface conditions (alteration, encrustations, roughness, irregularities), as well to the artefact's thickness (the minimum thickness required to have reliable measurements is about 3 mm).

The XRF data (normalised raw counts) allow us to separate the objects into different groups. According to the results obtained on geological samples with our analytical protocol, it was observed that some sources could be directly identified (Arteni, Gegham, Tsaghkunyats), while others showed systematic overlap (Gutansar, Hatis, Sarıkamış, Yağlıca).

Only the results obtained using LA-ICP-MS will be given in Figure 1 and in the Appendix and plotted on the binary diagrams. However, comparison between XRF and LA-ICP-MS data is given in the form of graphs in Figures 15-16.

Results

The barium and zirconium contents and the yttrium/zirconium, niobium/zirconium, barium/strontium and barium/zirconium ratios led to the obsidian artefacts from Aknashen being distributed into nine main compositional groups (Figures 1-5) located on the map (Figure 6). Results obtained by LA-ICP-MS, allow, in some instances (Arteni, Sarıkamış, Tsaghkunyats

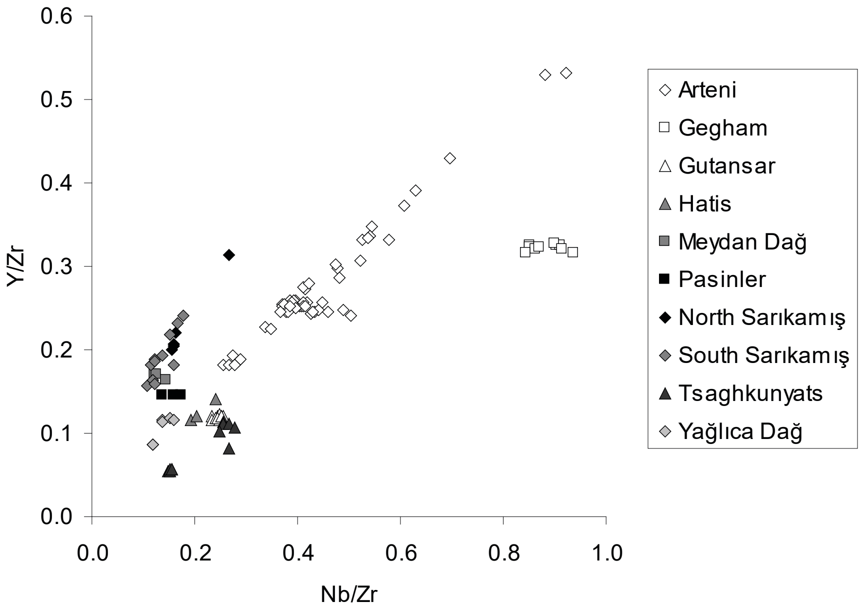


Figure 2. Binary diagram of Y/Zr-Nb/Zr ratios for the obsidian artefacts from Aknashen.

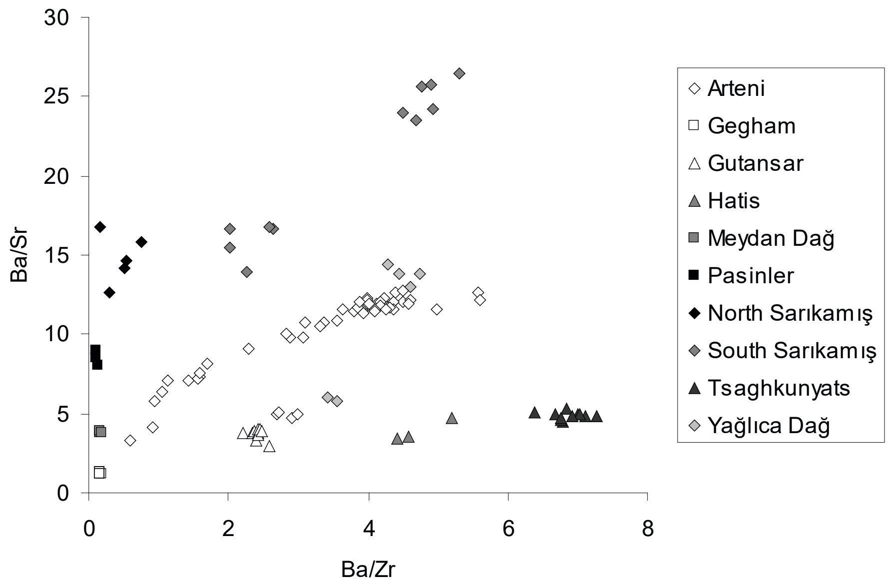


Figure 3. Binary diagram of Ba/Sr-Ba/Zr ratios for the obsidian artefacts from Aknashen.

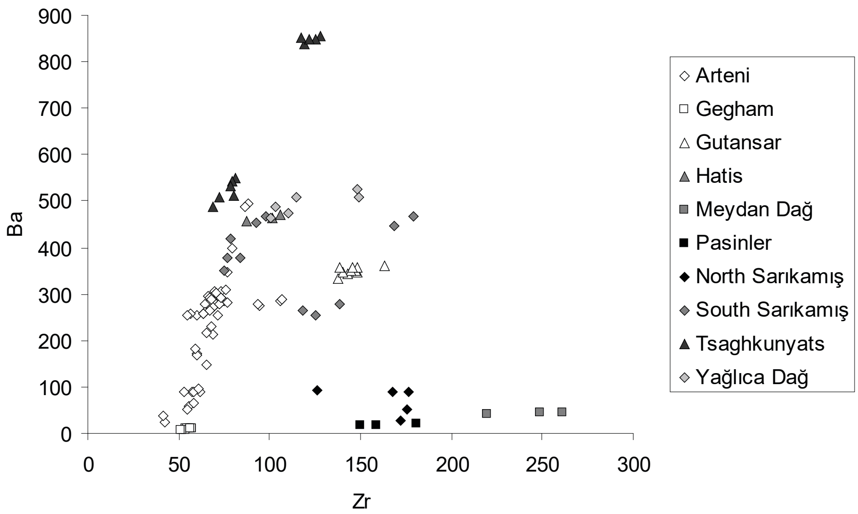


Figure 4. Binary diagram of Ba-Zr contents for the obsidian artefacts from Aknashen.

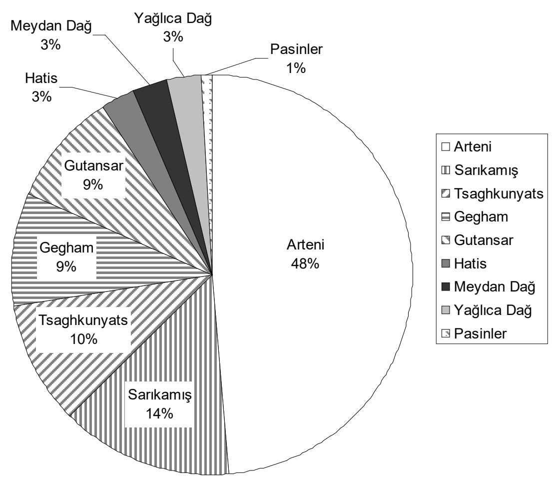


Figure 5. Distribution of the obsidian artefacts originating from Aknashen among the main identified volcanic areas.

and Yağlıca) a more precise attribution to particular outcrops of these volcanoes, and 23/24 sub-groups have been defined in this way (Figure 1 and Figures 7-9).

If we refer to recent published studies focusing on the sources of obsidian in the South Caucasus and North-eastern Turkey (Astruc *et al.* 2012; Chataigner and Gratuze 2014a; Chataigner *et al.* 2014b; Robin *et al.* 2014; Chataigner *et al.* 2020), these groups and subgroups correspond to the obsidian sources of the volcanoes of Arteni (53 artefacts distributed within 4/5 sub-groups), Gegham (Geghasar and Spitaksar) (10 artefacts), Gutansar (10 artefacts), Hatis (3 artefacts distributed within 2 sub-groups), Meydan Dağ (3 artefacts), Pasinler (1 artefact), Sarıkamış (15 artefacts distributed within 8 sub-groups), Tsaghkunyats (11 artefacts distributed within 3 sub-groups) and Yağlıca Dağ (3 artefacts distributed within 2 sub-groups) (Figures 1 and 6).

With the exception of some of the artefacts attributed to the region of Arteni (‘Arteni ?’, Aknashen 37) and Kars/Sarıkamış (sub-group ‘N 3B’, Aknashen 6; subgroup ‘S 1A’, Aknashen 36), for which we have no geological reference of identical composition, the attributions were made by comparing the measured compositions of the tools to those obtained, by the same method of analysis, on geological obsidian collected during geological surveys in the various volcanic zones in Turkey, Armenia and Georgia (Chataigner and Gratuze 2014a; Chataigner *et al.* 2014b).

Concerning the 3 artefacts (Figures 7-14) attributed to Arteni and to the sub-groups Sarıkamış N 3B and S 1A, the correspondence with a source of obsidian in this region was established in an indirect way.

For Arteni, four analyses were carried out on Aknashen 37 (three during the first series of analysis and one in the second). The composition found does not match that of any geological obsidian in our database. Its composition lies in the domain defined by Arteni 3 and Arteni 4 (ex Arteni 3b in Chataigner and Gratuze 2014b) for Y/Zr, Y/Nb and Rb/Cs ratios and Gutansar for Ba/Zr and Ba/Sr ratios. However, except for a low content of barium (similar to that of obsidian from Arteni 3 and Gutansar), its composition appears more similar to that of obsidian belonging to the sub-group Arteni 4 than to that of Gutansar’s obsidian (Figures 7, 11 and 14).

From a geochemical viewpoint, the artefacts of the sub-group Sarıkamış N 3B present lower titanium, iron, zirconium and rare earth element contents than the other artefacts attributed to the Sarıkamış North area (Kizil Kilisa / Hamamlı / Arpaçay / Kiblepinar / Handere; Chataigner *et al.* 2014b), but remain within the whole chemical domain defined by geological samples from the area (Figures 7-12). Other artefacts attributed to that sub-group have also been identified at Kıçık Tepe, and Mentesh Tepe in Azerbaijan (Palumbi *et al.* 2021; Astruc et *al.* forthcoming).

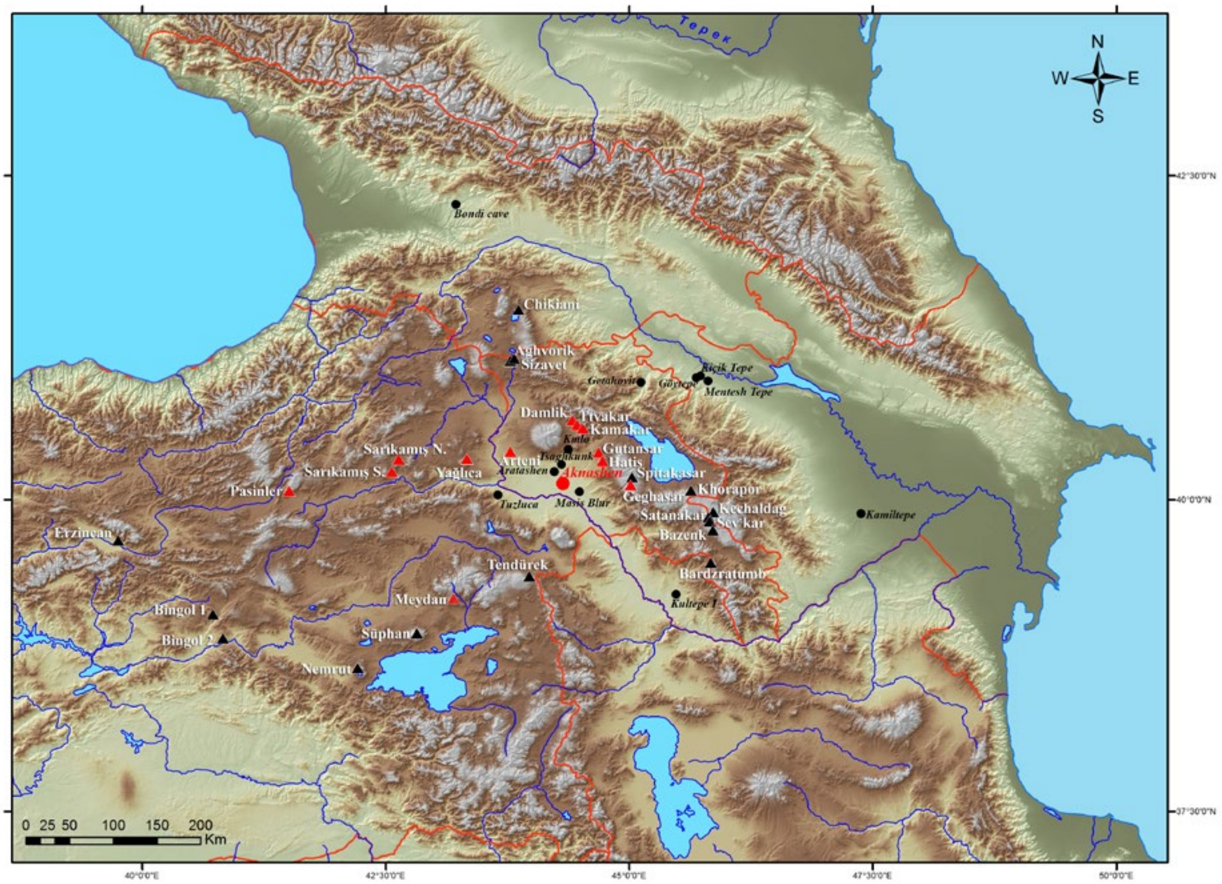
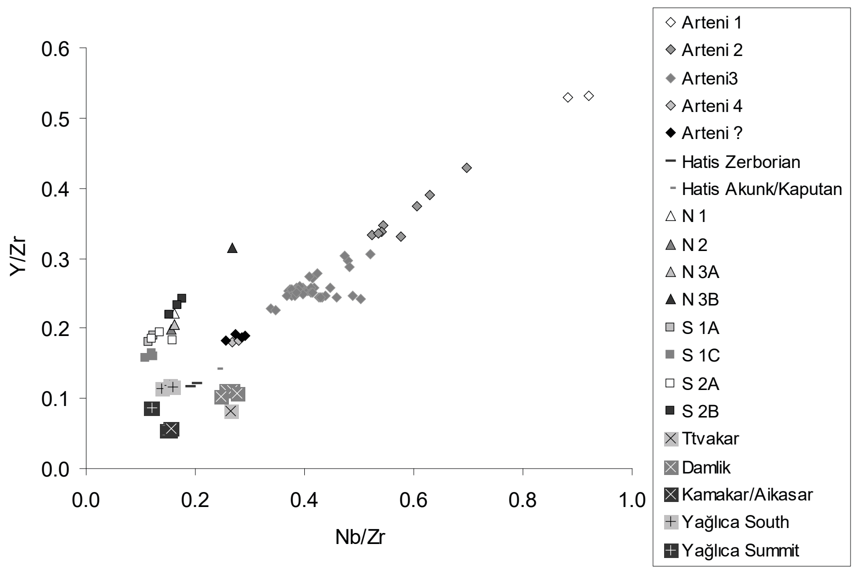


Figure 6. Map of the obsidian supply at Aknashen. Red triangle: source attested at Aknashen; black triangle: unattested source

The artefact of sub-group Sarıkamış S 1A has a composition which lies in the composition group defined by the outcrops of Sarıkamış and Yağlıca Dağ (Chataigner *et al.* 2014b). When the contents of barium, strontium, zirconium and rare earths are considered, the composition of this artefact is close to those at outcrops of Sarıkamış South (Mescıtlı / Sehitemin / Susuz / Çiplak Tepe / Kesedag / Karakurt; Chataigner *et al.* 2014b) as regards barium and strontium content, to those of the outcrops of Sarıkamış North as regards content in zirconium and rare earths (Figures 7-11 and 13) and to those of Yağlıca Dağ regarding barium, strontium and zirconium content. This sub-group is, however, found not only at Aknashen, since other

Figure 7. Binary diagram of Nb/Zr-Y/Zr ratios for the obsidian sub-groups defined among Aknashen's artefacts.



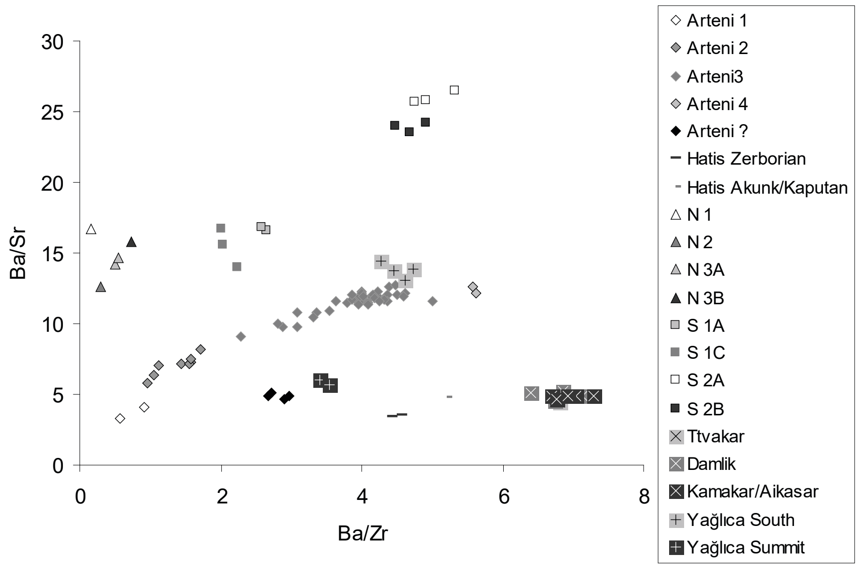


Figure 8. Binary diagram of Ba/Sr-Ba/Zr ratios for the obsidian sub-groups defined among Aknashen's artefacts.

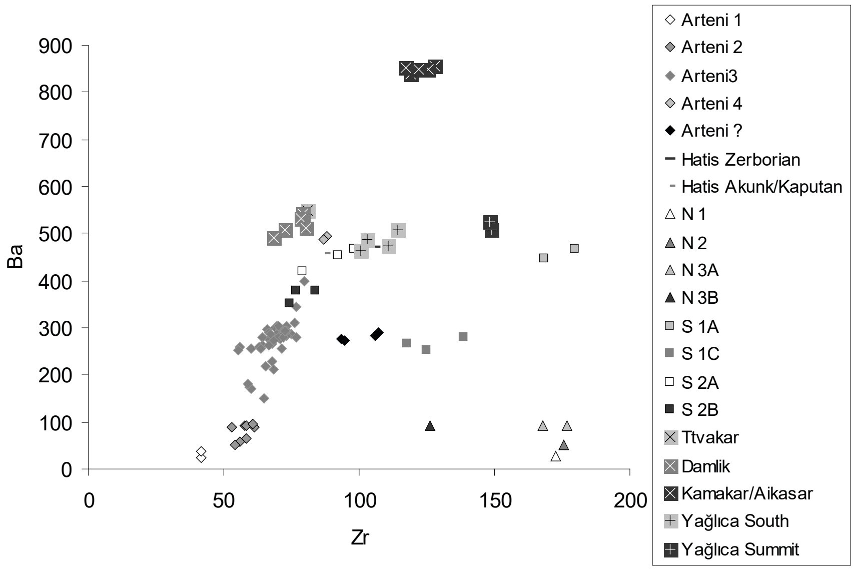


Figure 9. Binary diagram of Ba-Zr contents for the obsidian sub-groups defined among Aknashen's artefacts.

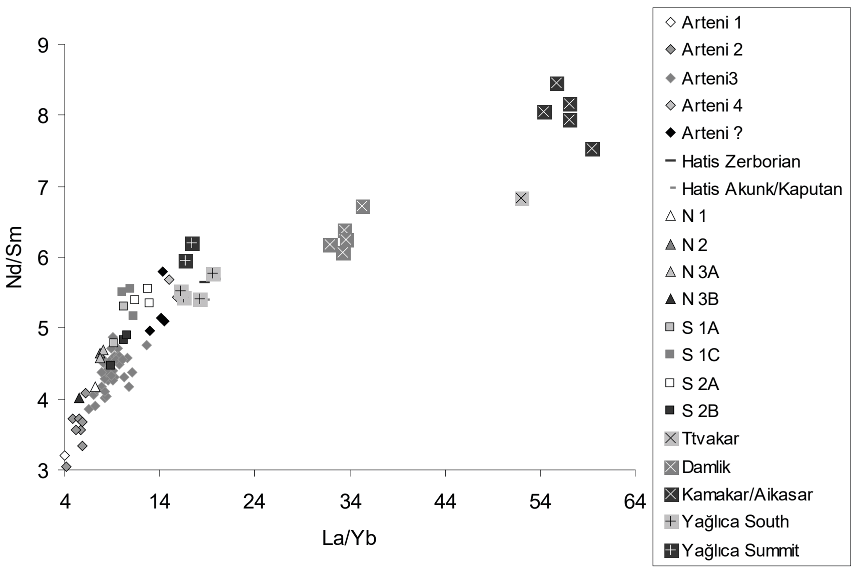


Figure 10. Binary diagram of La/Yb-Nd/Sm ratios for the obsidian sub-groups defined among Aknashen's artefacts.

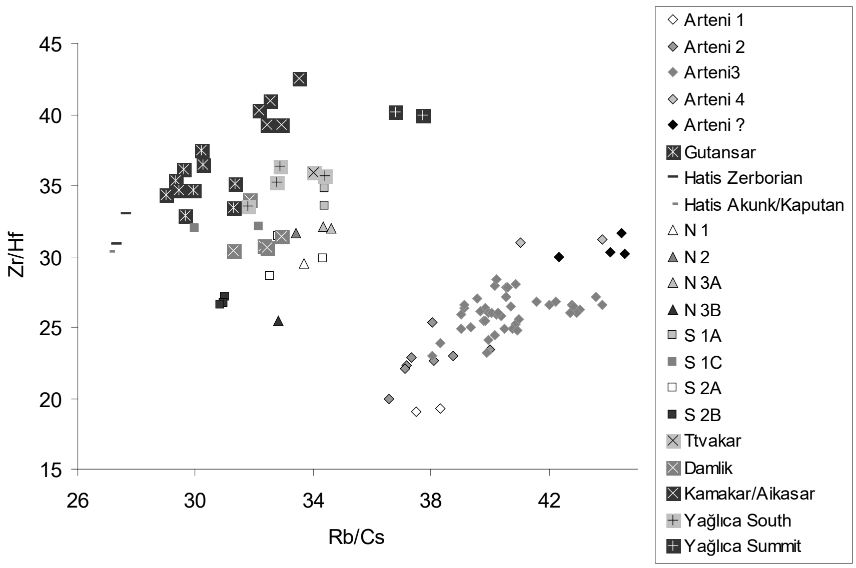


Figure 11. Binary diagram of Rb/Cs-Zr/Hf ratios for the obsidian sub-groups defined among Aknashen's artefacts.

obsidian artefacts found in Azerbaijan (Mentesh Tepe, Ismayilbey and Kıçık Tepe) and Armenia (Getahovit) have a composition similar to that of the artefacts of the S 1A sub-group (Chataigner *et al.* 2020; Palumbi *et al.* 2021; Astruc *et al.* forthcoming).

It should be remembered that the distinction between the zones of Sarıkamış North and South is in fact more related to the composition of the obsidian than to their geographic locations, and more particularly to their barium and zirconium content. The obsidian attributed to north Sarıkamış (N 1, N 2, N 3) is characterised by a high zirconium content (> 130 ppm) and a low barium one (< 100 ppm), whereas, inversely, obsidian attributed to Sarıkamış South (S 1 and S 2) revealed a low zirconium content (< 130 ppm) and a high barium content (> 200 ppm). The artefact from S 1A has an intermediate composition (high zirconium contents, > 150 ppm, and barium > 300 ppm), while the artefact from N 3B shows low contents of these elements (Zr < 130 ppm and Ba < 100 ppm). Pending a more detailed survey of the volcanic zone of Sarıkamış, these two artefacts will be considered as originating from this volcanic area.

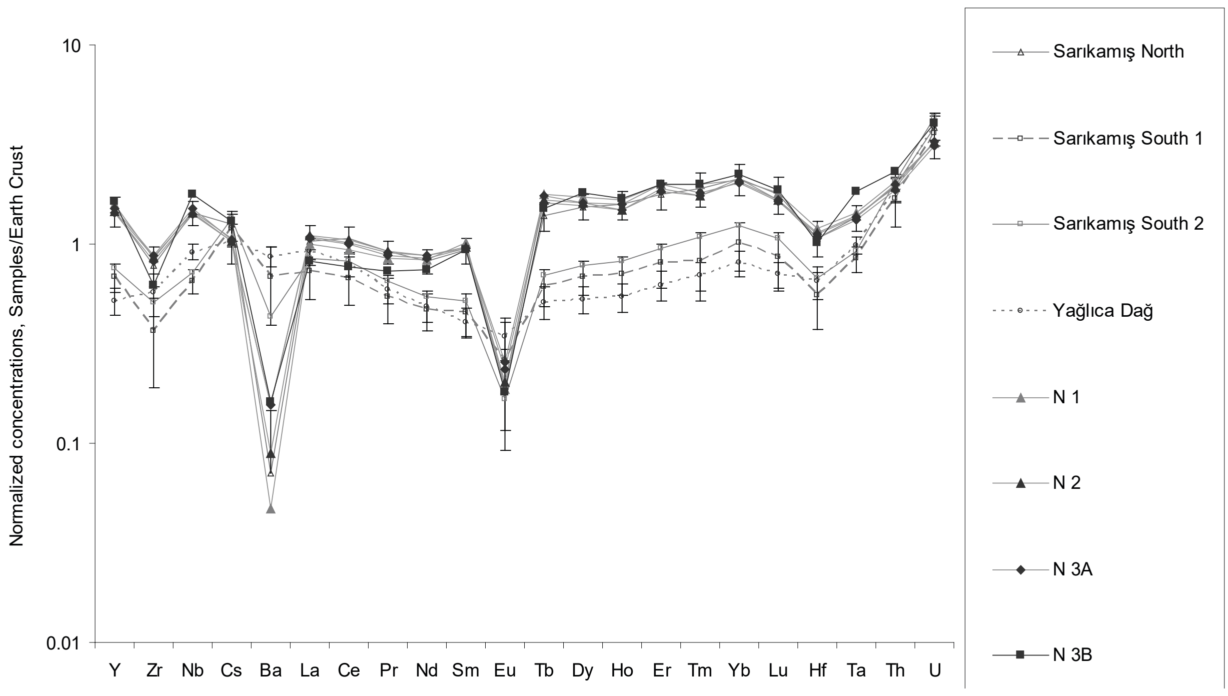


Figure 12. Spectra of Earth's crust-normalized REE (Rare Earth Elements) values (Wedepohl 1995) for the analysed obsidian attributed to the Sarıkamış North area (N 1, N 2, N 3A, N 3B), comparison with geological samples from Sarıkamış and Yağlıca Dağ.

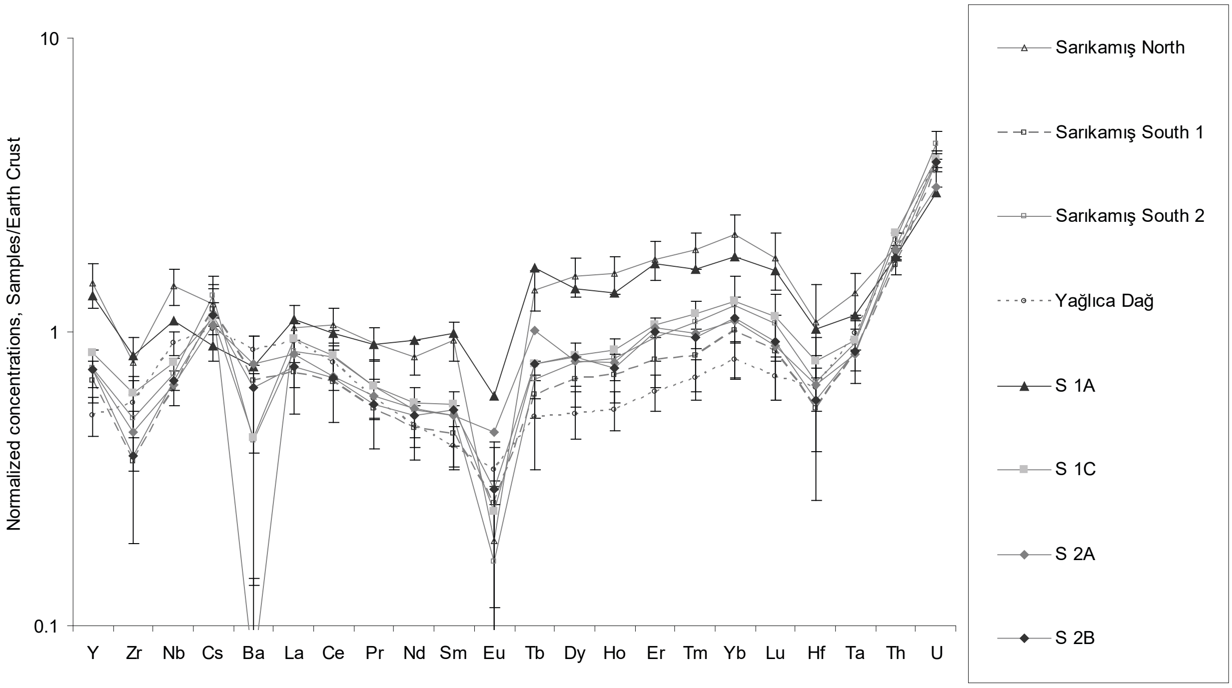


Figure 13. Spectra of Earth's crust-normalized REE (Rare Earth Elements) values (Wedepohl 1995) for the analysed obsidian attributed to the Sarıkamış South area (S 1A, S 1C, S 2A, S 2B), comparison with geological samples from Sarıkamış and Yağlıca Dağ.

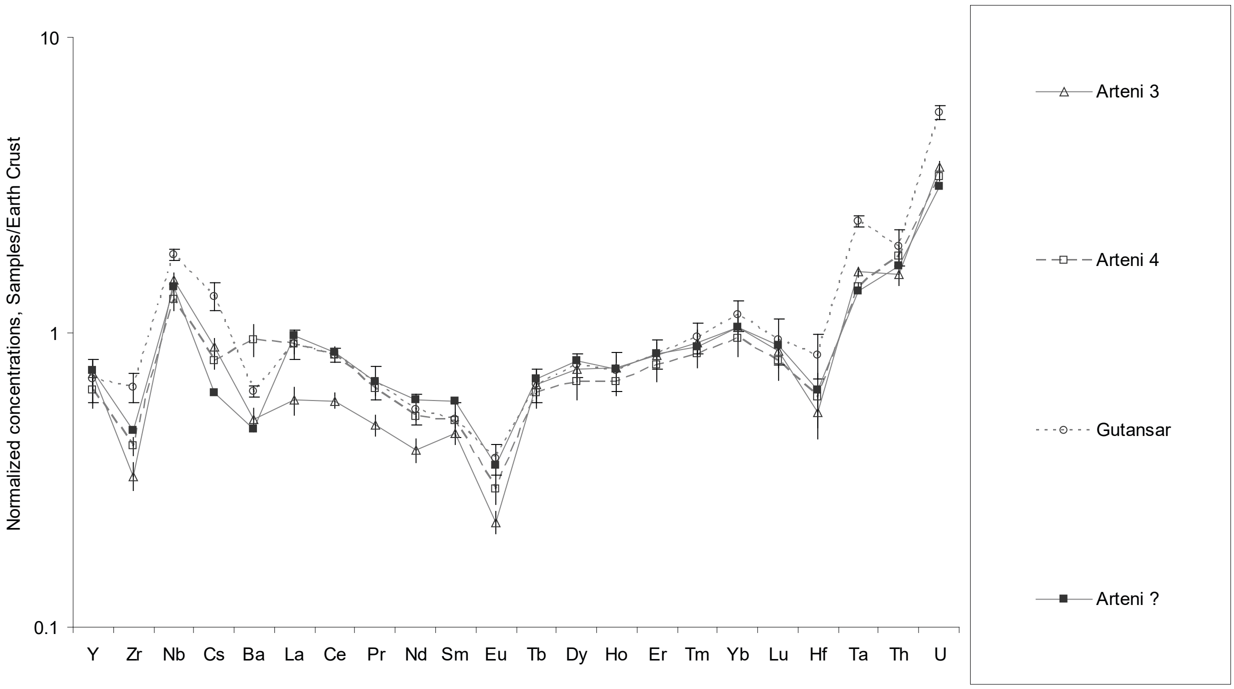


Figure 14. Spectra of Earth's crust-normalized REE (Rare Earth Elements) values (Wedepohl 1995) for the analysed obsidian n°37 attributed to the Arteni area, comparison with geological samples from Arteni 3 & 4 and Gutansar.

Comparison between LA-ICP-MS and XRF analyses.

Depending on the measured element, XRF data are more or less in agreement with LA-ICP-MS results. As shown on Figure 15, the correlation coefficient between XRF counts and LA-ICP-MS concentrations ranges from 0.34 for potassium to 0.98 for strontium. With the exception of rubidium (0.85), for most of the other main differentiating elements, namely Sr, Y, Zr, Nb and Ba, the correlation coefficient is more than - 0.9 or 0.95. In the case of these elements, this fairly good agreement makes possible the calibration of XRF measurements using LA-ICP-MS values. As XRF is more matrix dependant, this calibration gives the possibility to work exactly in the same analytical conditions. However, in the case of barium, the poor value of the XRF detection limit prevents the determination of barium below 100 ppm level. Despite these results, it is not possible to distinguish all obsidian sources and sub-sources, since (as shown in Figure 16) several sources and sub-sources overlap (e.g. Hatis/Tsaghkunyats, Pasinler/Sarıkamış North, and respectively some of the sub-groups of Arteni, Sarıkamış North and South). Nevertheless, this method remains essential in the case of large artefacts that do not fit inside the ablation cell, or for measurements in the field. In that respect it can be used to preselect the artefacts that have to be analysed using LA-ICP-MS, and to characterize a larger corpus of artefacts in order to define a more realistic obsidian procurement policy based on a statistical approach.

Discussion

Diachronic analysis (Figure 17) shows a great similarity in obsidian procurement for horizons VII (*ca.* 5950-5850 cal BC in median values), V and IV (*ca.* 5810-5650 cal BC) and highlights by contrast the singularity of horizon VI (between 5850 and 5810) (see Badalyan and Harutyunyan in this volume; Chataigner *et al. – Bayesian analysis* - in this volume).

Horizon VI corresponds to the phase of flooding and marshy sediment deposition on the village's territory, following a rise in the waters of the paleo-lake (Badalyan and Harutyunyan in this volume; Karakhanyan *et al.* in this volume). The 13 obsidian samples from this level are pebbles with a river rolled cortex, and their small size testifies to a long journey from the outcrop from which they originate. The presence of these pebbles in horizon VI is in all likelihood natural in origin. The Kasakh river, which flows at the foot of the Tsaghkunyats range, transported many blocks of obsidian coming from the outcrops until reaching the Sevjur river, in the valley where Aknashen lies. The Sarıkamış obsidian pebbles may have been transported by the Araxes river, which collects on the one hand streams crossing the South Sarıkamış deposits, and on the other hand the Akhuryan, which carries obsidian pebbles from its confluence with the Kars river, where there is an important secondary deposit originating from North Sarıkamış (Chataigner and Gratuze 2014b).

In the occupation levels preceding the flood (Horizon VII) or post-dating it (Horizons V-IV), the analysed obsidian samples are artefacts, flakes and blade or bladelets fragments. The provenance analysis shows that there was no significant change in procurement between these different horizons. One can however note the absence of material originating from Tsaghkunyats in the upper horizons (V-IV), which are moreover the only ones to have yielded obsidian from Meydan (or Gürgürbaba) (Mouralis *et al.* 2018) and from Pasinler. One should also emphasize that the sources of the Kars-Sarıkamış region are attested during the entire sequence, in comparable quantities, regardless of the horizon.

The techno-typological study of the Aknashen obsidian assemblage shows that different knapping techniques were used: indirect percussion, pressure with a crutch and pressure with a lever (see Chabot *et al.* in this volume). At Aknashen, as at other sites of the Aratashen-Shulaveri-Shomutepe culture (Aratashen, Mentesh Tepe), the provenance analyses show that there is no obvious link between the origin of the material and the debitage technique used or the type of tool made (Chataigner and Gratuze 2014b; Astruc *et al.* forthcoming).

It is true that the recorded pattern of obsidian procurement at Aknashen might change when the number of analyses increases. However, the basic structure of this procurement in the context of contemporary sites of the Ararat valley seems quite clear. All Neolithic sites in the Ararat valley testify to a multi-source procurement model, because they simultaneously use obsidian originating from 6 to 9 sources (Badalyan 2010). The high number of sources and their obvious hierarchical distribution – main, secondary, and occasional – evidently reflect the various different reasons for their acquisition, as well as showing different mechanisms.

As regards the sites of Aknashen and Aratashen, the main source of obsidian, which provided 49% to 62% of the used material, is the Arteni volcanic complex, located at distances between 52 and 47km towards the north-west on quite even ground, i.e. approximately 11h or 1.5 days' walk, according to GIS 'least cost path' modelling (Chataigner and Gratuze 2014b). Previous analyses on obsidian artefacts from Aknashen corroborate this absolute predominance of Arteni, which appears to have been the focus of deliberate exploitation in a direct and systematic way by Aknashen's population.

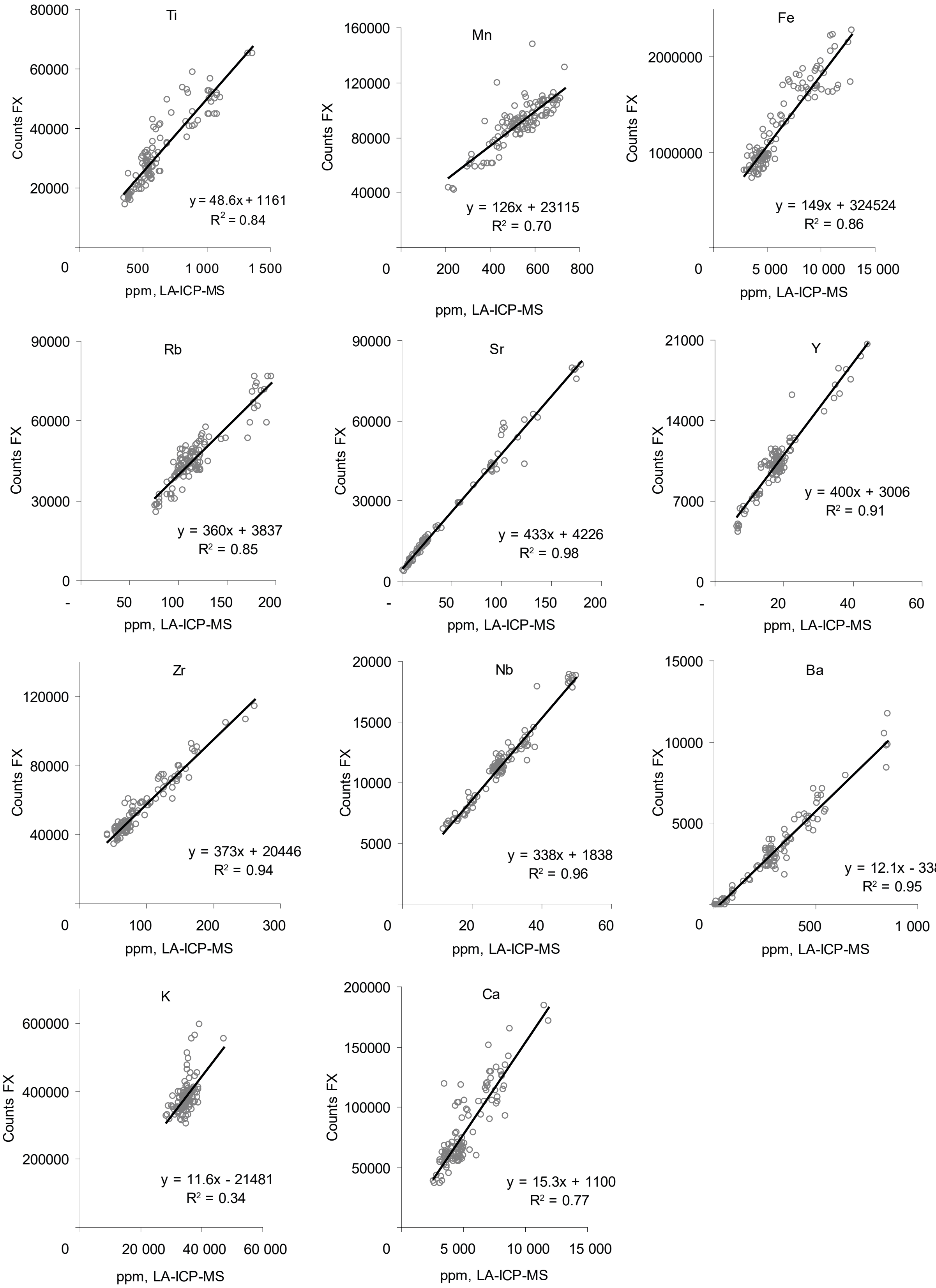


Figure 15. Correlation diagrams between LA-ICP-MS concentration in ppm and XRF counts for Ti, Mn, Fe, Rb, Sr, Y, Zr, Nb, Ba, K and Ca.

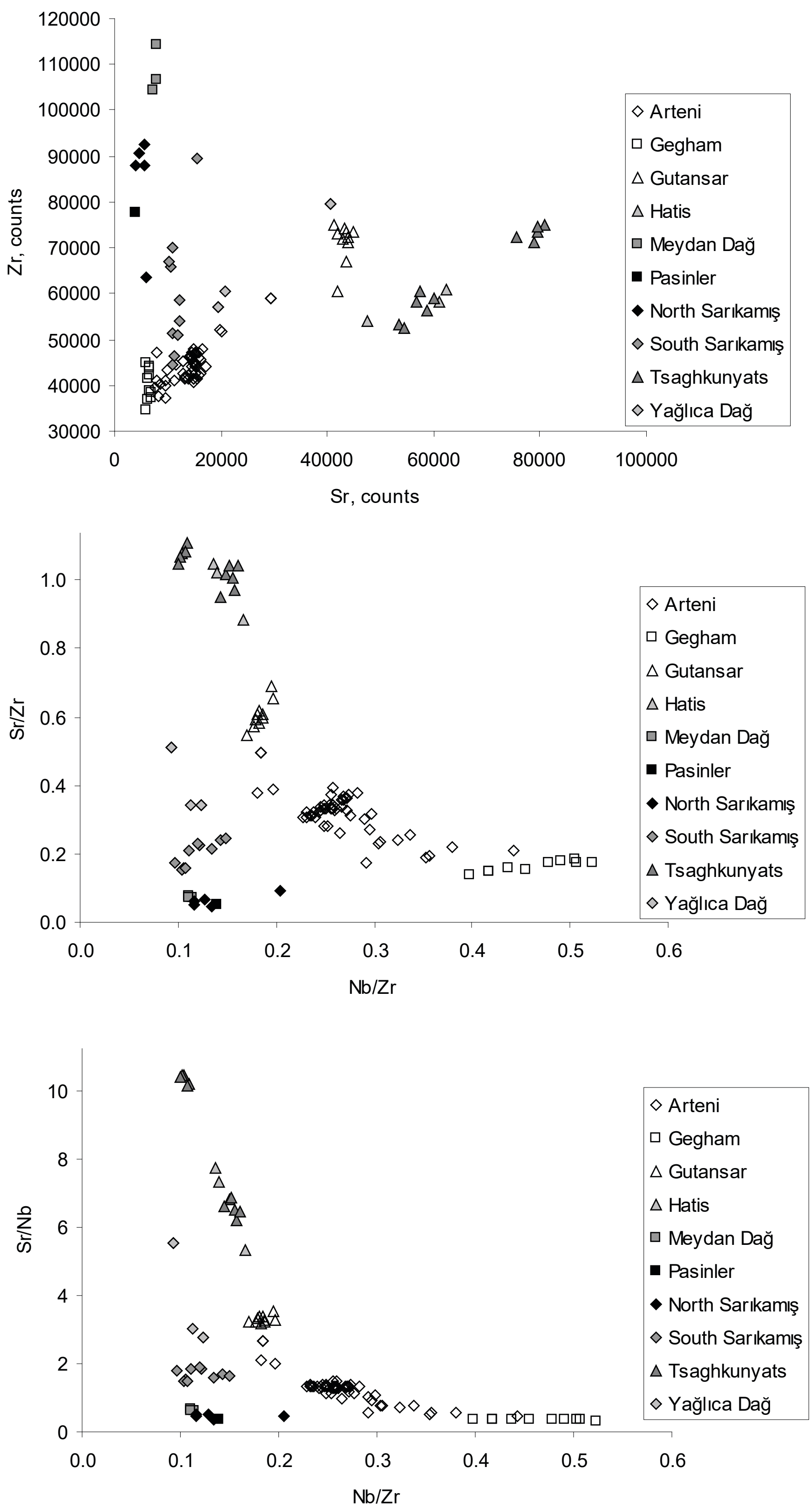


Figure 16. Binary diagrams for counts or ratios of counts for Sr-Zr, Nb/Zr-Sr/Zr, and Nb/Zr, Sr/Nb according to XRF measurements. Obsidian groups are issued from La-ICP-MS data.

Hor.	N	Arteni	Gutansar	Hatis	Gegham	Tsaghkunyats	Meydan	Sarıkamış	Yağlıca	Pasinler
IV	40	Art.1 (2) Art.2 (2) Art.3 (17) Art.4 (1) Art.? (1)	3	Zerborian (2)	4	0	2	N 1 (1) N 2 (1) N 3A (1) S 1A (1	South (1)	1
V	26	Art.2 (2) Art.3 (12)	4	0	2	0	1	N 3B (1) S 1C (2) S 2A (1)	Summit (1)	
VI	13					Damlik (5) Kamakar (5)		N 3A (1) S 2A (1) S 2B (1)		
VII	30	Art.2 (3) Art.3 (13)	3	Kaputan-Akunk (1)	4	Damlik (1)		S 1C (1) S 2A (1) S 2B (2)	South (1)	
Total	109	53	10	3	10	11	3	15	3	1
%	100	48.6	9.2	2.8	9.2	10.1	2.8	13.8	2.8	0.9

Figure 17. Obsidian procurement at Aknashen, by horizons.

The outcrops of Gutansar, and those of the Sarıkamış region, which provided 9 to 14% of Aknashen's supply, are of secondary importance. The Tsaghkunyats deposits, appearing essentially as pebbles found in horizon VI (10 samples out of 11), cannot be considered as a supplementary source.

In the framework of the presence of a main source nearby potentially covering all needs in raw materials, the existence of secondary sources in important numbers suggests different motivations for more or less regular visits to these areas rich in obsidian.

The Gutansar complex is geographically closer to Aknashen than Arteni, because it is located 8.5 walking hours away, i.e. a little more than a day's walk. Yet the various outcrops of this complex were less exploited than those of Arteni. Non-environmental considerations (territorial limits...) are perhaps the reason for this choice: on all Neolithic sites located in the Ararat valley's northern part (Aknashen, Aratashen, Tasghkunk), Gutansar is a source of obsidian of secondary importance (Badalyan 2010), while at Masis Blur, which is located in the south-eastern part of the Ararat valley, Gutansar (29%) is the main source, followed by Arteni (28%) (Martirosyan-Olshansky 2018a: 25).

As regards the source of Geghasar, located at an elevation of 3000m and approximately 18.5 hours away on foot (i.e. 2.5 days), the motivation was perhaps mainly associated with the practice of transhumance (Barge and Chataigner 2003). From the viewpoint of geographical and climatic conditions for the population of the Ararat valley, where climate is semi-desert and summer very dry, the conditions of the Gegham range pastures must have been optimal. If this is the case, then it is quite obvious that the collection of raw materials on the Geghasar outcrops was done concomitantly with the pasturing of flocks on summer grazing land, and is therefore a sub-product of this type of economic activity.

At all Neolithic sites of the Ararat valley, a more or less substantial quantity of obsidian originates from sources in the Kars-Sarıkamış region. These sources are also attested in contemporary settlements of the Kura basin, where they even make up the majority of the supply (52 to 54%), both at Mentesh (Astruc *et al.* forthcoming) and in the lower levels (14-8) of Göytepe (Nishiaki *et al.* 2019a). The cultural context and economic motivations behind this stable supply of Sarıkamış obsidian, in such an extensive geographical area, remain enigmatic; this is mainly because of the lack of data on the Kars region Neolithic. Yet in both the case of the Ararat valley and that of the Kura basin, the time-distances towards the Sarıkamış North and South deposits are clearly higher than for other obsidian sources, and the hypothesis of a transhumance towards this region seems implausible.

One is left, therefore, with the hypothesis of exchange with populations moving about the Sarıkamış region during the summer, either pastoralists who were leading their flocks in a transhumance from the Upper Euphrates and Upper Tigris valleys (as is the case today, according to ethnographic studies) (Thevenin 2014), or hunting groups. No site of the first half of the Holocene has yet been discovered in this region, but the Sarıkamış obsidian outcrops were known to hunter-gathering populations of the late Pleistocene (Bondi Cave, in Georgia) (Le Bourdonnec *et al.* 2012) and the early Holocene (Kmlo-2, in Armenia) (Chataigner and Gratuze 2014b). As a consequence, a plausible hypothesis is that the obsidian of the Kars-Sarıkamış deposits may have arrived in the Ararat valley settlements through exchange, the place of contact between populations being the source of mineral salt at Tuzluca to the West of Aratashen, near the confluence of the Akhuryan and Araxes rivers (Chataigner and Gratuze 2014b).

Obsidian from several sources appears only in rare instances (Hatis, Yağlıca Dağ, Pasinler, Meydan Dağ – 1 to 3%); the motivation for the presence of these various examples of obsidian is clearly not economic, and is not related to the needs in additional raw materials of Aknashen's inhabitants. It seems that the presence of these pieces in the assemblage from Aknashen is either due to occasional arrival, itself resulting from a mix with materials from neighbouring sources (Hatis volcano rises close to Gutansar and Yağlıca Dağ is located in the vicinity of the Sarıkamış South sources), or as the consequence of exchange.

The diffusion of obsidian pieces from sources in the Lake Van basin (Meydan Dağ, Nemrut Dağ), in settlements of the Ararat valley and the Araxes river valley (Meydan Dağ obsidian at Aratashen, Aknashen, Kültepe I of Nakhichevan; Nemrut at Sardarapat)[1] probably occurred concomitantly with the arrival of Halaf ceramics (Aknashen, Aratashen, Kültepe I of Nakhichevan) (Badalyan 2002, 2010). This vector of diffusion also coincides with the direction from which malachite may have come from, namely the Ergani Maden deposits (Badalyan *et al.* – Miscellaneous objects – in this volume).

It is significant that obsidian originating from the Lake Van basin has not appeared on contemporary sites of the Kura basin (even in the largest series of obsidian analysed – at Göytepe, with 900 samples – there is not a single piece of Lake Van obsidian) (Nishiaki *et al.* 2019). A single sample from a source close to Doğubayazit (Tendürek?) was identified by J. Blackman's analyses at Khramis Didi Gora. Thus there is a direct correlation between the absence or scarcity of imported Samarra / Halaf pottery in Kura basin settlements and the absence of obsidian from Lake Van (Badalyan *et al.* - Conclusion - in this volume).

Finally, it is noteworthy that none of the Ararat valley sites revealed obsidian from the Javakheti or Syunik sources. The Javakheti source (Chikiani) was largely used in the Kura river basin (Badalyan 2010); those of Syunik (above all Sevkar) were discovered in the Kura basin, at Göytepe (Nishiaki *et al.* 2019a) and Mentesh, in samples that were not divided into those from the Neolithic, the Chalcolithic and the Bronze Age, as well as on the later site of Kamiltepe (Lyonnet *et al.* 2012: 172).

[1] This sample was identified by means of X-Fluorescence analysis carried out by J. Keller.

Conclusion

More than 60,000 obsidian artefacts were found at the Neolithic site of Aknashen (Badalyan *et al.* in this volume). Chemical analyses allowing a determination of the provenance of this material can deal only with a small part of the set of artefacts, and therefore provide only a partial vision of reality. To compensate for this inconvenience, several analyses of provenance were carried out by using different methods, and by taking samples from the site's various horizons, in order to clarify possible evolution through time. The results of the first two analyses through INAA (10 non-stratified artefacts and 40 artefacts from horizons V-III) were summarised in Badalyan *et al.* (2010): Arteni (48%) predominates over Gutansar (32%) and five other sources (Hatis, Geghasar, Sarıkamış, and two undetermined sources). The analysis presented here was carried out through LA-ICP-MS and XRF on 109 artefacts originating from horizons VII to IV.

The obsidian sources identified in horizon VII have also been found in horizons V and IV , which follow the hiatus provoked by flooding (horizon VI); the same population therefore came back to settle on the site, a fact confirmed by other elements of Aknashen's material culture (architecture in particular). In horizon VI, the pieces of obsidian analysed are pebbles of small size: they were clearly brought to the site by river flow, the Kasakh in the case of the Tsaghkunyats obsidian and the Araxes in that of Sarıkamış.

In horizons VII, V, and IV, the supply of obsidian to Aknashen was multi-source (9 sources identified), with a marked predominance (49%) from Arteni, which is 1.5 days away on foot, and could be directly exploited by the site's inhabitants. Obsidian from the deposits of Gutansar, Geghasar and Sarıkamış played a secondary part (14% to 9%), but the manners of acquisition of raw materials for each of these three sources were in all likelihood different. Gutansar's obsidian, located only one day's walk away, could be easily and directly acquired; its restricted importance in Aknashen's supply might have been related to non-environmental constraints (territories belonging to different populations?). The Geghasar source, located at an elevation of approximately 3000 metres, was only exploitable during the summer, and pastoralists leading their flocks to higher grazing land located along outcrops could have carried down some of this raw material. The deposits of Sarıkamış North and South are very far from Aknashen, so the hypothesis of exchange with groups of hunters or pastoralists moving about the high plateaus of the Kars is favoured. Finally, the sources of Meydan (Gürgürbaba), Pasinler and Yağlıca, which only exceptionally appear in the studies on the obsidian retrieved, are probably also the result of occasional exchange.

Appendix

Compositional data obtained by LA-ICP-MS for the 109 obsidian arfefacts from Aknashen analysed using LA-ICP-MS. Data are expressed in wt. % of oxides for the main major and minor elements (Na_2O to Fe_2O_3) and in parts per million for trace elements (Li to U), 1ppm = 0.0001 %.

		Na_2O	MgO	Al_2O_3	SiO_2	K_2O	CaO	TiO_2	MnO	Fe_2O_3	Li	B	Ti	Mn	Fe	Zn
Arteni 1	Av.	4.02%	0.041%	13.4%	77.2%	4.08%	0.47%	0.059%	0.094%	0.50%	63.2	50.0	354	726	3522	40.8
2/2	Std.	0.07%	0.001%	0.2%	0.1%	0.03%	0.01%	0.001%	0.002%	0.01%	1.1	11.4	8	16	42	0.4
Arteni 2	Av.	3.73%	0.046%	13.3%	76.9%	4.59%	0.59%	0.072%	0.080%	0.53%	47.4	41.4	433	616	3714	36.9
7/8	Std.	0.35%	0.002%	0.7%	0.8%	0.65%	0.09%	0.004%	0.008%	0.11%	20.6	2.4	21	59	749	2.8
Arteni 3	Av.	3.70%	0.058%	13.4%	77.1%	4.27%	0.60%	0.090%	0.069%	0.65%	41.3	35.5	541	535	4528	35.1
42/42	Std.	0.14%	0.004%	0.5%	0.6%	0.16%	0.07%	0.004%	0.006%	0.08%	5.2	2.1	24	43	562	3.1
Arteni 4	Av.	3.50%	0.086%	12.9%	77.7%	4.06%	0.69%	0.11%	0.060%	0.75%	41.3	31.2	677	468	5264	34.0
1/2	Std.	0.09%	0.0002%	0.3%	0.2%	0.17%	0.02%	0.002%	0.009%	0.12%	4.3	0.2	14	71	815	0.7
Arteni ?	Av.	3.83%	0.22%	13.7%	75.7%	4.01%	0.97%	0.17%	0.079%	1.24%	42.4	26.1	1024	608	8643	43.8
1/4	Std.	0.09%	0.01%	0.3%	0.5%	0.11%	0.09%	0.005%	0.006%	0.28%	5.0	0.4	28	48	1993	3.4
Gegham	Av.	4.07%	0.041%	13.6%	76.6%	4.23%	0.67%	0.065%	0.084%	0.55%	66.5	43.2	392	650	3868	31.1
10/10	Std.	0.12%	0.002%	0.5%	0.6%	0.15%	0.07%	0.001%	0.004%	0.05%	5.4	1.8	6	33	316	1.9
Gutansar	Av.	4.02%	0.20%	14.4%	74.7%	3.77%	1.06%	0.18%	0.080%	1.43%	55.3	26.2	1052	623	9967	44.1
10/10	Std.	0.12%	0.02%	0.6%	0.7%	0.14%	0.08%	0.006%	0.007%	0.22%	4.1	1.1	35	53	1530	2.7
Hatis Zerborian	Av.	3.92%	0.36%	15.4%	73.2%	3.45%	1.64%	0.18%	0.067%	1.67%	39.6	22.7	1051	522	11706	41.0
2/2	Std.	0.002%	0.03%	0.1%	0.1%	0.04%	0.04%	0.004%	0.003%	0.17%	0.3	1.1	24	22	1213	1.0
Hatis Akunk/Kaputan	Av.	3.94%	0.22%	14.2%	75.2%	3.91%	1.21%	0.12%	0.056%	1.02%	39.7	25.1	728	438	7133	35.6
1/1																
Meydan Dağ	Av.	4.51%	0.041%	13.5%	75.6%	3.94%	0.48%	0.080%	0.068%	1.59%	78.3	35.8	482	527	11094	75.1
3/3	Std.	0.13%	0.001%	0.5%	0.6%	0.07%	0.08%	0.001%	0.006%	0.03%	5.5	0.8	8	44	219	3.1
Pasinler	Av.	4.07%	0.051%	12.7%	76.8%	4.42%	0.44%	0.11%	0.050%	1.28%	50.8	25.5	630	386	8954	42.5
1/3	Std.	0.24%	0.001%	0.2%	0.3%	0.24%	0.07%	0.001%	0.005%	0.16%	4.1	1.4	7	42	1139	3.8
N 1	Av.	4.30%	0.028%	13.4%	76.4%	3.98%	0.44%	0.078%	0.082%	1.20%	47.6	25.6	470	638	8361	67.0
1/1																
N 2	Av.	4.39%	0.039%	13.4%	76.0%	4.13%	0.44%	0.091%	0.090%	1.35%	48.7	24.3	546	699	9444	75.4
1/1																
N 3A	Av.	4.42%	0.045%	13.4%	75.8%	4.45%	0.44%	0.10%	0.081%	1.13%	95.8	24.1	606	627	7922	67.8
2/2	Std.	0.24%	0.005%	0.1%	0.2%	0.30%	0.00%	0.002%	0.013%	0.18%	66.4	0.4	11	97	1269	6.2
N 3B	Av.	3.99%	0.039%	13.8%	76.9%	3.86%	0.37%	0.087%	0.089%	0.76%	56.7	27.4	524	687	5322	50.8
1/1																
S 1A	Av.	4.42%	0.089%	14.8%	73.9%	4.20%	0.73%	0.11%	0.082%	1.55%	34.4	20.1	676	634	10838	68.8
1/2	Std.	0.12%	0.013%	0.6%	0.7%	0.43%	0.03%	0.003%	0.013%	0.40%	9.7	0.6	17	102	2826	7.8
S 1C	Av.	3.75%	0.096%	12.8%	76.6%	4.57%	0.53%	0.15%	0.030%	1.39%	42.3	31.8	912	230	9729	32.3
3/3	Std.	0.18%	0.008%	0.2%	0.2%	0.15%	0.04%	0.004%	0.002%	0.18%	7.3	0.6	23	13	1281	3.1
S 2A	Av.	3.85%	0.063%	13.0%	77.0%	4.30%	0.57%	0.098%	0.042%	0.90%	34.7	20.7	585	326	6326	30.5
3/3	Std.	0.08%	0.001%	0.3%	0.5%	0.12%	0.10%	0.002%	0.004%	0.09%	1.4	0.8	12	34	640	0.3

		Na_2O	MgO	Al_2O_3	SiO_2	K_2O	CaO	TiO_2	MnO	Fe_2O_3	Li	B	Ti	Mn	Fe	Zn
S 2B	Av.	3.74%	0.051%	12.8%	77.5%	4.31%	0.54%	0.084%	0.041%	0.75%	35.8	22.3	502	318	5250	28.4
3/3	Std.	0.13%	0.001%	0.4%	0.7%	0.09%	0.04%	0.002%	0.002%	0.08%	1.6	0.3	11	15	568	1.0
Ttvakar	Av.	4.04%	0.11%	12.8%	76.8%	4.12%	0.90%	0.11%	0.060%	0.89%	41.1	22.3	632	468	6245	31.1
1/1																
Damlik	Av.	3.86%	0.10%	13.6%	75.9%	4.30%	1.00%	0.10%	0.056%	0.89%	42.3	20.2	609	433	6213	34.9
5/5	Std.	0.16%	0.02%	0.5%	0.5%	0.17%	0.05%	0.005%	0.003%	0.14%	12.1	0.6	28	22	999	2.8
Kamakar/Aikasar	Av.	4.18%	0.17%	14.3%	74.3%	4.23%	1.17%	0.14%	0.055%	1.24%	33.1	19.3	850	423	8707	36.8
5/5	Std.	0.08%	0.02%	0.1%	0.2%	0.18%	0.04%	0.005%	0.003%	0.12%	2.3	0.4	29	26	829	3.5
Yaglica South	Av.	3.86%	0.14%	12.9%	77.0%	4.03%	0.73%	0.14%	0.045%	1.08%	28.2	38.3	852	345	7527	31.8
2/4	Std.	0.19%	0.01%	0.5%	0.7%	0.16%	0.08%	0.01%	0.005%	0.17%	8.8	0.8	31	41	1181	3.3
Yağlıca Summit	Av.	4.42%	0.24%	14.3%	74.6%	3.61%	1.00%	0.22%	0.068%	1.40%	37.4	28.9	1344	525	9759	43.6
1/2	Std.	0.09%	0.005%	0.4%	0.05%	0.22%	0.01%	0.004%	0.0002%	0.05%	6.1	1.2	25	2	350	0.4

		Rb	Sr	Y	Zr	Nb	Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb
Arteni 1	Av.	124	8.21	22.2	41.8	37.7	3.29	31.0	9.43	21.5	2.14	8.08	2.50	0.18	2.19	0.55
2/2	Std.	5	1.26	0.2	0.2	1.3	0.08	9.5	0.20	0.1	0.05	0.10	0.001	0.02	0.04	0.01
Arteni 2	Av.	122	11.1	20.6	57.4	33.3	3.21	78.9	12.6	26.4	2.53	9.30	2.60	0.23	2.37	0.55
7/8	Std.	7	1.7	1.7	2.9	2.6	0.26	17.3	1.3	3.0	0.21	0.66	0.13	0.04	0.44	0.08
Arteni 3	Av.	105	23.2	17.5	68.3	28.0	2.60	268	17.7	35.2	3.08	10.9	2.50	0.35	2.60	0.50
42/42	Std.	5	3.1	1.5	5.8	1.1	0.14	47	2.2	5.5	0.31	1.0	0.25	0.12	0.41	0.08
Arteni 4	Av.	91.9	39.7	15.9	87.5	23.9	2.17	490	28.8	49.3	4.15	14.4	2.58	0.56	3.01	0.50
1/2	Std.	4.5	0.7	0.1	1.1	0.4	0.01	5	0.9	3.7	0.04	0.1	0.10	0.25	0.44	0.04
Arteni ?	Av.	92.3	57.5	18.8	100	27.6	2.10	281	30.7	53.4	4.77	16.8	3.20	0.52	3.17	0.57
1/4	Std.	2.4	0.9	1.3	7	0.9	0.02	7	1.9	3.5	0.33	1.1	0.21	0.12	0.57	0.12
Gegham	Av.	184	7.26	17.7	54.9	48.5	6.40	8.98	14.2	27.5	2.75	10.0	2.51	0.17	2.41	0.52
10/10	Std.	6	0.39	0.7	2.2	0.7	0.29	0.68	0.9	2.5	0.30	0.6	0.26	0.01	0.31	0.06
Gutansar	Av.	120	95.5	17.4	146	35.7	4.01	351	28.6	49.6	4.29	15.0	2.69	0.55	3.16	0.51
10/10	Std.	4	10.6	0.9	7	1.1	0.14	9	1.8	5.3	0.30	0.8	0.14	0.14	0.63	0.08
Hatis Zerborian	Av.	80.2	135	12.3	104	20.5	2.92	467	27.2	42.4	3.93	13.9	2.46	0.67	3.28	0.45
2/2	Std.	0.2	3	0.002	3	0.2	0.02	4	0.6	0.4	0.13	0.5	0.07	0.02	0.10	0.02
Hatis Akunk/ Kaputan	Av.	95.9	96.2	12.3	87.7	21.1	3.54	457	27.2	45.5	3.80	13.4	2.48	0.93	2.80	0.52
1/1																
Meydan Dağ	Av.	181	11.1	40.9	243	31.6	7.65	42.6	27.2	62.8	6.40	26.4	6.12	0.30	5.56	1.22
3/3	Std.	9	0.4	4.5	22	1.1	0.27	1.8	2.0	5.9	0.54	2.1	0.60	0.03	0.72	0.26
Pasinler	Av.	158	2.25	23.7	163	25.4	4.73	19.2	45.3	77.7	6.64	22.8	4.01	0.093	4.53	0.72
1/3	Std.	12	0.02	2.3	16	0.6	0.35	1.1	6.4	10.3	0.85	2.4	0.40	0.034	0.63	0.16
N 1	Av.	122	1.64	38.0	172	27.9	3.63	27.4	30.2	56.5	5.68	22.4	5.37	0.24	5.04	1.15
1/1																
N 2	Av.	118	4.15	34.9	176	27.3	3.53	52.4	33.1	62.6	6.15	23.8	5.14	0.26	6.18	1.08
1/1																

		Rb	Sr	Y	Zr	Nb	Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb
N 3A	Av.	122	6.28	35.4	172	27.7	3.54	90.6	32.3	60.7	5.96	23.3	5.03	0.32	6.14	1.10
2/2	Std.	0.3	0.15	1.2	7	1.1	0.01	0.1	0.1	0.4	0.11	0.5	0.03	0.02	0.43	0.07
N 3B	Av.	144	5.94	39.6	126	33.8	4.39	93.7	24.5	46.2	4.87	19.9	4.97	0.23	4.60	0.97
1/1																
S 1A	Av.	108	27.3	32.1	174	20.6	3.13	456	35.7	65.2	6.47	26.1	5.18	0.95	5.18	1.10
1/2	Std.	5	0.6	0.5	8	0.1	0.14	14	3.7	8.7	0.59	1.3	0.12	0.23	0.43	0.05
S 1C	Av.	126	17.4	20.3	127	14.9	4.04	266	28.9	51.6	4.54	16.4	3.03	0.28	2.88	0.53
3/3	Std.	4	1.5	1.4	10	0.3	0.20	13	2.7	4.3	0.42	1.8	0.29	0.07	0.17	0.08
S 2A	Av.	117	17.2	16.8	89.7	12.4	3.52	446	25.5	46.5	4.05	14.9	2.74	0.58	3.38	0.57
3/3	Std.	2	1.2	2.1	9.8	0.4	0.06	24	2.4	3.7	0.35	1.5	0.32	0.28	0.77	0.17
S 2B	Av.	119	15.4	18.1	78.5	13.0	3.86	369	22.3	39.9	3.72	13.8	2.91	0.42	2.79	0.55
3/3	Std.	1	0.5	0.2	4.8	0.2	0.02	16	2.9	6.6	0.44	1.5	0.19	0.04	0.49	0.04
Ttvakar	Av.	81.1	124	6.56	80.9	21.5	2.38	550	34.9	53.8	4.18	12.7	1.85	0.35	2.77	0.24
1/1																
Damlik	Av.	97.7	105	8.28	75.8	19.7	3.04	516	30.2	47.2	3.93	12.9	2.05	0.60	3.16	0.36
5/5	Std.	3.0	7	0.60	5.0	0.5	0.05	21	1.5	3.0	0.20	0.7	0.18	0.20	0.27	0.06
Kamakar/Aikasar	Av.	78.0	175	6.83	122	18.6	2.38	849	44.8	65.0	5.17	16.2	2.02	0.78	4.31	0.36
5/5	Std.	1.6	4	0.19	4	0.3	0.04	7	1.5	1.3	0.11	0.5	0.13	0.15	0.48	0.04
Yaglica South	Av.	108	35.1	12.4	107	15.7	3.29	483	27.1	43.9	3.64	12.2	2.21	0.48	2.55	0.37
2/4	Std.	2	1.7	0.6	7	0.3	0.13	20	2.7	4.6	0.36	0.9	0.19	0.14	0.25	0.06
Yağlıca Summit	Av.	94.9	87.7	12.9	148	17.7	2.55	517	28.5	45.4	3.94	14.1	2.32	0.50	2.68	0.34
1/2	Std.	1.9	5.6	0.1	1	0.02	0.10	12	0.4	1.6	0.06	0.5	0.01	0.03	0.19	0.01

		Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U	Ba/Zr	Ba/Sr	Nb/Zr	Y/Zr
Arteni 1	Av.	3.63	0.74	2.20	0.31	2.40	0.34	2.18	2.11	12.0	6.80	0.74	3.74	0.90	0.53
2/2	Std.	0.12	0.01	0.01	0.001	0.02	0.02	0.01	0.08	0.1	0.13	0.23	0.58	0.03	0.002
Arteni 2	Av.	3.39	0.67	2.18	0.31	2.33	0.32	2.54	2.00	12.7	6.62	1.37	7.07	0.58	0.36
7/8	Std.	0.30	0.05	0.23	0.02	0.13	0.02	0.15	0.17	0.8	0.81	0.29	0.71	0.06	0.04
Arteni 3	Av.	2.86	0.58	1.86	0.26	1.99	0.28	2.63	1.67	13.3	5.59	3.91	11.51	0.41	0.26
42/42	Std.	0.22	0.05	0.19	0.03	0.15	0.03	0.22	0.09	1.2	0.39	0.54	0.78	0.04	0.02
Arteni 4	Av.	2.44	0.50	1.72	0.23	1.87	0.26	2.82	1.42	15.2	5.06	5.60	12.35	0.27	0.18
1/2	Std.	0.14	0.01	0.004	0.01	0.01	0.0003	0.03	0.05	0.3	0.51	0.02	0.33	0.01	0.001
Arteni ?	Av.	3.15	0.62	2.05	0.29	2.19	0.33	3.28	1.54	15.1	5.36	2.82	4.90	0.28	0.19
1/4	Std.	0.21	0.04	0.22	0.03	0.10	0.01	0.21	0.08	0.9	0.34	0.14	0.16	0.02	0.005
Gegham	Av.	2.87	0.57	1.88	0.26	2.03	0.28	2.58	3.79	24.2	13.1	0.16	1.23	0.89	0.32
10/10	Std.	0.11	0.03	0.11	0.02	0.13	0.02	0.14	0.11	1.0	1.2	0.01	0.05	0.03	0.004
Gutansar	Av.	2.83	0.56	1.87	0.26	2.10	0.30	4.16	2.49	16.1	8.11	2.41	3.70	0.25	0.12
10/10	Std.	0.14	0.03	0.15	0.02	0.08	0.02	0.21	0.11	0.9	0.68	0.09	0.34	0.01	0.002
Hatis Zerborian	Av.	2.11	0.41	1.40	0.19	1.41	0.23	3.25	1.61	15.2	6.56	4.50	3.46	0.20	0.12
2/2	Std.	0.002	0.01	0.04	0.001	0.03	0.01	0.05	0.03	0.2	0.05	0.10	0.05	0.01	0.004

		Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U	Ba/Zr	Ba/Sr	Nb/Zr	Y/Zr
Hatis Akunk/Kaputan 1/1	Av.	1.99	0.38	1.43	0.18	1.45	0.19	2.90	1.58	15.9	8.35	5.21	4.75	0.24	0.14
Meydan Dağ	Av.	7.06	1.42	4.54	0.62	4.69	0.68	7.22	2.07	22.1	7.75	0.18	3.84	0.13	0.17
3/3	Std.	0.77	0.14	0.55	0.06	0.37	0.07	0.80	0.09	2.4	0.55	0.01	0.08	0.01	0.004
Pasinler	Av.	3.97	0.79	2.72	0.36	3.03	0.43	4.99	1.58	30.5	10.0	0.12	8.52	0.16	0.14
1/3	Std.	0.29	0.04	0.33	0.03	0.26	0.04	0.46	0.04	3.5	0.6	0.005	0.48	0.02	0.0003
N 1 1/1	Av.	6.49	1.34	4.20	0.60	4.22	0.63	5.84	1.58	17.7	5.47	0.16	16.74	0.16	0.22
N 2 1/1	Av.	6.12	1.20	3.98	0.52	4.29	0.58	5.56	1.52	16.3	5.59	0.30	12.61	0.16	0.20
N 3A	Av.	6.00	1.23	4.04	0.54	4.09	0.58	5.38	1.48	16.4	5.44	0.53	14.4	0.16	0.21
2/2	Std.	0.17	0.06	0.25	0.02	0.06	0.004	0.19	0.03	0.7	0.19	0.02	0.3	0.0001	0.001
N 3B 1/1	Av.	6.83	1.36	4.22	0.60	4.50	0.65	4.96	2.04	19.8	6.86	0.74	15.8	0.27	0.31
S 1A	Av.	5.36	1.06	3.66	0.49	3.66	0.56	5.09	1.19	15.8	5.57	2.62	16.7	0.12	0.18
1/2	Std.	0.00	0.03	0.08	0.003	0.09	0.01	0.10	0.09	0.7	0.71	0.04	0.1	0.01	0.01
S 1C	Av.	3.21	0.69	2.24	0.33	2.69	0.41	3.92	1.03	18.4	7.09	2.10	15.4	0.12	0.16
3/3	Std.	0.27	0.07	0.25	0.05	0.19	0.03	0.40	0.06	1.8	0.53	0.13	1.4	0.01	0.003
S 2A	Av.	2.79	0.57	1.95	0.26	2.05	0.29	3.00	0.87	15.3	5.53	5.00	25.9	0.14	0.19
3/3	Std.	0.30	0.07	0.38	0.04	0.20	0.02	0.31	0.06	1.9	0.25	0.29	0.4	0.02	0.01
S 2B	Av.	3.06	0.62	2.12	0.29	2.24	0.33	2.93	0.94	15.2	6.18	4.70	23.9	0.17	0.23
3/3	Std.	0.11	0.02	0.04	0.01	0.09	0.01	0.21	0.02	0.9	0.51	0.22	0.3	0.01	0.01
Ttvakar 1/1	Av.	1.07	0.19	0.70	0.09	0.67	0.10	2.25	1.32	25.9	9.16	6.80	4.45	0.27	0.08
Damlik	Av.	1.40	0.27	0.98	0.11	0.91	0.13	2.42	1.33	20.2	7.22	6.83	4.94	0.26	0.11
5/5	Std.	0.11	0.01	0.09	0.01	0.07	0.01	0.24	0.08	1.1	0.49	0.28	0.28	0.01	0.004
Kamakar/Aikasar	Av.	1.09	0.22	0.91	0.10	0.79	0.13	3.03	1.15	25.3	7.18	6.94	4.85	0.15	0.06
5/5	Std.	0.08	0.01	0.05	0.01	0.04	0.01	0.18	0.04	1.1	0.17	0.24	0.09	0.003	0.001
Yaglica South	Av.	1.99	0.40	1.40	0.19	1.54	0.23	3.05	1.07	17.9	6.72	4.52	13.8	0.15	0.12
2/4	Std.	0.08	0.01	0.10	0.01	0.07	0.01	0.28	0.04	1.3	0.54	0.19	0.6	0.011	0.002
Yağlıca Summit	Av.	2.10	0.46	1.38	0.19	1.67	0.24	3.70	1.05	14.4	5.10	3.48	5.90	0.12	0.09
1/2	Std.	0.01	0.004	0.02	0.003	0.02	0.005	0.03	0.02	0.3	0.03	0.09	0.24	0.001	0.0003

The macrolithic industry from Aknashen

Caroline Hamon and Khachatur Meliksetian

Introduction

Despite their ubiquity, macrolithic tools have been the subject of less attention than other components of the material culture in the study of the development of Neolithic cultures in the Near and Middle East and its 'neighboring' regions. Nonetheless, they provide crucial information for identifying the nature and organization of activities. They characterize the various functions of domestic areas, as well as the craft production (Wright 1992, 2014). In this sense, their techno-functional study is of paramount importance in understanding the emergence and development of the Aratashen-Shulaveri-Shomutepe culture in the southern Caucasus during the 6th millennium BC (Hamon 2008, 2012). Because of its location at the crossroads of the southern Caucasus, eastern Anatolia and northern Iran, the Aknashen assemblage is key to tracking influences and origins of the emergence of a Neolithic economy in the Caucasus.

The study of the 311 macrolithic tools from Aknashen-Khatunarkh was conducted during excavation campaigns between 2004 and 2015 (Figure 1). Our presentation follows the terminology established in previous works (Hamon 2008), in partial correspondence with the reference work of Wright (1992). The high diversity of tool types represented in the Aknashen assemblage is most striking. The most important part of the tools consists of milling (34%) and grinding tools (12%) made of basalts and sandstones. A high number of small abraders (21%), especially in pumice and perlite, are also present, however. More surprising is the near-absence of hammerstones throughout the whole duration of occupation at the site.

In order to conduct a use-wear analysis, thirty-five tools were selected. Twenty-one tools were observed directly. The others were only sampled for PVS peels for later identification of the use-wear traces. Observations at low magnification (up to x60) were carried out using a Nikon SMZ800 stereomicroscope. The analysis was conducted in order to be as representative as possible of the main categories of tools: six grinders in basalt and andesite, five in sandstone, three sharpeners and five hand abraders. It was nevertheless highly limited by the importance of concretions on some of the tools, and by the reduced size of the zones available for use-wear analysis on vesicular basalts and pumice, due to their high degree of porosity. Use-wear comparisons

Tool type	N
quern	13
grinder	86
grinder /grinding slab	1
grinder - pestle	2
undet. grinding tool	4
grinding slab	7
mortar	5
pestle	18
pestle - handstone	1
pestle-hand abrader	1
pestle-sharpener	4
pestle-grinder	1
pestle-crusher	3
crushing tool	6
hammerstone	2
chopping tool	2
intermediate tool	2
hammer	2
macehead	2
flat polisher	1
hand abrader	54
grooved abrader	10
grooved and hand abrader	3
sharpener	12
handstone	11
handstone-hammerstone	1
smoother	6
perforated tool	20
tool on flake	1
spoon	1
receptacle	3
stone vessel	2
undetermined tool	12
flake	1
fragment	7
natural	4
Total	311

Figure 1. Number of tools per techno-functional type.

were established with the experimental referential developed in Dubreuil (2004) for basalt tools and Hamon (2006) for sandstone ones. Unfortunately, no residue analysis was undertaken, as most of the tools were studied several years after their retrieval, and with no possibility to compare possible results to the content of the surrounding sediments.

Raw materials

Several raw materials were selected depending on the types of tools. Determining rock types was made macroscopically on a sample of tools from excavation campaigns 2013-2015.

Most of them are cobbles sampled in alluvial deposits, possibly from the terraces of the river Araxes and its tributaries, like the Kasakh and Hrazdan, suggesting a low supply distance less than 5km for the most important part of selected blanks (Figure 2). The three main groups of volcanic rock found in the macrolithic assemblage could originate from the Araxes valley: cobbles of andesite and vesicular basalts of various qualities were particularly selected for grinding tools, while red and

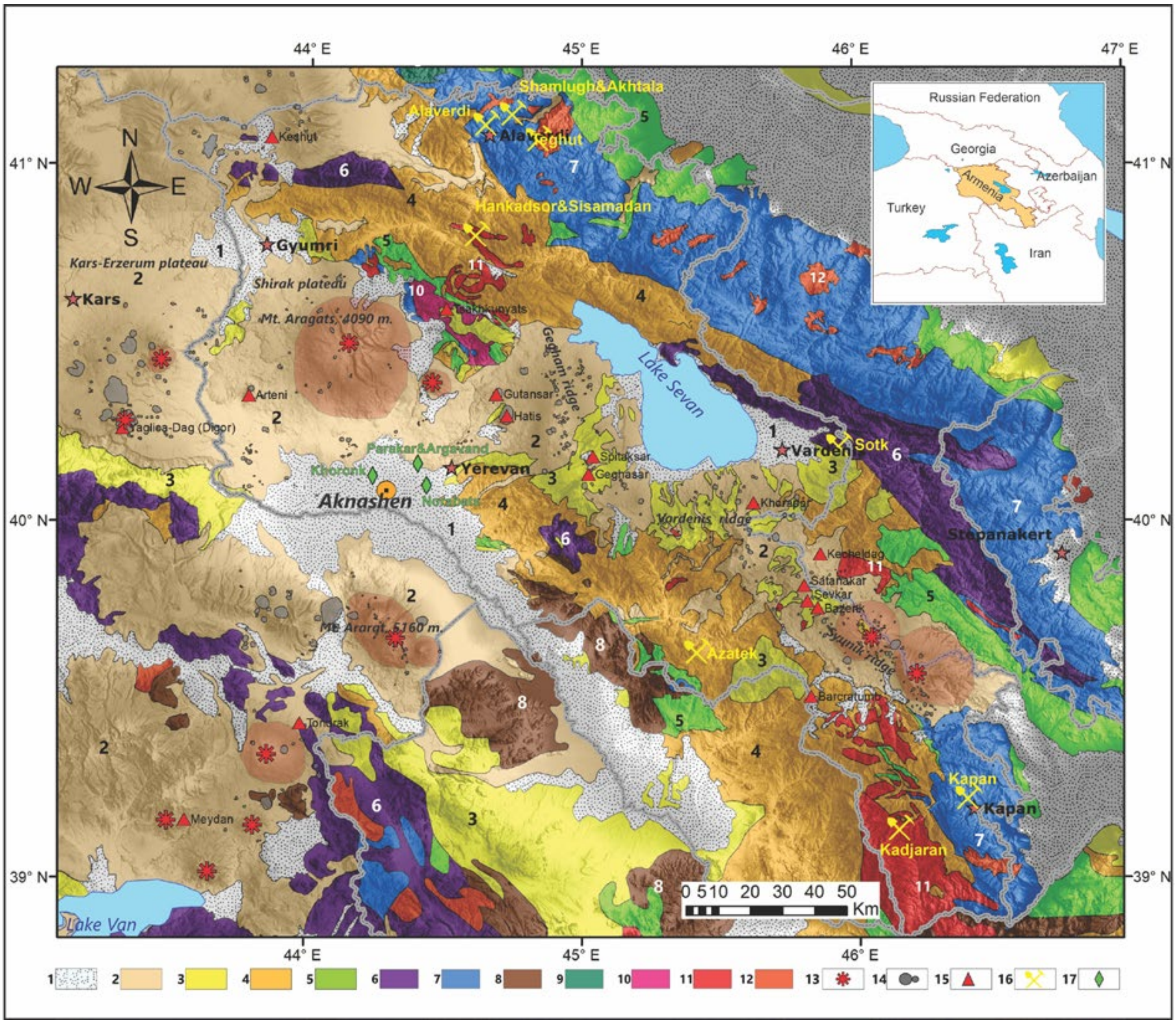


Figure 2. Simplified geological map of Armenia and adjacent areas. Legend: 1. Quaternary sediments; 2. Quaternary volcanic units; 3. Neogene volcanic and sedimentary units; 4. Paleogene volcanic and sedimentary units; 5. Ophiolite complexes Amasia-Sevan-Akera suture zone, maphic and ultramafic rocks, sedimentary suits; 6. Upper Cretaceous volcanic and sedimentary units of Lesser Caucasus Mesozoic island arc, sedimentary and volcanic rocks; 7. Jurassic-Lower Cretaceous units of Lesser Caucasus Mesozoic island arc, sedimentary and volcanic rocks; 8. Paleozoic - Triassic platform sedimentary cover of South Armenian Block, limestones, sandstones, quartzites, marbles; 9. Variscan (Paleozoic) metamorphic basement of Eurasian margin; 10 Proterozoic-Early Paleozoic metamorphic basement of South Armenian Block and cutting Precambrian to Mesozoic intrusive rocks; 11. Cenozoic intrusions; 12. Mesozoic intrusions; 13. Stratovolcanoes; 14. Monogenetic volcanoes; 15. Obsidian sources (Kechut group includes Aghvorik and Sizavet sources; Tsakhkunyats group includes Damlik, Ttvakar, Kamakar); 16. Major copper and polymetallic ore depostis; 17. Clay sources of Ararat depression around Aknashen.

black small fragments of light pumices were chosen as abraders for their high abrasiveness. These materials are all present in the Araxes valley, and even large-size blocks of vesicular basalts were sometimes made into querns. Several cobbles of dolerite or gabbro were used for pestles. A cobble of granite (a sharpener) could come from a yet unidentified source, other than the Araxes valley, but it is noteworthy that abundant granitic and other intrusive rocks are known in the valley of the Marmarik river, a tributary of the Hrazdan, and it may originate from there. One receptacle in white pumice could come from a relatively long-distance supply, for instance the Arteni volcano, which was known as a source of obsidian, perlite and pumice, and which is located ~45-50km NW from Aknashen.

Among sedimentary rocks, different kind of sandstones (from calcareous to quartzitic) were particularly used for grinders, grinding slabs, abraders and handstones. Limestones were meant for percussion tools and perforated tools. A piece of argillite was used as a pestle-abrader, and a fragment of micaceous schist as an abrader. Although all these rocks are absent from the Ararat valley, they are quite abundant and varied among the Miocene and Eocene geological layers of the Garni region, which is located some 50km to the north-east of Aknashen. They may also be found in secondary position in the lowest basin of the Hrazdan river, or even in the foothills of the Gegham ridge.

The sources exploited throughout the occupation of the site appear stable, as no clear changes can be evidenced. Yet two main regions of origin, corresponding to two different territories of raw material supply, can be suggested as a result of the study of the macrolithic tools. The Araxes terraces and the Hrazdan river are the main local sources of materials for making tools from cobbles of vesicular basalts, andesite and dolerite-like rocks. Outcrops or secondary sources of sedimentary rocks were exploited in the Garni region, located approximately 50km to the north-east of Aknashen. The major source of basalts and andesite and scoria (slags) used at Aknashen is the Lower-Middle Pleistocene Shamiram monogenetic volcanic plateau, located ~12km to the north-west. Some basaltic rocks, including vesicular basalts, exploited to make tools at Aknashen, belong to the so-called 'doleritic' or plateau basalts of Upper Pliocene – Lower Pleistocene age, described in detail by Sheth *et al.* (2015) and Neill *et al.* (2015). Large volumes of plateau basalts are known in the Hrazdan river basin and the canyon of the Akhuryan river (a tributary of the Araxes). These types of basalts characterized by sub-ophitic texture are abundant in (both modern and palaeo) alluvial sediments of the Araxes and Hrazdan rivers.

Tool types

Adzes and grooved polishers are discussed in another chapter of the book.

Grinding tools

The diversity of the grinding systems (used in a back and forth movement) at Aknashen illustrates the real diversity of techniques used for food preparation and craft production. The range and types of grinding tools, however, are comparable to the domestic toolkit known at other Neolithic sites in the southern Caucasus, in particular in the Kura valley (Hamon 2008, 2012). One should first of all notice the imbalance between the number of querns (12 examples) and grinders (85 instances) in the entire assemblage. Half of the querns and two thirds of the grinders are complete. Although this may be partly explained by the differing lifetime of these tools, this could also suggest a higher rate of quern reuse for architectural purposes (cooking structures, infilling of some circular structures, etc.).

Querns were mainly made from volcanic rocks: vesicular basalts were chosen for 77% of the querns and andesite for 10%. Only one quern is in coarse sandstone. In most cases, their backs and sides are regularized by coarse pecking. Only five querns show no traces of shaping of their external surface. In both cases, the active surface was prepared by fine pecking, even if in the case of most vesicular basalts, no further pecking was necessary to preserve the ruggedness and porosity essential for a high efficiency grinding. Though querns are generally ovoid in shape, with a concave active surface (except in one case), they can be divided into two types found in equivalent numbers (Badalyan *et al.* 2010) (Figure 3a-d). Saddle querns have a central basin, bordered by a large peripheral rim on their ends and sides. Their blanks are quite wide (17 to 25cm wide), but the length of the complete querns does not exceed 30cm, with a sickness between 5 and 9cm. In the centre of the upper face, the basin shows widespread polishing and linear striations, and in some cases concentrations of percussion impacts. This type would correspond to a combined back-and-forth and ovoid grinding motion. The second type of querns (Hamon 2008's 'saddle-shaped slabs') has concave active surfaces, both longitudinal and transversal, with depth reaching several centimeters (up to 4cm). They are sometimes bordered at one or both ends by a small rim that is generated by intensive use. Their blanks are narrower, with lengths between 36 to 48cm, widths between 18 and 21cm and thickness reaching 11cm. This type was used only for back-and-forth motion.

Another type of grinding tool, distinct from querns, is represented by seven fragments of thin sandstone slabs (Figure 3e-f). Shaped by pecking, these grinding

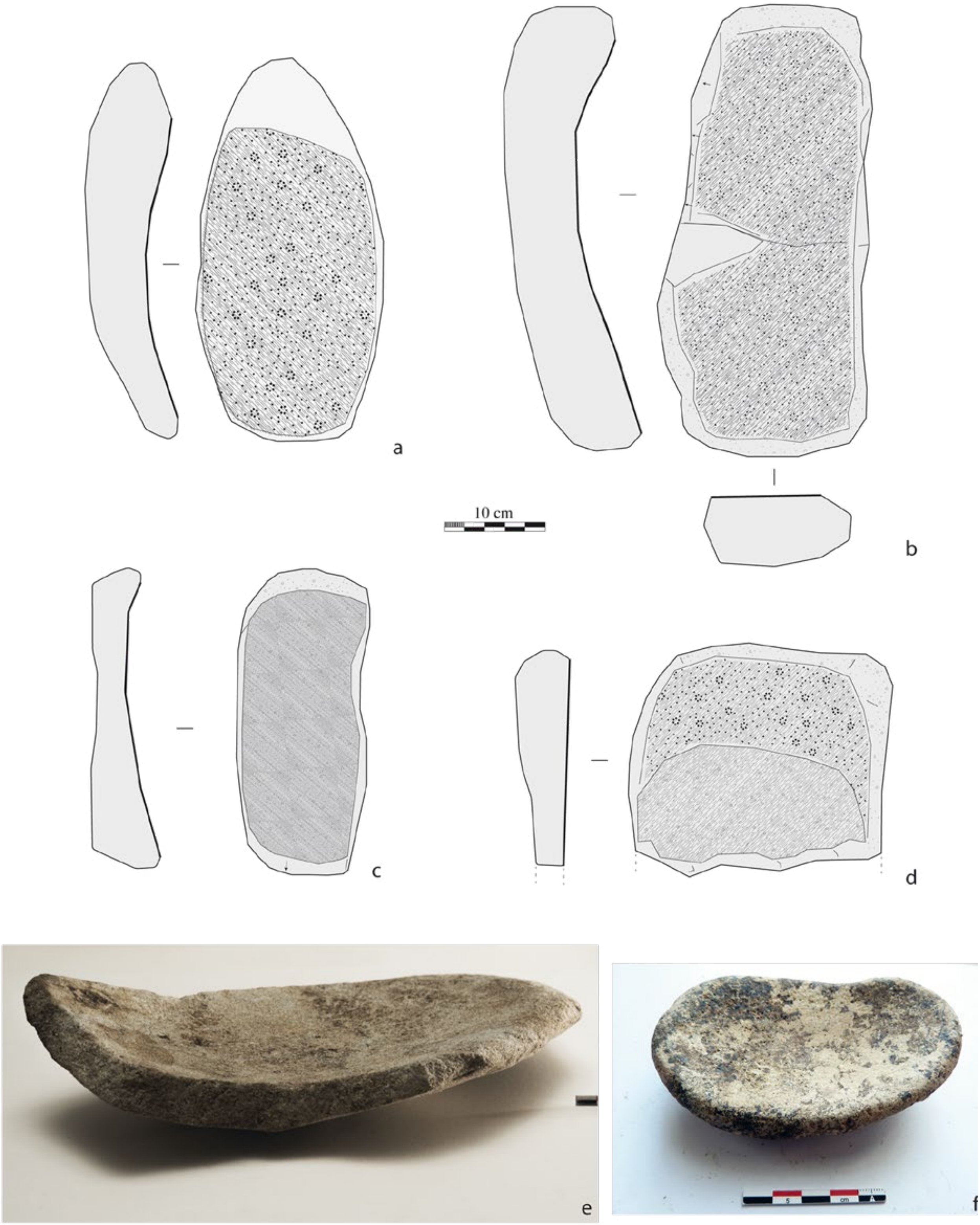


Figure 3. Querns: a) basin quern - Tr.3 UF6b F8; b) concave quern - Sond.A UF11 F7; c) concave quern - Tr.6 UF11 F11; d) ovoid basin quern - F4 str.3; e) grinding slab – Tr.5 UF11a F23; f) grinding slab - Tr.12 UF4 [photos : V. Hakobyan; drawings: C. Hamon].

slabs are approximately 4 to 5cm thick and of small dimensions. They possess concave surfaces of different dimensions used in a multidirectional motion of circular and linear grinding. This generated active surfaces whose morphology is circular to ovoid. These surfaces are bordered by fine flaking, and show uniform polishing. The choice of sandstone, the small dimensions of the slabs and the slight concavity of their active surfaces suggest a fine grinding motion, distinct from daily cereal grinding. One example in lithified tuff shows a regular ovoid shape created by pecking, with a narrow polished peripheral rim (Figure 3f); traces of red pigmentation can be observed on its external side.

A higher variability of types and raw materials can be noticed among the 86 grinders identified. Though cobbles of vesicular basalt (70% of the grinders) and andesite (15%) were used for querns and grinders, 15% of the grinders were made from sandstones. Sandstones are generally less porous and slightly softer than volcanic rocks. The use of different raw materials (one harder and the other softer) for the upper and lower part of the grinding system, is documented by several ethnographic examples (Gast and Adrian 1965; Hayden 1987; Schön and Holter 1988). This could explain why more grinders than querns were used on site, since the use of softer materials for grinders induces a more rapid wear of the tools.

Generally the result of shaping ovoid cobbles, grinders show a fine degree of shaping. A quarter of the grinders, particularly those in vesicular basalts, do not show any traces of shaping (21 ex.), while 26 other examples (31%) were completely shaped by coarse pecking. Fifty-four grinders (67%) are shaped mainly on their sides, either through fine pecking (especially for andesite examples) or coarse hammering (for vesicular rocks). Two sandstone grinders revealed evidence of flaking as part of the shaping sequence. Shaping by flaking was not identified on vesicular basalt and andesite grinders, but it may be hidden by another further pecking sequence. The shaping of grinders shows a gradient from the direct use of natural cobbles to fine pecking all over the external surface, which seems somewhat to be an adaptation to the porosity of the raw material. Fifteen grinders show polishing zones on their back, related to handling. Twenty-seven grinders have two active surfaces, and up to three active surfaces in the case of one grinder. There is no link between the number of active surfaces and the type of raw material, which indicates that there was no particular wish to optimize the use of a specific raw material. Most of the active surfaces show a high intensity of use, as indicated by the average to high degree of polishing. The general dimensions of the grinders vary from 8 to 26cm in length and 7 to 17cm in width, but this very much depends on the type of grinder; their thickness is generally low and included between 1 and 8cm (Figure 4).

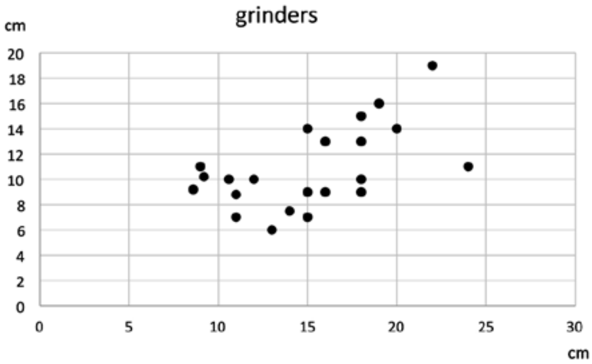


Figure 4. Dimensions of grinders.

At least eight types of grinders were defined, based on the dimensions of the blanks and the morphology of the active surfaces (Figures 5-7):

- Type 1: The most frequent type of grinder shows a plano-convex active surface, on a quite large blank that is semi-circular in section, with its back shaped by coarse pecking (Figure 6a-c);
- Type 2: Quite frequent at the site, it is of reduced dimensions (less than 15cm long), and could be held in one hand (Figure 6d-g). Generally made of vesicular basalt cobbles (and more infrequently andesite and sandstone), these tools have one or two active surfaces. Ovoid in shape and section, their active surfaces are narrow, convex to plano-convex. Their face and peripheral edges are entirely polished, and sometimes show a shiny aspect that covers the fine pecking resulting from the preparation process. This kind of grinder is well known in the Kura Neolithic assemblages. One instance (from the surface) shows residues of ochre processing. Another is associated with the use of its ends as a hammerstone;

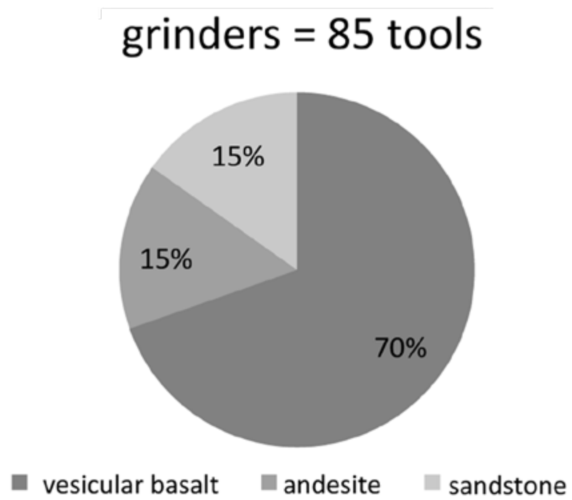


Figure 5. Raw material composition of the assemblage of grinders.

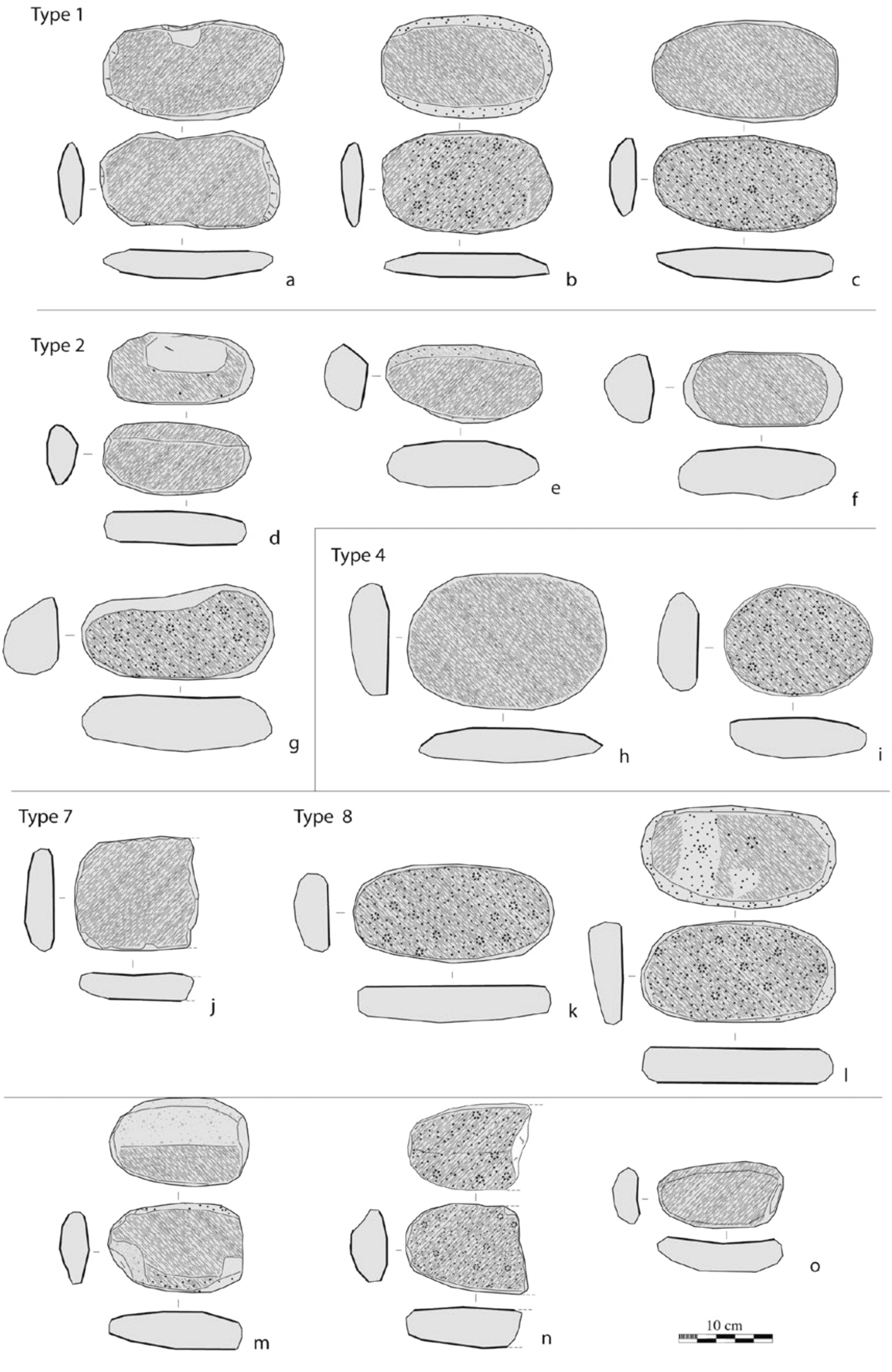


Figure 6. Different types of grinders. *Type 1:* a) Baulk2/5 UF7; b) Tr.8 UF8a F4; c) Tr.8 UF8a; *Type 2:* d) Baulk1/2 UF8 F5; e) Tr.5 UF9c F12 ; f) Tr.1 UF9a F26; g) Tr.5 UF11a; *Type 4:* h) Baulk2/3 UF5 ; i) Tr.4 UF11 ; *Type 7:* j) Sond.A UF1; *Type 8 :* k-l) Tr.8 F8; *other types* : m) Tr.4 UF11a W11; n) Tr.5 UF8a; o) Tr.3 UF7c [drawings : C. Hamon].

- Type 3: This consists of a fragment of overlaping grinder, recognizable at the rim, located at the ends of one of its two active surfaces (Tr.8 UF8a);
- Type 4: These are thick ovoid grinders in vesicular basalt showing convex active surfaces; they correspond to the 'bread-shaped' grinders (Figure 6h-i);
- Type 5: Large and thin grinders made from sandstone, with semi-circular sections shaped by fine pecking and completely unknown in other Caucasian Neolithic contexts. They have a double active surface, used in complex ways (Figure 7d). At least three examples were identified (Baulk2/5 UF7 F1, Tr.4 UF7a F7, Tr.4 UF8a F6). The first active surface is concave, sometimes bordered by a rim, and is evenly polished. The second surface shows two narrow and symmetrical semi-circular bevel-like areas of use, marked by transversal striations and showing well-developed use-wear;
- Type 6: Sandstone grinders, with convex active surface and striations;
- Type 7: Thick quadrangular grinders, made of basalt and various sandstones (Figure 6j);
- Type 8: Thick and large basaltic grinders (Figure 6k-l; Figure 9a).

Although the two first types are numerous, the other ones are represented only by a few examples. The functional analysis of a sample of 11 grinders suggests that the choice of certain raw materials was related to different functions (Figure 7). The basalt grinders were used for more or less intensive processing of cereals: the leveling of the surface goes together with the smoothing of the asperities, while the grains are highly contiguous. On the other hand, sandstone grinders were preferably used to grind minerals into powder: the leveling of the relief is accompanied by an irregular micro-topography, micro-fractures of the grains, which are at times smoothed, and transversal striations on the active surface's periphery. In the case of two samples, residues of red pigmentation are clearly visible, and suggest that these tools were intended in particular for the processing of ochre (Figure 7c). Such a functional specialization of types and raw materials for grinding appears to be quite peculiar in assemblages of the southern Caucasus.

The combination of high investment in shaping and a certain intensity of use of the grinding tools, both the upper and lower parts, indicate they were not 'opportunistic' tools, but were used for domestic tasks in the context of a permanent settlement. Two main grinding systems can be identified from the characteristics of querns and grinders. Saddle querns were probably used with the type 2 grinders, considering the relative dimensions of their active surfaces. Concave querns were apparently associated to different types of grinders of varying weight, with various rates of lengthening, different morphologies of the parts handled and of the active surfaces. As opposed to other Neolithic contexts, the reuse of grinding tools was not very developed in southern Caucasus assemblages. At Aknashen, one can mention only a single grinding tool on a quadrangular slab in vesicular basalt which shows dissymmetric distortion of both its active surfaces, which were used as a grinder and a grinding slab, respectively (Figure 9a).

Pounding tools

Five mortars were made from cobbles of vesicular basalts and pumices (Figure 8), with external surfaces prepared by fine or coarse pecking. Two complete mortars correspond to two sizes, with diameters around 11cm and 20cm. Mortars generally show circular concave depressions, with depths indicating different motions and use. A fragment of a massive mortar in vesicular basalt possesses a depth of 14cm, and was shaped by pecking and superficial polishing (Figure 9c). It should have been a tool working in tandem with a long and massive pestle, of either wood or stone. Other mortars are thinner and shallower (up to 2 to 4cm in depth); they were used with smaller pestles or crushing tools. The distribution of the uniformly polished areas demonstrates that they were used mainly in a circular grinding motion.

Eighteen pestles were made with cobbles of vesicular basalts, andesite, dolerite/gabbro and sandstones, in some rare cases shaped by coarse pecking of their sides (Figure 9b,d). They are generally cylindrical, with circular or ovoid sections. Their length varies between 10 and 26cm, their width 4 to 16cm and their thickness 3 to 9cm. Their active surfaces are located on either one or both of their ends, and have not revealed any intense traces of use. They generally show a localized zone of percussion on convex surfaces, associated with several peripheral flakes and scattered polished areas, indicating alternating percussion and circular grinding. About ten pestles also revealed a secondary function: one example was also used as a hand abrader, four others as grooved abraders and a third example as a sharpener. Four other pestles had two of their faces meant for grinding and crushing. Due to their low number and degree of use, these pounding tools do not seem to play an important part in the technical system and daily activities at Aknashen.

Six crushing tools, in active or dormant position, show one or two surfaces of use. Each tool represents one particular type of crushing implement, which explains the great variety in morphology and dimensions. Their dimensions are varied: lengths are between 9 and 19cm, widths 7 to 16cm and thickness 3 to 9cm. They are generally shaped by pecking for better handling or

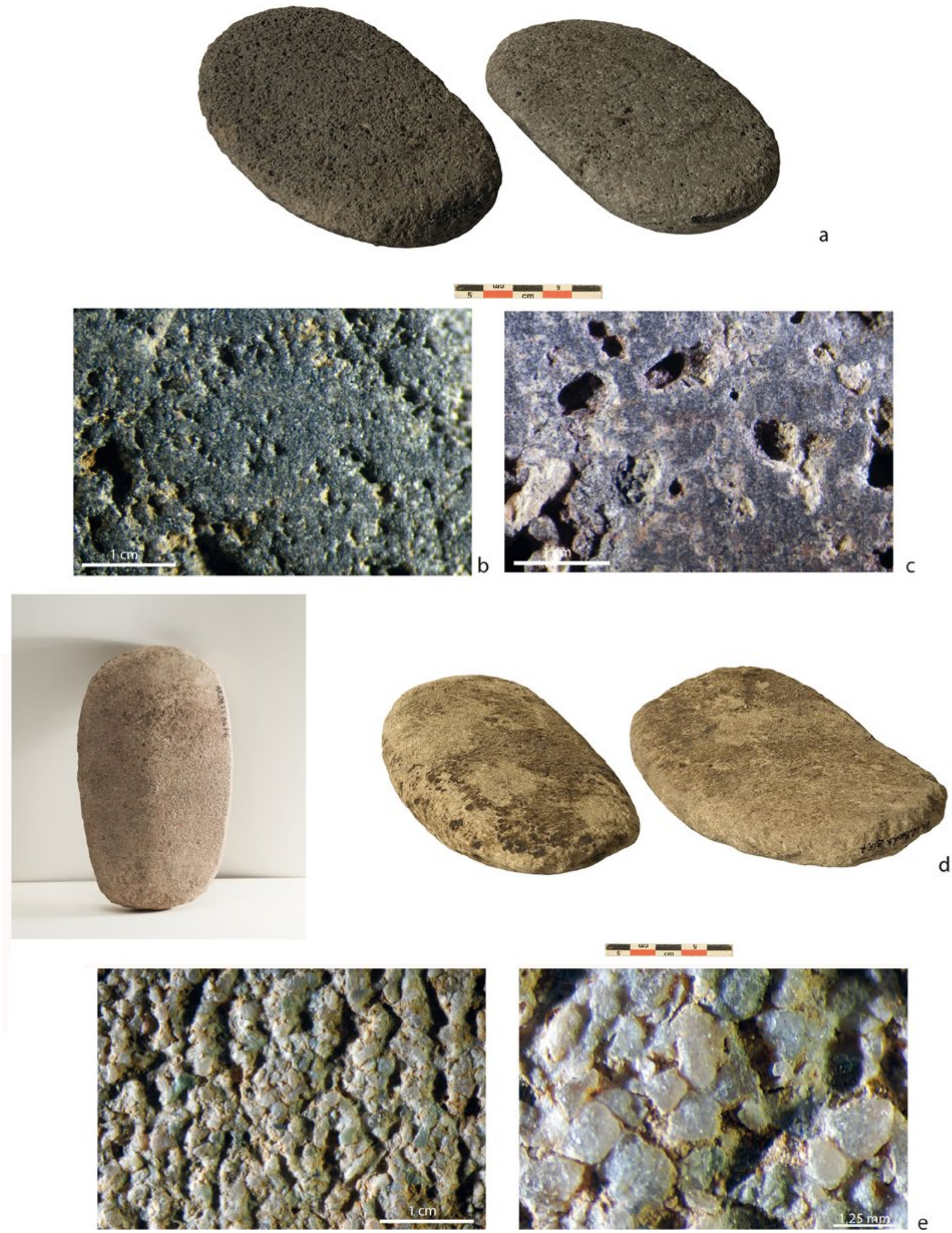


Figure 7. Grinders: a) *examples made of basalt*; b) active surface used for cereal grinding x10 (Tr.5 UF9c F12); c) active surface used in cereal and (subsequently) ochre grinding x10 (Tr.8 UF8 F14); *examples of sandstone* d) Tr.5 UF8a F6; e) active surface used in mineral grinding x10 et 60 (Tr.1 UF9a F26); [photos: V. Hakobyan; micro-photos: C. Hamon].

	vesicular basalt	andesite	sandstone	pumice	doelrite / gabbro	Total
grinding slab			6			**6**
crushing tool	5			1	1	**7**
mortar	4			2		**6**
pestle	9	5	2		2	**18**
pestle - hand abrader				1		**1**
pestle -sharpener	2	1		1		**4**
pestle - grinder		1				**1**
pestle - crushing tool	2		1			**3**

Figure 8. Raw materials used for manufacturing grinding tools (grinding slabs, mortars and pestles).

stability, depending on the cases. They show crushing areas, created by hard percussion on one or two of their faces. In some cases, real cavities caused by percussion were pre-shaped by pecking. One of the tools shows a cavity on top of one of its ends (Sond.A UF6). As previously mentioned (Badalyan *et al.* 2010), one quadrangular crushing tool has four deep percussion cavities on its two faces and sides, directly over the natural surface, covered by a slight polish of asperities and irregularities (Figure 9e). These areas are of varying depth, and are generally associated with polished areas resulting from grinding at their periphery. In other cases, these areas are simple concentrations of impacts (Figure 9f). The association of crushing and grinding movements on a single tool is frequent in the Neolithic of the Kura valley (Hamon 2008).

Figure 9. Examples of *grinding tools*: a) grinding slab at the back of a basalt grinder (Tr.4 UF10); b) pestle in vesicular basalt (Sond.A UF6) [photo: V. Hakobyan]; *Massive grinding tools:* c) half-mortar (Tr.10 UF4 Burial5); d) pestle and detail of the end (Sond.A UF6) [photos: C. Hamon]; *Crushing tools:* e) lower (Tr.8 UF8); f) crushing hand (Sond.A UF11) [photos: C. Hamon].

In comparison to the important number of grinding tools, pounding tools at Aknashen seem to have played a minor part in the technical system. Their diversity highlights their involvement in a wide range of activities, in rather opportunistic fashion.

Percussion tools

Surprisingly, percussion tools are hardly present in the occupation levels of Aknashen, with only 8 tools standing for 4 functional categories:

- Only two small hammerstones on andesite cobbles were identified: they were used at their ends, and are of very small dimensions (less than 10cm long).
- Two chopper-like tools on vesicular basalt and a metamorphic rock share more or less the same dimensions (from 12 to 16cm in length, 5cm in thickness). Their broadest sides were flaked in order to obtain a convex edge, which was then used for percussion.
- In the case of two splintered pieces on gneiss and limestone cobbles, the distal ends show a flaking associated with a certain type of polish.
- Two grooved hammers on cobbles of andesite and vesicular basalt are similar in dimensions (approx. 15cm long and 8cm thick; Figure 10). Grooves were made by pecking in the centre of the tool, to facilitate handling. Their ends are not intensively used for percussion, as they are only marked by peripheral flaking. Although vesicular basalts are of low quality and hardness for extractive operations, such tools are generally interpreted as related to mining activities. Comparable items can be found in different Chalcolithic sites of the southern Caucasus (Khramis Didi Gora; Hamon 2008: 104, fig. 19: d-g) and at Kültepe in Nakhichevan (Abibullaev 1982: 58, pl. IV:ll; Marro *et al.* 2010). Nonetheless, their low level of use suggests other functions, such as weights or percussion tools.

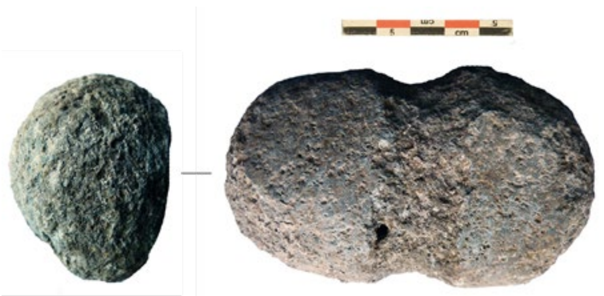


Figure 10. Grooved hammer (Baulk6/8 UF8 F3) [photo: C. Hamon].

The scarcity of percussion tools at Aknashen is in total contrast with the composition of tool assemblages at other Neolithic sites in the southern Caucasus, and raises the issue of the reason for this absence of an entire part of the technical background.

Abrading tools

Sixty-six hand, ten grooved and three multifunctional abraders, constitute most of the polishing tools (Figures 11-13). In their overwhelming majority, they are made with red and black pumices and vesicular basalts, except for a couple of hand abraders in sandstone (Figure 11). The choice of porous rocks was meant to enhance the efficiency of abrading movements, as the ruggedness of the rock became more important with use, and the edges of the vesicles are naturally sharp. Small fragments of varied shapes and dimensions (less than 12cm long and less than 5cm thick) were generally used without any shaping whatsoever. They have several active surfaces (up to four), which reflects a process of optimization of different surfaces available on the tools.

The active surfaces of hand abraders are marked by a concave deformation resulting from wear, which shows a uniform polish and regular leveling. The wear and surfaces are the consequences of various types of motion:

- Passive transverse abrasion on the faces, which creates flat or concave longitudinal areas of abrasion. Some other (Sond.A UF13b) thin quadrangular tools show abraded semi-circular edges at their ends, which may indicate the polishing of the internal side of a convex object, with a motion similar to smoothing (Figure 12a-c).
- A dozen tools of semi-circular to triangular shape were used on two or three of their faces. They are characterized by the presence of invasive abrasion facets organized in beveled position,

	vesicular basalt	sandstone	pumices	steatite / ophicalcite	dolerite	other	Overall total
flat polisher	1						1
hand and grooved polishers		1		3	1		4
hand abraders	28	6	24			1	59
grooved abraders	3	1	2				7
hand and grooved abraders	1		2				3
sharpeners	5		6			1	12

Figure 11. Raw materials used in the manufacture of abraders.

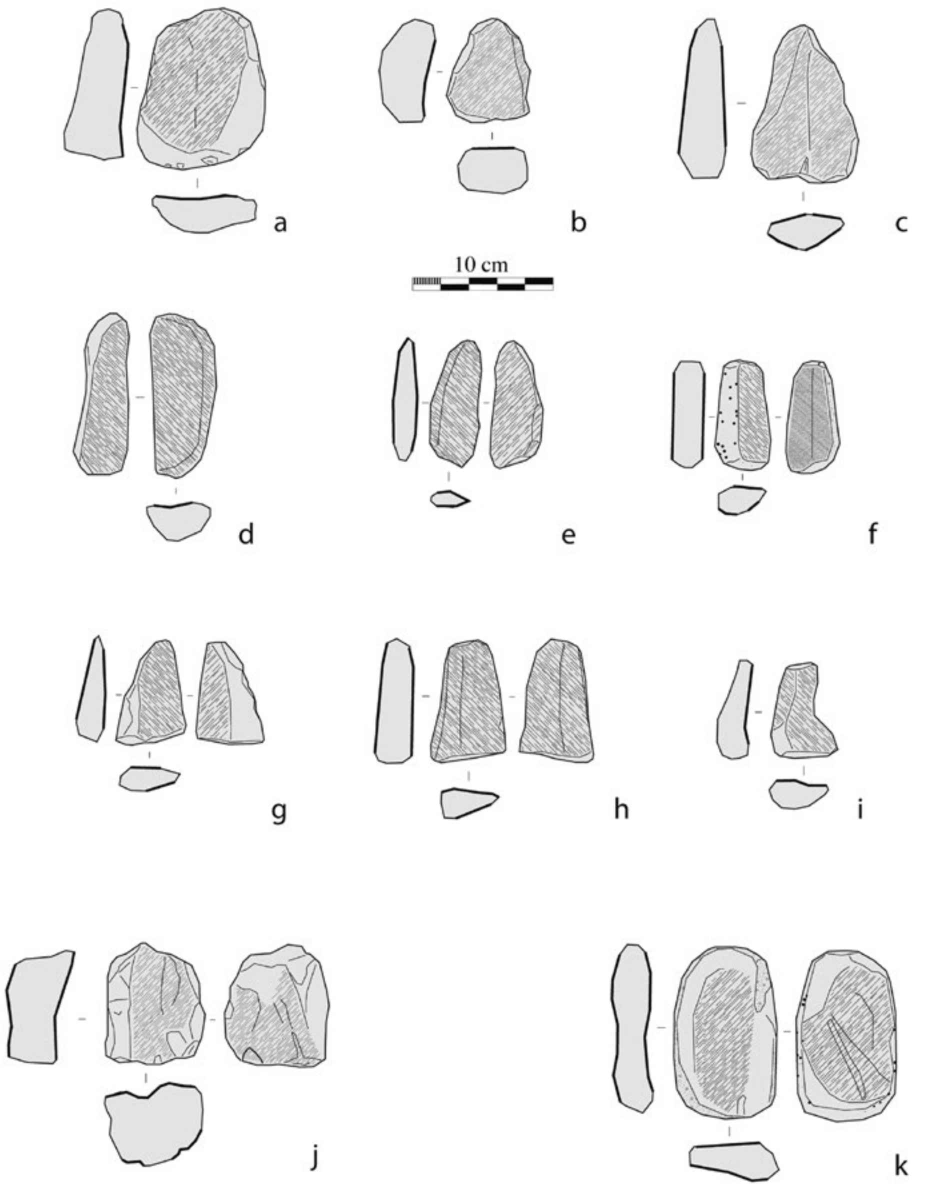


Figure 12. Abraders and sharpeners a) Tr.5 UF11a -378cm; b) Tr.2 UF9; c) Baulk5/6 UF6; d) Tr.4 UF10a F26; e) Tr.7 UF8a -305cm ; f) Tr.4 UF9a F18 ; g) Tr.2 UF10 -349 cm; h-i) Tr.5 UF10b F18; j) Tr.5 UF11b -374cm ; k) Tr.2 UF11 -375cm [drawings: C. Hamon].

separated by a sharp edge (Figure 12d-h; Figure 13e-f). They recall use in a transversal motion, similar to that of sharpeners. In one case, the 'hook'-like shape of the abrader seems related to a semi-circular motion of abrasion (Figure 12i).

– An active abrading motion would have rather distorted the surface, to the extent that it would reflect the shape of the transformed object in negative. As an example, a cylindrical abrader was probably used to shape or regularize the internal part of a hollowed tool (Sond.A UF13a str.1).

The use-wear analysis of eight abrading tools yielded very few results, as their high porosity prevented a proper development of use-wear (Figure 13). On two abraders and three tools resembling sharpeners, the use-wear analysis was closely comparable to that of implements used for the abrasion of hard animal matter (bone), especially tools showing important mechanical leveling of their surfaces, apparent in well-individualized grains and the irregular aspects of the faces of grains (Figure 13b).

A longitudinal abrasion of the sides or ends of objects created grooves of varied sections and morphology on some tools:

– Asymmetric grooves, slightly curvilinear, on convex areas;
– Short grooves close to notches, seen at the end of the tools (Tr.6 UF8a);
– A juxtaposition of multiple short-pointed grooves, with a large open base on one side of the tool. In the case of a single grooved abrader (Figure 13h), the grooves were made from opposite sides on one face of a rhomboidal-shaped flat and thin fragment; their lengths do not exceed 3.2cm and their widths, in general approximately between 0.2 to 0.4cm, do not exceed 1.6cm;

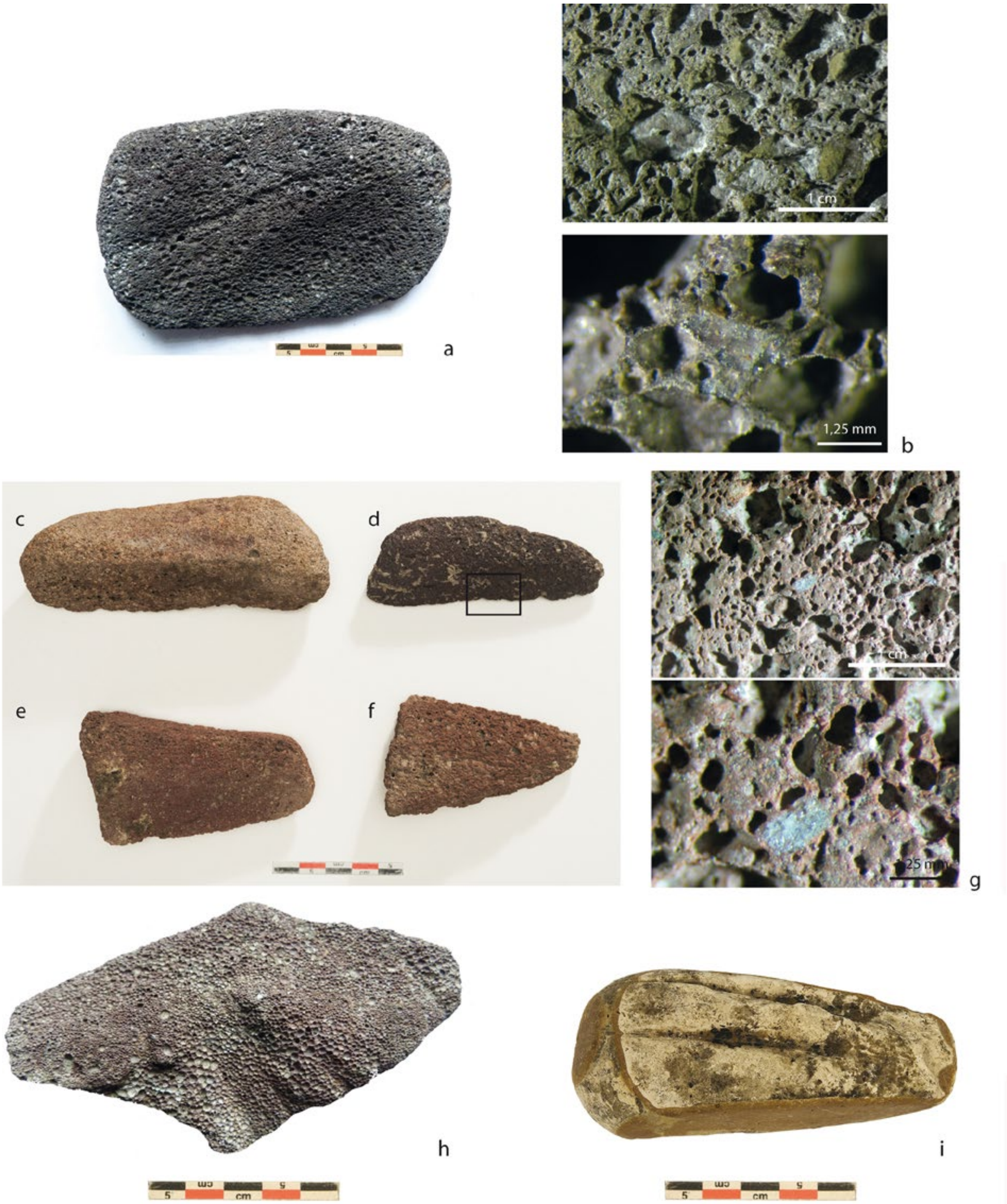


Figure 13. Abraders in pumice: a) *Hand abrader* (Tr.2 UF11); b) its active surface x10 & x60 [photo: C. Hamon]; *Sharpener-like abrader:* c) Tr.4 UF10a F26; d) Tr.7 UF8a; e) Tr.5 UF10b F11 ; f) Tr.2 UF10 [photo: V. Hakobyan]; g) active surface tool: Tr.7 UF8a [x10 and x60 photo: C. Hamon]; *Grooved abrader*: h) Sond.A UF12 [photo: C. Hamon]; i) Tr.4 UF8b in sedimentary rock [photo: V. Hakobyan].

– Longitudinal, narrow, V-shaped grooves, of varied depth and blanks (limestone cobbles, porous basalts). One example (Sond.A UF12) on dense red vesicular basalt is narrow and deep (1.3cm deep and 0.8cm wide);

Several tools combine various of these motions and actions. One of the tools was used as both a pestle and an abrader (Tr.3 UF4): its two ends were used for percussion, whereas its four plano-concave faces are intensively abraded. Another tool revealed the combination of several actions: a rounded peripheral edge, which suggests use as a burnishing implement, and two concave active surfaces associated with a small groove used in passive fashion (Figure 12k; Figure 13a). Another tool (Tr.1a UF14) combines a face used in active motion to shape a convex surface by abrasion, with another side used as a passive sharpener. Another hand abrader (Tr.2 UF10) associates the use of its convex faces for an alternation of abrasion and coarse percussion, and its ends for pounding; one concave end has levelled and smoothed asperities combined with oblique striations, the other plano-convex end showing a general leveling of its surface and colouring residues.

Friction tools

Twelve handstones were made of sandstone fragments and vesicular basalt cobbles. Their dimensions are quite standardized, varying between 8 and 12cm long, between 5 and 9cm in width, and 2 to 4cm in thickness; the morphology goes from ovoid to quadrangular. Most of them are shaped by fine pecking, and show polishing due to handling. Their active surfaces generally show dense transverse striations associated with a covering polish on one or two of their active faces (Tr.5 UF12b), and a polish due to handling on their back (Sond.A UF6). At Aknashen, the active surfaces are rather more plano-concave than convex (sandstone in Tr.1 UF6, basalt in Tr.3 UF7c).

Six smoothers made use of small cobbles (less than 10cm long and 2cm thick), from different raw materials like metamorphic rocks, limestones, sandstones and pumices. Whatever their shape, they all show highly distorted and lustrous active surfaces, which vary from plano-concave to convex, compatible with a use for smoothing and finishing of pottery surfaces. They remind some burnishers from Khramis Didi Gora in the Kura valley (Hamon 2008).

Perforated cobbles

Among the eighteen perforated tools found at Aknashen, several types can be identified.

The most important part of the assemblage is made of ovoid basalts, pumices or limestone cobbles of different sizes (from 4 to 9cm long, to 2 to 8cm in thickness). They reveal the different stages of shaping: some are in course of being perforated, while others are clearly entirely perforated. The perforations are bi-conical, and made by pecking on both faces. Their probable use as weights has deformed the upper part of their perforation, with apparent notches indicating the orientation of their suspension.

Several of these tools were found together in some contexts; they were made of different raw materials and are of various dimensions. Such association suggests they were used in sets for efficiency (Figure 14).

Figure 14. Perforated cobbles: a) three tools from Tr.5 UF11a F22; b) Baulk5/6 UF10 [photo: C. Hamon].

Maceheads

Two tools were identified as maceheads. The bi-conical morphology of one of the tools in andesite was the result of pecking and polishing. Its two ends are flattened (Figure 15a). A central zone about 1cm wide was polished and could have been used for fixing or handling. Since it is not perforated, it can be considered as a roughout. Three other perforated objects are probably other roughouts of limestone mace heads. Their diameter varies between 4 and 5cm, and they are 2 to 4cm thick. Their cylindrical perforations show concentric striations, which attest the use of a mechanical method of perforation. One of them, in siliceous limestone, was given a quadrangular shape by fine pecking and polishing (Tr.2 UF10). Another example clearly shows a rim outside its central perforation (Tr.1 UF9). The last tool, made out of fine limestone, was partially hollowed out, on one face only (Figure 15b; Tr.9 UF5).

Receptacles and stone vessels

Three objects of different shapes and raw materials are interpreted as receptacles (Figure 16). One receptacle of sandstone (Tr.5 UF1) was manufactured by flaking and pecking, in order to create a regular ovoid concave surface for grinding (7.8 x 6.8 x 3.8cm). Another fragment of vesicular basalt shows a rim made by pecking, and a deep hollow created by pecking, the reason for the cavity's angular shape (Tr.5 UF6). Finally, a quadrangular receptacle in light and porous white pumice was manufactured by flaking (19 x 18 x 6cm) (Figure 16a). It has a peripheral rim of about 0.5cm, outlining a concave active surface. The distribution

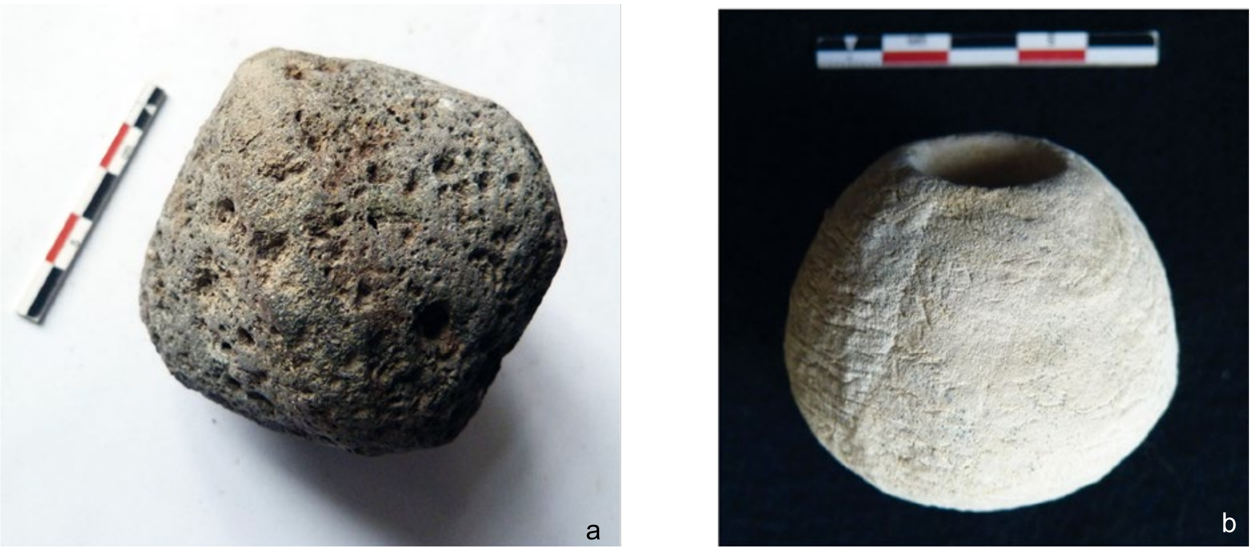


Figure 15. Macehead: a) andesite (Tr.5 UF6); b) limestone (Tr.9 UF5) [photo: C. Hamon].

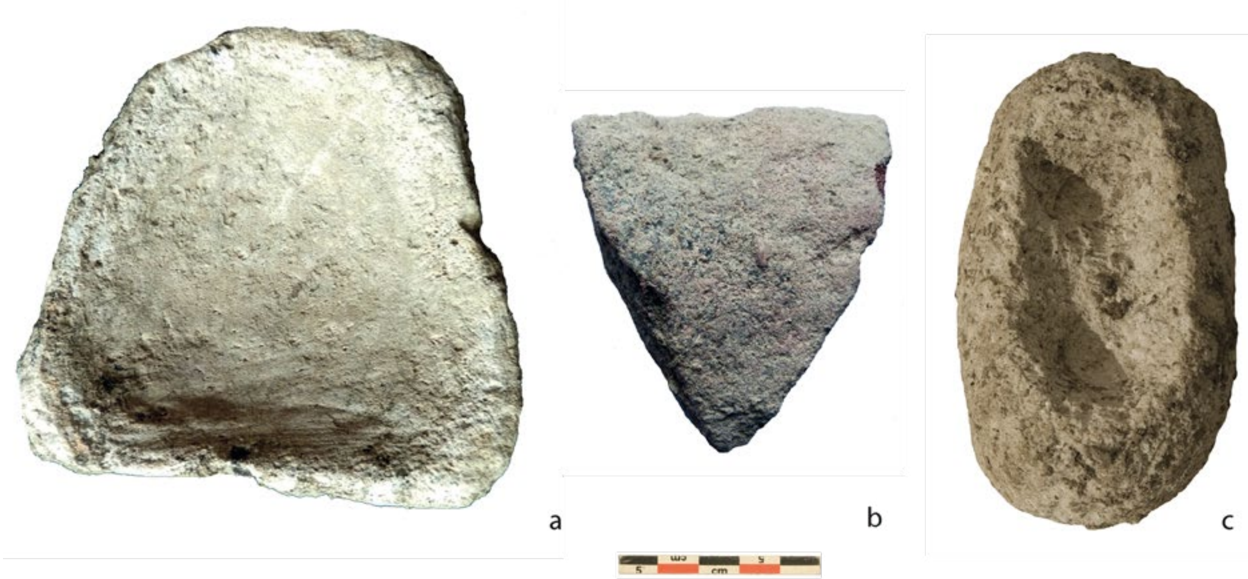


Figure 16. Receptacle: a) receptacle made of tuff (Tr.10 UF4); b) fragment of stone vessel in sandstone (Tr.9 UF4) [photos: C. Hamon]; c) roughout made of silicified limestone (Tr.8 UF7) [photo: V. Hakobyan].

of the polish indicates a circular movement of mixing rather than grinding, while a series of longitudinal striations along the internal side of the cavity are reminiscent of scraping.

A fragment of stone vessel in sandstone was also identified (Figure 16b). The dimensions of this vessel fragment suggest a quite open shape and high sides, based on the orientation of its rim.

An ovoid object on silicified limestone (10.5 x 8.5 x 6cm) was entirely manufactured by coarse pecking. On its upper face, a basin was hollowed out by creating two contiguous circular depressions made with coarse pecking. Its function is unknown, but it is closely comparable to roughouts of stone vessels (Figure 16c).

Rare tools

A single scraper was made with a primary flake of dacite. A convex edge, opposite to the butt, was used in a transversal scraping motion, as shown by the shiny lustrous ridge combined with a fine flaking from use (Tr.2 UF13a). Such industries on flakes have been identified in Neolithic occupations at Kamil tepe in the Mil plain, and at Mentesh Tepe in the Kura valley (Lyonnet *et al.* 2012: 165).

A very peculiar object in andesite was identified (26 x 12 x 6 cm) (Tr.8 UF8 F18). This object has two parts: a cylindrical handle was shaped by fine pecking of the back and sides, while a wider sub-circular part was created by flaking the back of the tool (Figure 17). The upper part, preserved as a natural surface, was slightly pecked. This object is perhaps a rough kind of 'spoon', in fact an object of unknown function.

A discoid object (15cm in diameter and 8cm thick) is the probable roughout of an unidentified tool; its natural surface is worn out by coarse pecking on two-thirds of its natural face (Tr.6 UF11 F13).

A natural cobble of ovoid shape has a concave surface on its upper face (25 x 15 x 6cm) (Baulk 2/5 UF9 F4). It was completely smoothed, either by use or due to taphonomy. No other use-wear traces were recognized.

Figure 17. Roughout of 'spoon-like' tool (Tr.8 UF8 F18) [photo: V. Hakobyan].

Such characteristics would suggest a possible function as a receptacle.

Finally, several of previously unidentified objects can be considered as tools, on the basis of visible polished areas or residues of pigmentation (Tr.4 UF11 F29; Tr.3 UF12b), whose pattern is nevertheless not clear enough to identify their function and mode of action. Several small flat cobbles show traces of polishing on their asperities.

The search for comparisons with these specific and rare objects did not yield parallels within the southern Caucasus or in regions further afield.

Synthesis

The chronological evolution of assemblages and of the characteristics of the tools

Some observations can be made on the representativeness of each category of tools, depending on the horizons. First of all, half of the tools found at Aknashen come from Horizons IV (19%) and V (32%), while the other horizons contained between 5 and 13% of the total (Figure 18). This can be explained by their respective degree of preservation and extent: the upper layers (Horizons I to III) are more or less disturbed by more recent occupations, while the deepest levels (Horizons VI-VII) were only excavated at this stage in smaller surfaces. Nonetheless, some observations of chronological significance can be surmised.

Several categories of tools appear throughout the sequence, but in variable proportions, like grinders, pestles and crushers, hand abraders and perforated tools. Their distribution indicates a relative stability in activities carried out (food processing, tool manufacturing), and beyond that, of subsistence and economy, during the site's long occupation. Some complementary observations can however be formulated.

First of all, no querns were found in Horizons IV and V, although these have yielded most of the tools recovered on site, particularly the highest number of grinders. Although in all horizons, the proportions of querns and grinders are equal and in fact quite low, the absence of querns in Horizons IV and V is surprising, in the light of an exponential increase in the number of grinders. This may have several explanations: the querns from these two horizons may have been reemployed or reused for architectural purposes in the following horizons (III and II). This would imply a specific behavior regarding raw material supply, either in terms of the reduced possibility of exploiting outcrops of big blocks, or in terms of broader recycling to maximize locally available resources. The first hypothesis implies

	I	II	III	IV	V	VI	VII	?	Total
quern	1	3	2			3	1	2	12
grinder	5	5	2	16	25	3	2	4	62
grinder /grinding slab					1				1
grinder - pestle		2							2
undet. grinding tool				2					2
grinding slab		2	2		1				5
small grinders	2	1	2	3	8	3	2	4	25
mortar		1	1	2					4
pestle		5	7	5	3			2	22
multifunctional pestle	1	1	1	1	2				6
crushing tool	1	1	1	1	1	1			6
intermediate tool					2				
hammerstone			1		1				2
hammer	2							1	3
mace			1						1
macehead		1							1
chopping tool					2				2
hand abrader	1	5	5	12	20	5	4	3	55
grooved abrader		1		1	3		2		7
grooved and hand abrader				1		1	1		3
sharpener			1	4	7				12
flat polisher			1						1
handstone	2		5	1		1	1		10
handstone-hammerstone					1				1
objet à surface polie			2						2
smoother				2	4				6
spoon					1				1
perforated tool		2	4	3	8	3		1	21
sracper							1		1
receptacle	1	1	1						3
stone vessel		1		1					2
undetermined tool			3	3	5	5	4	2	22
Total général	16	32	42	58	95	25	18	19	303
	4,97%	9,94%	13,04%	18,01%	29,50%	7,76%	5,59%	5,90%	

Figure 18. Representativity of each category of tools depending on the horizons.

a limited access to outcrops of big blocks, and can be explained by a change in territories explored, or by the exhaustion of the source itself during former periods of occupation. The second hypothesis induces that such a rate of recycling might express a wish to perpetuate the technical identity of prior inhabitants, but it can also be interpreted in terms of continuous use of these long-life tools between Horizon III and IV. The short time-span between the abandonment of Horizons IV and III could indicate that the same inhabitants would have occupied both horizons and taken their surviving querns with them, or that inhabitants of Horizon III would have inherited querns from previous generations settling Horizon IV. In any case, the high number of grinders in both horizons indicates an intensification of grinding activities. Moreover, the fact that some other categories of tools are only represented in Horizons IV and V can only be interpreted as a statistical result of the wealth in finds of these two horizons, and of their better preservation compared to the upper strata, since they belong to very particular categories of tools. All the smoothing tools, the two choppers, the roughouts of basalt receptacles and almost all of the sharpeners and abraders come from these two horizons. To sum up, according to the macrolithic artefacts, Horizons III and IV would correspond to a phase of intensification of grinding and craft activities.

Other observations can be put forward when examining in detail the characteristics of each category of tools and their chronological distribution.

- The low number of querns recovered makes it difficult to examine a hypothetical chronological evolution of different types throughout the occupation sequence. Saddle-querns, however, were only found in the deepest occupation levels (Horizon V, VI, VII), while the narrower concave type is present only in horizons III and VI. These observations, although based on a low number of tools, suggest a chronological evolution similar to that observed in the Kura valley on Neolithic sites in Georgia, where saddle-querns were found in the earliest occupation levels (Hamon 2008: 109). Such evolution of the grinding systems throughout the 6th millennium BC probably reflects deeper changes in the economy, at least in food practices, at the scale of the whole region.
- Some of the types of grinder seem to have a chronological significance. Type 1 is represented in almost all the horizons except I and III, and does not seem diagnostic of a specific phase of occupation. Type 2 grinders show a more interesting pattern, as 80% of them come from Horizon V, with two examples from Horizon IV and only one from Horizon VI. Such a concentration makes it a fine chronological indicator, and raises the issue of the intensity of their use, specifically in Horizon V. The two examples of Type 5 grinder, not found on other Caucasian sites since, both come from Horizon IV: in this sense they may be considered as both a chronological and a functional marker. In the same vein, the fact that the two grinders of type 7 come from upper horizons (I and III) suggests an increase in thickness and weight of the grinding implements through time.
- The distribution of grooved abraders in the entire sequence is also informative. Although hand abraders are present throughout the sequence, this is not the case for grooved ones. With the notable exception of one example from level II, all the grooved abraders are distributed in Horizons IV to VII, and are absent from the upper layers. This suggests the abandonment of abrasion techniques for the shaping of objects at the end of the occupation sequence.

The analysis of tools from the most ancient levels does not provide clear evidence of differentiation in comparison to the following levels; only 22 macrolithic tools were actually recovered from the small excavated zones in Horizons VI and VII. At this stage, we can only notice the presence of two grinders of the smaller type 2, made of basalt and sandstone; this could be an indication of their anteriority in the evolution of grinding systems. The only instance of scraper made out of a dacite flake originates from Horizon VII. By contrast, following Badalyan *et al.* (2010), the latest horizons (III-I) witnessed the appearance of some particular objects, particularly grooved hammers, maceheads (perforated or not) and stone vessels / receptacles. This finds parallels at other sites in the southern Caucasus. In the Kura valley, stone vessels were only identified at Khramis Didi Gora (Hamon 2008: 103), whose occupation corresponds to the latest stages of the Kura valley site sequence, according to Kiguradze (1986). Other clues to the presence of stone vessels in the Chalcolithic levels of Mentesh Tepe have also been recently documented (Lyonnet *et al.* 2012: 168). As regards grooved hammer stones, they are well known in contexts belonging to the Chalcolithic and Kura-Araxes culture of the Araxes valley, especially in the Nakhichevan region - for example in the Duzdağı salt mine (Marro *et al.* 2010) and at Kültepe I (Abibullaev 1982: 58). Such tools, however, are known more broadly in the southern Caucasus, and are probably related to extraction activities or ore processing in later contexts, such as at Shresh Blur (Bayburtyan 1939/2011), Khramis Didi Gora (Hamon 2008: 104, fig. 19: d-g), and Sakdrisi (Stöllner and Gambashidze 2011).

Spatial and contextual distribution

If one focuses on the context of discovery of these macrolithic tools at Aknashen, one should consider that a more systematic collection was carried out in the deepest excavation layers.

According to Badalyan *et al.* (2010), ground stone tools were mainly found reused in secondary contexts, either in the fills of *pisé* structures mixed with other pebbles, or as cooking stones in fireplaces (Badalyan *et al.* 2010: 197). For this reason, most of the querns were deliberately broken into smaller pieces.

When we examine the concentrations of tools, the associations suggesting a functionally coherent toolkit linked to specific configurations or zone of activity are in fact few:

- In several cases, several grinding tools were associated with pebbles, lithic industries and bone tools, within the same structure. This is the case for feature F26 (Tr.1 UF9a), which yielded a concentration of five grinders and a few other percussion tools, and for features F10 (Tr.6 UF11; three grinding tools) and F29 (Tr.4 UF11; three grinding tools). Such associations and configurations suggest a coherent and single area for domestic waste, possibly linked to the last phase of use of the building or area;
- Some exclusive associations of other categories of tools suggest craft areas or craft wastes, but

this deserves a more accurate examination of the whole toolkit. In structure 11 (Tr.5 UF10b), a sharpener was found together with a hand abrader, possibly used for the manufacture of other tools. In pebble structure F22 (Tr.5 UF11a), several perforated cobbles were exposed together. In F4 (Baulk 2/5 UF9), a receptacle was deposited together with two grinders. Since no other categories of macrolithic tools were unearthed in these contexts, the association of these functionally coherent tools suggests wastes of a single specific craft activity.

– Within a few pebbled structures, the presence of a concentration of tools, especially used for grinding activities, is in itself intriguing. For example, in Tr.3 UF5 F2, a pebble structure contained an important set of three querns and grinding table, three grinders, three pestles and crushing tools, without any other functional categories of macrolithic tools. The easiest interpretation is to consider that they were simply reemployed for architectural purposes. This may have been the case for some of tools placed in a flat position at the centre of a multilayered pebble structure (Sond.A UF11 F7). One should also consider, however, that such a concentration may be related to the meaning (rather than the function) of these structures. Such practices could for instance reflect the need to break and bury tools used for daily food preparation belonging to previous occupations, a measure with symbolic or sanitary purposes.
– A clear reuse of grinding tools as architectural elements can be highlighted, for example in fireplaces (Tr.5 UF8c F9).
– Such a configuration is clearly unrelated to the discovery of paired querns and grinders, found in locations of use, such as in feature 8 (Tr.3 UF6b). A narrow and complete quern (48 x 20cm) was found with its grinder (38 x 19cm). Despite its presence along an exterior wall, this milling equipment seems to have been abandoned at its location of use, rather than being the result of deliberate arrangement: the quern is facing the sky, and next to it the grinder is facing the ground.

The analysis of the relations between macro-lithic tools and other remains permits, moreover, reconstructing part of the technical system. According to an archeo-botanical study (Hovsepyan in this volume; Hovsepyan and Willcox 2008), no deep changes in the assemblage can be observed throughout the sequence. In this sense, the diversity of tool types could appear inconsistent, unless we consider their functional diversity. As already mentioned, specialization in the use of sandstone grinders for the processing of mineral ores contributed to this diversity. The use (or reuse) of macrolithic tools for grinding pigments is a second explanation, which is reminiscent of other contexts that are widespread throughout the Caucasian Neolithic (Hamon 2008; Lyonnet *et al.* 2012).[1] Yet this diversity in grinding material must also be interpreted in terms of cultural choice, just as in the case of craft activities. At least, and despite a low degree of reliability of the use-wear results, the use of pumice abraders for the shaping of bone tools appears in accordance with the results of their techno-functional analysis (Chataigner *et al.* – Neolithic bone tools - in this volume). Their abundance at the site would then reinforce the impression of high investment in the on-site exploitation of hard animal matter in the production of tools of high quality.

Cultural comparisons

Closest comparisons can be made with the assemblage of Aratashen, located 6km north-west of Aknashen (Badalyan *et al.* 2007). Both sites share the same composition of assemblage and the same raw materials: volcanic rocks of more or less local origin (basalt, andesite, pumice) were used to create most of the grinding and abrading tools. At both sites, bifacial grinders in sandstone and beveled-like sharpeners of pumice are most common. Also at these sites, massive mortars were discovered.

Like at Aratashen, the macrolithic assemblage shares close comparisons with the Shulaveri-Shomu sites, even if some novel types of tools were identified (Kiguradze 1986; Hamon 2008). As an example, grinding tools share many common characteristics: saddle querns are well known at Shulaveri, and narrow ones at Arukhlo; short grinders in sandstones and lava are comparable to examples at Shulaveri and Imiris. The existence of massive mortars and cylindrical or truncated pestles is also a feature of both regions. Crushing cobbles are also known in a few instances at Imiris and more often at Khramis Didi Gora. At this site, a pestle-abrader is clearly comparable to the single example from Aknashen (Hamon 2008). The many weights made of perforated cobbles are also a common feature found at the different sites of the Araxes and Kura valleys. However, some tools from Aratashen and Aknashen are completely unknown in the Caucasian region: one can mention the double-sided grinders made of sandstone or the beveled sharpeners in pumice, which seemed to have played a particular part in Aknashen's technical system. Similarly, some tools completely integrated in the assemblages of the Kura valley are completely unknown in the Araxes basin, like the circular grinding slabs of sandstone from Imiris, the numerous

[1] Traces of ochre were detected in small amounts in different parts of the site, especially on floors and around concentrations of pebbles, obsidian and bone tools, in Horizons VII and VI; see details in Badalyan and Harutyunyan in this volume.

hammerstones of green and metamorphic rocks or the sandstone abraders. To summarize, these observations confirm the cultural link between both areas during the 6th millennium BC, but also emphasize significant regional differences, partly related to a different pattern of cultural influences in both parts of the south Caucasus.

Some of these features have parallels in the Hassuna and Halaf cultures, even though direct comparisons with detailed macrolithic studies are difficult. In the Halaf levels of Tell Sabi Abyad (Huigens *et al.* 2014), the choice of basalt for the manufacture of grinding tools finds parallels at several sites, even when this choice required a supply from exogenous deposits located at distances of up to 100km. Saddle-shaped querns were also identified, together with cylindrical or truncated pestles manufactured by the splitting open of the distal end of a cobble.

Maceheads are known in very small quantities in various areas of the southern Caucasus, for instance at Shulaveri (Kiguradze 1986: 29). Typological comparisons (shape and dimensions) are found at Halafian sites, notably at Tell Sabi Abyad (Huigens *et al.* 2014: 424), Tell Halaf (Huigens *et al.* 2014: Tafel XXXVI n° 23-24) and Tilkitepe (Korfmann 1982). The absence, however, of detailed analyses on the origin of the rocks used for their manufacture make it impossible to discuss their possible circulation over long distance exchange networks, although this remains a plausible hypothesis.

The absence of stone vessels at Aknashen is in itself quite surprising, since fine limestone productions are known at several Kura valley sites like at Khramis Didi Gora (Hamon 2008), Mentesh Tepe or in the Mil steppe plain (Hamon 2008; Lyonnet *et al.* 2012: 168). Several 'receptacles' which could be interpreted as mortars, are nonetheless present at Aknashen, and could have a function analogous to that of the stone vessels.

Conclusion

The macrolithic tools from Aknashen are characterized by a high diversity of tool types used in craft and food production. As such, these tools played an important part, together with obsidian and bone tool productions, in the technical system and activities of the inhabitants of Aknashen. The exploitation of both volcanic and sedimentary rocks for their manufacture testifies to the close link established between the site and at least two supplying territories, one of them local (along the Hrazdan and Araxes rivers), and another, on a more regional scale, in the Garni region. Some exogenous rocks suggest long distance exchange and the circulation of raw materials or, more plausibly, of objects. Important similarities between the middle Araxes and the middle Kura basins are visible through the study of the Neolithic macrolithic assemblages. They contribute to reinforce the close cultural links between the two areas during the 6th millennium BC. Nevertheless the cultural entity comprising Aknashen and Aratashen shows clear regional specificities, through the intensive use of very particular tools unknown in the rest of the southern Caucasus. Despite the relative paucity of studies and documentation on macrolithic tools in neighboring regions, some close comparisons can be made with the Halafian sphere in eastern Anatolia and north-western Iran, especially in the first third of the 6th millennium BC.

Axes and grooved polishers from Aknashen

Caroline Hamon, Ruben Badalyan and Lilit Sahakyan

Introduction

Polished tools considered of most cultural if not symbolic value, such as polishers and axes, were made in exogenous rocks (ophiocalcites, kaolinite, serpentinite), although their origin has not yet been determined precisely. The choice of soft and homogeneous raw materials is of particular importance for their aesthetic aspect, especially for the polishers. Due to their highly technical but also aesthetic investment, these objects wear part of the expression of the identity of the first Neolithic people of Caucasus. For this reason, their study has been considered apart from the rest of the macrolithic tool assemblage.

Axe and adze blades

Three types of polished blades have been determined at Aknashen. They are fashioned from various rocks, including diorites or dolerites, quartzites, cherts and dacite, gathered as cobbles (large pebbles) from the alluvial terraces of the Kasakh or Araxes rivers (see also Badalyan *et al.* 2010).

Perforated blades

A deposit consisting of three perforated blades was discovered in Horizon 1 (Tr.3 UF3) (Badalyan *et al.* 2010: 198 and fig. 3.1); they were deposited close to each other, their edges facing in the same direction. Such an arrangement is comparable to other deposits or caches of obsidian nuclei on the site. They may be interpreted as craftsmen's storage reserves, caches with intention to be dissimulated, or may carry a symbolic meaning. However, their context of discovery does not allow us to go deeper into such hypotheses of interpretation, due to the strong disturbance of the first horizon (Badalyan and Harutyunyan in this volume). They are thus reminiscent of hoarding behavior that is well known in pre-ceramic contexts in the Near East (Astruc *et al.* 2003).

The hafting is perpendicular to the cutting edge, suggesting a use as adzes. There are two variants: the smallest one (length 11cm) is a 'perforated celt', with a cutting edge that is symmetrical in section, the two larger (length 15cm and 19.4cm) have an asymmetrical cutting edge with an upper surface that is convex and the opposite surface concave (Figures 1 and 2).

As already mentioned in Badalyan *et al.* 2010, such artefacts are quite rare in the Neolithic of the Near East: a hoe-like implement with a large perforation near the butt was found at Matarrah, in northern Iraq (7th millennium) (Braidwood *et al.* 1952: 21), another at YarimTepe 1 dating to the beginning of the 6th

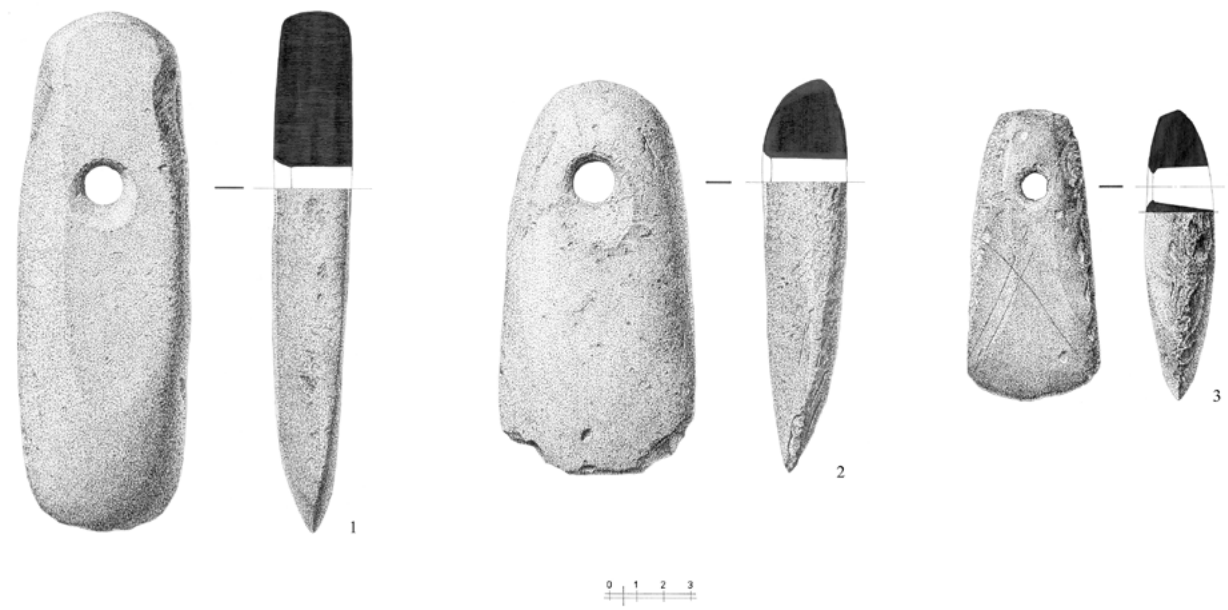


Figure 1. Three perforated blades from Horizon I [drawing: H. Sargsyan] (after Badalyan and Harutyunyan 2014).

Material	Hafting	Dimensions	Perforation diameter	Weight
Chert	transverse hafting	11 x 5.0 x 2.6cm	1.0cm	208g
Diorite	transverse hafting	15 x 7.4 x 3.0cm	1.5cm	484g
Diorite	transverse hafting	19.4 x 6.4 x 2.8cm	1.5cm	611g

Figure 2. Description of the three perforated blades from the hoard in Horizon I.

millennium (Munchaev and Merpert 1981: fig. 36: 2) and another at Tell Sabi Abyad (Collet and Spoor 1996: 438, fig. 7: 7). In the southern Caucasus, some perforated celts were found on the site of Shulaveri, but their dimensions are much smaller (Kiguradze 1986: fig. 11: 33). However, the closest parallels to the Aknashen artefacts come from Kültepe of Nakhichevan, where four 'shaft-hole adzes' (lengths 13 to 18cm) were found in the lower layers (Abibullaev 1982: pl. IV: 1-3). This parallel would indicate a rather late date for these tools. Besides, in the absence of proper use-wear analysis of these tools, the function of these tools appears quite speculative: generally considered as wood-working artefacts, adzes have also been used for the preparation of earth in the fields, for butchering activities and even to process hide in other Neolithic contexts (Masclans *et al.* 2017).

Pointed perforated tool

Another pointed perforated tool from Horizon 1 (Tr.1 UF2) was made in siltstone, and completely smoothed by fine polishing (Figure 3). It is broken at its cylindrical perforation, caused by mechanical action as clearly indicated by the circular striations visible (diameter 1.2cm). Its ovoid point was flattened by abrasion rather than percussion, as suggested by the combination of smoothed areas and groups of oriented striations. This is in contrast to the overall shape of the object, which corresponds more to a hammer type. These observations suggest a possible reuse, or a late date for this artefact, which was possibly used for the shaping and smoothing of metallic objects. It is also directly comparable to a fragment of tool found in the lower layers of Kültepe (Nakhichevan) (Abibullaev 1982: pl. IV: 13).

Blades

Eleven other blades are smaller in size and were used as axes; the cutting edge is parallel to the hafting. Most of the axes, including roughouts, are from the two Neolithic horizons IV and V. They are made in various hard raw materials, including quartzites, chert, a probable dolerite and black dacite.

Three roughouts have been identified in Horizon V (Tr.8 UF8a F17). Two triangular axes in andesite have similar dimensions (18 x 8 x 4cm); they are shaped by uni- or bifacial flaking of the sides, the opposite faces remaining unworked (Figure 4). The roughout made from a dolerite cobble is shorter (12 x 8 x 4cm) and of ovoid shape; no edge was created, although an initial smoothing stage by pecking occurred on one face, side and end (Tr.2 UF 9 F12).

Most of the other seven axes (Figures 5 to 7) are trapezoidal in shape with wide cutting edges. In length they measure between 4.2 and 12.5cm, in width between 3.5 and 6.8cm and in thickness between 1 and 2.6cm. They are cobbles that were shaped by fine pecking then partially polished, particularly on the distal edges. The distal edge was shaped by flaking, then smoothed by transverse polishing, resulting in a shiny polish and fine transverse striations (Figure 5: 1). Usage of these axes produced wear traces of smoothing and microflaking.

Two of them are very short in length, less than 4cm, although their width is average: this suggests that the reduction of their length was the result of more intense cycles of use and reshaping than for the longer axes

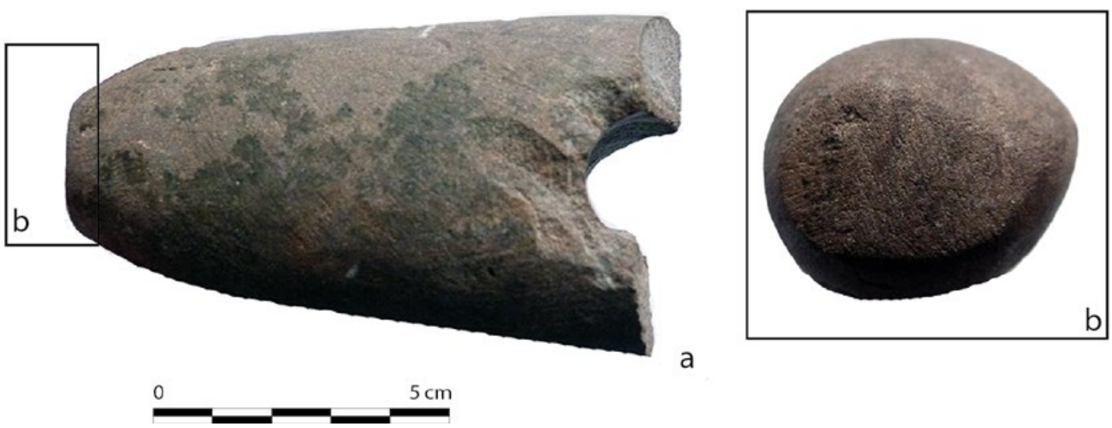


Figure 3. Perforated tool from Horizon I : a) general view; b) detail of the traces visible on the flat end [photo: C. Hamon].

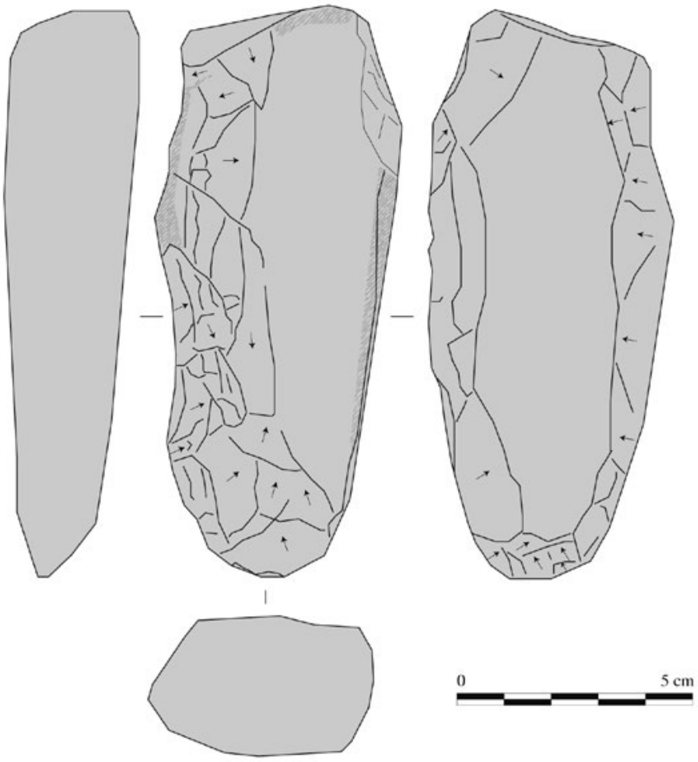


Figure 4. Roughout of axe from Horizon V [drawing: C. Hamon].

al. 2007), Masis Blur (Martirosyan-Olshansky et al. 2013: fig. 4), Kültepe in Nakhchivan (Abibullayev 1982: 57, table IV), as well as in the Kura valley (Hamon 2008; Kiguradze 1986: Abb. 35: 72-73). More broadly, the small dimensions of these axes, the raw materials, shape and shaping sequence are closely comparable to examples in the Hassuna-Halaf sphere. In eastern Anatolia, there exist similar axes from Halaf contexts, while at Tilkitepe, axes present the same shaping sequence (Korfmann 1982: Tafel 14). In northern Mesopotamia, such axes have been found at Tell Sabi Abyad (Huigens et al. 2014), YarimTepe 1 (Munchaev and Merpert 1981: 121), Tell Shimshara (Mortensen 1970) and Tell Kashkashok (Matsutani 1991).

(Figure 5: 4). In one example, a thin flake of dacite was shaped by polishing to obtain a quadrangular axe with two active ends, presenting beveled polished active zones (Figure 6: 3). Another appears to have been in the process of being reshaped, suggested by an overall bifacial flaking alternating with zones of previous fine polishing (Figure 6: 4). One of the axes presents traces of probable colouring residues on areas located on both sides of the polished edge, at the location of a possible handle.

The distribution of these tools is widespread, as five axes were found in Horizon IV, and a single element in Horizons II and V (Figure 7). The characteristics of the shaping sequence and the dimensions of these small axes are clearly reminiscent of the characteristics of the tools found in the Neolithic levels of Aratashen (Badalyan et

Grooved Polishers

Six grooved polishers have been discovered since then in Aknashen. They come either from Horizon II, or from older horizons (V to VII) (Figure 8). Ophiocalcites, kaolinites and a chloritized sandstone were used to create these grooved polishers. Their specific shape and constrained associated gesture distinguish definitely these tools from polishers and other burnishers.

All six Aknashen samples are quite different in their morphology, and their stratigraphical positions present no pattern. However, four different groups of polishers that present a combination of raw materials, morphology of the grooves and dimensions can be defined (Figure 9).

Description

One polisher from Horizon II (Sond.A UF4) is made from a doleritic basalt ovoid cobble (8 x 6 x 4cm), and shows a fine transverse groove V-shaped in section, together with parallel striations (Figure 9: 1). The ends show several percussion impacts, a shiny polish and a high number of colouring residues (Figure 10). In the

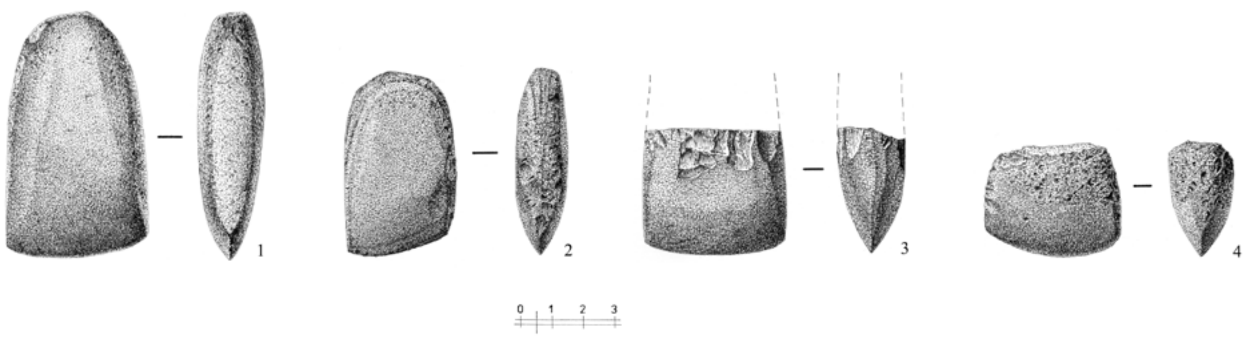


Figure 5. Examples of axes [drawing: H. Sargsyan] (after Badalyan et al. 2010)

Figure 6. Examples of axes: 1. Tr.8 UF8; 2. Tr.6 UF8b F4; 3. Tr.12 UF4; 4. Tr.5 UF10a/c F28 [photos: V. Hakobyan].

Material	Dimensions	Location	Horizon	Figure
dacite	6.7 x 4.7 x 1.0cm; weight: 92.6g	Tr.12 UF4	II	6-3
quartzite	broken; 3.6 x 4.5 x 2.0cm	Tr.1 UF7b	IV	5-4
quartzite	broken; 4.2 x 4.7 x 2.2cm	Tr.4 UF7a	IV	5-3
quartzite	5.9 x 3.6 x 1.6cm; weight: 63g	Tr.5 UF8a	IV	5-2
chert	8.0 x 4.4 x 2.2cm; weight : 126g	Tr.4 UF7a str.5	IV	5-1
dolerite/ diorite	9.6 x 6.8 x 2,5cm; weight : 199g	Tr.6 UF8b F4	IV	6-2
dacite	12.7 x 4.7cm; weight: 268g	Tr.8 UF8	V	6-1

Figure 7. Description of the axe blades

N°	Material	Object	Location	Horizon	Figures
250	Basalt pebble	Oval shape (L: 6.6cm) one transversal V-shaped groove (barely marked)	Sond.A UF4	II	9-1; 10
255	kaolinite	sub-rectangular bar (5.7 x 2.3cm) with one oblique groove (1cm wide)	Tr.1 UF5	II	9-2
12	kaolinite	Sub-rectangular bar (4 x 2.5 x 1.8cm). Longitudinal grooved on two faces and one side.	Tr.2 UF9	V	12
256	kaolinite	Semi-oval shape (4.5 x 3.7cm) lower face: two groups of parallel grooves (deeper and longer in the right group) upper face: incised grid pattern	Sond.A UF10a	V	9-3
	ophiocalcite	sub-rectangular bar (7.5 x 6.3 x 2.7cm) with three deep (0.9cm) parallel U-shaped grooves	Sond.A UF13a	VII	9-4; 13
331	micaceous chloritized sandstone	Sub-rectangular bar, on one side are three parallel U-shaped grooves 0.5-0.6cm wide, on the other side are parallel lengthwise furrows	Tr.1 UF13c	VII	11

Figure 8. Description of the grooved polishers in kaolinite and ophiocalcite.

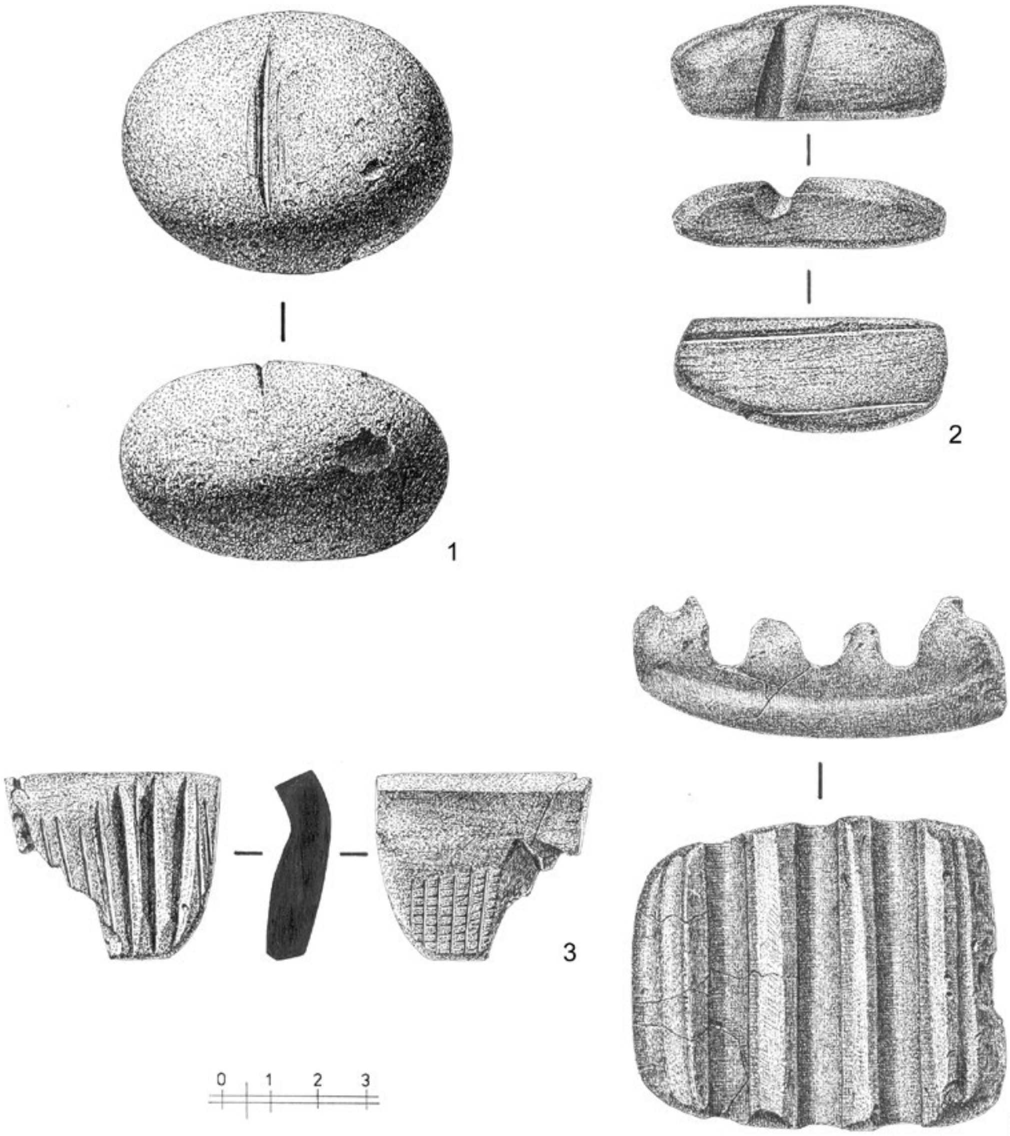


Figure 9. Grooved polishers: 1. incised type of grooved polisher (Sond.A UF4); 2. kaolinite grooved polisher from Tr.1 UF5; 3. kaolinite grooved polisher from Sond.A UF10a; 4. ophiocalcite grooved polisher from Sond.A UF13a [drawings: H. Sargsyan] (after Badalyan *et al.* 2010).

Caucasus, it is reminiscent of some examples from Imiris Gora and Khramis Didi Gora (Hamon 2008), and one from Hacı Elamxanlı Tepe (Nishiaki *et al.* 2015b, fig. 15-1). But for this type of grooved polisher comparisons may also be found farther afield, for example in the final aceramic occupation of Chogha Bonut in south-western Iran dated to *ca.* 7200 BC (Arimura *et al.* 2010: fig. 6; Alizadeh 2003).

Another fragment of grooved polisher from Horizon VII (Tr.1 UF13c, -438cm) was made on a micaceous and chloritized sandstone (Figure 11). Its quadrangular morphology was shaped by fine pecking, while its sides and ends were shaped by abrasion, as suggested by the strong polishing and covering striations. Its upper convex face presents 8 parallel and longitudinal irregular incisions. On the opposite side, three wide transverse grooves (approx. 1cm) with a U-shaped section are covered by longitudinal striations and a very strong polish from use. It presents close similarities to a polisher found at Aratashen, interpreted as a shaft-straightener (Badalyan *et al.* 2007).

In the same Horizon VII (Sond.A UF13A) another example of a small ophiocalcite bloc (7.5 x 6.3 x 2.7cm) shows three other parallels and deep U-shaped grooves (0.9cm). The raw material and the shaping of these tools are clearly related to aesthetic considerations (Figure 9: 4; Figure 13). All the surfaces of the tool are polished and functional. On one of the sides of the tool, thin parallel striations are visible. It is not directly similar to the other polishers made in kaolinite, although it was clearly used in the same way as the U-shaped grooved abraders illustrated in Figure 9: 2;

Figure 10 . Transversely grooved cobble with traces of hammering and ochre residues on its ends from Horizon II (Sond.A UF4) [photo: C. Hamon].

Figure 11. Transversely grooved polisher on chloritized and micaceous sandstone from horizon VII (Tr.1 UF13c) [photo: V. Hakobyan].

Figure 12. Transversely grooved polisher on kaolinite from Horizon V [photo: C. Hamon].

Figures 11 and 12. However, the different qualities and properties of the raw material could have been used at different stages of the abrading process. Its origin has not yet been precisely determined: it could come either from the Vedi region or from northern Iran. Ophiolite formations are identified in the Middle Jurassic to Lower Cretaceous levels of the Sevan zone, and in the region of Vedi, located 50 km south of Aknashen in the Araxes valley (Galoyan *et al.* 2009; Hässig *et al.* 2013). Other ophiolite outcrops are also present in different parts of northern Iran. Depending on their exact origin, they may have been imported from other cultural spheres and would thus reflect long-distance contacts and exchange, or are another indication of the participation of the Aknashen inhabitants in long-distance networks throughout the southern Caucasus and neighboring regions, as has been demonstrated for obsidian (Chataigner and Gratuze 2014b).

Figure 13. Polisher from Horizon VII (Sond.A UF13a) (scale on fig. 8-4) [photo: V. Hakobyan] (after Badalyan and Harutyunyan 2014).

Three other polishers were made from the same raw material, kaolinite. Kaoline ($Al2Si2O5(OH)4$) has a very similar chemical formula to serpentine, and is sometimes considered to be a member of the serpentine group. The serpentine group of minerals is the trioctahedral equivalent of the kaolin group. The black part of tool n° 255 is a clayey ferritizated mineral, with limonites. According to Nisanyan and Petrosov (1980) the main clay minerals in Paleozoic rocks from the Ararat basin (Araxes zone) are kaolinite (50-80%), hydromica (20-40%), and paragonite (20%), which is the result of deep epigenesis or metagenesis (Nisanyan and Petrosov 1980). A possible source for that mineral is the Urts anticline (Urts Ridge is part of the mountain range overlooking the Araxes valley) in the south-eastern part of the Ararat basin, about 50km south-east of Aknashen (Vedi district; Avagyan *et al.* 2015).

A particular polisher from Horizon II (Tr.1 UF5) presents a rectilinear base, but a curvilinear overall shape (Figure 9: 2). All its convex faces and sides show a high degree of polishing, generally shiny, and fine longitudinal striations. The bottom face wears two parallel longitudinal incisions along the sides, and covered by a series of fine striations. The upper face shows a wide transverse groove with a U-shaped section, completely polished by use-wear.

The third polisher in kaolinite (Horizon V; Sond.A UF10a) presents two distinct patterns of grooves on both faces (Figure 9: 3). One face is covered by three groups of transverse grooves of 'oval' morphology: two narrow curvilinear grooves on the left side of the face, three wide and long grooves in the centre of the face, and four shorter grooves on the left side. They all present fine, longitudinal and parallel striations. A white paste was clearly deposited on the surface of the shorter grooves, but some residues are also visible around the larger ones. On the opposite face, a wide longitudinal groove with covering striations occupies the bottom part; the deepest concave part is covered by a fine layer of white paste. The upper part is marked by vertical parallel grooves, crossing thin transverse striations in a checkerboard-like manner. Both sides are shaped by longitudinal abrasion, but only one convex side completely smoothed and covered by a white paste can be interpreted as an active surface.

One polisher (Horizon V; Tr.2 UF9) shows either grooves or polishing facets on all of its five faces (Figure 12). Three of the faces present abraded zones with fine dense striations; these are oriented longitudinally on the faces and transversally on the facets at their ends. Longitudinal grooves are present on three of the faces. Although of varied width, these all have a wide base and a narrow end, with subparallel sides. The grooves are of semi-circular section, and show a shiny polish and fine longitudinal striations. A white deposit, of unknown origin, is particularly developed in these grooves, and probably corresponds to a material applied during the polishing action, either for purpose of colouration or to enhance the polishing power of the action. Three other facets present a combination of polish and crossing striations, particularly dense on their ends.

Discussion

To summarize, these tools share different characteristics which make them of important symbolic, or at least, aesthetic value. First, they are made from exogenous and quite rare raw materials, different from the more common abraders. Second, they are completely shaped by fine abrasion or scraping. In some cases, it appears difficult to distinguish the striations due to shaping from those caused by use-wear. Third, they present different kinds of mineral residue. In one case, red pigments were reduced by grinding with the ends of a grooved cobble. In the case of kaolinite polishers, white residues cover the tools, and are still visible on the active zones, such as the grooves and some curvilinear surfaces, where their density is higher. In both cases, the use of colouration is clearly linked to the function and/or the symbolic aspect of the tools, though their precise function has still to be determined and avoid any further interpretation of the activities in which they were involved. The highly probable symbolic value of these tools is also suggested by the grid motif created on one of the kaolinite polishers.

As previously mentioned in Badalyan *et al.* 2010, there are very few direct comparisons to be found for these polishers in other assemblages in the southern Caucasus. As noted above, several samples were found at Aratashen (Badalyan *et al.* 2007: fig. 7c-d; Chataigner *et al.* 2014a: fig. 10) and one in Masis Blur (Martirosyan-Olshansky *et al.* 2013: fig. 6),[1] while the sharpeners on the sites of the Kura basin are rare and have a single groove (Imiris Gora, Khramis Didi Gora, Hacı Elamxanlı Tepe (Chataigner *et al.* 2014a; Hamon 2008; Kiguradze 1986; Nishiaki *et al.* 2015b: fig. 15). Thus, their higher numerical presence at Aknashen would appear to indicate more intense influences or exchanges between the Ararat valley and other regions, from northern Iran to eastern Anatolia. Some authors (Badalyan *et al.* 2007; Badalyan *et al.* 2010; Arimura *et al.* 2010) have distinguished two regional variants among grooved abraders, over a long period from the 11th millennium to the 6th millennium BC, from the Levant to western Iran. According to these authors and other recent works (Molist *et al.* 2013), longitudinally grooved abraders are more likely to be found in the Levant and western Mesopotamia, whereas in northeastern Mesopotamia and the Zagros (Zawi Chemi, Karim Shahir, Jarmo, *etc.*), they are more often transversely grooved (Solecki 1981; Howe 1983; Moholy-Nagy 1983; Matthews and Fazeli Nashli 2013). The tools found at Aratashen would correspond to the Type C defined by Vered (2013). However, similar tools are widespread from the Near East and central Europe to Central Asia (Usacheva 2013). On the basis of ethnographic examples, notably in relation to the Indians of America, they have been interpreted as straighteners for shafts that were either in wood or another rigid plant material. But other studies on Natufian grooved abraders from Near Eastern contexts have clearly established their use for bone tool shaping (Christensen and Valla 1999), which is confirmed by the discovery of one of the Aratashen samples in a functional context with a bone arrowhead (Badalyan *et al.* 2007: 52). Beyond morphological comparisons, these transverse grooves clearly share the choice of valuable and aesthetic raw materials together with decorative motifs, especially made by incision, beginning in the Natufian and the PPN (Molist *et al.* 2013). A close review of incised motifs found on seals and grooved abraders clearly illuminates their close connection with the decorated grooved abraders of Aknashen: at Masis Blur in the Ararat valley (Martirosyan-Olshansky *et al.* 2013), in the Halaf sphere at Tell Halaf and Tell Sabi Abyad (Collet and Spoor 1996), and in the middle Halaf of south-eastern Anatolia, from Level III of Tilkitepe (mid-6th millennium, in Korfmann 1982: 104, 106; figs 19: 5 and 20: 3-5). Two motifs are present in both areas: oblique narrow crossing lines and rectilinear patterns with alternation of long wide horizontal and short longitudinal striations. Such similarities in types and motifs suggest an importation of these objects from southern areas to the Araxes basin.

As a matter of fact, the adzes and grooved polishers constitutes major cultural and chronological indicators. Their study contributes to design the origin and routes taken by Neolithic people to reach Southern Caucasus, and to draw some of the cultural frontiers within this geographical area at the raise of the 6th millenium BC.

[1] The authors consider the artefact as a seal (see Badalyan *et al.* – Miscellaneous objects - in this volume).

Neolithic bone tools from Aknashen

Christine Chataigner, Ruben Badalyan and Rozalia Christidou

Introduction

The bone tools, abundant and diverse in terms of morphology and technology, constitute the major component of the bone industry of Aknashen during the 6th millennium BC. Presented here is a summary of the categories of bone tools, with morphological and typological data being used to draw comparisons between Aknashen and contemporary sites of the middle Araxes and Kura basins. The variability observed in the bone tool forms and raw materials is one of the most remarkable features of the material culture of the Aratashen-Shulaveri-Shomutepe complex. The bone ornaments are comparatively few; they are discussed in the chapter 'Miscellaneous objects' (Badalyan *et al.* in this volume).

Material and method

The bone tool collection

During the excavations carried out between 2004 and 2015 at Aknashen (Badalyan and Harutyunyan in this volume), 917 bone, horn core and deer antler artefacts were found (Figure 1). The total number of these artefacts shows a clearly decreasing trend from horizon V to horizon I, the areas excavated being equivalent. Further research is required in order to examine the influence of local dynamics concerning habitation and economy (Badalyan and Harutyunyan in this volume) on the frequency of the bone tools by horizon. The disturbance of the deposits of horizons II and III during the medieval and modern periods are not sufficient to explain sample size differences among the horizons.

Awls (or punches) are the most common class of bone artefact overall. They make up 59% to 69% of the total number of bone tools in horizons VII to III, with the exception of the collection from horizon VI, which is an abandonment phase. The proportion of awls is very high (86%) in the small sample from horizon II.

The majority of the tools recorded to date come from horizon V, which produced the most substantial remains of Neolithic occupation throughout the excavated area. In this presentation, finds from horizon VII, whose excavations are underway, are included for comparison. This horizon produced the earliest Neolithic deposits in the Ararat valley, dating to a cultural phase preceding the fully developed Aratashen-Shulaveri-Shomutepe culture (Badalyan and Harutyunyan 2014: 165–166). Together with parallels from neighbouring sites, they enable a better understanding of the local bone industry.

Most of the bone tools were recovered from various fills and spaces of the settlement. A significant number of tools (234 artefacts or 25.5% of the collection) were also found *in situ*, in clusters of similar or diverse artefacts. Bone awl clusters are the largest found at the site. They were discovered particularly in the upper part of horizon V (level V-2) and are associated with the animal skeletons lying on a fractured clay surface (Badalyan and Harutyunyan in this volume: Figure 12a-c). Tool clustering could suggest concentration of particular household activities within a limited space. Such contexts are: the group of 14 bone artefacts in Tr.1 UF9, of which 13 were awls; Tr.2 UF9 str.9 where 13 out of a total of 14 artefacts were also awls; and the cluster in Tr.3 UF9, which contained 14 awls and three other artefacts. Three perforated tools made from split ribs (Figure 8: 8-10) were also found, along with a bone spoon (Figure 13: 3), awls, burnt pebbles, stone tools and a chalcedony bead in Tr.3 UF11b F24, in the lower part

Horizon	Bone tools		Awls	
	N	*% over all bone tools*	N	*% over bone tools from the same horizon*
I	2	*0.2%*	1	–
II	36	*3.9%*	31	*86.1%*
III	133	*14.5%*	91	*68.4%*
IV	253	*27.6%*	149	*58.9%*
V	416	*45.4%*	289	*69.5%*
VI	53	*5.8%*	24	*45.3%*
VII	24	*2.6%*	15	*62.5%*
Total	917	*100%*	*600*	*65.4%*

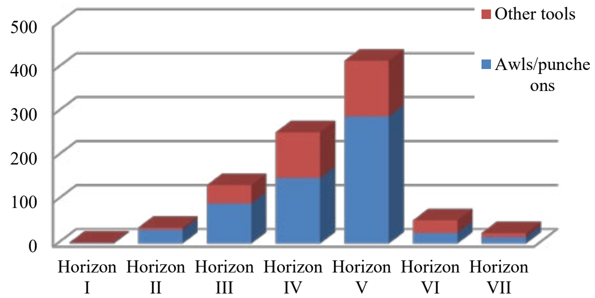


Figure 1. Total count of bone tools and bone awls from Aknashen by horizon.

of horizon V (level V-1) (Badalyan and Harutyunyan in this volume: Figure 11g-h). A scapula tool, or palette (Figure 12: 5), was associated with 13 awls as well as stone artefacts and bone tanged points in Tr.6 UF11a F22-23 of the same horizon (Badalyan and Harutyunyan in this volume: Figure 10a-c).

Method

The bone artefacts of Aknashen were recognised during the excavation and the faunal study. The skeletal and taxonomic identifications were made during the faunal analysis or by reference to osteological manuals (Barone 1986; Hillson 1992; Schmid 1972). The manufacturing marks were observed with the naked eye and with 5× to 60× magnification provided by a stereoscopic microscope available in the field. We had no access to equipment offering magnifications of 100× to 200×, which are suitable for a detailed description of microscopic marks from use-wear as well as from manufacture, present on the artefacts (see overview in Legrand and Sidéra 2007).

To classify the tools, we concentrate on their shape, in particular the shape of the active ends. We define three broad categories, pointed tools, scraping tools and the tools with flat working surfaces, then we consider standard morphological types within each of these categories. The majority of the tools belong to these categories. As in earlier studies (Badalyan *et al.* 2004a, 2010; Chataigner *et al.* 2014a), we employ the terms 'palette' and 'spoon' to describe certain characteristic tools from Aknashen. Finally, we consider picks and hammers, then unique and enigmatic objects (Figure 2).

This broad classification of the material may be refined as the study progresses and incorporates data on artefact use and production.

As discussed below, the differential use of bone materials (see also Figure 2) is a prominent characteristic of the Aknashen bone industry. These materials include long bones, scapulae and ribs from medium and large ruminants, antlers from red deer and horn cores from caprines. The diversity in raw materials and tool forms suggests that a variety of tasks were performed with these tools.

Details on the anatomical origin of the bones used as raw material and on the manufacturing processes, as well as on the metrical and morphological features of the objects, will be provided in a forthcoming paper by R. Christidou. Our study takes into account several of these data which, together with parallels from other sites of the Aratashen-Shulaveri-Shomutepe culture, allow us to propose an update of the evidence available on the bone implements of Aknashen and the Ararat valley.

Categories	Tools	Major class of raw material
Pointed tools	Awls	Long bone
	Points (tanged points, bipoints, simple points)	Cortical bone / Long bone
	Rounded points	Horn core
Scraping tools	Flat scraping tools	Rib
	Bevelled tools	Long bone / Red deer antler
Tools with flat working surface	Smoothers	Rib
	Palettes	Scapula
Spoons		Long bone
Picks and hammers	Picks	Red deer antler
	Hammers	Red deer antler
Rare artefacts	Soft hammer	Red deer antler
	Edged tool	Red deer antler
	Spinous process	Vertebra
	Notched artefact	Rib / Long bone
	Tubular object	Long bone

Figure 2. Main categories of bone tools and raw materials.

The terminology applied to bone orientation is followed for the tools that were little modified during manufacture. In all other cases, the nomenclature devised to describe the components and views of the osseous tools is employed (Camps-Fabrer and Stordeur 1979). Some terms are common to both descriptive systems but do not have the same meaning. For a tool, proximal refers to a part near the base or to the base itself. It is oriented downward in the drawings and photographs. The active end is also termed distal. The side that presents the greatest amount of modification during manufacturing is termed inferior, with a left half and a right half. The opposite of inferior is superior.

Pointed tools

The pointed forms include two distinct tool groups, the awls and the points. The *awls* are long bone fragments, longitudinal or with a complete shaft circumference in a portion of their length. They taper on one end to a point and have a plain base or an articular end of a bone or portion thereof as the base (Figure 3). The *points* have a reduced or tapered base, which takes the form of a tang in several cases, and solid rounded, oval or facetted central and proximal cross-sections shaped by working the entire circumference of longitudinal fragments of cortical bone (Figures 5 and 6). Three caprine *horn cores* with broken bases shaped into robust blunt points (Figure 7) are readily distinguishable from the rest of the pointed tools from Aknashen. We describe these tools as 'rounded points'.

Figure 3. Awls from Aknashen. The arrows in the photograph indicate the flattened and thinned metapodial halves. In the drawing, they indicate battering marks. The oblique lines on the shaft of the drawn tool represent grinding marks blunted by use [Photograph by V. Hakobyan; drawing by R. Christidou].

Awls

The upper row of the photograph in Figure 3 presents several tools made from halves of metapodials of small ruminants. During the Late Neolithic, the metapodials of these animals, mainly sheep, were the raw material of choice for manufacturing awls. The use of other species was occasional. A single tool was made from a gazelle metapodial.

Unfused and fusing metapodials were found throughout the horizons and contexts excavated, but are not abundant. Typically, the anterior and posterior faces of the metapodials were grooved with the edge of a stone tool along the midline sulcus in order to be bisected. Most often the halved distal condyle of the bone was kept as the base of the tool. Halves were also sometimes further cut to produce metapodial quarters. These blanks were used with the attached portion of the proximal or the distal epiphysis. Reduction waste is scant, suggesting intensive exploitation of the raw material. The tools were heavily used and re-sharpened. Like most of the awls from the site, the metapodial specimens were often found complete (or nearly so). Their lengths are mostly concentrated between 55mm and 70mm and indicate shortening of the blanks, which would have been at least 90mm long. There is no evidence for reduction of the lengths of the diaphyses of the metapodials during blank production.

The shaping style appears to have been extremely variable but, as a rule, the blanks were only moderately modified to taper and shape the point. The next most recognisable modification is the flattening and thinning of the anterior and posterior sides of the bone, i.e., the left and right sides of the tools, respectively. The length and amount of attrition varied. This work was done using grinding. Apart from this technique, scraping was also often used to taper the blanks as well as to re-sharpen the awls.

Other blanks recognised at Aknashen are long bone splinters and fragments with complete bone shaft circumference. These fragments are mostly from broken metapodials and tibiae of small ruminants, usually caprines. Occasionally, tibia fragments were used with the talus attached at the distal articular end. This should be discussed in relation to carcass processing for food. Caprine tibiae were the second most important source of raw material for awls as well as for scraping tools (see below).

As mentioned above, standard high-magnification analysis of micro-wear on the bone artefacts of the Ararat valley has not yet been possible. Thus the materials worked by these tools and the use modes of the tools cannot be determined. However, one can reasonably assume that the dulling of manufacturing marks and the polish developed on numerous tools are consistent with their use on soft animal and plant materials. In some cases, more detailed observations can be made using low magnification. For example, the bases of some awls bear battering marks. Associated with attrition on the tool apex, these marks suggest that the awls had served as intermediate pieces for working with indirect percussion to open slits or perforate (cf. Christidou and Legrand 2005). Use-wear marks could shed light on the ancient techniques with which the large awl corpus of Aknashen would have been associated.

The predominance of awls in the Aknashen bone tool assemblage (and especially of metapodial awls) is not peculiar to the site. It is also observed in the neighbouring Late Neolithic sites of Aratashen (Badalyan *et al.* 2007) and Masis Blur (Hayrapetyan *et al.* 2014: Fig.9: 11-13), as well as in the Kura basin, at Hacı Elamxanlı (Nishiaki *et al.* 2015b), Arukhlo (Hansen *et al.* 2007a) and Mentesh Tepe (Lyonnet *et al.* 2012).

Points

So far, 29 specimens are securely classified as points. The majority come from horizons VII, VI and V (Figure 4). Two come from horizons IV and II (see also Badalyan *et al.* 2010: 200). The production and use of tanged points later than horizon IV are also attested at Aratashen. No tanged point from Masis Blur has been published, only an illustration of a simple bi-pointed tool (Hayrapetyan *et al.* 2014: Fig. 9: 5). Elaborate and simple bi-pointed forms are markers for Late Neolithic culture in the area under study. For that reason, specific details on their morphology and dimensions are provided below.

Horizons	VII	VI	V	IV	III	II	I	Total
Tanged points	1	1	6	1	-	1	-	**10**
Bipoints	3	5	3	-	-	-	-	**11**
Simple points	-	-	2	-	-	-	-	**2**
Point fragments	-	-	6	-	-	-	-	**6**
Total	**4**	**6**	**17**	**1**	**0**	**1**	**0**	**29**

Figure 4. Points and point fragments from Aknashen by horizon.

Tanged points

With the exception of the horizon VII specimen, which is almost complete (Figure 5: 1), the other specimens are a tang and distal fragments (Figure 5: 2-6). The horizon IV specimen was reworked after the tang was broken. An almost complete tanged point from level IIc/d of Aratashen (Figure 5: 7), a parallel to horizons V and IV of Aknashen (Bălăşescu *et al.* 2010: 27), is very

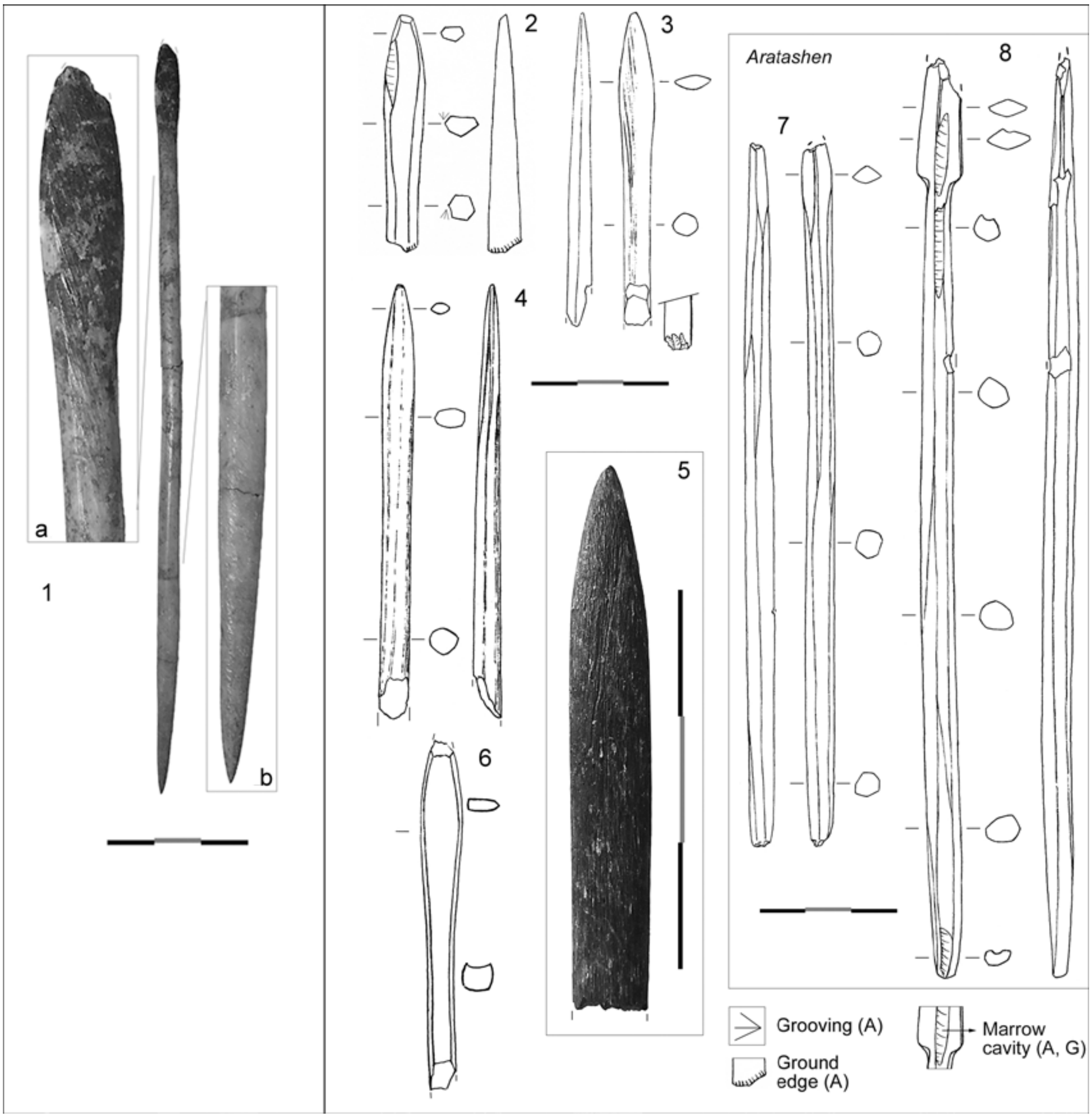


Figure 5. Tanged points from Aknashen (1-6) and Aratashen (7-8): 1) Tr.2 UF13; 2) Sond.A UF8; 3) Baulk 5/6 UF10; 4) Tr.2 UF9; 5) Tr.3 UF10; 6) Tr.4 UF11); 7) Level IIc/d; 8) Level IIb (cf. Badalyan *et al.* 2007: Fig. 6c) [Photographs and drawings by R. Christidou].

similar to the Aknashen tanged points and is helpful for determination of their shape and size. These artefacts have symmetrical forms and straight profiles. They present a very long narrow tang with sub-parallel sides that widen near the active end and form a smooth transition to it. This end, which is flat, has convex lateral edges and a sharp or facetted apex. The shape of the distal cross-section is biconvex or lozenge-shaped. In this case, a median ridge runs along both faces of the point. Also, the ridge can be present on one face and absent on the other, which appears flat or convex in cross-section. The surface is also flat or slightly bulging on both faces and a lateral side. The complete tangs from horizons VII and IV taper from the midpoint toward the proximal end. On the former specimen, this end is a sharp point and on the latter a blunt one, similar to that seen on a double-shouldered tanged point from level IIb of Aratashen (Figure 5: 8). Shouldering was not employed at Aknashen. The surface of the proximal third of the lengths of both tangs was roughened by grinding with coarse-grained abrasives. This shaping is common for the bipoints.

The tanged points appear to be long artefacts. The lengths of the horizon VII tanged point and the horizon IV tang fragment are 162.5mm and 149.7mm, respectively. Only the above-mentioned Aratashen IIb point is longer, exceeding 205mm. The maximum tang thickness measured at Aknashen is 5-6.5mm. These measurements and the presence of small portions of medullary cavity on two points (Figure 5: 2, 6) indicate use of the cortical bone of long bone diaphyses of large mammals. However, the specimen shown in Figure 5: 6 could be from an animal of medium size.

The tanged points were intensively scraped to shape them (Figure 5: 5). Any reduction marks, longitudinal grooves in particular, are thus obscured. On a single specimen, the Aknashen IV point, marks of longitudinal grooving, possibly associated with bone reduction, are preserved. The tangs of the Aknashen IV point, and another two specimens from horizon V, present old fractures with curving slope profiles, located near the midpoint of the tang or close to the distal end (Figure 5: 2-4). The reworked proximal edge of the Aknashen IV specimen suggests that such accidents could have occurred before the tools were abandoned, possibly during their use as projectile points.

Tanged points are known at the sites of the Aratashen-Shulaveri-Shomutepe culture in the Kura basin (Arukhlo, Hansen 2017: Fig. 10; Khramis Didi Gora, Kiguradze 1986: Abb. 74: 12 and 76: 22; Toyretepe, Narimanov 1987: Fig. 18; Shomutepe, Akhundov 2013: Pl. 62) as well as the Halafian level III of Tilkitepe in the Lake Van region (Korfmann 1982: Abb. 18: 7-8).

Bipoints and simple points

The bipoints are quite variable in shape and size. They usually have straight profiles (Figure 6: 1-3, 5), but a horizon V specimen (Figure 6: 4) is curved. Three specimens, one from horizon V (Figure 6: 2) and two from horizon VII (Figure 6: 3), are plano-convex. The

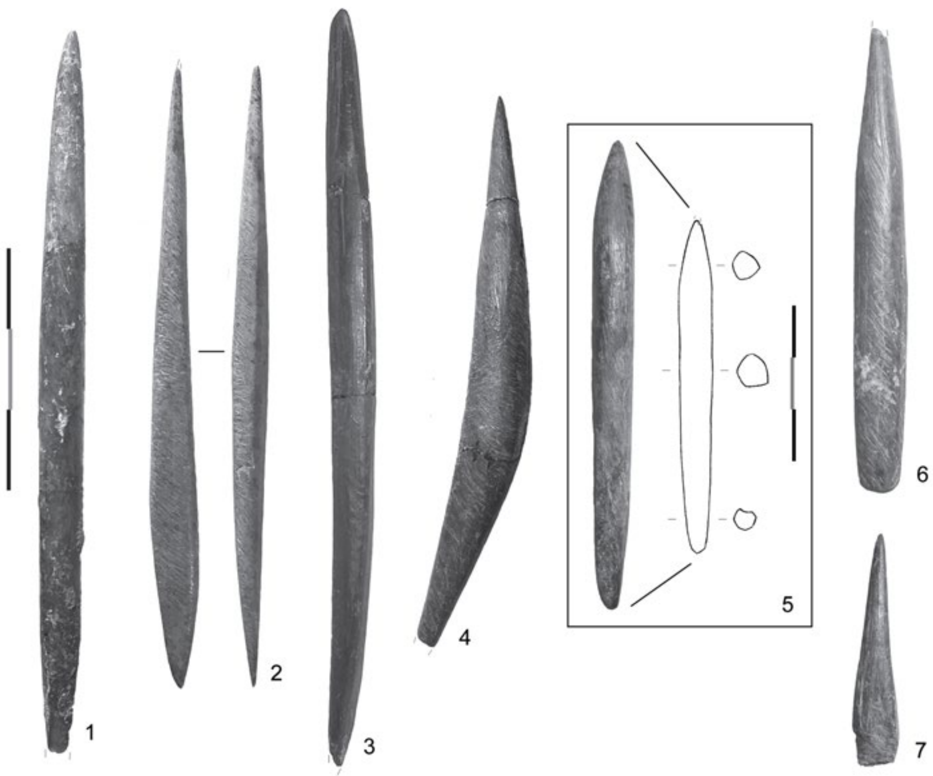


Figure 6. Bipoints (1-5) and simple points (6-7) from Aknashen: 1) Tr.4 UF11; 2, 5-6) Tr.3 UF10; 3) Tr.6 UF13; 4) Tr.6 UF11; 7) Tr. 6 UF10 [Photographs and sketch by R. Christidou].

simple bipoints tend to be shorter than the tanged specimens. The greatest bipoint length recorded is 92.1mm (Figure 6: 3), the smallest 42.1mm. Bipoints with lengths exceeding 100mm and reaching 144mm were found in levels IIc and IIb of Aratashen. The central and proximal cross-sections of the tools are rounded, oval or facetted. The proximal areas of the plano-convex specimens were flattened. The proximal tips are blunt or sharp.

All of the tools are highly modified pieces of cortical bone; reduction marks are not preserved. On three points, small portions of medullary cavity (Figure 6: 5) indicate that long bone diaphyses were the raw materials. The maximum thickness of the objects is 4.4-6.3mm, which suggests large-sized mammals or large individuals among medium-sized mammals. Like the tanged points, the bipoints were scraped and then often ground to rectify profiles and shape the proximal part. In only one case (Figure 6: 2) was the entire tool ground. Grinding is also responsible for the rough aspect of the proximal surfaces of most of the bipoints. Roughening could have facilitated wrapping or hafting. A single bipoint, from horizon VI, shows that usage smoothed and polished the shaping marks, which are less present on the distal part. The other part of the tool was probably tightly wrapped or fixed into a handle or a shaft. The other bipoints present various degrees of polish and smoothing brought about by use.

Two points from horizon V (Figure 6: 6-7) were proximally reduced but not pointed. The reduced areas were ground and roughened. The specimen in Figure 6: 6 is a re-sharpened tool; the specimen in Figure 6: 7 has a triangular shape, comparable to that of the awls. The proximal reduction was carried out quickly and indicates expediency. The object could be a recycled awl fragment.

The bipoints and the simple points could be tools with various functions. According to Russell (2016: 125), bone points could have been used for various tasks including basketry, the sewing of textiles and decoration (incising) on leather and pottery. Hansen (2017: 255 and fig. 9) has described the bipoints of Arukhlo as '*polished bone pins*' used as '*ornaments in the hair*.'

Bipoints are common in the bone tool assemblages of the Aratashen-Shulaveri-Shomutepe culture sites in the Kura basin: at Arukhlo (Hansen 2017: fig. 9), Khramis Didi Gora (Kiguradze 1986: Abb. 74: 10-11), Shomutepe (Akhundov 2013: pl. 63)... They are also present on contemporary sites of the Mil steppe, Ilanlytepe (Narimanov 1987: fig. 40) and Kamiltepe (Taha and Le Dosseur 2017: 406 and pl. 1: 1), as well as at Tilkitepe, in the Halafian level III (Korfmann 1982: Abb. 18: 6).

Rounded points

Three horn cores of caprines from horizon V were used as tools with blunt ends, of which one was a rounded point shaped on the broken lower extremity of the bones (Figure 7: 1-2). Two are from goats and have a total cranial length of between 250-270mm. One of them presents on the medial and lateral sides incised lines in chevron patterns (Figure 7: 2). The third specimen is a broken point.

It was questioned whether the worked horn cores were used as punches or retouching tools. The polish and smoothing on the best-preserved tool ends must be interpreted before consideration of their use. The same tool type is represented in level IIa at Aratashen.

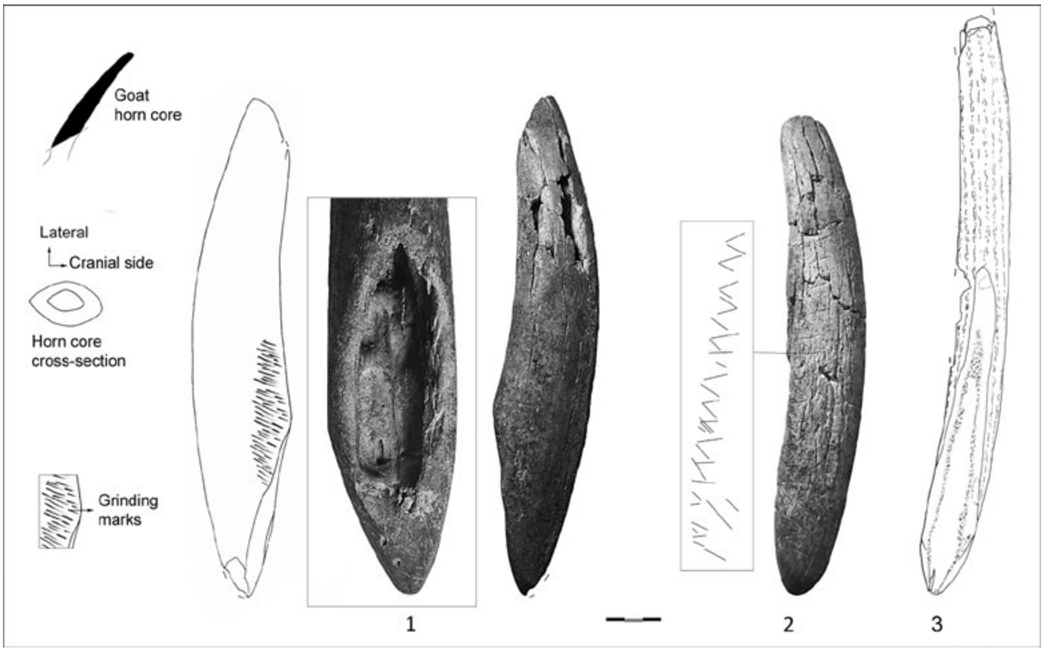


Figure 7. Rounded points cut on two horn cores from Aknashen (1-2) and an antler tine from Aratashen (3): 1) Tr.5 UF10; 2) Baulk 2/5 UF9; 3) level IIb. The insert for specimen 2 indicates the distribution of the incisions [Photographs and drawings by R. Christidou].

Levels IIc and IIb of the same site also provided red deer antler tines, which, like the horn cores, were reduced and pointed at the base (Figure 7: 3). They are longer than their horn core counterparts and reach 365mm in length.

The utilisation of horn cores and antler tines is attested at Shulaveri (Kiguradze 1986: Abb. 17: 19) and Imiris Gora (Kiguradze 1986: Abb. 38: 17) in the Kura basin. Pointed fragments of worked horn cores have been published from Jarmo in the northern foothills of the Zagros Mountains, dated to the end of the 8th and the beginning of the 7th millennium BC (Watson 1983: 356). They are considered to be retouching tools or heavy-duty awls.

Scraping tools

These tools account for less than 20% of the material. They were made from ribs (mainly from cattle), long bones and red deer antlers. The rib tools have a distinctly flat form, determined by the raw material, and are examined separately from the long bone and antler specimens.

Flat scraping tools

These tools are made from rib shafts of large mammals, mainly cattle. These shafts were cut transversely or were split (Figure 8). Due to the fragmentary state of the worked ribs from Aknashen, several pieces are difficult to classify based on the reduction and shaping styles (Christidou forthcoming). Some tools made from split ribs could have been pointed before they were broken (note the presence of such an example in Figure 8: 5) but continued to be used after they were broken at an angle and an edge was formed (Figure 8: 9-10).

Transverse fragments were used for making tools with rather wide working edges, about 18-19mm. The lengths of the working edges of the split examples range between 8 and 13mm. This group of tools provides evidence for intensive shaping by scraping. Grinding was used to correct profiles. There are examples with shaped handles and/or proximal perforations. One of these tools (Figure 8: 11) presents an incised pattern composed of opposed triangles and lozenges.

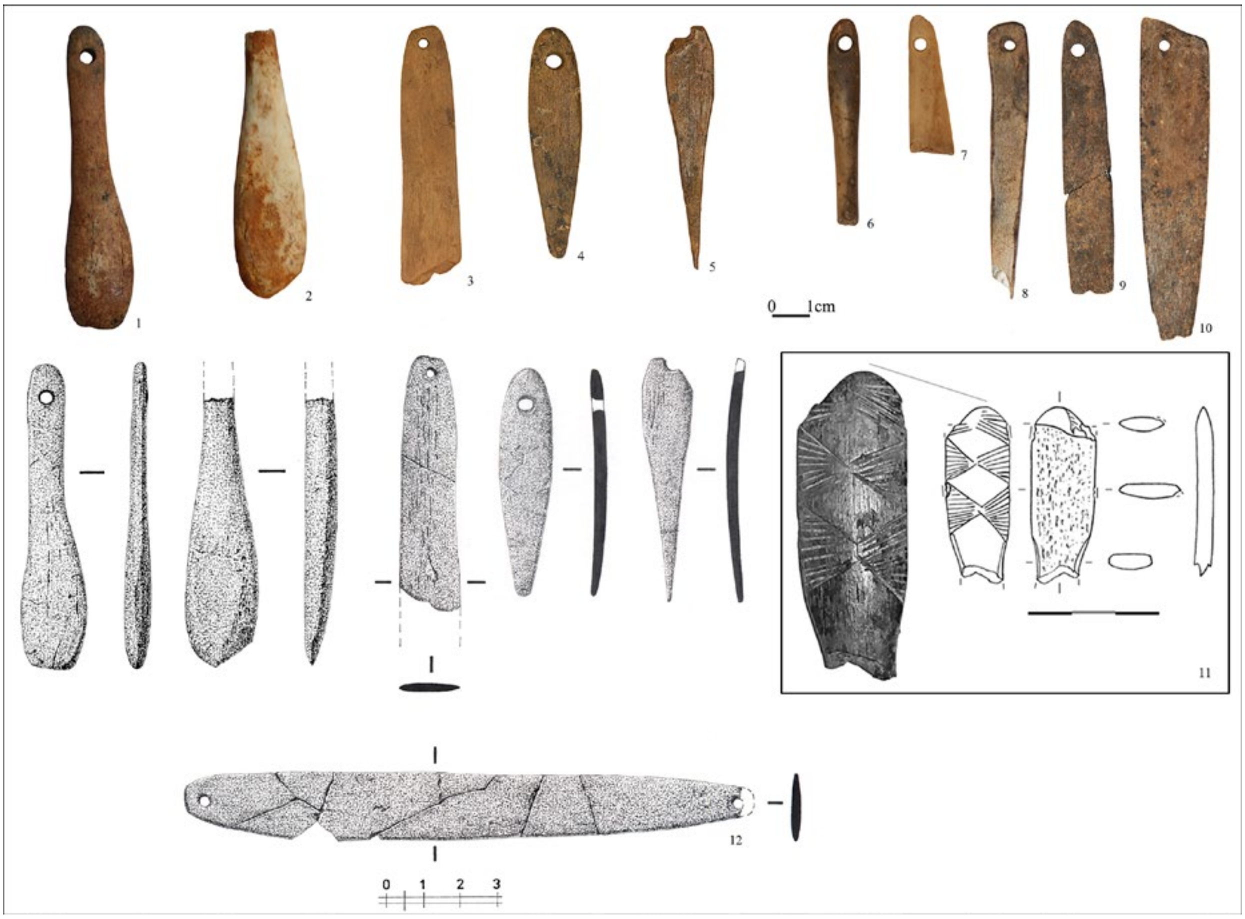


Figure 8. Flat scraping tools: 1) Tr.8 UF5 F5; 2) Tr.7 UF6a; 3) Tr.4 UF 7b; 4) Tr.4 UF 7a; 5) Tr.1 UF 7; 6) Tr.7 UF8c; 7) Tr.8 UF8; 8-10) Tr.3 UF11b F24; 11) Tr.8 UF8a; 12) Tr.4 UF 7a F7 [1-10,12: photographs by V. Hakobyan and drawings by H. Sargsyan; 11: photograph and drawing by R. Christidou].

Use-wear observed on some tools under low magnification suggests that they were used as scrapers (Christidou forthcoming). The use of the ribs for scraping, especially for hide-working (Christidou and Legrand 2005), is also known for other prehistoric sites in Anatolia and the Near East (Stordeur and Christidou 2008).

Flat scraping tools were widespread in the Kura basin, notably at Khramis Didi Gora (Kiguradze 1986: Abb. 74: 5-8, 79: 2-5) and Imiris Gora (Kiguradze 1986: Abb. 39: 1-6 and 12-14), where they are often decorated, and also at Mentesh Tepe (Taha and Le Dosseur 2017: pl. 2: 3).

Bevelled tools

This category includes long bone fragments with complete shaft diameters and transverse fragments of red deer antler that were bevelled in order to create cutting edges.

Among the long bones, caprine tibiae occur most often (Figure 9: 1-7). As mentioned above (Awls), tibial shaft fractures in the middle and proximal thirds were selected. Usually the fabrication is low-intensity for this tool group. The blanks could be recovered from among food remains or bones were broken to obtain fragments suitable for use. Then, the broken surfaces were scraped and/or ground to shape the working end of the tool. This non-specialised form of tool could be used for a variety of purposes. The study of the surface wear of the tools, experimental reconstructions and ethnographic comparisons suggest that they could be used for scraping hide or for working wood or antler (Camps-Fabrer *et al.* 1998; Choyke and Schibler 2007).

The object shown in Figure 9: 8 is of particular interest for two reasons: it was made from a long bone (radius) of a large mammal; the proximal end, on the bone's metaphysis, was hollowed. Such tools could be fixed onto a handle and used as digging tools (see, e.g.,Van Gijn 2007: 88).

The antler specimens (Figure 9: 10-11) were reduced and roughed out using percussion, then scraped and ground to finish the tool. The degree of finishing could have

Figure 9. Bevelled tools: 1) Tr.5 UF10b F18; 2) Tr.5 UF10c; 3) Tr.4 UF9b; 4) Tr.5 UF10c F19; 5) Tr.6 UF10 F7; 6) Tr.3 UF11; 7) Baulk 5/6 UF10; 8) Sond.A UF12; 9) Tr.4 UF 7a F10; 10) Tr.4 UF 7a; 11) Tr.1 UF10; 12) Tr.3 UF 7b [1-8: photographs by V. Hakobyan; 9-10,12: drawings by H. Sargsyan; 11: drawing by R. Christidou].

varied, but in general these tools are elaborate, as more than 75% of the natural surface was usually worked. It appears that fragments of the lower beam with attached burr, from shed antlers, were preferentially used. The well-preserved pieces show battering marks on the base and extensive damage, as well as reworking of the active end. They appear to have been used as chisels or wedges to work hard materials such as wood. However, at this stage of the research, it is not possible to exclude other modes of use. Similar forms of tools are also known to have been used as scrapers or de-fleshers (Van Gijn 2005).

In some cases, bevel-ended tools made from antler present transverse perforations cut for hafting the tools (Figure 9: 12). It is possible that these artefacts had more specialised uses, for example as cleavers in animal butchering. Whatever the case, the group of cutting-edge tools made from antler appears to be a distinct category.

These objects are widespread in the Neolithic cultures of the Caucasus, in particular on the sites of the Aratashen-Shulaveri-Shomutepe culture: at Shulaveri (Kiguradze 1986: Abb. 16), Imiris Gora (Kiguradze 1986: Abb. 37: 38), Khramis Didi Gora (Kiguradze 1986: Abb. 76), Shomutepe (Akhundov 2013: pl. 60-61), Gargalar Tepe (Narimanov 1987: fig. 26: 8-9), Mentesh Tepe (Taha and Le Dosseur 2017: pl. 2: 1; pl. 9: 3), Ilanlytepe (Narimanov 1987: fig. 40).

Tools with flat working surface

This category is comprised of *smoothers* made from transverse fragments of the rib shafts of large ruminants, and *palettes* made from the scapulae of mammals similar in size to the latter. The flat bones of large mammals appear to have been a choice that well served the need for broad, even working surfaces.

Smoothers

Based on the type of wear and its distribution on the tool surface, clearly visible at low magnification, as well as on the raw material and the shaping characteristics, five tools could be securely classified as smoothers. Two come from horizon VII and three from horizon V. These are complete and broken tools made from transverse fragments of cattle rib shafts (Figure 10); they present extensive polished zones associated with abundant abrasion features on the internal side of the bone. Secondary use zones are also present. For three of the specimens, the caudal side of the rib, naturally wider than the proximal, was snapped off and the blank was narrowed. The roughouts were then scraped and ground to shape ogival ends and somewhat reduce the external natural curvature of the bone on the distal half of the blanks. This modification is also observed on the proximal part of the surface of a smoother (Figure 10: 3).

The size of the smoothers varies. It is noteworthy that two of the well-preserved specimens are 145mm and 162mm long. The third measures 303mm in length. A broken smoother is about 145mm long. The use wear on the tools suggests prolonged friction against an abrasive mineral material.

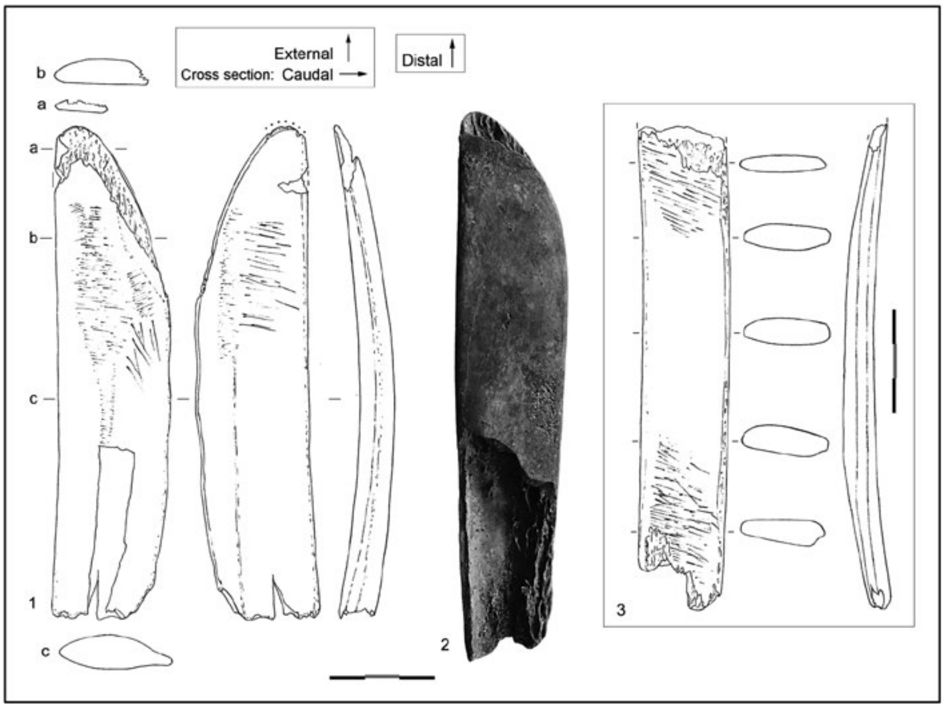


Figure 10. Smoothers: 1) Sond.A UF12; 2) Tr.6 UF11; 3) Tr.1 UF13 [Photograph and drawings by R. Christidou].

Smoothers from the 7th and 6th millennium BC occupations of Jarmo and Girikihaciyan, respectively, were associated with hide-working (Watson 1983: 362). They are defined as polishers of pottery at Çatal Höyük (Russell and Griffitts 2013: Fig. 16: 16). Abrasive mineral materials are used in a variety of tasks, including building, artefact production and hide-working. Such activities could have taken place at Aknashen. The possible uses of smoothers need careful investigation.

Palettes

Abrasion and polishing are also present on the smooth medial side of the portion of scapula blade, which was retained on the active part of the palettes. This side of the bone blank appears to have been the working surface of the tool. Tool-makers exploited the triangular shape of the scapula blades of large ruminants, cattle in particular, and prepared the active end of a palette on its broad thin proximal part and the handle on the narrow side. The palette was roughed out by severing bone from the spine and the borders of the bone. The articular end was snapped off at the neck (Figure 11: 1) or was retained as the base of the tool (Figures 11: 2 and 12: 6). The blank was scraped. Often, it was also ground locally to smooth the surfaces cut during the rough shaping. Overall, the intensity of the shaping varied.

The observations summarised above were based on a sample of twenty-two palettes, mostly fragmented. The surfaces of the handles are better preserved because the compact bone of the scapula becomes thicker and denser distally. The thin proximal part is often broken and weathered. In addition to post-abandonment damage, breakage and reuse of broken tools was observed.

There are variations in the outline and size of the original tools. The handle was typically distinguished from the active end. The transition to this end is gradual or clear-cut; in the latter case, shoulders were shaped. A palette found in horizon V is unusual; it has a rhomboid outline (Figure 11: 1). The preserved active ends are oblong or oval. There are also tools with a transverse or oblique edge, usually dull, at the end of a shaft with subparallel sides that widen near this edge. With one exception, these are reused broken handles of palettes. On the other tools, the tip of the active part is blunt, facetted, or takes the form of a short single or double bevel. In this case, the sloping surface is lateral or medial, in anatomical terms.

Teeth were sometimes formed on a lateral edge of the active part or on the shoulders at the end of the handle (Figures 11: 3 and 12: 3). The rhomboid palette presents multiple transverse densely packed incisions along one of the lateral borders of its working surface (Figure 11: 1). Their function is unclear. They are affected by use-wear as is the rest of the surface. Use-wear is clearly present along the edge of the specimen shown in Figure 11: 3, marked by shallow teeth sawn from the lateral side of the bone. It is not possible to say whether this

Figure 11. 'Subtriangular' palettes (1-5) and 'shovels/hoes' (6-7): 1-3) Aknashen (Baulk 3/6 UF9; Tr.7 UF10; Tr.6 UF11) [Photographs by R. Christidou]; 4) Mentesh Tepe (after Le Dosseur and Taha 2017: pl. 4: 1-2); 5) Çatal Höyük (after Russell 2016: fig. 2 bottom); 6) Göytepe (after Nishiaki *et al.* 2018: fig. 7: 4); 7) Khramis Didi Gora (after Kiguradze 1986: Abb. 78: 1).

edge was an active zone. Perhaps it is worn because of the prolonged contact with the worked material.

Two complete specimens were measured. They are 244mm and 248.8mm in length. There are sizeable fragments that measure longer than 128mm, some reaching 193.9mm. These data are only indicative of the size of the palettes. Handles would represent about two-thirds of the total tool length, but a fragment from horizon IV shows a rather short grip at the end of a partially preserved active end that retains the naturally triangular shape of the scapula and is less elaborate than other tools. A similar situation was observed on two palettes from Aratashen IIa. These examples are not sufficient to propose that the tool type changed through time. The greatest width of the tools suggests the existence of large and relatively narrow tools. In the first case, the width would be 112mm or larger. The other tools are 60-63mm or even only about 40mm wide. Reused fragments tend to be of the smallest size or are somewhat narrower. The tools examined were from horizon VII through horizon III.

On other sites in the wider region of Aknashen, morphological variability also becomes apparent. We use data from Aknashen as well as published information, and propose the existence of two large morphological groups of palettes, that of the '*subtriangular palettes*' (Figure 11) and that of the tools with curvilinear shapes, termed '*palettes with a rounded top*' (Figure 12).

With the former group are associated the rhomboid and oblong shapes mentioned above. Similar artefacts occur in the Kura basin, in the upper level I of Shulaveri (Kiguradze 1986: Abb.17: 20), Imiris Gora (Kiguradze 1986: Abb. 38: 22), Khramis Didi Gora (Kiguradze 1986: Abb. 74: 14 and 75: 5) and possibly at Mentesh Tepe (see fragments in Figure 11: 4; Taha and Le Dosseur 2017: Pl. 4: 1-2). Examples are also present in the Mil steppe (Taha and Le Dosseur 2017: Pl. 12 and 13: 2).

The second group is common in the Ararat valley. It is present at Aratashen (Figure 12: 6) and Masis Blur (Hayrapetyan *et al.* 2014: Fig. 9: 2). Such artefacts were found in the lower levels of Hacı Elamxanlı in the Kura basin (Figure 12: 7; Nishiaki *et al.* 2015b: Fig. 16: 4) and in the neighbouring site of Göytepe (Arai 2020: 294 and fig. 15.21). To these artefacts can be compared an incomplete active end from horizon V of Aknashen

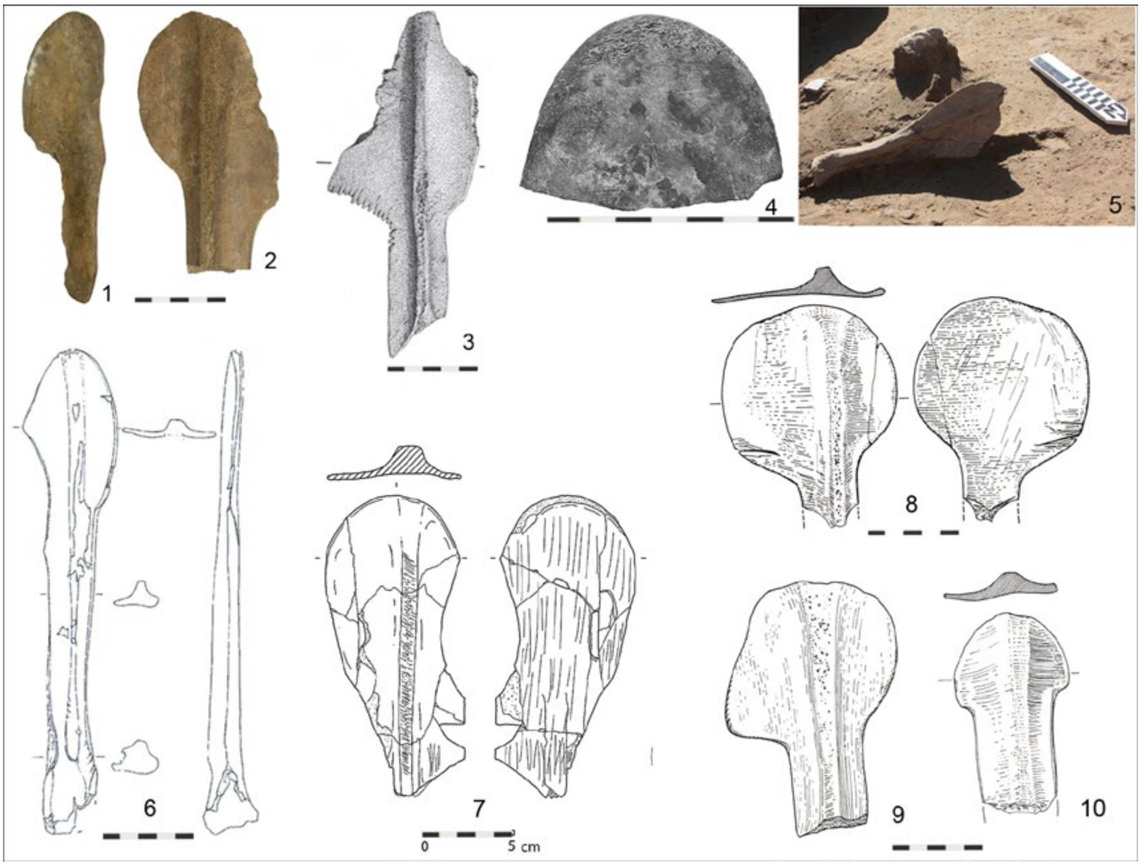


Figure 12. Palettes 'with a rounded top': 1-5) Aknashen (Tr.5 UF11a F23; Tr.5 UF11b; Baulk 3/7 UF8; Baulk 2/5 UF11; Tr.6 UF11a F22-23); 6) Aratashen; 7) Hacı Elamxanlı (after Nishiaki *et al.* 2015b: fig. 16: 4); 8-10) Tilkitepe (after Korfmann 1982: fig. 17: 3-5) [Photographs: 1-2 by V. Hakobyan; 4) by R. Christidou; 5) by R. Badalyan; drawings: 3) by H. Sargsyan; 6) by R. Christidou].

(Figure 12: 4). Other finds come from the Halafian level III of Tilkitepe (Figure 12: 8-10; Korfmann 1982: Fig. 17: 3-5).

Scapulae worked into palettes appear in Central Anatolia as early as the 9th millennium BC. They are well-represented at the Aceramic Neolithic mound of Aşıklı Höyük (Christidou 2014). They occur in small numbers in the 7th millennium levels of Çatal Höyük where they are referred to as 'plaster tools', used in a way similar to a mason's trowel (Figure 11: 5; Russell and Griffitts 2013: 290 and Fig. 16: 17-18; Russell 2016: fig. 2). On the working surfaces of the Aknashen palettes, use-wear striations often run perpendicular or oblique to the long axis of the tools and sets of striations overlap and intersect, suggesting full contact between the bone surface and the worked material and use of a sliding motion with variations in direction.

Only a few palette fragments were found in the extensively excavated 6th millennium occupations of Güvercinkayası near Aşıklı Höyük (Christidou, pers. observation). They appear to be absent from the contemporary site of Kösk Höyük, which is located further east, in the Bor Plain (Özkan 2002). The chronological and spatial distribution of palettes in Central Anatolia is not established. One cannot exclude a decline of the tool type over time. A similar trend is predicted for the Chalcolithic period in the Ararat valley (Badalyan *et al.* 2010: 200).

The palettes are different from the scapula tools termed '*shovels*' or '*hoes*', which were perforated by one or two holes and hafted at the Neolithic sites of the Kura valley, namely Göytepe (Figure 11: 6; Nishiaki *et al.* 2018: Fig. 7: 4; Arai 2020: fig. 15.22), Mentesh Tepe (Lyonnet *et al.* 2016: Fig. 6: 9), Shomutepe (Akhundov 2013: pl. 30) and Khramis Didi Gora (Figure 11: 7; Kiguradze 1986: Abb. 76: 15-16). No shovel was found at Aknashen.

Spoons

These artefacts occur in small numbers on the Late Neolithic sites of the Ararat valley (Badalyan *et al.* 2007: 49 and Fig. 6f; Hayrapetyan *et al.* 2014: 181-182 and Fig. 91: 1). At Aknashen, four spoons and a possible spoon fragment come from horizon V. An additional two spoons are from horizons IV and III. Four are complete (or nearly so) and two are fragments with attached small portions of handle.

The bowl parts of the spoons are shallow, asymmetrical, elongated and rectangular; in one case this part is roughly square, with rounded distal corners (Figure 13: 1-2, 4). There is also a specimen with a deep round bowl (Figure 13: 3). A specimen (Figure 13: 5) is broken, and the shape of the bowl (oval?) has not been reconstructed.

The transition to the handle is gradual on four specimens and sharply defined on two. The preserved handles are straight with oval cross-sections and a tapered proximal end (rectangular-bowl specimens) or with a round cross-section widening toward the proximal end, which is spatula-shaped with a small central circular hole (round-bowl specimen). The longest spoon is approximately 179mm long and has an elongated rectangular bowl (Figure 13: 2). The other example of this kind (Figure 13: 1) is 93.7mm long.

The spoons have a twisted profile that suggests the use of spiralling bone splinters as blanks for these tools. The greatest thickness was measured for four spoons: about 5.7-6mm, suggesting the use of thick cortical bone from large or medium-to-large mammals. The presence of small portions of metaphyses on the distal ends of two spoons (Figure 13: 1-2) indicates the use of long bone fragments. Neither the shapes of the bowls nor the lengths of the metaphyses preserved indicate exploitation of this part of the bones for shaping the bowls, a style known in other European regions (Sidéra 2005: 81-82). The surfaces of the spoons were scraped and made uniform. The circular hole on the round-bowl spoon was bifacially cut, as was usual at Aknashen; the deep round bowl was probably formed using a compact drill and abrasives. The bowls of the spoons present marks of shaping better than the handles, which were more or less well worn by use.

Bone spoons are considered to be a prominent feature of the Aratashen-Shulaveri-Shomutepe culture. They are known from Shulaveri (Kiguradze 1986: Abb. 16: 4), Imiris Gora (Kiguradze 1986: Abb. 38: 15), Arukhlo (Hansen 2017: Fig.11), Shomutepe (Akhundov 2013: Pl. 67: 1-2,4-6), Gargalartepesi (Narimanov 1987: Fig. 25) and Toyretepe (Narimanov 1987: Fig. 18). A spoon with a proximal perforation was found at Tilkitepe level III (Korfmann 1982: Abb. 18: 12).

Bone spoons from Late Neolithic sites of the Near East are also known. About 15 specimens were recovered from the 7th millennium BC deposits excavated at Jarmo (Watson 1983: Fig. 144: 14-20 and 145: 17-18). Most of them have round bowls. Two display oval and rather flat bowls. One handle was perforated near the proximal tip. The longest spoon of the series is 175mm long. Bone spoons were found in 7th millennium BC settlements in Anatolia (Çatal Höyük; Russell and Griffitts 2013: 290). They are a marker for the pre-Fikirtepe and Fikirtepe cultures (Erdalkıran 2015: 26-28).

Picks and hammers

Finds classified on other sites as picks and hammers occur at Aknashen and Aratashen.

Figure 13. Spoons: 1) Baulk 2/5 UF11 F8; 2) Tr.6 UF10; 3) Tr.3 UF11b F24; 4) Tr.1/4 UF6 str.2; 5) Tr.7 UF8a; 6) Baulk 1/2 UF9 F5 [Photographs black-and-white by R. Christidou; colour by V. Hakobyan].

Picks

Two red deer antler brow tines, measuring 190-200mm, were found in horizons V and VI. One is badly weathered and crusted (Figure 14: 1), the other bears hacking marks at the base (Figure 14: 2). Similar finds from the Kura basin are published as picks or digging tools (Arukhlo and Imiris Gora, Kiguradze 1986: Abb. 55: 13 and 38: 19). Similar artefacts were found at Aratashen (Figure 14: 3-4). Their bases show that they were chopped off the antler beams. They also present damage *in vivo* of the pointed end (Jin and Shipman 2010). These specimens could represent waste from antler processing. As we have already indicated, tines were employed for making tools (see 'Round points'). Sometimes, macroscopic wide furrows appear on their surface; these are damages caused by the gnawing of rodents.

Hammers

Figure 15 groups together tools from Aknashen and other sites in the area where these tools are recognised as hammers or axe-hammers. The artefacts shown in Figure 15: 1, 6 are very similar to the bevelled antler tools with a cutting working edge (see above 'Scraping tools'), the first being from horizon VI of Aknashen and the second from Hacı Elamxanlı. There are also specimens made in the same style as these latter tools, but with a transverse perforation; they do not have the cancellous interior of the bone and appear hollowed (Figure 15: 2-3). Poor preservation prevents confirmation of their use as sleeves. If this were the case, these tools would represent 'axe-hammers.'

Such tools occur at Aratashen (Figure 15: 4-5) as well as the sites of the Kura basin: at Arukhlo (Kiguradze 1986: Fig. 57: 9), Khramis Didi Gora (Kiguradze 1986: Fig. 78: 3-4), Göytepe (Guliyev and Nishiaki 2012: Fig. 9) and

Figure 14. Picks: 1-2) Aknashen (Tr.6 UF11; Tr.5 UF12); 3-4) Aratashen (layer IIc) [photographs by V. Hakobyan; drawings by H. Sargsyan].

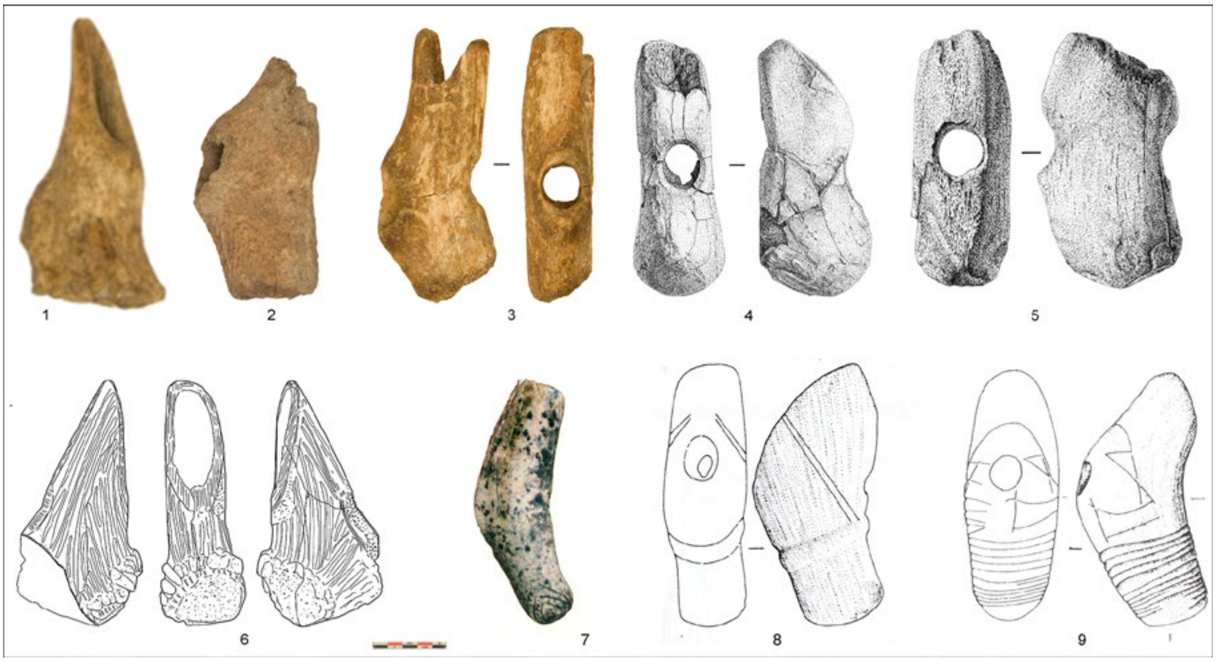


Figure 15. Hammers : 1-3) Aknashen (Tr.4 UF12; Tr.2 UF12b; Tr.6 UF8a) (photographs by V. Hakobyan); 4-5) Aratashen (drawings by H. Sargsyan); 6) Hacı Elamxanlı (after Nishiaki *et al.* 2015b: fig. 16: 5); 7) Göytepe (after Guliyev *et al.* 2009: 52); 8-9) Khramis Didi Gora (after Kiguradze 1986: Abb. 79: 8 and Abb. 80: 1).

Gargalar Tepesi (Narimanov 1987: Fig. 24: 1). Khramis Didi Gora has provided examples decorated with motifs that are incised or in relief (Figure 15: 8-9). This kind of tool is also present at Tilkitepe level III (Korfmann 1982: Abb. 17: 2).

According to Nishiaki *et al.* (2015b: 18 and fig. 16: 5), an evolution occurred between the unperforated form (Figure 15: 6), attested in the upper levels of Hacı Elamxanlı and dated to ca. 5900-5800 cal. BC, and the perforated form (Figure 15: 7), which is widespread at Göytepe, where it is dated to ca. 5650-5450 cal. BC (Guliyev *et al.* 2009: 52). At Aknashen, the two forms coexist in horizon VI.

Rare artefacts

Here we consider a number of objects that occur as single finds or in very small numbers at Aknashen. Among these items are unusual artefacts made from red deer antler and from bone.

Rare artefacts made from antler

Soft hammer

A tool with a broad active end was possibly used as a *soft hammer* for flaking stone. It was made from the burr and lower beam of a shed antler after the ring surrounding the burr as well as the brow and bez tines were chopped off (Figure 16: 1). The active part of the tool was assigned to the burr; the beam was used as a handle. The entire surface of the tool was peeled by percussion and then smoothed by scraping and grinding. Near the end of the handle, a broad shallow circular groove and a bulging ring surrounding the extremity were formed, as well as a second, semi-circular groove. It is possible that the grooves served to receive an attachment. The object measures 340mm and comes from horizon VI.

This type of tool appears to be absent or very rare in the Kura basin. A possible parallel is an incomplete specimen from Shulaveri (Figure 16: 2; Kiguradze 1986: 24 and Abb. 17: 22).

A fragment of the central part of a tool from horizon V of Aknashen, made from the antler beam or large tine of a red deer, shows complete smoothing of the cortical surface by working in a way similar to that described for the hammer. This fragment measures approximately 200mm in length. It could be part of a long handle like that of the hammer from horizon VI.

Edged tool

The upper part of the beam of a red deer antler, found in horizon VII, was shaped into an *edged tool* (Figure 16: 3). This object, which is about 410mm long, is badly weathered and details of morphology and shaping cannot be determined. However, it is clear that the upper third of the beam segment was worked to produce an edge, either cutting or blunt. The lateral edges of the tool widen toward this upper extremity, the transition of the beam to the crown being retained on the tool blank. The transverse edge is about 93mm long.

Rare artefacts made from bone

Tool on spinous process

The dorsal and caudal edges of a *spinous process* that measures 357mm in length and comes from a very large ruminant were worked by grinding. The dorsal edge was sharpened, and a transverse edge was formed (Figure 17: 1). The length of this edge, which is partly broken, exceeds 60mm. The flat shape of the tool resembles that of the ribs, but its unusually large dimensions set it apart. The length of the transverse edge is comparable only to that of the above-mentioned tool made from the upper beam of an antler.

Notched artefacts

Two *notched artefacts* from horizon V of Aknashen (Figure 17: 2-3), one made from a rib and the other from a long bone, present on one lateral edge a small semi-circular notch. They measure 290mm and 230mm in length, respectively, and come from the same context, Tr.1 UF10. A similarly notched artefact, possibly made from a scapula, was found at Arukhlo in the Kura basin (Kiguradze 1986: Abb. 55: 1) (Figure 17: 4); it is about 300mm long. The function of the notches is not yet known.

Tubular artefacts

A *tubular artefact* in the Aknashen bone collection is an almost complete diaphysis of a hollow long bone (ulna?) of a bird, found in horizon VI (Tr.3 UF12, Figure 18: 1); it is 141mm long. One of its ends is broken. The other end does not present evidence of having been worked. It shows light scaling on the cut edge, which is polished, as is the entire outer surface of the specimen. Another tube from a long bone of a bird was

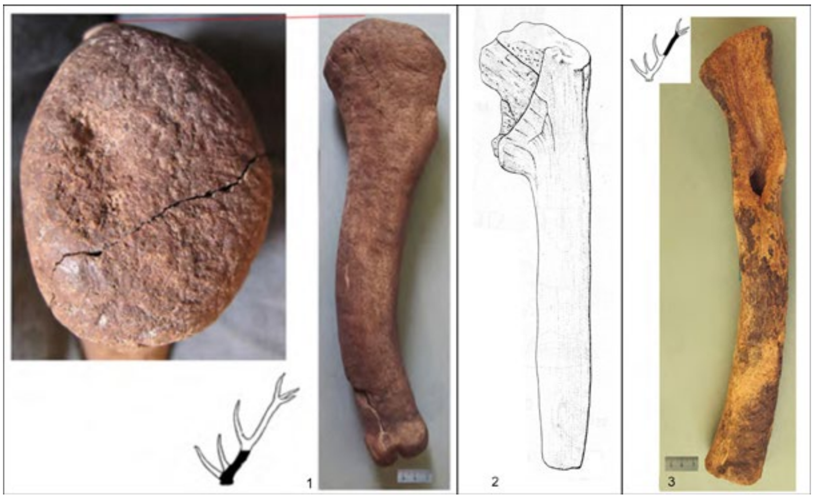


Figure 16. Unique antler artefacts: 1) Aknashen (Tr.5 UF12a); 2) Shulaveri (horizon IV; after Kiguradze 1986: Abb. 17: 22); 3) Aknashen (Tr.4 UF12) [photographs by R. Christidou].

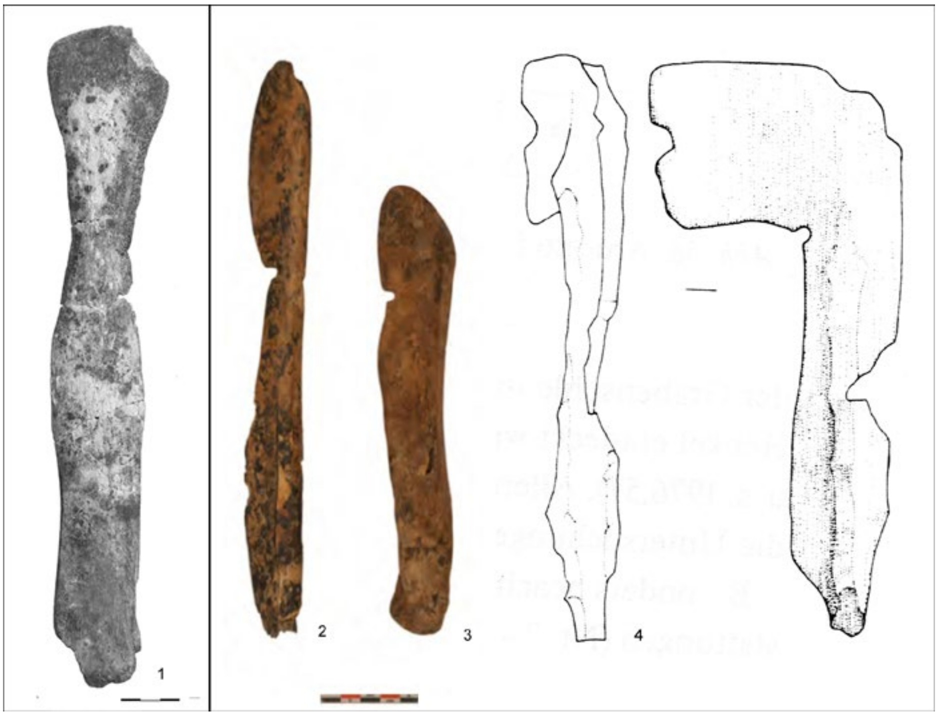


Figure 17. Unique bone artefacts: 1) Worked spinous process (Baulk5/6 UF9) [photograph by R. Christidou]; 2-3) Notched artefacts from Aknashen (Tr.1 UF10; Tr.1 UF10a F22) [photographs by V. Hakobyan]; 4) Notched artefact from Arukhlo (after Kiguradze 1986: Abb. 55: 1).

Figure 18. Tubular forms: 1) Aknashen (Tr.4 UF10a) [photograph by R. Christidou]; 2) Shomutepe (after Akhundov 2013: pl. 70: 4); 3) Aknashen (Tr.3 UF12) [photograph by R. Christidou].

found in level IIb of Aratashen. Tubular bird bones with processed ends, besides those of the Ararat valley sites, are also known for synchronous settlements in the Kura basin. In particular, cutting marks were observed on the extremities of two samples from Shomutepe (Akhundov 2013, pl. 70: 3-4) (Figure 18: 2).

The function of these tubular objects (sound-producing instrument, hunting device, item of adornment) is as yet undetermined.

The surface of a nearly complete shaft of a fox metapodial, found in horizon V (Figure 18: 3), is polished and smoothed. The specimen is about 36mm long and is broken at one end. The margin of the opposite end is completely rounded and does not preserve manufacturing marks. The medullary surface is covered with sediment incrustation and use-wear is not visible. The rounded end and the anatomical origin of the shaft differentiate it from those of the birds, which were probably from species of medium size.

Tubular beads cut from the long bones of small mammals as well as birds are known beginning in the Palaeolithic at various sites in Europe and the Near East (Maréchal and Alarashi 2008: 584 and Figs. 17: 4/6 and 17: 4/8; Pitulko *et al.* 2012: 646 and Fig. 3; Yelözer and Christidou 2020: 202-205 and Figs 2 and 3; see also Badalyan *et al.* 2010: 199 with references). Usually the bone shafts were cut into multiple pieces, and the beads made from the metapodials of small mammals are shorter than those of the Aknashen specimen. Long specimens such as the Aknashen shaft are comparatively rare. They could represent bead spacers. Further analysis is required to relate wear to function.

Conclusion

A considerable variety of tool forms is observed at Aknashen. In addition to the metapodials of caprines, cut in half and used to make most of the awls, fractures of the mid-shaft and the proximal third of the tibia of these animals were also exploited for the awls, as well as for scraping tools. The horn cores and the transverse portions of red deer antler beams were shaped into rounded points and bevelled tools, respectively. Large ribs, especially those of cattle, were exploited for their size and flatness. Smoothers and scraping tools were based on cross-cut elements. Variability in tool size and shape increases in the split ribs, which are not only associated with narrow tools, but also with unclassified fragments of larger tools. Cattle scapulas were used to directly shape large work surfaces, and long bones of birds were chosen to quickly produce tubes. The long bones of small mammals also appear to have had special uses. Furthermore, at least one tool shows the use of red deer burr to shape the active end of a soft hammer. The size of the bones used as raw material also contributed to the production of the most elaborate tools, points, spoons and split-rib tools. There were therefore close links between the shapes of the tools and the parts of the skeleton.

Several techniques were chosen to work certain bones and tools: percussion with stone edges for the antlers, scraping for the points, spoons and split rib, rough abrasion for the bases of the points. Fracturing was essential for acquiring and roughing blanks from long bones, horn cores and shoulder blades. With the exception of the worked horn cores, which are rare and whose absence in the oldest horizons may therefore reflect a low sampling bias, all other major classes of tools as well as particular types of tools, such as flat scraping tools and tanged points, appear throughout the Neolithic sequence excavated at the site and suggest a well-established tradition. Based on this evidence, we have made comparisons with neighbouring as well as more distant sites.

A similar phenomenon - the exceptional number and variety of bone implements - is a distinctive feature of all settlements of both the Aratashen-Aknashen and Shulaveri-Shomutepe groups. For almost every category of tools at Aknashen and Aratashen, stable morpho-typological analogies can be found at the synchronous sites in the Kura basin, which, among other indicators, is one of the criteria that brings them closer together. Although a number of similarities are also observed with bone implements of the later Mil plain settlements, these do not present such a diversity.

In the neighbouring region of northern Mesopotamia, where Halaf culture developed in the 6th millennium, the bone industry is also characterised by a limited number of objects and less variety in the typology. For example, at the large site of Halula in the middle Euphrates valley, the pre-Halaf period (ca. 6300-6000 cal BC) is represented by 260 bone artefacts, whereas the Halaf levels have provided only 32 objects (Taha *et al.* 2017: 55). At the Halafian site of Girikihaciyan in the upper Tigris valley, only three categories of bone artefacts are represented: awls, flat scraping tools, and bones with deep parallel notches (Watson and Leblanc 1990: 87-94). The site of Tilkitepe on the eastern shore of Lake Van, whose lower level (III) provided pottery characteristic of the Halaf culture (Korfmann 1982), is thus an exception, because its bone industry is exceptionally varied, including in particular types (palettes 'with a rounded top') that are widespread in the Ararat valley. This suggests close contacts between the sites in this valley and Tilkitepe, contacts that are confirmed by the presence of Meydan Dag (Gürgürbaba) obsidian at Aknashen (Gratuze *et al*. in this volume).

Miscellaneous objects from Aknashen

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Ernst Pernicka and Rozalia Christidou

In this chapter we present a series of artefacts and ecofacts, that reflect the utilitarian and non-utilitarian spheres of the life of the population of Aknashen. These are mainly adornments – beads and pendants in natural materials (bone, teeth, shells, minerals) – the quantity and diversity of which constitute one of the specific features of the complex of Aknashen that clearly distinguishes it from the neighbouring, contemporary settlement of Aratashen, giving it a more 'living' character.

One particular category consists of several unique objects that possess a clearly social significance: a stone stamp-seal and cones in clay (tokens). Finally, a relatively important series, probably related to activities of production, concerns fragments of different minerals, which served, it appears, to obtain colours, as well as discs fashioned from pottery sherds.

All these materials reflect not only the aesthetic preferences of their owners, but also their relations with the world around them and their familiarity with natural resources, as much from nearby regions as well those relatively distant.

Beads and pendants

Beads in antigorite

The discoid beads in antigorite[1] (a mineral of the serpentine group) constitute the largest group numerically: 418 examples were discovered between 2004 and 2015, measuring 0.3 to 0.6cm in diameter and *ca.* 0.1cm in thickness with a cylindrical perforation (Figure 1).

Figure 1. Antigorite beads: 1) from horizon IV (Building 3, Baulk5/6 UF7 F1); 2) from horizon V (Baulk2/5 UF11 F7).

These beads were found in all the horizons of the settlement from the oldest (VII) to the most recent (I); however their stratigraphic and planigraphic distribution is very irregular[2] (Figure 2). Although the finds tended to be sporadic, the absolute majority of beads (73%) came from two concentrations. In horizon IV (Building 3, Baulk 5/6 UF7 F1) on a surface measuring 40 x 25cm, 118 beads were found together (Figure 1: 1); in horizon V (Baulk 2/5 UF11 F7) on a surface measuring 30 x 20cm, 201 beads formed a compact assemblage (Figure 1: 2).There are no data that enable definition of a reason for these concentrations (caches? places of production?). It must also be noted that relatively high numbers of beads (eight examples) were found as much in the eastern part of Building 1 in horizon IV (Tr.5

[1] The determination was carried out in the laboratory of the Institute of Geological Sciences of the Academy of Sciences of the Republic of Armenia. The antigorite in the studied sample was determined by applying optical microscopy based on the optical properties of the mineral. The resolution of the method was increased by placing the sample in an immersion liquid with a high refractive index. Antigorite is characterised by a flat crystalline appearance, while most similar minerals of the serpentine subgroup are characterised by a fibrous appearance.

[2] The excavations of 2016-2019, during which the number of recovered beads reached one thousand, showed that their quantity clearly tends to be higher in the lower horizons.

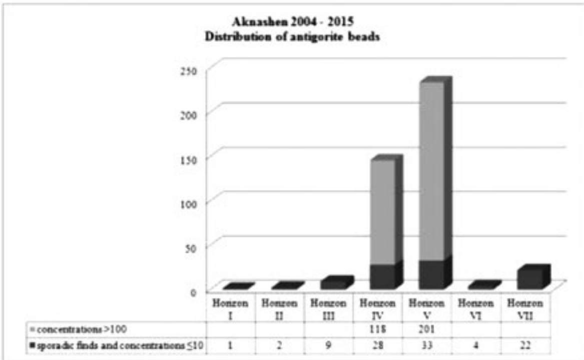


Figure 2. Distribution of antigorite beads according to the horizon.

UF7b) as in an open-air work area in horizon V (Tr.8 UF8a) (see Badalyan and Harutyunyan in this volume). Although the quantity of beads may suggest that their production took place on the site, no phase in the *chaine opératoire*, in the form of fragments of raw material or unfinished objects, has been discovered.

Similar beads have been discovered on all the contemporary sites excavated in the Ararat valley, however their quantities vary quite significantly. Thus in level II of Aratashen only ten examples of these beads (Badalyan *et al.* 2007) were found.[3]

The potential source of antigorite for these beads, the geographically nearest source (about 50km away), could be the ridge of Urts, on the southern flank of the valley of the Vedi, a tributary of the northern bank of the Araxes.

Tubular beads in bone

The beads made from the tubular bones of birds or other animals (22 examples in all) come from horizons III, IV, V and VI. These finds are sporadic and not related to precise contexts. A relative density of these beads is observed only in the ruins of buildings built in cob in horizon IV (Tr.2 UF8a), where four complete examples and a few fragments were found (see also Chataigner *et al.* this volume: 210 and figure 18: 3).

These beads are relatively varied: next to smooth cylindrical beads (length from 6-8 to 13-16.5mm, diameter between 3.6 and 6mm), numerically in the majority (Figure 3: 1-7), some grooved examples (length 9-18mm, diameter 4-5mm) (Figure 3: 8-9) were found in horizons III and IV.

According to A. Bălășescu, these beads were made from metapodial diaphyses of *Lepus* (Figure 3: 1, 3, 4), diaphyses of undetermined animals (Figure 3: 2, 6-8) and hollow long bones of birds (Figure 3: 5).

Copper bead

Finally, a third category of Aknashen beads is represented by a single example, a highly oxidized copper bead,[4] discovered in horizon V in an undisturbed context, a stain of ashes (hearth) filled with organic material, charred bones and fragments of obsidian (Sond.A UF10 F5). It consists of a fragment of a cylindrical bead made from rolled metal leaf (diameter 0.4-0.6cm) (Badalyan *et al.* 2010: 199).

Figure 3. Beads from the tubular bones of animals and birds: 1-3) Horizon V (1:Tr.4 UF10; 2:Tr.3 UF10; 3:Tr.2 UF10); 4-8) Horizon IV (4:Tr.6 UF8a; 5-8: Tr.2 UF8a); 9) Horizon III (Tr.4 UF6a).

[3] Before mineralogical studies were carried out, these beads were identified visually as being made of paste.

[4] A previous publication (Badalyan *et al.* 2010: 199) mentioned a copper ring fragment, discovered in a child's tomb in Tr.7; this object must be excluded from the elements of Neolithic body ornaments, because of a revision of the dating of the tomb by radiocarbon analyses.

Fifty-seven similar beads weighing between 0.37 and 0.72g each (total weight 12.55g), rolled around a slender stem, formed a bracelet 6cm in diameter, discovered *in situ* at Aratashen (level IIb) (Badalyan *et al.* 2007). These beads are in native copper, practically pure chemically (with only some insignificant natural impurities) (Meliksetian *et al.* 2007).

In the South Caucasus, such beads have been found on 6th-millennium sites belonging to the Shulaveri-Shomutepe culture: Khramis Didi Gora, Gargalar Tepe (Kavtaradze 1999), Arukhlo (Lyonnet *et al.* 2012: 84, fig.127; Steiniger 2017).

This type of bead belongs to a tradition widespread on Neolithic sites of the Near East between the beginning of the 8th millennium and the end of the 6th millennium, at which point it disappeared (Schoop 1995).

Pendants made from animal teeth and bones

The following category of body ornaments consists of a series of pendants made from teeth of domestic and wild animals (herbivores and carnivores) as well as their imitations in bone, and of rare pendants made from mollusc shells and fish vertebrae.

These pendants were found in almost all the horizons of the site (II-V, VII), however most came from horizons IV and V, which are the richest in many ways. These finds are sporadic and not related to specific situations. Some samples of pendants, both from teeth and their bone imitations, were specially investigated by R. Christidou.

Pendants made from teeth

The pendants of the first group were made from the canines and incisors of *Sus domesticus / Sus scrofa* (4 ex.), *Bos taurus* (2 ex.), *Vulpes vulpes* (2 ex.), *Canis* (1 ex.), and one unidentified *Carnivora* (1 ex.) (according to the determinations of A. Bălășescu) (Figure 4).

The absolute majority of these pendants possess a perforation near the extremity of the root; in two pendants made from wild boar canines, there are two perforations (Figure 4: 1-2). In only one case, a transverse groove was made, not a perforation (Figure 4: 5).

The root of the canine of the dog size carnivore (Figure 4: 10) is wider buccolingually. This was exploited to bore biconically a hole at a distance of about 5.5mm from the apex. Lopsided cone profiles and uneven cone rims suggest use of a hand-held perforating stone tool. Although the walls of the cones are manganese coated, discontinuous grooves indicating incomplete rotation of the tool are perceptible. The tooth was not further worked. The crown and the root above the level of the perforation were split on the mesial side. The broken surface does not show smoothing and polish that would suggest use after the damage. Use polish is visible on the rims and the inner ridges of the perforations. These areas are also rounded on the apical side. This wear sweeps over the rims on the outer surface of the pendant but fades quickly. It suggests that the hole was used to hold thread.

Pendants made from animal teeth are known at Arukhlo (from a bear tooth; Hansen *et al.* 2006: Abb. 54; Hansen 2017: 255, fig. 8), Gadachrili Gora (boar canine; Batiuk *et al.* 2019: 16), Mentesh Tepe (from wild boar

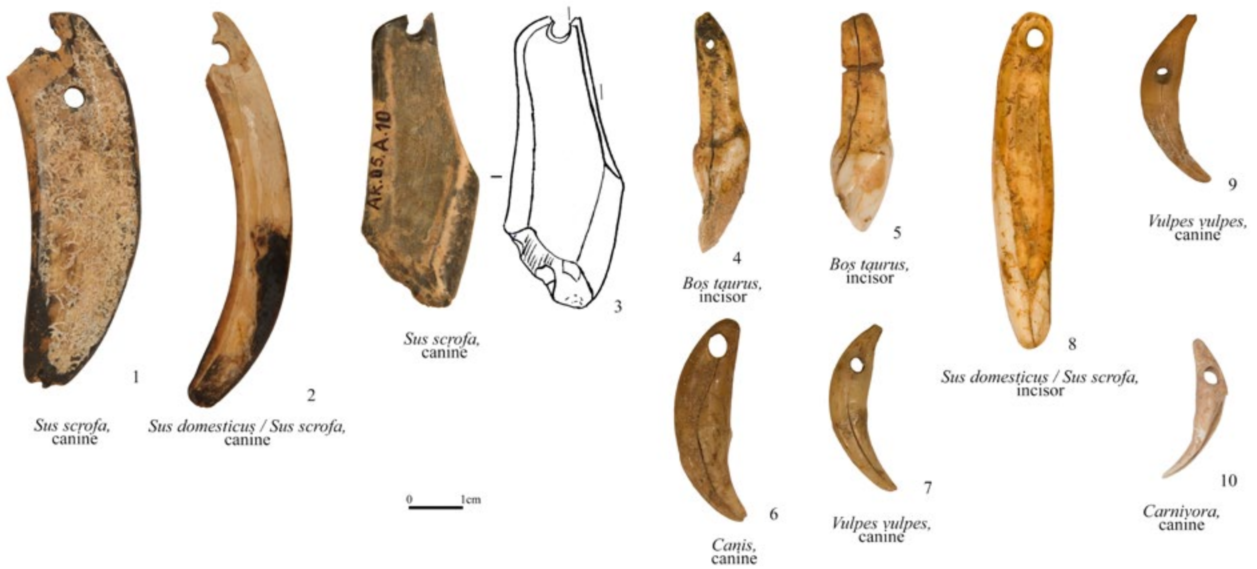


Figure 4. Pendants made of animal teeth. 1-3) Horizon V (1: Tr.5 UF9b F15; 2: Tr.7 UF8b; 3: Sond.A UF10); 4-7) Horizon IV (4: Sond.A UF8; 5: Tr.1 UF7c; 6: Tr.6 UF7c; 7: Tr.8 UF5); 8) Horizon III (Baulk1/2 UF6); 9) Horizon II (Tr.6 UF5 F1); 10) Tr.5 cleaning.

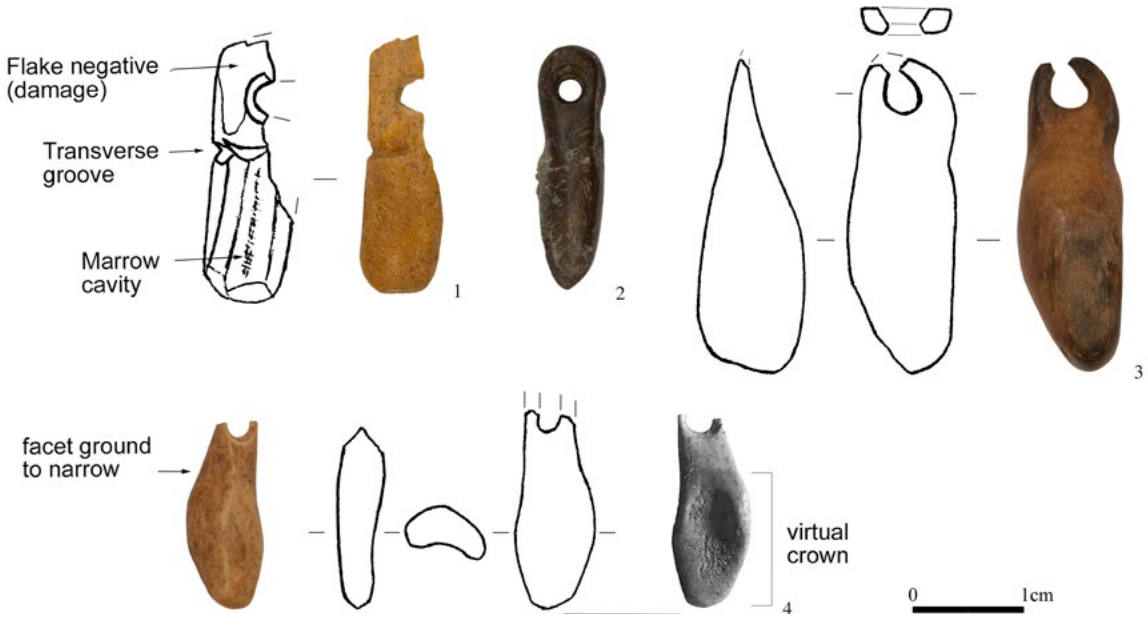


Figure 5. Pendants made of animal bone. 1-2) Horizon IV (1: Sond.A UF7; 2: Baulk2/3 UF8); 3-4) horizon V (3: Tr.2 UF10 str.11; 4: Tr.8 UF8a).

canines and an incisor of a ruminant with a transverse groove; Taha and Le Dosseur 2017: 401, pl. 8: 3,5,6) and Kamiltepe (MPS 1) in the steppe of Mil (made from wild boar canines; Taha and Le Dosseur 2017: 407, pl. 13: 3).

Pendants in bone

The pendants of the second group are in bone (Figure 5). They have a teardrop shape, but at least two of them (Figure 5: 3-4) imitate the canines of red deer.

A pendant made from a linear fragment of a large mammal long bone comes from horizon IV (Figure 5: 1). It is about 24mm long and 7.7mm wide and has a vertically oriented asymmetric shape divided by a transverse groove into two parts of unequal lengths. The shortest part, which is partially broken, was perforated by a circular biconical hole using a hand-held stone tool. The artefact was thoroughly shaped and does not preserve reduction marks. It was scraped and flattened on the medullary side. The split edges of the bone fragment were also probably scraped. Scrape marks are preserved on the left side of the perforated part. Both lateral edges of the non-perforated part were ground obliquely to the bone grain at the end of the shaping. The cortical surface of the bone fragment, naturally convex in cross-section, was also ground but not flattened. All ridges including the left side of the perforated part were blunted. The grinding followed the cut of the transverse groove. It is not possible to say if this mark was shaped before or after the scraping. Grinding was also employed to cut small facets at different angles and round the end of the non-perforated part of the pendant.

The deer canine imitations are abstract representations of the tooth. Both come from horizon V and are broken at the level of the perforation. There is a small specimen (Figure 5: 4) measuring about 19mm in length. Its greatest width is 10mm with a thickness of 5mm. It was made from a linear fragment of a medium size mammal long bone. It preserves the medullary cavity on the widest part of the object, which, seen in plan view, simulates the bulging crown of a deer canine. When the object is viewed in profile, the root is thicker than the crown.

The crown is apprehended in both the plain and side views of the large specimen (Figure 5: 3), which is nearly complete. This object measured about 29mm in length. Its greatest width is about 10mm with a thickness of 11mm. It was made from a thick piece of compact bone, probably from the shaft of a long bone of large mammal. The part representing the root was bevelled on one side. On the other sides, the root is separated from the crown by shallow concavities. On the small copy, two rounded obtuse angles were cut to indicate the transition to the root. They were not put at the same distance from the virtual occlusal end of the tooth. Thus the crown is clearly asymmetric in plan view. On the large copy, a bevel with rounded profiles was cut to show asymmetry. The holes were put on the root parts as on the real deer canine pendants. The root of these teeth is buccolingually compressed and the axis of perforation runs in this direction. This form of root was obtained for the small imitation by choosing a long bone shaft fragment with a width measuring twice the thickness. On the large specimen, it was obtained by bevelling. In this case, the bone fragment was extremely thinned. Both pendants exhibit biconical perforations, but the large specimen shows that a cone was first cut deep and the opposite was simply used to widen the opening and complete the perforation.

The large imitation is very polished and manufacturing marks cannot be observed under low magnification. The small specimen preserves grinding marks on the split edges and the outer side of the bone fragment. On this side, oblique facets were ground in order to reduce the bone and to complete the shaping of the abovementioned obtuse angles that differentiate the crown from the root. The grinding striations became dull during the use of the object.

In conclusion, with the exception of the perforated canines of carnivores, at least two tooth pendants are schematic representations of deer canines. To create these representations the artisans exploited both natural characteristics, especially the size of the bone fragments, as well as technical means such as bevelling and notching. Although the pendants were schematic, their wearers recognized analogies between the shaped and the real teeth. The specimens examined correspond to the imitations of Type 1 defined by Choyke (2008), since they were cut from raw materials readily available on the site. It has been suggested that in contexts where both real teeth and copies were used, rudimentary representations could be a means to distinguish between users of copies and real teeth (Yelözer and Christidou 2020: 215).

Similar pendants, also considered according to the authors to be imitations of deer canines, were found on sites MPS 4 and MPS 5 in the plain of Mil (Taha and Le Dosseur 2017: 407, pl. 13: 3; Lyonnet *et al.* 2012: 10, fig. 12; Heit 2017: 79, Abb. 7: 2,4,5).

Pendants made of shell or fish vertebra

The pendants of this group consist of only a few examples. They were fashioned from *Conus* sp. shells, the apex having been sawn (horizon III, Tr.7 UF4; Figure 6: 1), from *Spondulus* sp. (horizon IV, TR.2 UF8a T2W5; Figure 6: 3) or from the vertebra of a large *Silurus glanis* (horizon III, Tr.5 UF6; Figure 6: 2).

The latter pendant may be compared to similar objects in the contemporary complex of Mentesh Tepe (Taha and Le Dosseur 2017: 401, pl. 8: 1-2), and perhaps to one from Gadachrili Gora described as a 'bone button or whorl' (Batiuk *et al.* 2017: fig. 13d) and another from Shulaveri, supposed to have been used as a 'spindle whorl' (Batiuk *et al.* 2019: 16).

It must be emphasized that some of the pendants mentioned above for comparison (made from animal teeth and fish vertebrae) came from a funerary context (collective tomb of Mentesh Tepe; Lyonnet and Guliyev 2017: 131; Pecqueur *et al.* 2017: 175).

While the *Silurus glanis* lived in the area around Aknashen (Bălășescu and Radu in this volume), the presence of *Conus* and *Spondylus* shells on the sites of the Ararat valley and in the South Caucasus is evidence for the implication of the population in a network of contacts, enabling the circulation of exotic materials and thus of evidently prestigious materials. In particular, pendants made from *Conus* shells were found on many Neolithic sites in Anatolia and the Levant; they came mainly from the Mediterranean Sea (Bar-Yosef 2005), but some originated from the Red Sea (for instance, at Çayönü; Bar-Yosef Mayer 2017: 2 and fig. 3).

Pendants made from mineral material

The pendants made from minerals are also rare.

One lozenge-shaped bead/pendant in chalcedony (3.2 x 3.2cm, maximum thickness 0.9cm) with a cylindrical perforation made from both sides is certainly contemporary to the layer in which it was found (horizon V, Tr.3 UF11b F24). This bead had been polished, one surface is flat, the other is gable. In the semi-transparent mineral, in the light, a fault in the bilateral drilling can be clearly seen: the holes made from each side are slightly out of line (Figure 7: 1).

A bead, similar to this one in shape, dimensions and material, comes from the Hassunan site of Yarimtepe I (Munchaev and Merpert 1981: 136, fig.41). Beads of this type spread across the Fertile Crescent from the end of

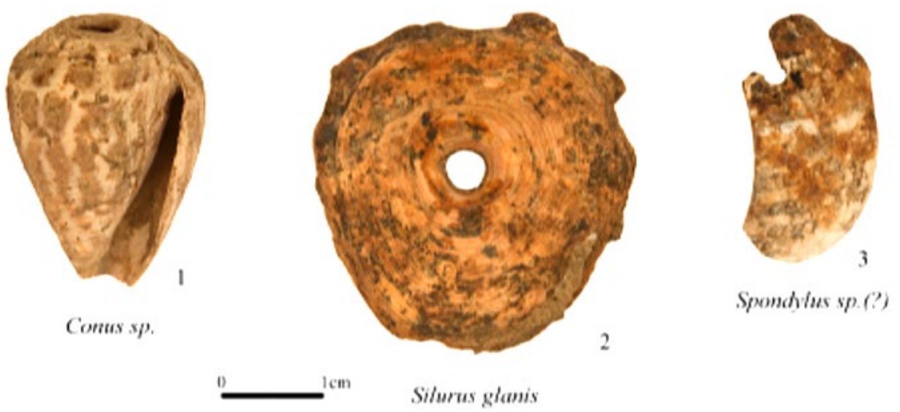


Figure 6. Pendants from shells and vertebrae. 1-2) Horizon III (1: Tr.7 UF4; 2: Tr.5 UF6); 3) horizon IV (Tr.2 UF8a T2W5).

Figure 7. 1) Rhomboid pendant/ bead in chalcedony, horizon V, Tr.3 UF11b F24; 2) Anchor/ ax-shaped pendant in jasper, horizon II, Tr.11 UF4 str.2.

the 9th millennium (Kozlowski and Aurenche 2005: 186; Alarashi 2016).

The second pendant in mineral material is one in jasper in the shape of an anchor or an axe (Figure 7: 2), which comes from horizon II (Tr.11 UF4 str.2). It was discovered in the layer of very compact tamped earth, obviously of natural origin, which covers all the surface area of the excavation between the depths of 1.85 and 2.02m. This pendant (3.2 x 2.4cm, thickness 0.9cm) has no exact parallel among the Neolithic objects known to us, although it bears some resemblance to the 'headless female figurines' from the synchronous (6200-5450 cal. BC) settlement of Domuztepe (Carter *et al.* 2003: fig.12). Given the large number of intrusions of different periods which occurred in this horizon in general and in Tr.11 in particular, the determination of the age of this object requires additional research.

Stamp-seal, stone segment and clay cones

Distinguished from the objects examined above, which are elements of personal adornment, is a group of artefacts which all come from the earliest horizon (horizon VII) and have no parallels in the levels above. It is possible that these finds, or some of them, should be considered in a context of social relations.

Stamp-seal

This object is a unique 'stamp-seal'(Tr.1a UF14; Figure 8), in the form of a block of rectangular polished ophiocalcite (?) (5.1 x 2.9 x 1.5cm), slightly concavo-convex, the concave face presenting a figure '8' motif which is carefully sculpted (Badalyan and Harutyunyan 2014). The finishing, the balance, the rhythm of the motif and the sharp contour of the block distinguishes it from stone objects having bundles of parallel strokes and/or grid/lattice, which have open and amorphous contours. The latter, including the object of Masis Blur called a stamp (Martirosyan-Olshansky *et al.* 2013: fig. 6; Hayrapetyan *et al.* 2014: 181, fig. 8*)*, should be integrated into the category of polishers (Hamon *et al.,* in this volume).

The object from Aknashen (horizon VII) can be generally attached to the category of 'decorated rectangular plaquettes' (Kozlowski and Aurenche 2005: 31). It has no equivalent among the objects of the Aratashen-Shulaveri-Shomutepe culture. Nor does it have direct parallels, to our knowledge, in the contemporary complexes of the Near East; however, a general iconographic resemblance can be observed with a serpentine seal with slightly convex sides from Domuztepe (Campbell *et al.* 1999: fig. 14: 5) and with a similar object from Amuq-Judaideh phase B (Braidwood and Braidwood 1960: fig. 66: 6-7), both dated to the end of the 7th millennium.

Figure 8. Stamp, horizon VII, Tr.1A UF14.

Clay cones and stone segment

The objects in this category, in contrast, belong to a group of artefacts that are well known in the geographic and chronological context under consideration. It consists of a small series of clay cones (one complete example and two fragments; Tr.2 UF13c F36, F41), fashioned in very pure clay that was carefully refined and lightly fired; the complete example measures 3.1cm in height and 1.7cm in diameter at the base (Figure 9). The cones come from an area of ash that contained blocks of burnt clay, fragments of bone and obsidian, in one of the habitations of horizon VII.

In the culture of Aratashen-Shulaveri-Shomutepe, similar objects have been found, in particular at Khramis Didi Gora (Kiguradze 1986: Abb. 82: 12-15), Imiris Gora (Kiguradze 1976: 155) and Arukhlo (Hansen *et al.* 2006: Abb. 57), but also on the MPS 4 site in the steppe of Mil (Lyonnet *et al.* 2012: 10, fig. 13). Clearly these objects belong to the 'geometric objects' or 'tokens', widely spread over time (10th/9th – 7th/6th millennia) and space (Near East) (Schmandt-Besserat 1977; Kozlowski and Aurenche 2005: 235).

It is possible that a segment in dark green stone (3.0 x 1.3cm), found with the stamp-seal, also belongs to this assemblage (Figure 10).

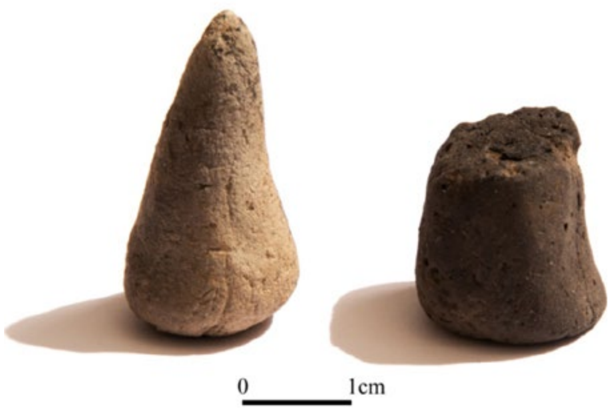


Figure 9. Clay tokens, horizon VII, Tr.2 UF13c F.36 and F41.

Figure 10. Segment, horizon VII, Tr.1A UF14.

It is perhaps worth noting that, in spite of their morphological similarity and even their identity, the functions of the seals and the 'tokens' could have been different in specific historical situations in the Near Eastern Neolithic, from one site to another (Costello 2011: 248).

Pottery discs

The discs made from pottery sherds make up one of the categories of artefacts characteristic of the Aknashen complex (Harutyunyan 2014).

During the excavations of 2004-2015 at Aknashen, 16 discs were recovered (7 whole, 9 in fragments) and an oval fragment, perhaps a side-scraper or a polisher. The circular pottery discs are flat, sometimes slightly concave, their diameter varying between 2.8 and 6cm and their thickness between 0.75 and 1.25cm (Figures 11 and 12).

The perforations were apparently made from both sides, as the size of the holes on the upper and lower faces is 1 to 2mm larger than the holes themselves, the diameters of which vary from 3.9mm to 9.4mm, depending on the size of the artefact. Ten examples have complete perforations in the centre of the object (sometimes slightly out of line), on three others the perforation was not completed and a cavity is present on the interior side. The other discs are either not perforated or existing fragments are too small to determine the presence of a perforation.

The edges of most of the discs had been well reworked and polished; one example with an uncompleted perforation has roughly worked edges that only provide a crudely rounded shape (Figure 11: 5), clearly reflecting an initial stage of production.

Almost all the discs are made from fragments of vessels of the Grit-tempered II group, one example from horizon II having been fashioned from a sherd of imported pottery (Figure 11: 1). This is a compact homogenous sherd made from fine clay, light yellow-green in colour (pale yellow 5Y 8/2). The edges are highly polished. Such sherds belong to vessels that were decorated with dark grey or dark brown painted motifs.

Naturally, the stratigraphic distribution of these pieces corresponds to the stratigraphy of the pottery as a whole; 6 discs come from the upper level of horizon V, where pottery appears for the first time, including the Grit-tempered II group; five examples were found in horizon IV, where the pottery of this group predominates, two in horizon III and three in horizon II.

Among the discoveries recorded, only two were found *in situ* (horizon V, Tr.8.UF 8), within a concentration of tools in stone and bone and of fish vertebrae (F 14) in Building 11.

Although ceramic discs are few in number, the available artefacts reflect all the successive stages of production, from a sherd chipped on the edges with a hole at the beginning of perforation to the finished object with the edges polished and a hole in the centre (Orelle *et al.* 2012: 649).

For some reason such discoveries have not been recorded as such in the publications on Neolithic sites in the South Caucasus. The only parallel, found in illustrations, is from Arukhlo (Kiguradze 1986: Abb. 54: 3). In the Near East, their numerous parallels, traditionally defined as spindle whorls or weights, are known beginning in the Natufian period; they are particularly widespread in the Halaf period, next to conical and biconical spindle whorls in clay (Lloyd *et al.* 1945: Plate X: 1-12; Munchaev and Merpert 1981: 133, fig. 39; 230; Arimura *et al.* 2000: 251; Kozlowski and Aurenche 2005: 257).

Another tool made from a sherd of the Grit-tempered II pottery group comes from horizon III (Figure 11: 3). This is an oval object with the same polished edges, although it is evident that its purpose is different from that of spindle whorls. It was perhaps used as a polisher or end-scraper. Experimental analyses using pottery sherds in different regions have demonstrated the possibility of using them at different stages in the working of hides (Borodovskiy 1996; Shamanaev and Zyryanova 1998; Shamanaev 2001; Molodin *et al.* 2012). Often pottery with an addition of sand in the composition plays the role of an abrasive scraper during the cleaning of hides by removing the fat. It should be noted that the pottery of the Grit-tempered II group contains much sand as well as grog (pottery waste products). In all cases, the question of the function of the object remains open.

Minerals

In this section we discuss the archaeological finds of malachite, azurite, hematite and galena minerals from the Neolithic settlement of Aknashen.

Malachite and azurite

The most abundant mineral finds are represented by malachite and azurite – 80% of the total number

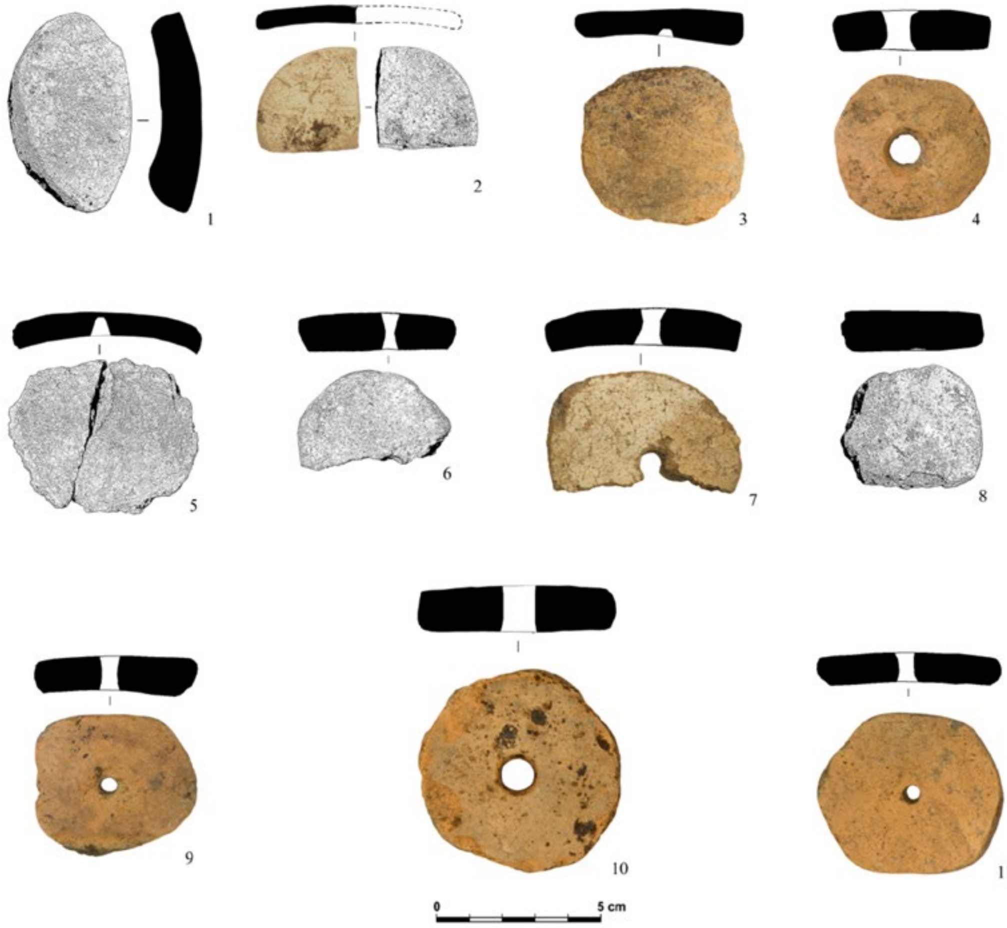


Figure 11. Discs made from pottery sherds: 1. Scraper/polisher, horizon III; 2-11. Spindle whorls (2-3: Horizon II; 4: Horizon III; 5-7: Horizon IV; 8-11: Horizon V; see Figure 12).

	Code number	Horizon	Ceramic group	Shape	Integrity (%)	Dimensions, mm	Sherd thickness, mm	Hole diameter (outer – core -inner, mm)	Unfinished drilling, d/ depth (mm)	Weight (g) fragment/ reconstitution.	Outer surface colour	Inner surface colour	Color of core (ext. margins)	Color of core (int. margins)	Color of core	Abrasion	Fig.11 : #
polisher																	
0	Ak.07. Tr.7.3	II	Grit II	'oval'	100%	61.3x37.1	10.6-16.3			36	light brownish gray 10YR 6/2 -reddish yellow 7.5YR 6/6	brown 10YR 5/3	light brownish gray 10YR 6/2 -reddish yellow 7.5YR 6/6	brown 10YR 5/3	gray Gley 1 5/N	+++	1
spindle whorls																	
1	Ak.06.A`.5	II	Grit II	rounded square	100%	50x53.2	7.5-10.8		5.0/3.25 drilling from inside	30.5	brown 7.5YR 5/2 - light brown 7.5YR 6/4	brown 7.5YR 5/3	light reddish brown 5YR 6/4	light reddish brown 5YR 6/4	greenish gray Gley 1 5/1	+	3
2	Ak.06. Tr.2.5	II	import (Halaf)	'rounded'	25%	r-28	5.0-6.5	traces		7.3 / 29.2	pale yellow 5Y 8/2	pale yellow 5Y 8/2			pale yellow 5Y 8/2	++++	2
3	Ak.05.A.6	III	Grit II	'rounded'	100%	45x42	10.7-12.5	11.2 - 9.1 - 11.3		24.7	light brown 7.5YR 6/4	brown 7.5YR 5/4	light brown 7.5YR 6/4	light brown 7.5YR 6/4	gray Gley 1 5/N	+++	4
4	Ak.07. Tr.1.6	III	Grit II	'rounded'	30%	d ≈ 60	8.0-9.0	≈ 9.0		10 / 33.3	reddish yellow 7.5YR 6/6	reddish yellow 5YR 6/6			grayish brown 10YR 5/2	+++	
5	Ak.15. Tr.11.5	III	Grit II	'rounded'	55%	40	8.0-9.0	7.0-6.0-6.5		10.9 / 19.8	light yellowish brown 10YR 6/4	light yellowish brown 10YR 6/4			gray 10YR 5/1	++++	
6	Ak.09. Tr.1.7a	IV	Grit II	'rounded'	20%	d≈64	11.8-12.6	traces		11.2 / 56	dark grayish brown 10YR 4/2	reddish yellow 5YR 6/6	reddish brown 5YR 5/4	reddish yellow 5YR 6/6	dark reddish gray 5YR 4/2	+++	
7	Ak.09. Tr.1.7a.F5	IV	Grit II	'rounded'	50%	d-57.7	8.4-9.56	≈ 7.3		21.3 / 42.6	pale brown 10YR 6/3 - pale yellow 2.5Y 8/2	light brownish gray 10 YR 6/2	pale brown 10YR 6/3	pale brown 10YR 6/3	greenish gray Gley 1 5/1	++	7
8	Ak.11. Tr.2.UF7	IV	Grit II	rounded rectangle with unfinished edges	100%	58.6x48.6	6.8-9.8		6.8/5.0, drilling from inside	27	brown 10YR 5/3	dark grayish brown 10YR 4/2	light brown 7.5YR 6/4		dark gray Gley 1 4/N	0	5

	Code number	Horizon	Ceramic group	Shape	Integrity (%)	Dimensions, mm	Sherd thickness, mm	Hole diameter (outer – core -inner, mm)	Unfinished drilling, d/ depth (mm)	Weight (g) fragment/ reconstitution.	Outer surface colour	Inner surface colour	Color of core (ext. margins)	Color of core (int. margins)	Color of core	Abrasion	Fig.11 : #
9	Ak.11. Tr.7.UF 5-6	IV	Grit II	rounded	50%	d-48.6	9.0-10.5	traces		16 / 32	pale brown 10YR 6/3 - light brown 7.5YR 6/4	light brownish gray 10 YR 6/2	light brown 7.5YR 6/4		dark gray Gley 1 4/N	+++	**6**
10	Ak.12. Tr.8.7	IV	Grit II	'rounded'	40%	d≈35	8.5-10	≈.5		4.3 / 10.75	light brown 7.5YR 6/4	light brown 7.5YR 6/4			dark greenish gray Gley 1 4/1	+++	
11	Ak.05.A.9	V	Grit II	rounded rectangle	100%	41.5x46.9	8.36-11.1	4.26		23.6	brown 7.5YR 5/3	black Gley 1 2.5/N	light brown 7.5YR 6/4		dark gray Gley 1 4/N	+++	**9**
12	Ak.12. Tr.7.8b	V	Grit II	'rounded'	29%	r-19.2-21.6 d≈50	6.3-8.0	9-10.0		6.1 / 21	grayish brown 10YR 5/2	reddish yellow 5YR 6/6			reddish yellow 5YR 6/6	++++	
13	Ak.12. Tr.7.8b	V	Grit II	rounded rectangle	100%	43.4x38	9.8-11.4		3.7/0.1, drilling from inside	21.3	pale brown 10YR 6/3	grayish brown 10YR 5/2	light yellowish brown 10YR 6/4		dark gray Gley 1 4/N	++	**8**
14	Ak.12. Tr.8.8.F14	V	Grit II	rounded rectangle	100%	53.5x47.6	8.0-8.8	5.0-3.9-7.0		28	light yellowish brown 10YR 6/4	dark gray 10YR 4/1			dark gray 2.5Y 4/1	+++	**11**
15	Ak.12. Tr.8.8a	V	Grit II	'rounded'	100%	57x60	14-15	12.4-9.5 -13		58.7	pale brown 10YR 6/3	very dark gray Gley 1 3/N	light yellowish brown 10YR 6/4		dark gray Gley 1 4/N	++	**10**
16	Ak.14. Tr.7.9.F6	V	Grit II	'rounded'	15%	50	10	8		3.5 / 23.3	pale brown 10YR 6/3	light reddish brown 5YR 6/4			light reddish brown 5YR 6/4	++++	

Figure 12. List of the ceramic discs.

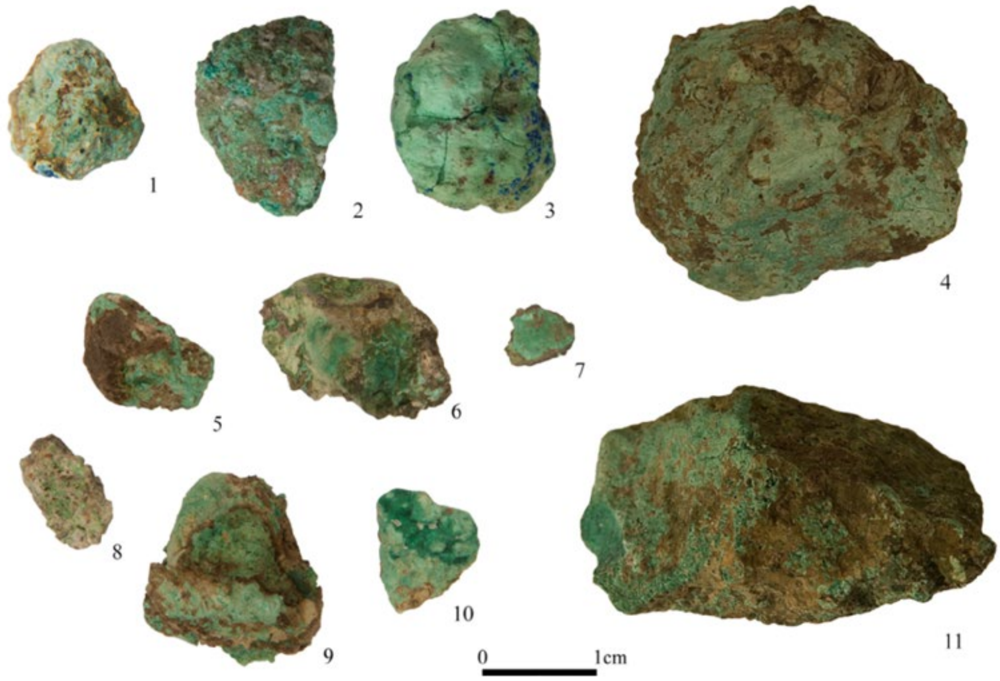


Figure 13. Malachite fragments: 1) Horizon VII (Tr.2 UF13a F42); 2-4, 6, 11) Horizon IV (2: Baulk2/3 UF9; 3: Tr.1 UF7f; 4: Tr.4 UF7b F9; 6: Baulk2/5 UF7; 11: Tr.8 UF5); 5, 7-10) Horizon V (5: Tr.2 UF9 str.1; 7: Tr.7 UF8b; 8, 10: Tr.8 UF8a; 9: Tr.2 UF9a F18).

of recorded examples of mineral finds. Examples of malachite and azurite were found in almost all horizons (II – V, VII) of the excavated settlement. The richest horizons are IV and V, where 75% of the mineral finds were discovered. The latest are mostly represented by detritus of small grains weighing between 0.1 and 3.1g. Relatively large pieces, weighing 17 to 20g, are recorded only in horizon IV (Figure 13: 4,11; Badalyan *et al.* 2010). The spatial distribution of these minerals shows that they occurred sporadically.

Malachite is a copper hydroxycarbonate, its chemical formula being $Cu_2[CO_3](OH)_2$. There were fragments of the host rocks (grey, brown, pinkish conglomerate aggregates) as well as brown-coloured iron hydroxide minerals (goethite, hydrogoethite and lepidocrocite) found in association with finds of malachite at Aknashen. The malachite is in the form of bright green, grass-green or dark green aggregates. The other copper hydroxycarbonate known at Aknashen is the bright blue mineral azurite ($Cu_3[CO_3]_2(OH)_2$), represented by several small pieces. Both malachite and azurite are common copper minerals that are formed in the oxidation zones of primary copper and polymetallic sulphide deposits; in many cases both occur together.

Two samples of malachite from horizon IV of Aknashen were analysed by INAA (Instrumental Neutron Activation Analysis) using the analytical procedure of Kuleff and Pernicka (1995). The results of these analyses are presented in Figure 14. In addition one malachite sample from the Aratashen Neolithic settlement near Aknashen (6km NW) was analysed for lead isotope compositions. All analyses were carried out at Curt-Engelhorn-Centre Archaeometry, in Mannheim, Germany.

The compositions of the analysed malachite samples reveal the following geochemical characteristics: a relatively high nickel content (300-900ppm) compared to Armenian volcanogenic massive sulfide (VMS) and porphyry ores (Meliksetian and Pernicka 2010), a high lead content (0.2-0.9 wt%), and of particular interest, a very high arsenic content (4.8-11.0 wt%). In relation to the high nickel content, such geochemical characteristics are known in ores situated within regional ophiolite belts, such as the Sotk deposit in Armenia (Magakyan 1986; Meliksetian and Pernicka 2010) and those of Ergani Maden, Siirt-Madenköy and others in SE Turkey (Akinci 2009 and references therein).

The lead isotope composition measured for a single malachite specimen from Aratashen ($^{208}Pb/^{206}Pb$=2.0575; $^{207}Pb/^{206}Pb$=0.8266; $^{208}Pb/^{204}Pb$=38.9940;$^{207}Pb/^{204}Pb$=15.6650; $^{206}Pb/^{204}Pb$=18.9520) is a perfect match with the lead isotope signatures of copper ores from the Ergani Maden copper deposit in SE Turkey (Wagner *et al.* 1989).

In archaeology, finds of malachite are particularly important as it is usually presumed that copper was first smelted out of malachite using a simple process of

Sample	MA110576	MA110577
Orig. Sample #	Ak-09.Tr.5 UF 8a	Ak-09.Tr.4 UF 8b
Cu %	83.5	94.2
Fe %	4.34	0.68
Co	231.8	<100
Ni	825	397
Zn	<2000	<2000
Pb	9420	1850
Bi	<100	<100
Sn	108	69
As %	11.1	4.9
Sb	<50	51
Se	74	<50
Te	<50	<50
Ag	58	<50

Figure 14. Chemical composition of the analysed malachite specimens. Concentrations of Cu, Fe, As in all samples are given in weight percentage, all others in ppm.

reduction with charcoal (Rostoker 1975: 311). Malachite contains up to 72% copper oxide; the discovery of the metallurgical process of smelting copper out of malachite is considered to have been accidental (Tylecote 1976). However, malachite was known and widely used in the Neolithic for adornment, amulets and pigment. In the culture under consideration, finds of malachite and azurite occur on sites of both the Araxes (earliest level IId of the neighbouring Aratashen settlement, Badalyan *et al.* 2007), and the Kura river basins (Arukhlo; Lyonnet *et al.* 2012: 85, fig. 128). For the 10th-6th millennia BC, numerous finds of malachite are known from Neolithic settlements in the Near East, the Armenian highlands, Anatolia and the Balkans (Tylecote 1976; Pernicka 1990; Schoop 1995; Munchaev and Merpert 1981; and others).

Galena

Another mineral discovered during the excavations at Aknashen is galena (two examples, horizon III, Tr.1 UF6 str.4 –cob structure in two sections, weight 22.0g, Figure 15: 1; horizon V, Tr.6 UF11, weight 2.4g, Figure 15: 2). Galena, lead sulfide (PbS), is the principal lead ore, but also an important source of silver, extracted using cupellation (Bayley *et al.* 2008). Galena has a dark silvery metal luster and during the Neolithic was used as a decorative material - beads made of galena were found in Level IX (*ca.* 6400 BC) at Çatal Höyük (Sperl 1990) and a bracelet (most likely of lead?) was found at Yarim Tepe I (Munchaev and Merpert 1981); it was also used as a pigment. Sometimes this lead ore was used in its mineral form (Hassuna Ia, Çayönü) (Schoop 1995).

Galena is a very common mineral in many polymetallic deposits of various origin, in flank mineralisation zones of VMS deposits (such as Alaverdi, Shamlug), epithermal gold deposits (such as Sotk) and Cu-Mo porphyry deposits such as Kajaran (Magakyan 1986); it is known in the South Caucasus, the Armenian highlands, NW Iran and Anatolia.

Hematite

Two pieces of hematite, iron oxide (Fe_2O_3), were found in horizon V (Tr.3 UF10, weight 12.7g, Figure 15: 4; Tr.6 UF10, weight 8.9g, Figure 15: 5). Hematite has a brownish-reddish colour and in prehistory was used as a pigment and as a decorative stone (Pernicka 2013). As is the case for other minerals found at Aknashen, hematite finds are also common on the Neolithic sites of Anatolia and the region (Pernicka 1990). Hematite is a fairly common mineral in almost all Armenian and regional iron ore deposits.

Examples of the iron hydroxides of limonite and goethite were discovered in horizon VII (Tr.1a UF14, weight 1.0g, Figure 15: 3).

Traces of minerals on the ground

Besides abundant finds of minerals in the form of pieces, they were also found as smears and traces on the ground. The dark cherry colour and chemical composition (basically iron + a small amount of SiO_2) of the samples, which were taken from the floor of building 1 of horizon IV (Tr.4 UF7a), suggest that these smears and traces represent hematite-based pigment.

Figure 15. Different mineral fragments: 1) Horizon III (Tr.1 UF6 str.4); 2, 4-5) Horizon V (2: Tr.6 UF11; 4: Tr.3 UF10; 5: Tr.6 UF10 F1); 3) Horizon VII (Tr.1a UF14).

This is not a natural form of hematite, but was probably reduced to a powder with an addition of clay, as the analysis indicates a content of 4-7% SiO_2. To confirm this assumption, it should be mentioned that in nature, aggregates of hematite having a red or cherry colour are very rare, but if the mineral is crushed to a powder, it always presents a dark cherry, dark violet or dark red colour. Finally, the reduction to powder of minerals is also indicated by a series of stone tool finds presenting visually identifiable traces of malachite (Gevorkyan 1980) and ochre (Hamon and Meliksetian in this volume).

The appearance of bright coloured minerals (mostly malachite) in early farming settlements of the Fertile Crescent is attributed to a change in colour preferences during the transition from the Palaeolithic, when ochre was widely used, to the use of minerals such as malachite, azurite and hematite in the Neolithic (Pernicka 2013). The use of native copper and ore minerals such as malachite, azurite, galena and hematite on Neolithic sites of the Near East is usually interpreted as an indication of a high degree of knowledge of ore minerals and an awareness of their sources in Neolithic early farming communities, before the development of smelting techniques later in the 5th millennium (Schoop 1995; Yalçin and Pernicka 1999; Lehner and Yener 2014).

Conclusion

To summarise, it should be noted that the assemblage of the small objects of Aknashen presented here contains all the categories typical of the cultures that are temporally close. Also to be noted is that among the categories of artefacts described (pendants, beads, etc.) there are no obvious types, characteristic of the culture studied. The composition of this assemblage, as well as the morphology of the objects in each category, is generally characteristic of the Neolithic of the South Caucasus and of the Near East. Moreover, the chronological framework of the existence of some of the above listed categories goes far beyond the 6th millennium BC, from the PrePottery Neolithic B (9th-8th millennia) to the Bronze Age (4th-2nd millennia). For example, pendants made of perforated canines (*canine*) of wild boars and canids have been recorded in several PPNB sites in the Euphrates and Tigris valleys and in the Levant (Alarashi 2014), as well as in the Kura-Araxes culture, in settlements (Gegharot;[5] Shengavit, Simonyan 2013: fig. 8: 5-6) and burial complexes (Elar, burial 37 (Khanzadyan 1979, fig. 56); Tandzaver / Kare ktur (Xnkikyan 2002: 21, plate III: 28); Amiranis Gora, burial 38 (Chubinishvili 1963: Table X: 11); burial 1 of Zagli I cemetery in North Ossetia (Rostunov 1988: 23, 28, fig. 16: 6); later - in the inventory of Martkopi kurgans 1 and 4 and Magaro (Japaridze 1998, fig. 3: 15, Table III, fig. 16: 122, Table XIX, fig. 46) and among Martkopi (?) materials of Sos Höyük (Sagona *et al.* 1995: 213, fig. 15: 3-4)).

Pendants of *Silurus glanis* vertebrae are found in the Early and Late Bronze layers of the Gegharot settlement (Badalyan *et al.* 2014: fig. 15: 21).

Conus shells are attested, in particular, in the elite burials of the Trialeti-Vanadzor culture of the Middle Bronze Age – in the Big Karashamb burial mound (Oganesyan 1993: 29, table XXV: 7) and burials 77, 78 and 94 of the Lori Berd cemetery (Devedjian 2006: 138, figs. 94: 9; 96: 4; 112: 8).

One of the latest series of finds of ceramic cones - token – comes from the Kura-Araxes settlements of Nakhichevan (Ashurov 2014: pl. IV).

The only difference of Aknashen assortment from the Near Eastern ‘standard’ lies in the absence of anthropomorphic figurines, which are present to varying degrees in the synchronous settlements of the Kura basin (Khramis Didi Gora, Arukhlo, Gargalar Tepe, Göytepe).

In this assemblage, a special place is occupied by the evidence for the knowledge of copper ore, both in its natural form (which permits various methods of utilisation) and in the form of copper artefacts. The latter, as well as those discovered at Aratashen and on the contemporary sites of the Kura basin, represent the earliest experiments in metallurgy for the region, in the present state of our knowledge.

The assemblage of small objects found at Aknashen is also evidence for a more or less active use of both local and regional resources, which reflects direct and/or indirect contacts with the surrounding world. Among all the possible directions, the links appear to point towards the south-west (malachite).

[5] Project ArAGATS excavations (co-directors R.S. Badalyan and A.T. Smith), materials are not published.

Animal subsistence economy at the Neolithic site of Aknashen

Adrian Bălășescu and Valentin Radu

Introduction

Archaeological excavation of the site of Aknashen was carried out between 2004 and 2015. A large quantity of faunal material, more than 45,600 remains (156.6kg) was sampled throughout this period (Figure 1). The fauna came from six horizons (H VII to H II), dated by radiometric (14C) and cultural data to the Late Neolithic (*ca.* 6000/5950 - 5450/5400 cal BC) (see Badalyan and Harutyunyan in this volume; Chataigner *et al.* – Bayesian analysis – in this volume).

We have excluded horizon I (H I) from our analysis because it is very poor in fauna and a risk of contamination exists because of much stratigraphic disturbance in this level. We also eliminated the material from uncertain archaeological contexts which could contain mixed remains from different cultural horizons.

The fauna of Aknashen is extremely important for understanding the mode of subsistence and exploitation of the environment by the Neolithic communities of Armenia, because there are very few studied sites in this region. Aratashen, for example, situated 6km north-west of Aknashen, is the only contemporary settlement for which archaeozoological studies have been published (Badalyan *et al.* 2004a, 2007).

The zoological analysis of a sample taken during the 2004-2009 excavations at Aknashen was presented at the international conference Archaeozoology of Southwest Asia and Adjacent Areas (ASWA), which took place at Al Ain (United Arab Emirates) (Vila *et al.* 2017). Another article, published in 2010 (Bălășescu *et al.* 2010), brings together the same faunal data obtained between 2004 and 2009. In these two scientific contributions, the archaeozoological information from Aknashen was presented in comparison with that of the site of Aratashen. Also, the information on the animal palaeo-economy of Aknashen was integrated into the general publication of the archaeological research at Aknashen (2004-2009) produced in the same year by the research group of the Caucasus mission (Badalyan *et al.* 2010).

In the present contribution we have assembled all the faunal data studied up to the present (2004-2015), including the data published earlier (Vila *et al.* 2017;

a) NISP (number of identified specimens)

Class/horizons	*VII*	*VI*	*V*	*IV*	*III*	*II*	*Total*
Molluscs				1			1
Fish	2	22	930	77	14	3	1048
Reptiles	1		9	2	2	1	15
Birds		3	3	7	3		16
Mammals identified	1608	1669	10770	5771	1543	531	21892
Medium mammals, unidentified	1354	1428	9416	5861	1827	742	20628
Large mammals, unidentified	159	277	678	325	451	112	2002
Total fauna	3124	3399	21806	12044	3840	1389	45602

b) Weight in grams

Class/horizons	*VII*	*VI*	*V*	*IV*	*III*	*II*	*Total*
Molluscs				2			2
Fish	1	8	337	71	8	2	427
Reptiles	2		14	4	3	4	27
Birds		14	14	11	2		42
Mammals identified	10344	10600	67610	29885	9977	7128	135544
Medium mammals, unidentified	789	843	6574	4753	1147	412	14518
Large mammals, unidentified	512	618	2159	1059	1289	357	5994
Total fauna	11647	12084	76708	35785	12426	7904	156554

Figure 1. General composition of the Neolithic faunal assemblages studied at Aknashen according to the horizon: a) NISP = number of identified specimens; b) Weight in grams.

Bălășescu *et al.* 2010) and have re-interpreted them in the light of the latest stratigraphic and chronological information (see Badalyan and Harutyunyan in this volume). The other Neolithic sites of the Caucasus region that have benefitted in the last 10-12 years from archaeozoological studies and 14C dating for better chrono-cultural determination, are extremely rare. These are the settlements of Arukhlo in Georgia, Mentesh Tepe, Hasansu I, Kamiltepe (Lyonnet *et al.* 2012; Berthon 2014; Benecke 2015) and Hacı Elamxanlı Tepe (Nishiaki *et al.* 2015b; Nishiaki *et al.* 2013; Arai unpublished) in Azerbaijan. All these sites are situated on the middle course of the Kura river, extending over 350km as the crow flies (from Arukhlo in the north-west to Kamiltepe in the south-east).

Methods

In this study we have quantified the fauna as 'number of identified specimens' (NISP) and each of the remains was weighed on electronic scales (Reitz and Wing 2008). The weight (W) offsets, in general, the high fragmentation of the faunal remains, which is the case for Aknashen. Thus, the high values of the number of remains recorded, for example, for the species of small/medium size or for the undetermined species of small size, decrease when the remains are weighed. The inventory and the practical study of the fauna at Aknashen were carried out in the field. The recovery of the bone remains was mainly by hand; a certain volume of sediment was sieved for archaeobotanical study, but the recovered remains were not abundant and very fragmentary.

Concerning the fish determinations, in our analysis we grouped under the name of Cyprinids those remains that have not been identified to the level of species/genus for this group. For size reconstructions we used data from Radu (2011) for asp, common carp, and wels catfish, as well as unpublished data from our reference collections and from FishBase (http://www.fishbase.org) of modern fish for barbel and Sevan khramulya. To estimate the minimum number of individuals (MNI) we used a combinatorial method (Poplin 1976).

The fishing season can be established on the basis of growth rings on the vertebral bodies. The existence of four seasons, with different food depending on the season, is reflected in the bone deposits that occurred during the life of the individuals. The method is applied here to the vertebral bodies and depends upon the interpretation of the growth layers (Castanet *et al.* 1992). The *annulus* winter layers are more translucent and narrower while the *zones* formed during the summer season are larger and more opaque. A *zone* with an *annulus* forms a complete ring. Casteel (1976) and Sternberg (1995) propose different methods of interpretation, but we have determined the season when the fish were caught in this way: up to 1/4 of the last layer complete – spring; 1/3 – 1/2 of the last layer complete – summer; 2/3 and more of the last layer complete – autumn.

The anatomical and taxonomic determinations for the mammals were carried out using the works of Barone (1986), Schmid (1972), Pales and Lambert (1971), Pales and Garcia (1981), Fernandez (2001) and Brugal (2009). Among the pieces of which the determination was difficult without a bone reference collection, some were taken to Romania to refine the diagnosis with the help of available osteological references. The discrimination between goat and sheep is based on analysis of the post-cranial elements (Boessneck *et al.* 1964; Clutton-Brock *et al.* 1990; Prummel and Frisch 1986), as well as on the dental remains determined according to the criteria established by Payne (1985), Helmer (2000), Halstead *et al.* (2002) and Balasse and Ambrose (2005). The dates for dental eruption are based on the data in Schmid (1972); the estimates of age according to dental wear are based on the work of Payne (1973) and Helmer (2000) for caprines, Ducos (1968) and Grant (1982) for cattle, and Horard-Herbin (1997) for suids. The kill-off profiles for the caprines have been established based on the heights of dental crowns (Helmer *et al.* 2007).

The correlation of the biological data with the zootechnical data was carried out in accordance with Forest (1997). The measurements of the bones were made with callipers having an instrumental precision of 1/10e of a millimetre. They were taken according to the recommendations of von den Driesch (1976). In spite of the imprecision of this method due to the presence of strong allometry in domestic animals, we have estimated height at the withers by using the coefficients combined by von den Driesch and Boessneck (1974) and by Udrescu *et al.* (1999). The biometric data were analysed statistically with the help of the Past program (Hammer and Harper 2006). The distribution of the mammal remains according to anatomical elements is found in Appendix 1.

Materials

The fauna studied presents all the characteristics of domestic waste, especially high fragmentation of the bones caused by disarticulation and flesh removal by humans for consumption. In addition are traces left by the teeth of carnivores (or suids) and sometimes rodents, traces of burning, and traces of rootlets of plants that were present particularly in the first two horizons studied (H III and H II). In the same horizons (H III and H II) the faunal remains have a lighter colour and sometimes a very fine limestone layer on the surface which prevents observation of anthropic traces. In the other horizons the bones have a darker colour, especially in the deepest level (H VII) because of their humid environment.

Taxa/Horizons	VII	VI	V	IV	III	II	Total NISP
Aspius aspius			1				1
Barbus sp.		2	13	3		1	19
Capoeta capoeta	1	5	160	12	1		179
Cyprinus carpio		1	260	12	4		277
Cyprinidae	1	11	133	27	6	1	179
Silurus glanis			5	13	1	1	20
Indetermined fish		3	358	10	2		373
Total Pisces	**2**	**22**	**930**	**77**	**14**	**3**	**1048**

Figure 2. Fish remains (NISP) according to stratigraphic horizon.

The list of identified taxa is quite long (N=33). It contains several species of different classes of animals: mollusks (1), fish (6), reptiles (1), birds (3) and mammals (22). Determination was made to the level of species/genus for 49.1% of the remains, totalling 22,973 specimens. Mammals are dominant in this sample with more than 44,000 remains (97.6%). The quantity of fauna is unequally distributed among the horizons because the surface under study has not all been excavated to the same stratigraphic and cultural level. The richest horizon is H V with more than 21,800 remains, followed by H IV (12,000), H III (3800), H VI (3300) and H VII with 3100 (Figure 1). The poorest horizon is H II with 1389 remains. Closely related to the quantity of fauna is the number of taxa identified. Thus the richest horizons present the most numerous taxa. One undetermined bivalve was found at Aknashen.

Fish

A total of 1048 fish remains have been identified in Horizons VII-II (Figure 2). The identified remains are exclusively freshwater fish. They belong to the Cyprinids family (62.5%): asp (*Aspius aspius*), barbel (*Barbus* sp.), common carp (*Cyprinus carpio*) and Sevan khramulya (*Capoeta capoeta*). [1] From the Siluridae family only the remains of wels catfish (*Silurus glanis*) are present (1.91%). Unidentified remains complete the list of fish remains (35.59%).

Concerning the stratigraphic distribution, most of the remains are concentrated in level H V (930), followed far behind by H IV (77). For the other horizons, the remains vary between 2 and 22 (Figure 2). Because of these large variations, an analysis of the frequencies of the remains according to level (horizon) is for the moment inappropriate.

The state of conservation of the remains is poor. The bones are fragile, sometimes the sediment adheres to the surfaces; some are burnt or deformed by being digested (some come from coprolites)

Horizon VII

Only two remains were analysed for this level: a vertebra belonging to an individual of the sub-species Sevan khramulya, about 0.5m in total length-TL (1.4kg) (Figure 3) and a fragment of a fin of a Cyprinid.

Horizon VI

The 22 remains in this level represent barbel (2), carp (1), Sevan khramulya (5), Cyprinids (11) and unidentified (3) (Figure 2). The two caudal vertebrae of barbel come from an individual measuring 0.56m TL (2.15kg) (Figure 4). The only bone of carp is a basioccipital from an individual of medium size, 0.45m TL (1.34kg). The vertebrae identified for Sevan khramulya (Figure 3) belonged to at least two very large individuals (0.6-0.65m; TL 2.3-3kg). For the Cyprinids the elements consist of ribs (9) and vertebrae (2), and for the unidentified, remains of fin (2) and ribs (1).

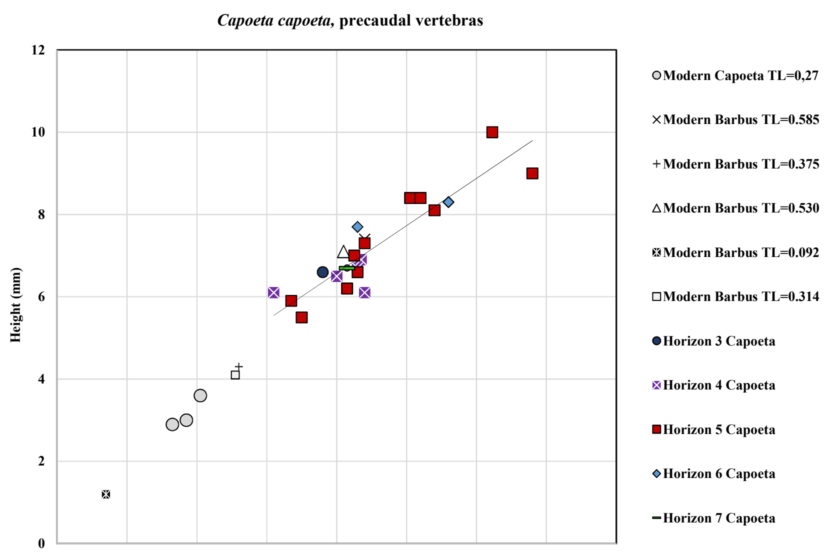


Figure 3. The dimensions of *Capoeta capoeta* praecaudal vertebrae from archaeological levels (Horizons VII-III) in relation to those belonging to *Capoeta capoeta* and *Barbus barbus* modern individuals used for Sevan khramulya size reconstruction.

[1] Tench (*Tinca tinca*) was identified in H I and for this reason is not included in this text (Bălăşescu *et al.* 2010).

Horizon	Trench	unit (UF)	Species	Anatomical element	Mesurements (mm) M1	M2	M3	M4	TL (m)	Mass (kg)
I	A	2	*Tinca tinca*	pharyngeal teeth				12.3	0.420	1.105
II	4	5	*Barbus* sp.	caudal vertebra	9.3	10.1			0.710	4.025
II	6	5	*Silurus glanis*	caudal vertebra	16.34	15.31	9.52		1.089	9.564
III	3	6	*Cyprinus carpio*	basioccipital	8.7				0.498	1.796
III	4	6	*Silurus glanis*	caudal vertebra	4.3	3.9			0.386	0.384
IV	8	7	*Barbus* sp.	cleithrum					0.530	1.500
IV	3	8	*Barbus* sp.	praecaudal vertebra	10.8	12			0.835	6.336
IV	7	7	*Cyprinus carpio*	caudal vertebra	10.8	12.5			0.605	3.320
IV	7	7	*Cyprinus carpio*	caudal vertebra	4.7	4.7			0.298	0.396
IV	7	7	*Cyprinus carpio*	praecaudal vertebra	6.2	7			0.373	0.794
IV	7	6	*Cyprinus carpio*	caudal vertebra	11.2				0.635	3.351
IV	8	7	*Cyprinus carpio*	pharyngeal teeth			20.2	8.7	0.274	0.308
IV	8	5	*Cyprinus carpio*	dentary				6.36	0.775	6.021
IV	Baulk1/2	8	*Silurus glanis*	I pectoral fin ray	23.2	20.5			1.745	40.538
IV	2	7b	*Silurus glanis*	praecaudal vertebra	13.4	14.2			0.919	4.983
IV	Baulk2/3	7	*Silurus glanis*	praecaudal vertebra	11	11.4			0.772	2.934
IV	6	7b	*Silurus glanis*	caudal vertebra	15.2	14.7			1.099	8.575
IV	7	6	*Silurus glanis*	I pectoral fin ray	13.1	12.7			0.964	5.774
IV	8	7	*Silurus glanis*	praecaudal vertebra	15.3	16.8			1.001	6.458
IV	8	6	*Silurus glanis*	praecaudal vertebra	14.3	15.6	7.8		0.928	5.132
IV	8	5	*Silurus glanis*	cleithrum			10.6		0.670	1.909
IV	A	7	*Silurus glanis*	caudal vertebra	24.8	24.3	15.4		1.585	29.832
IV	A	7a	*Silurus glanis*	caudal vertebra	25.1	23.4	16.9		1.586	29.872
V	8	8a	*Aspius aspius*	keratohyal	27	16.1			0.543	1.544
V	7	8a	*Barbus* sp.	praecaudal vertebra	7.9	10			0.614	2.759
V	7	8a	*Barbus* sp.	praecaudal vertebra	10	12.45			0.774	5.161
V	7	9	*Barbus* sp.	praecaudal vertebra	10.9	13.2	10		0.840	6.439
V	7	10	*Barbus* sp.	caudal vertebra	7.6	8.6	8		0.573	2.289
V	8	8	*Barbus* sp.	caudal vertebra	7.7	8.1	7.4		0.581	2.377
V	8	9a	*Barbus* sp.	caudal vertebra	7.1	8.6	7.5		0.534	1.892
V	8	8a	*Barbus* sp.	caudal vertebra	8.4	10.1	8.7		0.636	3.035
V	2	10	*Cyprinus carpio*	praecaudal vertebra	7.7	8.9	7.6		0.610	3.267
V	2	11	*Cyprinus carpio*	praecaudal vertebra	7.12	7.5	7.5		0.414	1.034
V	2	11	*Cyprinus carpio*	praecaudal vertebra	8.2	7.8	6.6		0.473	1.543
V	2	11	*Cyprinus carpio*	praecaudal vertebra	8.5	8.4	8.4		0.490	1.702
V	2	11	*Cyprinus carpio*	praecaudal vertebra	11.4	10	9.7		0.650	3.922
V	2	11b	*Cyprinus carpio*	praecaudal vertebra	5.8	7			0.395	0.900
V	2	11b	*Cyprinus carpio*	praecaudal vertebra	7.2	7.6	6.3		0.465	1.463
V	2	11b	*Cyprinus carpio*	praecaudal vertebra	8.3	8	6.8		0.479	1.592
V	2	11b	*Cyprinus carpio*	praecaudal vertebra	8.5	8.5	7		0.490	1.702
V	2	11b	*Cyprinus carpio*	praecaudal vertebra	9.6	10			0.610	3.267
V	Baulk 3/7	9	*Cyprinus carpio*	parasphenoid		8.6			0.391	0.872
V	Baulk 3/7	9	*Cyprinus carpio*	parasphenoid		9.7			0.440	1.250
V	Baulk 3/7	9	*Cyprinus carpio*	praecaudal vertebra	7.1	8.1			0.514	1.975
V	5	10c	*Cyprinus carpio*	praecaudal vertebra	12.2	12.5			0.690	4.898
V	6	11	*Cyprinus carpio*	opercular				11.7	0.437	1.222
V	7	9	*Cyprinus carpio*	caudal vertebra	9.7	10.7	8.8		0.566	2.620
V	7	10	*Cyprinus carpio*	praecaudal vertebra	12.6	13.4	12.4		0.729	5.528
V	8	8	*Cyprinus carpio*	opercular				9.2	0.338	0.526
V	8	8	*Cyprinus carpio*	hyomandibulair	14.5				0.453	1.410
V	8	8	*Cyprinus carpio*	praecaudal vertebra	8.4	9.8	7.6		0.535	2.026
V	8	8	*Cyprinus carpio*	hyomandibulair	20				0.632	3.777
V	8	8a	*Cyprinus carpio*	dentary				5.3	0.438	1.231
V	8	8a	*Cyprinus carpio*	opercular				14.6	0.556	2.588
V	8	8a	*Cyprinus carpio*	pharyngeal teeth			31.5		0.480	1.619
V	8	8b	*Cyprinus carpio*	opercular				12.2	0.468	1.631
V	8	8b	*Cyprinus carpio*	caudal vertebra	11.2	12.2			0.630	3.598
V	2	11a	*Silurus glanis*	caudal vertebra	9.2	8.4	7.4		0.693	2.332
V	5	10b	*Silurus glanis*	I pectoral fin ray	8.4	7.4			0.621	1.673
V	7	8c	*Silurus glanis*	I pectoral fin ray	26.1	21.4			1.909	45.863
VI	2	12b	*Cyprinus carpio*	basioccipital	7.5	9.3			0.451	1.340
VI	5	12	*Barbus* sp.	praecaudal vertebra	7.2	8.2	5.8		0.560	2.151

Figure 4. Fish sizes for all horizons.

Horizon V

The largest number of fish remains was sampled from this horizon (930). They are attributed to five species: asp (1), barbel (13), common carp (260), Sevan khramulya (160) and catfish (5). The Cyprinids consist of 133 remains, the unidentified elements number 358. For the asp, an individual of medium size, 0.54m TL (1.54kg) was identified. For barbel, the remains consist mainly of rachis (12) and a single piece of skull. The Minimal Number of Individuals (MNI) for this species was 7. All are large individuals measuring between 0.53 and 0.84m TL (1.89-6.43kg).

Among the 160 remains of Sevan khramulya, 117 are vertebrae, 39 are cranial elements and 4 are fins. We observed that in certain units there were concentrations of remains in connection, interpreted by us as accumulations that had been very little disturbed by taphonomic agents. This is the case for Trench 5 (UF 10b), in which the 15 vertebrae found come from two individuals, and for Trench 7 (UF 10) in which 115 (out of 134) remains of different parts of the skeleton (skull, rachis and fins) come from two large individuals (0.7m TL, 3.7kg). Concerning size (Figure 3), we observed a group of 5 individuals measuring between 0.4 and 0.5m TL (0.7-1.4kg) and another of 6 individuals measuring between 0.6 and 0.75m TL (2.3-4.5kg). The 260 remains of carp consist of rachis (196), skull (56) and fins (8).

As in the case of Sevan khramulya, we observed certain concentrations of remains. In Trench 2 (UF 11), 141 out of 150 (129 rachis and 12 skull remains) come from 8 individuals. In Trench 8 (UF 8), 67 out of 87 (34 skull and fin remains, 33 rachis remains) come from 5 individuals. The sizes for the 26 individuals range from 0.33 to 0.72m TL (0.52-5.52kg). Like the Sevan khramulya remains, the carp remains are divided into two groups according to size, 0.4 to 0.5m TL (12 individuals) and 0.6 to 0.70m TL (6 individuals) (Figure 5). The catfish is poorly represented in comparison with the other species. The five remains belonged to three individuals. Two are small, 0.62 and 0.69m TL (1.67 and 2.33kg) and the third very large 1.9m TL (45.86kg).

The remains of Cyprinids (133) are mainly fragments of vertebrae and ribs (58 from vertebrae, 8 from skulls, 12 from fins and 55 from ribs), while the unidentified remains consist mostly of ribs (73), fins (51), vertebrae (23) and other fragments (211).

Horizon IV

The 77 remains analysed for this level come from four species: barbel (3), Sevan khramulya (12), common carp (12) and catfish (13). For the cyprinids 27 were counted and for the unidentified, 10 remains. Barbel is represented by two skull bones (cleithrum) and a vertebra coming from two individuals, one of medium size, 0.53m TL (1.5kg), and the other large, 0.83m TL (6.3kg). For five individuals of Sevan khramulya we have identified ten vertebrae and two skull remains. The dimensions are generally large for 4 individuals (about 0.4-0.55m TL and mass 1-2.4kg) and very large for the fifth (0.75m LT and 4.5kg) (Figure 3). For the carp we analysed remains of skull (3), fin and vertebrae (9) of 6 individuals. The sizes range between 0.27 and 0.77m TL (0.30-6.02kg).

Although the remains of catfish number only 13, they come from 10 individuals. Seven are small, below 1.1m TL (0.67-1.09m and mass 1.9-8.5kg), and the others measure between 1.58 and 1.74m TL (28.83-40.54kg) (Figure 6). The remains of the Cyprinids come from various parts of the skeleton (5 from the skull, 4 fins, 6 ribs and 11 vertebrae).

Horizon III

For this horizon the 14 remains come from three species. For the carp we identified three remains of skull (dental, basio-occipital, praeopercular) and one of spine (caudal vertebra). The only individual was of medium size, 0.49m TL (1.79kg), and attributed to the breeding category. A single piece was attributed to Sevan khramulya; it comes from an individual of medium size (Figure 3). For the catfish we also have a vertebra of an individual of small size, 0.38m TL (0.38kg).

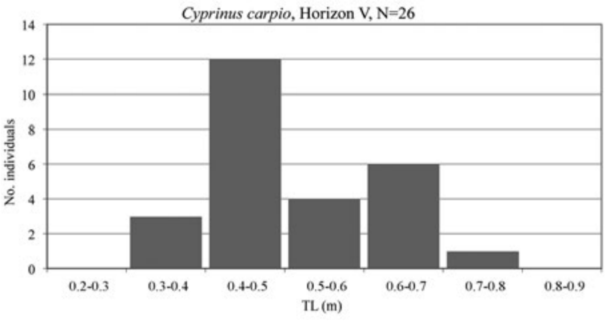


Figure 5. Common carp (*Cyprinus carpio*). Total length (TL) frequency distribution for Horizon V.

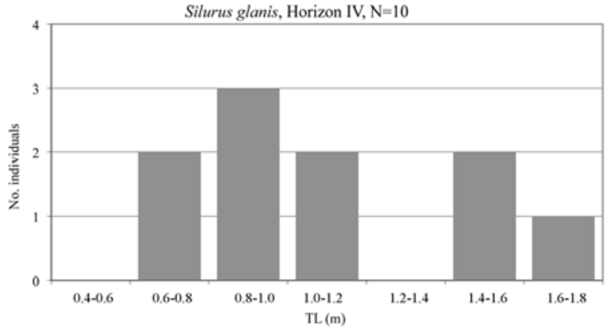


Figure 6. Wels catfish (*Silurus glanis*). Total length (TL) frequency distribution for Horizon IV.

Horizon II

In this horizon a caudal vertebra comes from a barbel measuring 0.70m TL (4kg), another from a catfish measuring 1.08m TL (9.56kg) and a rib from an unidentified Cyprinid.

Reptiles

Only remains of the species *Testudo graeca* (spur-thighed tortoise) were found. These included fragments of the carapace and the plastron, as well as the bones of the limbs, which are evidence for the consumption of turtles on the site. Of the total of 15 remains, 9 come from level H V. Most are isolated plates, but some are in connection and both the interior and exterior carry traces (H V, Trench 7 and H VII, Trench 5) that are evidence for the use of the carapace as an object of daily use (Figure 7).

Birds

In Horizons VI-III 16 remains of birds were identified (7 in H IV and 3 in each other level). Bones from one bird the size of a crane were recorded in H VI (humerus, radius and tarso-metatarsal) and in H IV (4 cervical vertebrae). The other remains are attributed to individuals of small and medium size. In H V (Trench 3, UF10) a proximal fragment of a large ulna (*Dip* – the greatest diagonal of the proximal end, after von den Driesch (1976)– is 24.7mm) presents traces of cutting on the diaphysis (Figure 8). The most probable reason for this is an operation carried out to recover the diaphysis, which would have provided good raw material for the fabrication of various objects. Also in H III a proximal humerus of great bustard (*Otis tarda*) was identified.

Figure 8. Ulna with cut marks for diaphysis extraction (scale in cm).

Mammals

The species identified in the faunal range of Aknashen belong to both wild and domestic mammals. These animals characterise two extremely important activities for the Neolithic community: animal husbandry and hunting. The domestic species are represented by the following taxa: cattle (*Bos taurus*), sheep (*Ovis aries*), goat (*Capra hircus*), pig (*Sus domesticus*) and dog (*Canis familiaris*). The wild species consist of: aurochs (*Bos primigenius*), wild sheep (*Ovis orientalis*), wild goat (*Capra aegagrus*), wild horse (*Equus ferus*), red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), gazelle (*Gazella* sp.), wild boar (*Sus scrofa*), wolf (*Canis*

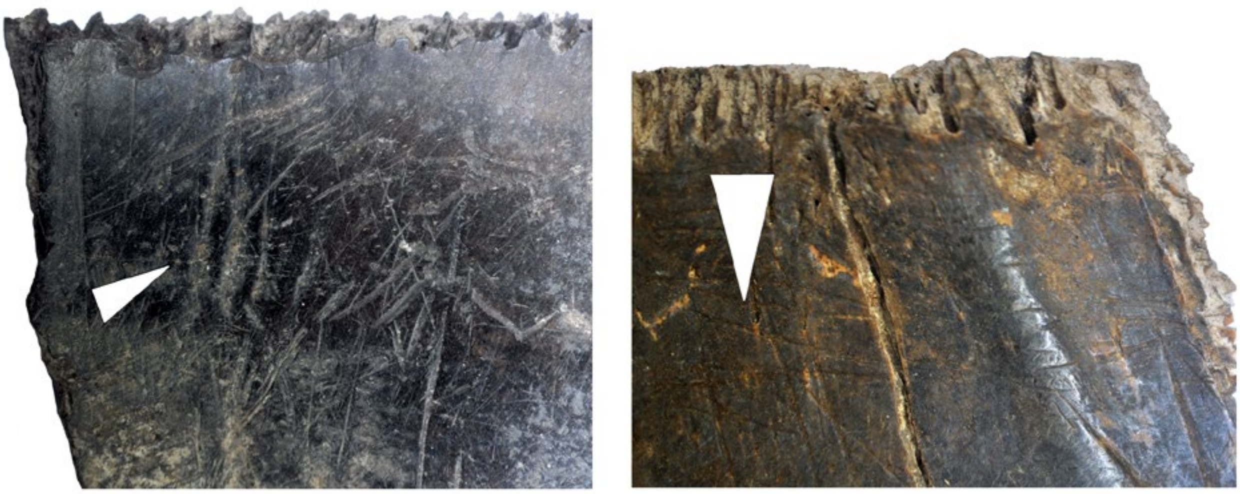


Figure 7. *Testudo graeca* (spur-thighed tortoise). Traces on the internal part of a turtle shell (no scale).

lupus), fox (*Vulpes vulpes*), badger (*Meles meles*), marten (*Martes* sp.), bear (*Ursus arctos*), wild cat (*Felis* sp.), hare (*Lepus* sp.), beaver (*Castor fiber*) and hedgehog (*Erinaceus* sp.). In the distribution of species are groups of cattle/aurochs (*Bos taurus/Bos primigenius*), suids (*Sus domesticus/Sus scrofa*) and caprines/gazelle (*Ovis/Capra / Gazella*) which comprise the faunal remains that have not been determined with precision because of their fragmentation. The remains of antlers are placed under a different heading because it is not known whether they are from hunted animals or from shed antlers.

Fragmentation of the remains

To see whether there existed differences between the horizons concerning the fragmentation of the faunal remains of mammals, we examined the relation between the weight (in grams) and the number of remains. We obtained an average weight for a determined piece, but also for the undetermined pieces of large and medium size (Figure 9). In horizons VII – III the relative values are similar; however, in horizon II the average is two times higher, especially in the case of an undetermined piece. One reason could be the relatively limited faunal sample studied for this horizon (1386).

Development of the mammalian fauna

We present below the mammalian fauna by horizon, from the earliest (H VII) to the latest (H II) (Figures 10 and 11). In all the horizons domestic animals predominate, and among these the remains of caprines (sheep/goat) are the most numerous. Thus in H VII the caprines comprise 79.7% and increase to 84.8% in H V; then they diminish slightly to 74.9% in H III and fall to 61.6% in H II (Figure 10b). Among the group of caprines, the remains of sheep are preponderant and the sheep/goat ratio varies between 3.4 to 1 in H VI and 11.5 to 1 in H V.

Domestic cattle follow the caprines. Their percentages differ to a high degree. In H VII they represent 5.5%, rising to about 9.5% in H IV and reach 22% in H II (Figure 10b). Pigs are under-represented with only a few bones (9), but it is possible that in the group of specific undetermined suids (*Sus* sp.; NISP=92) there are other fragments of this domesticated mammal. For this reason in Figures 10 and 11 we have counted *Sus domesticus* and *Sus* sp. together under the name of 'pig'. An interesting fact is that the pig, as well as the specific undetermined suids, present a slight increase between the earliest and the latest horizons. The percentage of *Sus domesticus* is only 0.06% in H VI; it reaches 0.56% in H II, whereas *Sus* sp. increases from 0.25% in H VII to 2.07% in H II (Figure 10b). Dogs are represented by only 99 remains, but their presence is also represented by bite marks found on bones.

Hunting decreased, as seen in the NISP. Frequencies vary between 0.8% and 5.5% in horizons VII to IV, then present a percentage of 9.8% in H III and H II (Figure 10b). The number of taxa is low in H VII (7) and H VI (6), but increases in H V (15), H IV (18), H III (12) and H II (10).

For the weight of mammal remains the same tendencies are observed, but closely depending upon the specific mass of each taxon (Figure 11). In the first horizons (H VII-III) the caprines predominate with percentages that range between 73.4% (H VII) and 44.6% (H III); they descend to 28.8% in H II, a decrease of about 45%. The cattle presents a different development. Frequencies increased from 13.3% in H VII to 45.2% in H II (Figure 11b). The hunted animals are more frequent in the late horizons, increasing from 10% in H IV to 18% in H III and H II (Figure 11b).

Results and discussion

Fishing activity

Species and size

Fishing was an activity that occurred throughout the Neolithic occupation, the fish remains found in each horizon providing the evidence. The fish identified for this period belong to local freshwater species, including asp, barbel, common carp, Sevan khramulya carp and catfish. The remains of Cyprinids (common carp and Sevan khramulya) are the most frequent. All these species of fish live in well-oxygenated waters, rivers being the main reservoirs and refuges. In lakes they survive during the dry summers and hard winters only if this type of aquatic reservoir is constantly fed by

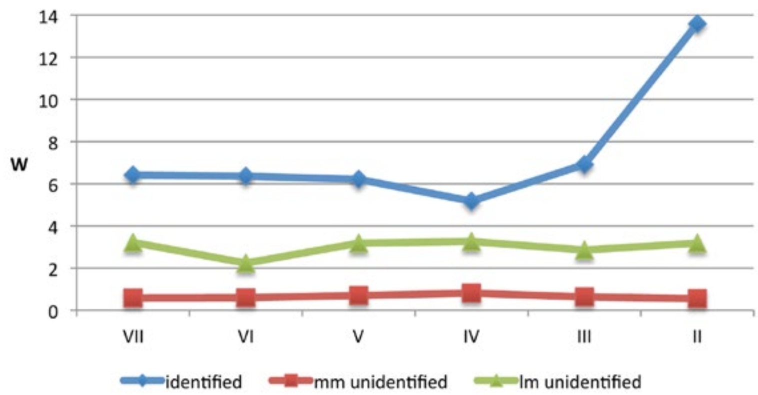


Figure 9. The average weight (in grams) of a determined piece and of an undetermined piece (medium mammals - mm and large mammals - lm) in the different horizons at Aknashen.

	VII	VI	V	IV	III	II	Total
Species	**NISP**	**NISP**	**NISP**	**NISP**	**NISP**	**NISP**	**NISP**
Bos taurus	92	116	616	550	213	117	1704
Bos taurus/Bos primigenius	5		5	8	2	12	32
Ovis aries	115	62	507	239	84	23	1030
Capra hircus	22	18	44	43	24	5	156
Caprinés	1149	1224	8586	4412	973	300	16644
Caprinés sauvage	15	3	6	11	7		42
Caprinés/Gazelle	172	223	791	153	68	2	1409
Sus domesticus		1	1	1	3	3	9
Sus sp.	4		38	20	19	11	92
Canis familiaris	9	11	28	29	15	7	99
Equus sp.				4	9	16	29
Bos primigenius	1		3	12	6	5	27
Cervus elaphus	17	3	60	115	19	5	219
Capreolus capreolus		1	2	1	7	2	13
Gazella sp.	1	1	8	69	41	3	123
Sus scrofa			40	17	13	2	72
Canis lupus			1	2			3
Vulpes vulpes	1		5	19	6	4	35
Meles meles				3			3
Martes sp.			3	1			4
Mustelid indet			4	7	8	2	21
Ursus arctos				1			1
Felis sp.	1		2	2			5
Lepus sp.	4	6	17	45	24	12	108
Castor fiber			1	4	1		6
Erinaceus sp.			2	3	1		6
Total mammals identified	**1608**	**1669**	**10770**	**5771**	**1543**	**531**	**21892**
deer antlers	14	4	20	18	16	8	80

a

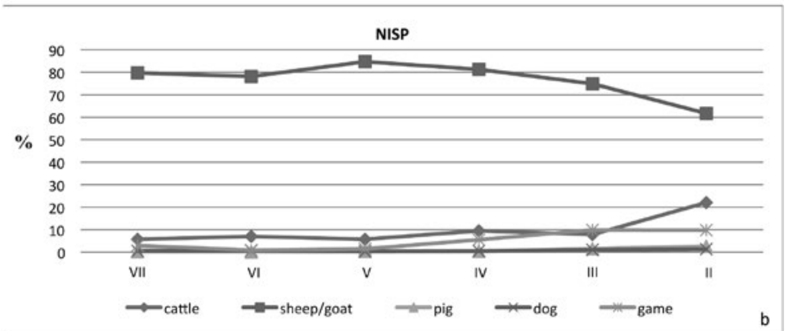


Figure 10. NISP (number of identified specimens) of the mammals in the Neolithic horizons studied at Aknashen: a) General composition; b) Frequency.

rivers and does not become dry. During the spawning period, they seek floodable zones with shallow water and vegetation to deposit their eggs. After reproduction, they rejoin the rivers and lakes.

Their sizes are generally medium and large for all these species. The sizes for barbel, common carp and Sevan khramulya exceed 30cm TL. This is characteristic for reproductive individuals. Although the sediment was sieved, the remains of small individuals in the samples studied are rare. The smallest remains (vertebrae) belonged to Cyprinids measuring between 20-30cm TL (150-300g). In this case the possibility cannot be excluded that they belonged to individual adults of small species that rarely attain 30-35cm TL, such as certain varieties of barbel. Concerning size, for three species (Sevan khramulya, common carp and catfish) there are two groups, medium/large and very large. There could be several reasons for this: sampling oriented towards large remains, unequal preservation, fishing oriented towards large individuals, use of fishing tools for capturing large fish.

Fishing season

The large number of vertebrae recorded in H V has enabled us to establish the fishing season. The 167 vertebrae selected come from trenches 2 (35), 5 (8), 7 (89) and 8 (35) and belong to 22 individuals (Figure 12). Where vertebrae belonging to several species were found, we retained vertebrae from at least two species to be sure that there was no disturbance.

The results for the archaeological structures analysed place the fishing season in spring and in summer (Figure 12). For the vertebrae of fish taken in spring the deposits of the last ring were quite fine, that is, up to ¼ of the last complete ring (Figure 13a). For those taken in summer the deposits are up to ½ of the last complete ring (Figure 13b-c). These variations in size of the last growth rings are in correlation with the biology of the fish (age, size, state of health, etc.), the climatic conditions (periods of freezing, drought, etc.) and the accessibility to sources of food (lake, upper/lower zone of the river, floodable valley, etc.). Thus for our sample it can be estimated that fishing began very early, in the spring (end of March-April) and continued throughout the summer.

According to the results obtained for H V, fishing was a summer activity. In this season the fish could experience vulnerable periods when they could be easily caught including during floods, during drought, and during spawning.

In all these cases, the fish could be caught with rudimentary fishing devices (basket traps, harpoons) and even by hand. During the spawning period, in the spring (end of March-June), the gregarious Cyprinids could be easily caught because they are less attentive, using traps/nets, harpoons, etc. The male catfish guards the eggs deposited on plants in low water for 4-5 days until they hatch. When the waters retreat or during long periods of drought, the lakes dry up and the fish are concentrated in the deep places. But in all these scenarios the presence and thus the capture of small individuals cannot be excluded. Up to now, small individuals have been lacking, and the data available indicates that fishing targeted large fish. In the present state of research, not all the causes that could lead to these results are known. Perhaps fish were not important in the management of animal food resources. The fishing of large fish could have been an opportunist activity that occurred by taking advantage of the ecology of these fish and favourable situations encountered in the surrounding environment. However, such an activity during the summer season demonstrates that for this type of activity the inhabitants understood very well the seasonal development of the level of the river as well as the most favourable places and circumstances (and possibly appropriate fishing devices) for the capture of large fish.

For the moment we do not know the fishing tools used or the range and size of the fish for all the levels of habitation, which would enable us to trace the development of fishing during the Neolithic occupation. Information concerning fishing on other, contemporary sites is rare. The same taxonomic range dominated by Cyprinids was identified on the neighbouring site of Aratashen (Bălășescu *et al.* 2010) as well as on the other side of the mountains in the sites of the Kura valley (Benecke 2015; Nishiaki *et al.* 2015b).

	VII	VI	V	IV	III	II	Total
Specie	**W**	**W**	**W**	**W**	**W**	**W**	**W**
Bos taurus	1376	2574	14532	8878	3305	3268	33933
Bos taurus/Bos primigenius	98		525	160	70	437	1290
Ovis aries	1384	821	6449	2101	776	375	11906
Capra hircus	257	232	669	250	221	82	1711
Caprinés	5956	6069	40062	14891	3455	1625	72058
Caprinés sauvage	177	54	166	308	108		813
Caprinés/Gazelle	389	519	2499	410	212	6	4035
Sus domesticus		2	2	2	26	22	54
Sus sp.	28		208	61	72	57	426
Canis familiaris	197	232	156	102	38	28	753
Equus sp.				259	274	838	1371
Bos primigenius	50		179	571	650	154	1604
Cervus elaphus	266	76	1486	804	231	129	2992
Capreolus capreolus		10	9	2	40	9	70
Gazella sp.	120	2	127	542	341	29	1161
Sus scrofa			432	396	94	24	946
Canis lupus			1	11			12
Vulpes vulpes	1		8	41	21	11	82
Meles meles				10			10
Martes sp.			4	2			6
Mustelid indet			5	9	9	2	25
Ursus arctos				2			2
Felis sp.	20		5	7			32
Lepus sp.	25	9	77	49	31	32	223
Castor fiber			6	13	2		21
Erinaceus sp.			3	4	1		8
Total mammals identified	**10344**	**10600**	**67610**	**29885**	**9977**	**7128**	**135544**
deer antlers	566	41	452	254	285	335	1933

a

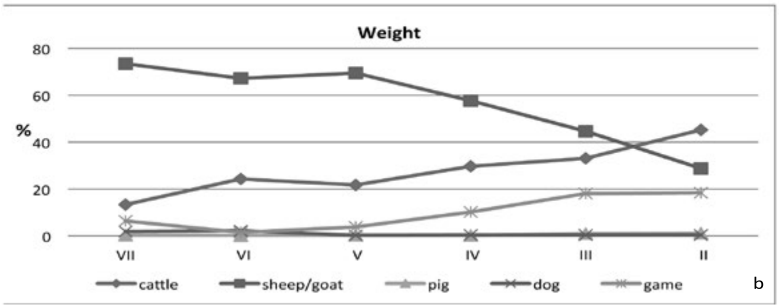


Figure 11. Weight in grams of the mammal remains according to the horizon: a) General composition; b) Frequency.

depth (cm)	Species	NMI	No. vertebras	Spring	Summer	Autumn
297-310	*Barbus* sp.	1	2		2	
297-310	*Cyprinus carpio*	4	18		18	
306	*Cyprinus carpio*	1	10		10	
319	*Cyprinus carpio*	1	4	4		
333	*Capoeta* sp.	1	8		8	
347	*Capoeta* sp.	2	89		89	
359	*Capoeta* sp.	1	1	1		
359	*Cyprinus carpio*	4	17	17		
360	*Capoeta* sp.	1	3	3		
360	*Cyprinus carpio*	5	14	13	1	
382	*Barbus* sp.	1	1	1		

Figure 12. The fishing season established on the basis of growth rings on the vertebral bodies.

Development of an animal palaeo-economy (mammals)

The archaeozoological study of the mammal remains reveals the development of an animal palaeo-economy within the chrono-cultural evolution. Characteristic for all the Neolithic horizons is the predominance of domestic mammals. Caprines and cattle played the most important roles. There was (according to NISP and W) a decrease in the importance of caprines between the earliest and the latest horizons, and at the same time an increase in cattle (Figures 10b and 11b). This development is very clear, especially when the weight of the bones is used as a parameter. Figure 11b shows that the values for cattle are higher than those of caprines in Horizon II. In these circumstances the mass (W) proves to be a more important parameter for understanding the development of the animal palaeo-economy.

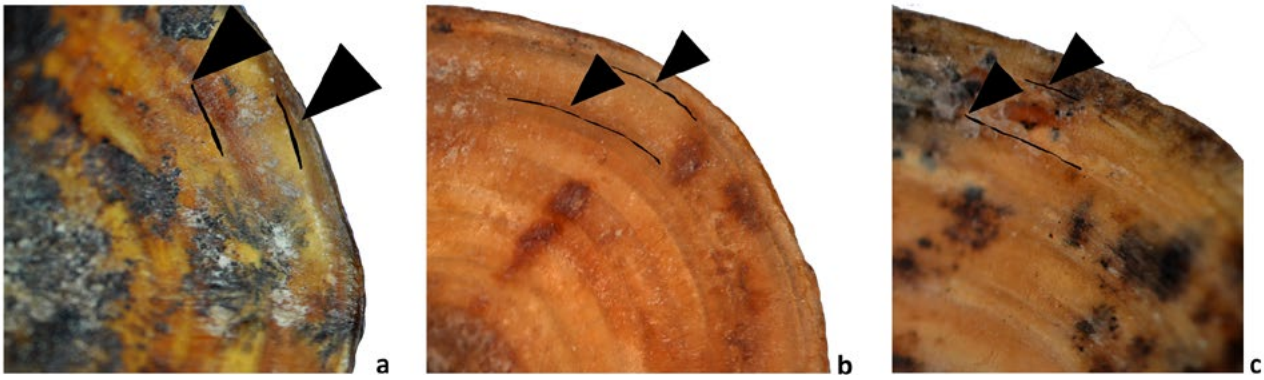


Figure 13. Position of the last growth ring from the last complete growth ring:
a. 1/4 – spring season (sample from Horizon V, Tr.2 UF11, depth of 360cm, *Capoeta capoeta*). No scale.
b. 1/3 – summer season (sample from Horizon V,Tr.8 UF18, depth of 310cm, *Capoeta capoeta*). No scale.
c. 1/2 – summer season (sample from Horizon V, Tr.7 UF10, depth of 347cm, *Capoeta capoeta*). No scale.

As the weight values for pig are very low, its economic importance was insignificant. In this case, the frequencies increase between H VII and H II. Although dog is very little present in the faunal material, it provides us with some particular information. The dog remains show traces of cutting, flesh removal and burning (Figure 14). Dog bones were found in all the horizons, except for H II. 12 fragments (which represent 12.1% of all the dog remains) indicate that this species was eaten and its hide used: two fragments with traces of cutting - flesh removal (a scapula and a coxal) and disarticulation (a pisiform bone), seven remains with traces of burning (three mandibles, a maxilla, an ulna, a tibia, an astragalus), two bones with traces of

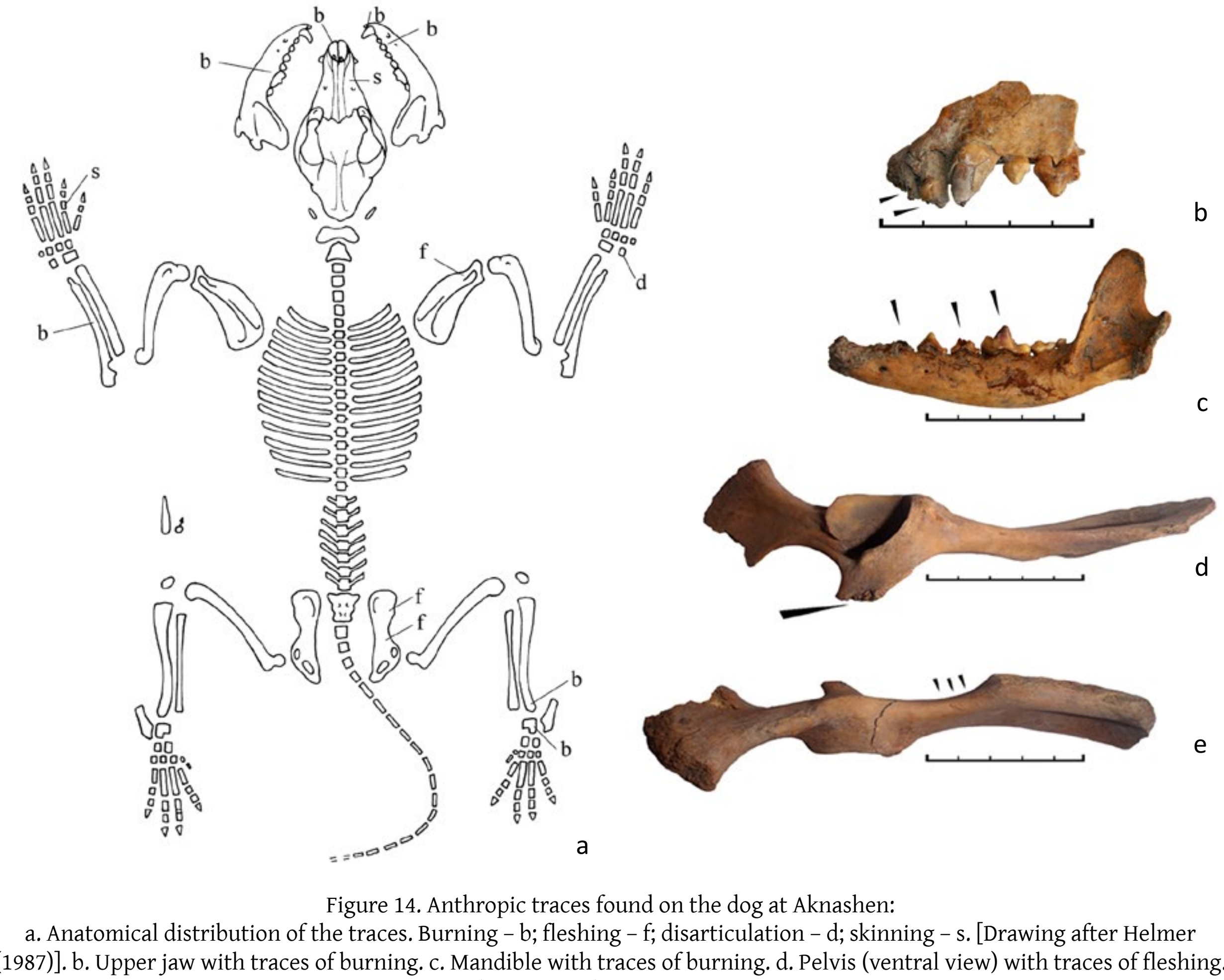


Figure 14. Anthropic traces found on the dog at Aknashen:
a. Anatomical distribution of the traces. Burning – b; fleshing – f; disarticulation – d; skinning – s. [Drawing after Helmer (1987)]. b. Upper jaw with traces of burning. c. Mandible with traces of burning. d. Pelvis (ventral view) with traces of fleshing. e. Pelvis (dorsal view) with traces of fleshing.

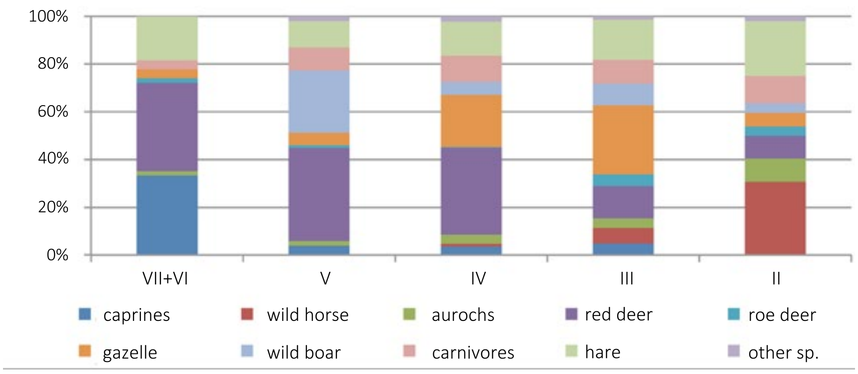


Figure 15. Relative frequencies of wild mammals in Aknashen based on fragment counts (NISP). Legend: caprines – wild sheep and wild goat; carnivores – wolf, fox, badger, otter, marten, wild cat, undet. Mustelidae; others sp. – beaver and hedgehog

flesh removal (a neurocranium and a phalange I). Its economic importance in the diet was extremely limited, considering the restricted number of discovered remains with these types of traces (Figure 14a). The phenomenon of cynophagy discovered at Aknashen is so far unique for the Neolithic in the Caucasus. However, on the Chalcolithic site of Godedzor, also in Armenia (3650-3350 cal BC; Bălășescu unpublished), we identified three fragments of which two showed traces of cutting (a maxilla and a hip bone) and one trace of burning (a mandible).

Indications of hunting are relatively limited in the early horizons (VII and VI), as much for the number of taxa as for NISP and W. Starting with Horizon V, in which the number of taxa increase, and Horizon IV, in which the NISP and W rise (Figure 15), hunting appears to have taken on a relative importance. In the late Neolithic levels (H V-II) the remains of medium- and small-sized taxa (especially carnivores, lagomorphs, insectivores, etc.) increase, which shows that the human population began to exploit other wild species, and not only those of large and medium size that provide considerable quantities of meat. The presence of hare is both constant and rising (from 0.25% in H VII to 2.26% in H II). Given its limited body weight, it cannot be confirmed that this species had high importance in the diet of these communities.

Probably, with time, the community began to exploit more and more the wild animals in the environment around the site. The most important species were those of large and medium size, such as the red deer, the horse, the gazelle and the wild boar (Figure 16). If the

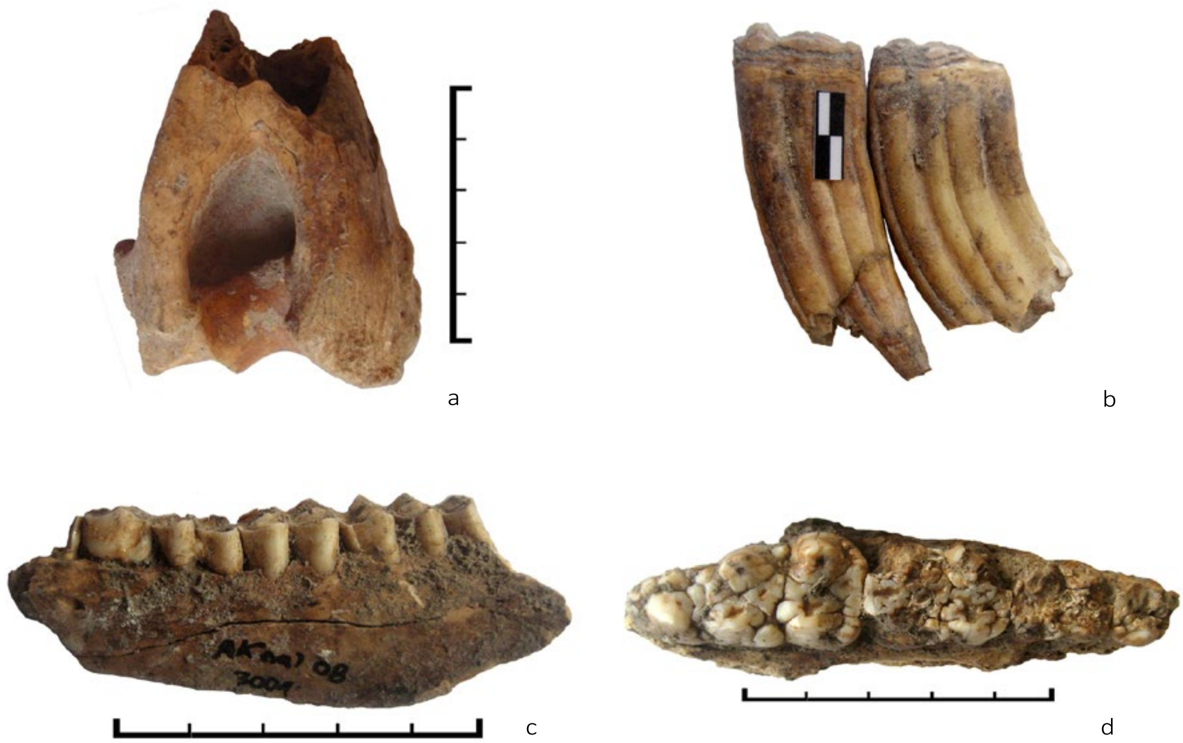


Figure 16. Wild mammals at Aknashen:
a. Red deer, humerus (caudal view). b. Wild horse, lower teeth (lateral view). c. Gazelle, mandible (lateral view).
d. Wild boar, upper jaw (basal view).

presence of wild mammals from the early horizons to the latest (H VI was counted with H VII because of the limited number of remains) is analysed, it is observed that the red deer is better represented up to H IV, its place then taken by the gazelle in H III and the horse in H II (Figure 15).

Exploitation of domestic mammals

The study of kill-off profiles of the domestic animals reveals the reason for which they were raised: for primary products such as meat and for secondary products such as milk, strength (for work), and exploitation of hair (wool?).

Caprines

The animal economy of Aknashen depended on the husbandry of caprines, with sheep dominant in the herds during the duration of the Neolithic occupation. Thus a study of kill-off ages was carried out mainly to analyse the types of exploitation of caprines and to define the main husbandry patterns. Given that goats are less frequent at Aknashen, the age profiles of the caprines are based on the data for both sheep and goats (Figure 17). The relatively large number of teeth has enabled us to present kill-off profiles for all the horizons studied. All the data presented in Figures 17 and 20 are corrected.

At Aknashen, the age profiles for the majority of horizons (VII-III) provide evidence for a kill-off peak which varies between 35.3% and 43.6% for the animals of class C (6-12 months), which suggests consumption of the tender meat of young animals. This class is followed by class D (1-2 years) which varies between 26.7% and 34.1% and which is also characteristic of meat production (Figure 17). This is the age at which sheep and goats attain their maximal size for a maximal weight. According to present-day traditional practices, it is above all the young males that are killed off at this age (Helmer *et al.* 2007).

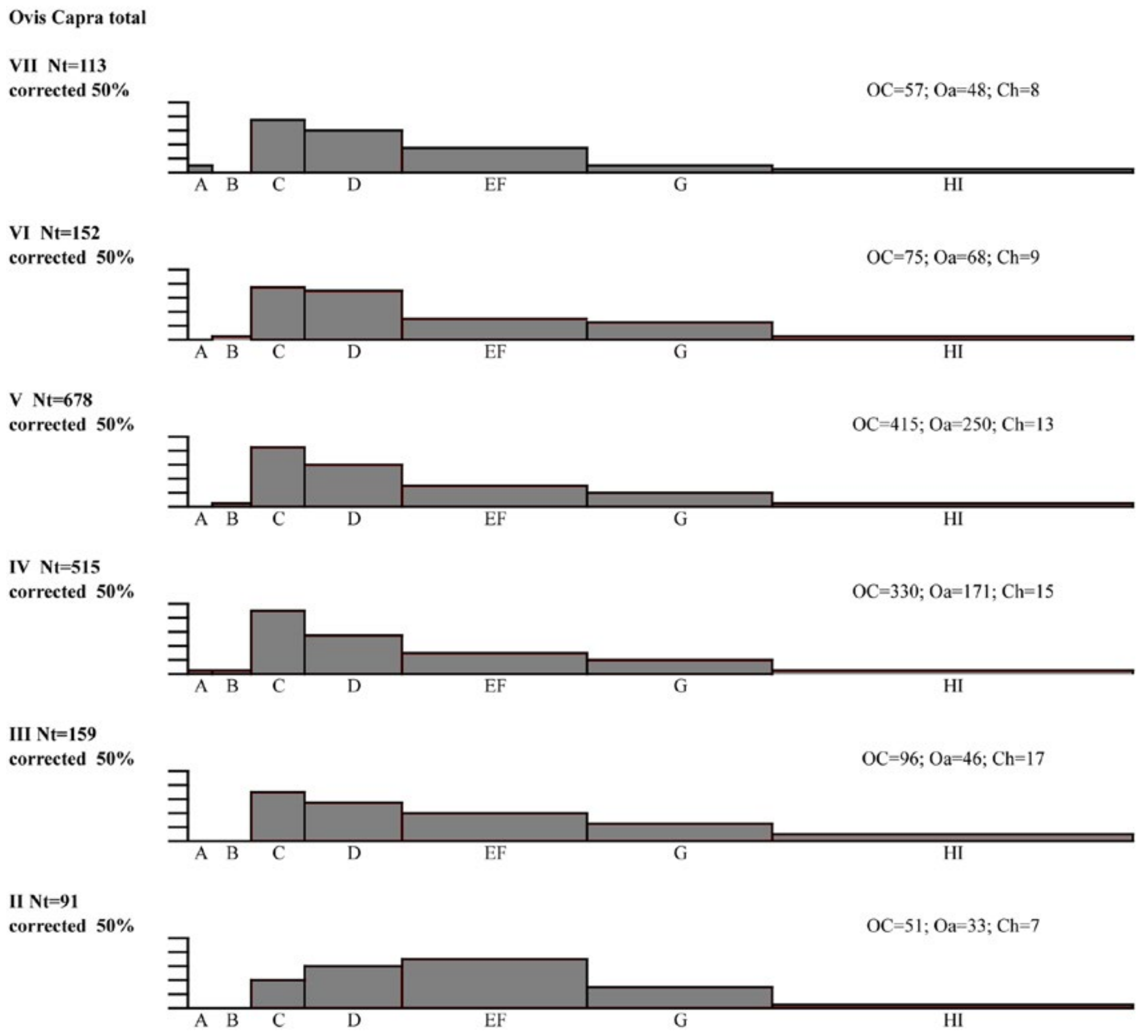


Figure 17: Age-at-slaughter profiles of sheep and goats together (caprines). Nt = number of teeth; O = *Ovis aries*; C = *Capra hircus*; OC = *Ovis/Capra* (class A ± 0-2 months; class B ± 2-6 months; class C ± 6-12 months; class D ± 1-2 years; class EF ± 2-4 years; class G ± 4-6 years; class HI > 6 years).

Figure 18. The numerical distribution of remains of young caprines based on the presence of appendicular skeletons according to horizon [classes of biological age after Forest (1997)].

Ovis aries/Capra hircus	H VII	H VI	H V	H IV	H III	H II	Total
newborn	3		12				15
newborn/infans	4	3	54	13	2		76
infans	21	7	74	29	5	1	137
infans/juvenil	5	6	31	20	5		67
Total	**33**	**16**	**171**	**62**	**12**	**1**	**295**
% from *Ovis/Capra*	**2.6**	**1.2**	**1.9**	**1.3**	**1.1**	**0.3**	**1.65**

Figure 19. Caprine bones:
a. Humerus diaphysis from newborn (caudal view).
b. Metatarsal (left side) and metacarpal (right side), from very young individual (dorsal view).

The presence of juvenile animals (class B, 2-6 months) is observed in horizons VI, V and IV although the numbers are low. The very young of class A (0-2 months) are absent in most of the horizons with the exception of H VII and H IV. Also observed is a kill-off of sub-adults/adults (class EF, 2-4 years, which varies between 13.2% and 33%) and adults (class G, 4-6 years, which varies between 4.6% and 16%) in all of the horizons of this site. Class HI, animals older than six years, consisting of those used for reproduction and for production of milk and hair (wool?), is also represented in all the levels with low percentages that vary between 0.5% and 5.3% (Figure 17).

Although the first five horizons (VII-III) present kill-off patterns that are relatively similar, the greatest modifications are observed in H II when the sub-adult/adult animals of class EF (2-4 years) become the most numerous (33%), which points to exploitation for milk. Another indicator for milk production is class G (4-6 years) which reaches 16% (Figure 17).

Our work indicates that in the earliest horizons (VII-III) the caprines were exploited primarily for meat production (represented by classes C and D) and especially by tender meat of very high quality (class C). The chrono-cultural development shows that the percentage of caprines exploited for milk (age classes EF and G) rises, and that these animals reach their maximum in H II (with class EF). These data reveal that during the Neolithic occupation changes occurred in the production of caprines on the site of Aknashen.

The absence of class A (0-2 months) and B (2-6 months) ovicaprid teeth in some horizons (Figure 17) could be related to the absence of thorough sieving of sediments in the different archaeological contexts. Although dental elements are absent in the analysed material from certain horizons, the remains of appendicular skeletons belonging to very young animals aged 0-6 months have been identified (Figure 18). Their importance varies between 2.6% in H VII and 0.3% in H II (Figure 18). Thus in the faunal material we have identified as many newborns (only in H VII and H V) as very young animals (1-3 months) in all the horizons and very young/juveniles (more than 3 months and up to 6-9 months) in all the levels except H II (Figure 19).

The combination of all the age criteria according to teeth and the appendicular skeleton demonstrates the presence of all biological classes at Aknashen (Figures 17 and 18). The fact that all the biological classes of caprines are present on the site is an argument for permanent occupation (throughout the year). This could suggest that the caprines were herded near the site, although part of the herd could have been sustained farther from the site (semi-transhumance). An isotopic study for domestic mammals (especially caprines) at this site could more precisely answer this question (Balasse *et al.* 2002; Makarewicz *et al.* 2017).

The distribution by sex for the caprines was carried out based on the cranial skeleton (horn core) and the appendicular skeleton (the coxal bones). These criteria indicate a predominance of females. The ratio between the sexes is seven females for one male in the case of goats and five females for one male in the case of sheep.

It is logical that the exploitation of caprines on this site should be compared to that of the neighbouring site of Aratashen (Bălășescu *et al.* 2010). A characteristic of Aknashen is the targeted kill-off of class C (H VII – H III), as opposed to that of class D at Aratashen (H IId – H IIb), especially in the earliest horizons of the two sites. Thus at Aknashen, the profiles suggest consumption of the tender meat of young animals (6-12 months), whereas at Aratashen, the profiles suggest the consumption of animals aged 1-2 years, concerning in particular the individuals that have reached a maximal weight for consumption. On both sites we observe that in the most recent horizons (H II at Aknashen and H IIa and H I at Aratashen), class EF becomes the most important (milk exploitation).

When the settlements of the Araxes river basin (the earliest horizons) are compared with those of the Kura basin (Arukhlo, Kamiltepe and Hacı Elamxanlı Tepe), the same characteristics are observed, that is, an exploitation of caprines primarily for their meat and to a lesser degree for their secondary products, principally milk (Benecke 2015: 12 ; Nishiaki *et al.* 2015b: 21; Arai unpublished).

Cattle

For the domestic cattle, we have provided a single kill-off profile for all the site of Aknashen because the number of dental remains is very limited for each horizon studied. Only 90 teeth were recovered from all the horizons, which has enabled the realisation of the profile presented in Figure 20. Thus we observe a kill-off peak of individuals aged 2 to 4 years (29%), followed by specimens aged 1 to 2 years (25.5%). These two age classes illustrate meat production, those animals having attained an optimal mass (2 to 4 years) being preferred in order to obtain a high return. The slaughter of individuals between the ages of 1 and 2 years indicates consumption of tender meat of very good quality.

The exploitation of milk is indicated especially by the individuals (the majority are females) aged between 4 to 6.5 years (9.5%) and 6.5 to 9 years (14%), but also by the very young animals between 6 and 12 months (19.4%), evidence for post-lactation kill-off (Figure 20). There is also a very small group of animals older than 9 years (2.5%), which suggests an exploitation of these animals for work (traction), although we have not identified in the material any pathologies that could provide evidence for this activity (Bartosiewicz *et al.* 1997). In conclusion, according to the kill-off profile, we can affirm that the cattle were exploited primarily for meat and secondarily for milk and possibly for their strength, useful for traction/work. At the settlement of Arukhlo in the Kura basin, we observe an exploitation of cattle similar to that at Aknashen (Benecke 2015: 12).

As in the case of the caprines, we observe that in the kill-off profile based on the teeth remains there are no young individuals (newborn and very young). This evidence is compensated by the existence of elements of appendicular skeletons which indicate the presence of individuals aged between 0 and 6 months (Figure 21).

Pigs

Concerning pigs, (*Sus domesticus*), the sample studied is too small to produce a kill-off profile. This material contains only remains from sub-adults (14-16 months and 20-36 months). The very young individuals identified as *Sus* sp. which are in the newborn (1) and very young (2) category could also be added. The other ages of undetermined specific suids (*Sus* sp.) are more than 8 months and less than 36 months (one 8-12 months; one 12-18 months; one 24-30 months and one 22-36 months).

Distribution of parts of the skeleton

We also wished to determine whether the distribution of skeleton parts was homogenous throughout the horizons. We carried out this analysis only for the caprines and the cattle, the most numerous in the studied faunal sample (Appendix 1). The following categories were selected: head, axial skeleton (vertebrae, ribs and sternum), limbs (scapula, coxal, humerus, femur, radius, ulna, tibia), extremities (carpal bones, tarsal bones, metapodials and phalanges). We also studied the number of remains and the weight of remains (Figure 22), but the discussion is based on the weight, because the NISP data are much more strongly affected by differential fragmentation than those of weight.

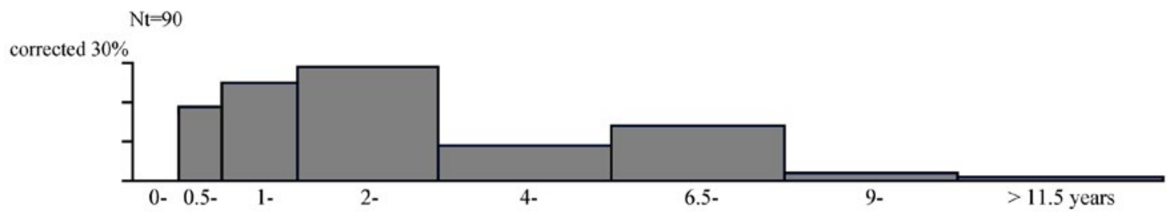


Figure 20. Age-at-slaughter profiles of cattle in all Horizons (VII-II). Nt = number of teeth.

Bos taurus	**H VII**	**H VI**	**H V**	**H IV**	**H III**	**H II**	**Total**
newborn		1					1
newborn/infans			2	1		1	4
infans		2	1	3	2		8
infans/juvenil	1		2	1	1	2	7
Total	**1**	**3**	**5**	**5**	**3**	**3**	**20**
% from *Bos taurus*	**1.1**	**2.6**	**0.8**	**0.9**	**1.4**	**2.6**	**1.2**

Figure 21. Numerical distribution of remains of young cattle based on appendicular skeletal elements by horizon [classes of biological age are after Forest (1997)].

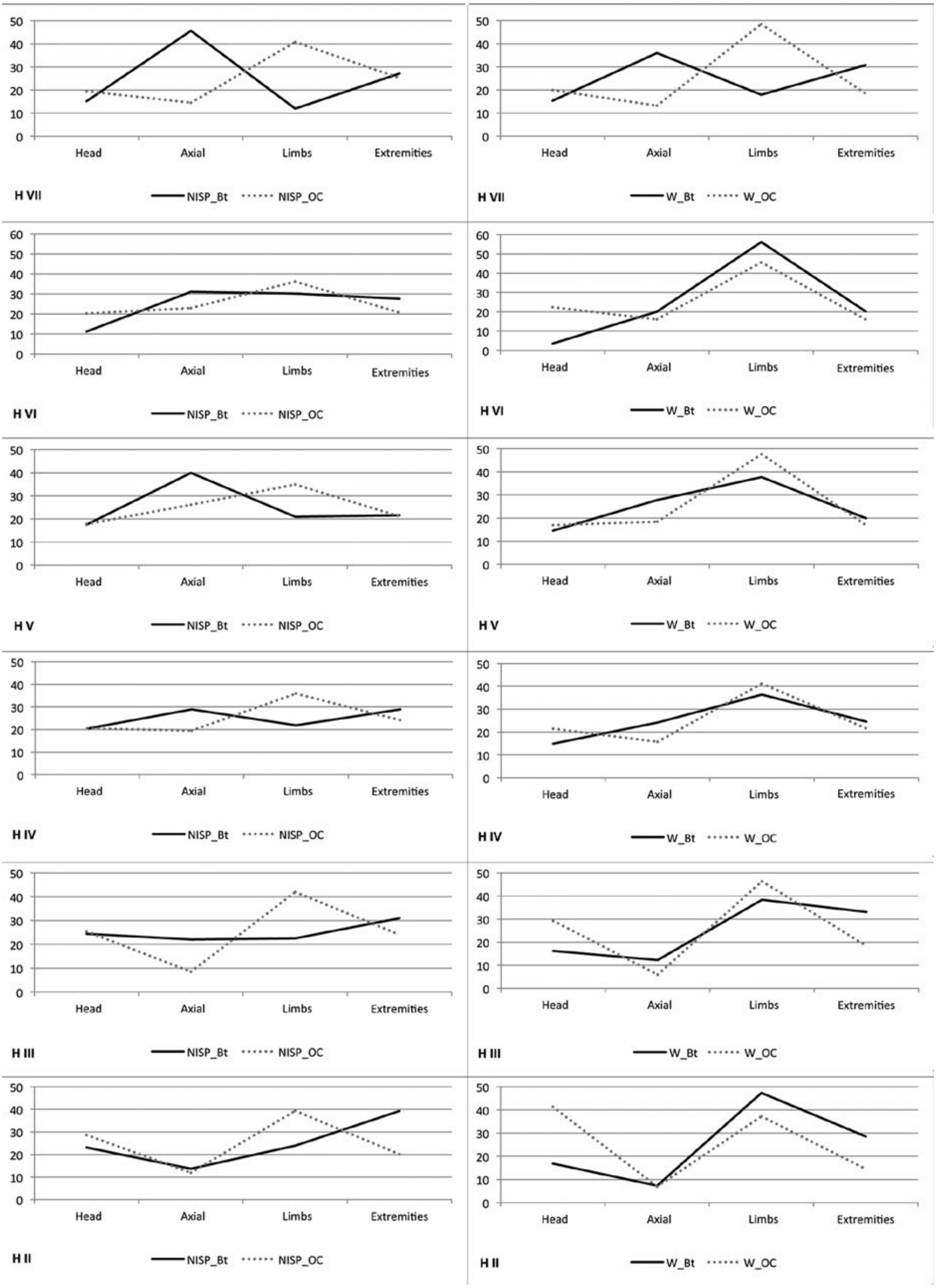


Figure 22. Percentages of the main domestic taxa in NISP and weight of remains in the different horizons at Aknashen according to the part of the skeleton. Legend: Bt – *Bos taurus* (cattle); OC – *Ovis aries/Capra* hircus (caprines).

The analysis of the results reveals in the case of the caprines that the limbs predominate, except for H II in which the remains of head (41%) are slightly more than those of limbs (37%). For the cattle, the tendencies are the same, especially the preponderance of the limbs. An exception is H VII, in which the axial skeleton is less present; but this could be explained by the limited sample (NISP=92).

In order to refine this analysis, we carried out comparisons not only on the gross weight of the skeleton parts, but on the relation of these parts to the weight that each skeleton part occupies in the body of a particular animal, for each species considered, applying a method already used by Oueslati (2002). Figure 23 shows the differences and similarities between the horizons. Thus we see a constant, low presence of the axial skeleton in all the horizons, and on the other hand we see that the extremities, which do not provide much meat and so have little culinary importance, have a high presence in all the horizons. The limbs that offer the largest amount of meat show high presence in H VII (only for caprines), H VI, H V, H IV, H III and H II (only for cattle). Also in the case of the cranial skeleton we see much fluctuation, from high presence in the case of cattle for H VII, H V, H IV, for both species in H III and H II, to low presence in H VI.

In the interpretations of our results we must take into account the fact that certain anatomical elements have a survival rate that is higher than others, depending upon their durability in the face of various taphonomic factors (Brain 1969: 19, table III). Thus mandibles have a survival rate of 91.4% in contrast to elements of the axial skeleton (ribs – 10.4%, vertebrae less than 8%). In the interpretation of Figure 23 we can refer to the differential destruction of anatomical elements. The low presence of axial skeleton elements could be related to this differential decomposition over time. In the case of caprines we can refer to the impossibility of determining the species precisely (due to the large number of taxa which have the same size), especially in the case of ribs. The fact that the limbs are generally the most numerous reveals that the carcasses of the slaughtered animals were present on the site or were consumed. The constant high presence of extremities can be related to the fact that they have a high survival rate, and the metapodials are much less broken/fragmented by human intervention given that they were not commonly used for food. The discovery of the remains of head, limbs and extremities suggests that the animals were slaughtered in the circumscribed zone of the site.

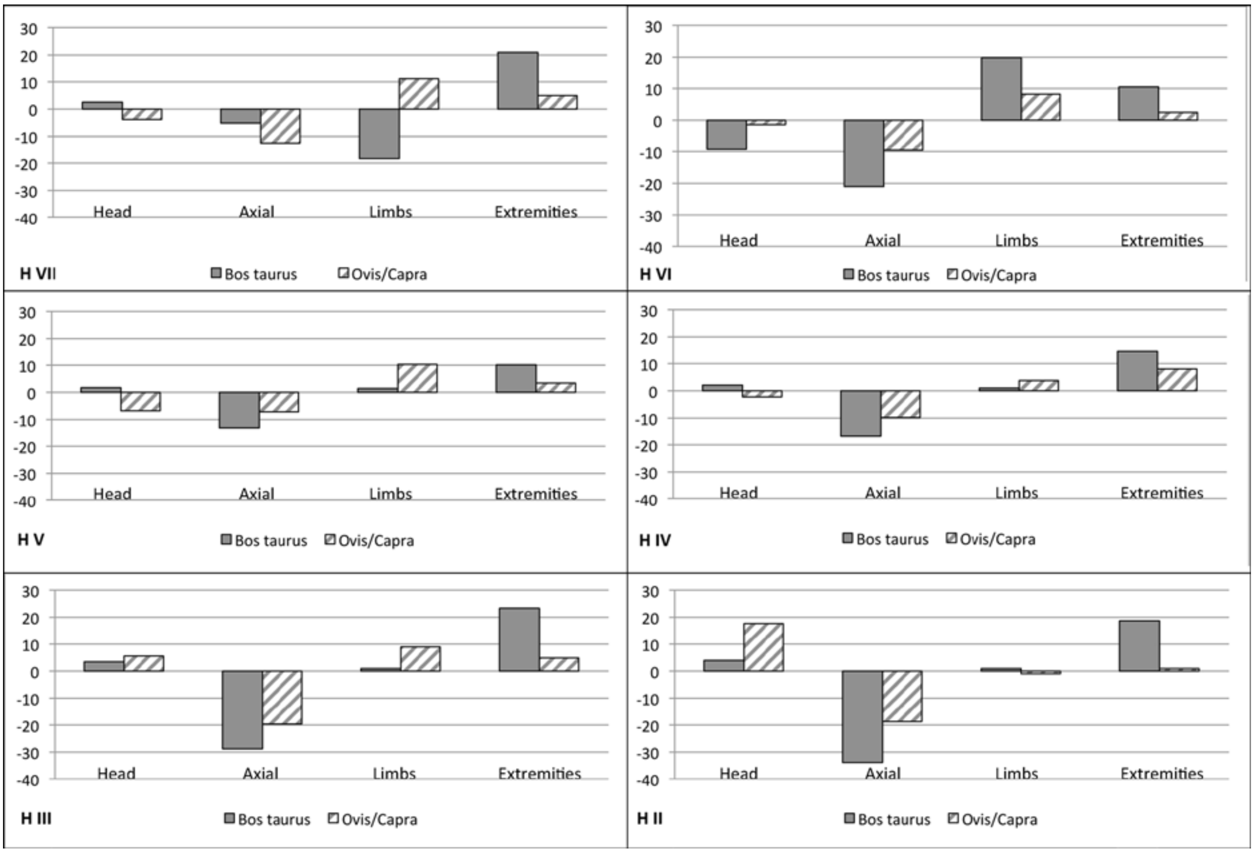


Figure 23. Low presence (-) and high presence (+) of the principal domestic taxa in weight of remains in the different horizons according to the skeleton part at Aknashen, expressed in comparison to a reference weight based on present-day skeletons. [Oueslati (2002)].

Biometry

For the region of the Caucasus, published raw biometric data are virtually non-existent. For this reason the size of the early domestic animals is not known and very few comparisons are available. Below we analyse mainly the caprines and the cattle, the most important animals at Aknashen. The most numerous data come from the caprines, especially the sheep (N=238). We used the log ratio method to make comparisons between the horizons. The log size index (LSI) is the logarithm of the ratio between a measurement 'X' and its standard 'S', and calculated as logX minus logS. The standard used here is based upon the size of a female wild sheep published by Uerpmann and Uerpmann (1994). Because the number of biometric data for sheep is relatively limited for some horizons (H VII, H VI, H III and H II), we preferred to unite the data. Thus, H VII was placed with H VI and H III with H II. Comparison between HVII+VI and H IV revealed no differences. A low increase in size appeared in horizons H III+II (Figure 24).

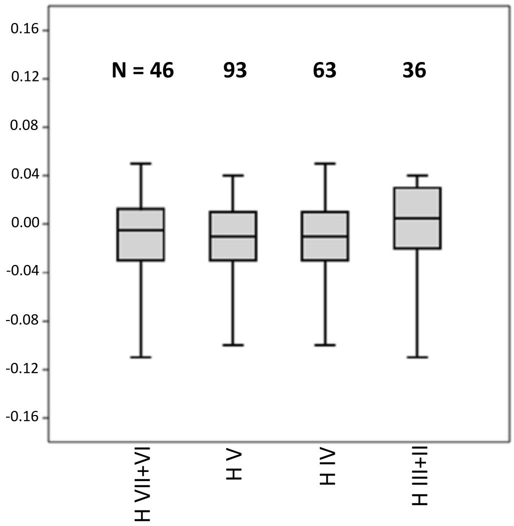


Figure 24. Comparisons between the sizes of sheep (*Ovis aries*) using the LSI method on the different Neolithic horizons at Aknashen.

A quick glance at some metrical data (GLL from astragali) from sites of different periods in Turkey (Bademagaci, Early Neolithic, 7000-6250 BC, de Cupere *et al.* 2008; Sos Höyük, Late Chalcolithic, 3500/3300-3000 BC, Piro 2009) and Syria (Sabi Abyad, Late Neolithic 6700-5900 BC, Russell 2010), shows that the average size of Neolithic sheep at Aknashen appears to be fairly large (Figure 25). Such observations need to be confirmed in the future by more biometrical analysis.

The discovery and the biometric study of several whole bones (a scapula, three humeri, four radii, five metacarpals, four metatarsals, nine calcanei and 33 astragali) (Figure 26) enabled estimation of the height at the withers of the sheep at Aknashen (Teichert index), an average of 67.2cm (N=59; limits 55.3 and 74.5cm). A comparison between the different horizons reveals a slight reduction in size of 3cm between H VII + H VI and H IV, followed by a relative increase in H III+II of about 2cm (Figure 27). It is difficult to determine whether this is due to sexual dimorphism or to relatively small samples (especially in the case of the early horizons VII and VI and the late horizons III and II). These relatively high values for the sheep of Aknashen are lower than those observed at Arukhlo (Benecke 2015: 12), for which the average is 70cm (N=52; limits 62 and 77cm). Apparently in the Kura basin this variation in size of sheep is also found on other sites such as Mentesh Tepe, Hasansu I and Kamiltepe (Benecke 2015).

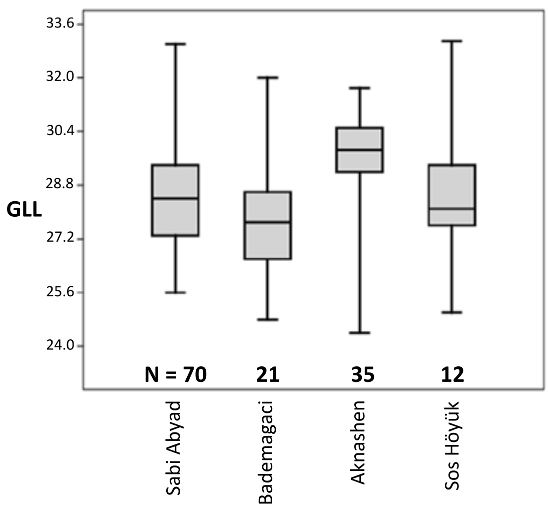


Figure 25. Comparisons of the sizes of astragali (GLL) from sheep (*Ovis aries*) at Aknashen with different sites in the region.

Figure 26. Whole sheep bones: humerus, two radii and a metatarsal (from left to right).

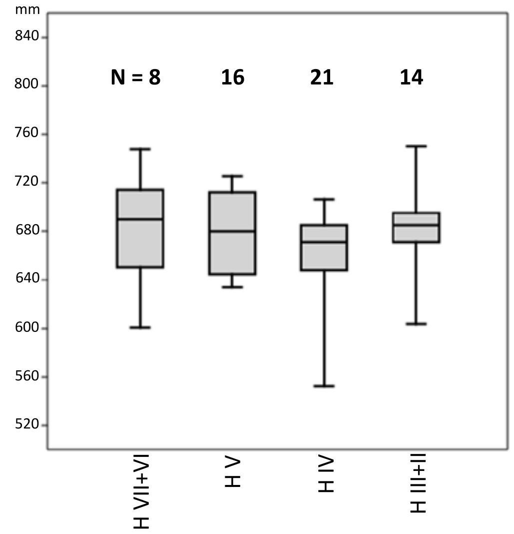


Figure 27. Comparisons of height at the withers of the sheep between the different Neolithic horizons at Aknashen.

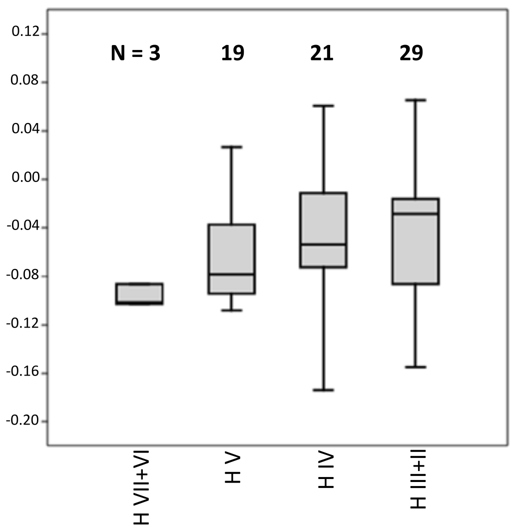


Figure 28. Comparisons between sizes of cattle (*Bos taurus*) using the LSI method in the different Neolithic horizons at Aknashen.

A preliminary analysis has also been carried out on the cattle remains. The number of biometric data for cattle (N=71) is lower than for sheep. For LSI in the case of cattle, we used as a reference the size of a female aurochs from Denmark (Degerbool 1970) from the Boreal Period (7000-6000 BC). The results show that there exists a slight increase in the average between the earliest horizons (H VII+VI) and the latest horizons (H III+II) but this could also be due to sexual dimorphism or allometry (Figure 28).

Biometric data for cattle are rare for the region. A quick glance at the size of cattle astragali from different Turkish and Armenian sites shows that the specimens from Aknashen appear similar to the specimens from

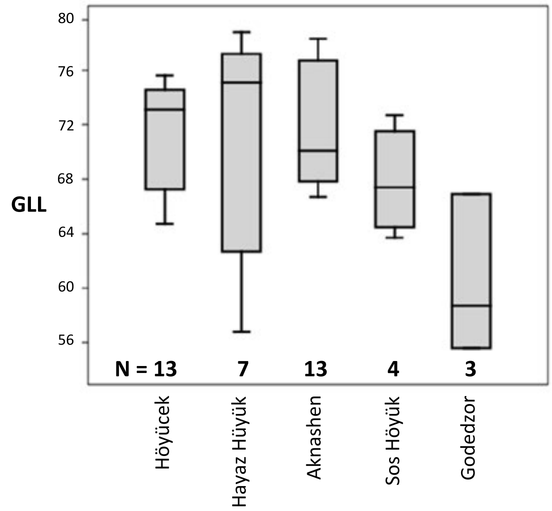


Figure 29. Comparisons of the sizes of astragali of cattle (*Bos taurus*) at Aknashen with those of different sites in the region.

Neolithic sites in Turkey (Hoyucek, Late Neolithic, de Cupere and Duru 2003; Hayaz Höyük, Late Neolithic, Buitenhuis 1985) and larger than the Chalcolithic specimens (Sos Höyük, Piro 2009; Godedzor, Bălășescu unpublished) (Figure 29). Of course, these observations are only preliminary. Systematic biometric analysis must be carried out on faunal remains from Armenia in order to understand the evolution of domestic animals in the Caucasus region.

Reconstruction of the environment of Aknashen

Besides providing information concerning fauna, morphology of species, palaeo-economy, etc., archaeozoology enables us to reconstruct environment and sometimes climate, based on the faunal spectrum. This is carried out mainly using the data provided by the wild fauna and sometimes using the data on the domestic fauna (when this is frequent enough). Certain wild animals have only limited ecological tolerance. They only inhabit the ecosystems that provide them with all their ecological requirements (stenobiontic animals), such as the beaver, for example. In this perspective, the presence/absence of these animals can provide information on the environment of a prehistoric settlement. The palaeo-ecological estimations based on mammal fauna are generally only relatively precise and should be treated with caution as they provide a minimum of information concerning the environment.

Our attempt to reconstruct the environment is somewhat audacious, considering that it is based only on the data drawn from the archaeozoological study, as so far no palynological analysis has been carried out in the region of Aknashen. The fact that caprines and cattle, ruminant animals, are predominant in our

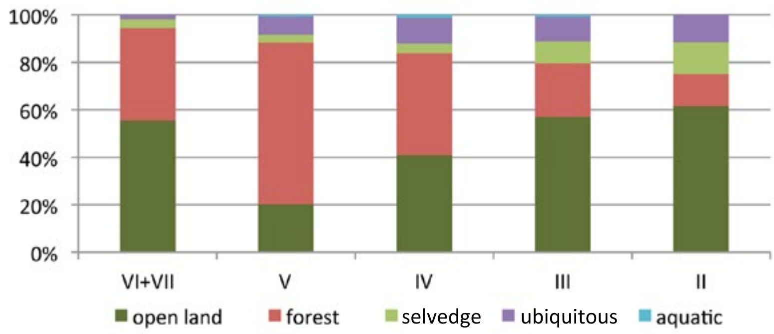


Figure 30. Relative frequencies of wild mammals in Aknashen according to ecological preference based on fragment counts (NISP). Legend: open land: caprines (wild sheep and wild goats), gazelle, horse, hare; forest – red deer, wild boar, bear, wild cat, marten; selvedge – aurochs and roe deer; ubiquitous – wolf, fox, badger, undetermined mustelids, hedgehog; aquatic – beaver.

material would suggest that around the site there were large open spaces of steppe type, suited to feeding these animals. The wild animals suggest a mosaic or mixture of milieus around Aknashen. Thus the open environment was inhabited by wild horses, gazelles and hares; the selvedge was occupied by aurochs and roe deer (which has a wide ecological flexibility), while the forest would have been home to red deer, wild boar, bears, wild cats and martens. Beavers would indicate a river.

If the importance over time of wild mammals at Aknashen is observed, the number of taxa that live in forest environments decreases between H V (68.2%) and H II (13.5%), while at the same time the number of taxa that prefer open environments increases, especially from H V (20.1%) to H II (61.5%) (Figure 30). Similarly the animals that live at the edge of the forest and the steppe (at the selvedge) increase from H VII+VI (3.7%) to H II (13.5%). These complementary variations could indicate the existence of a phenomenon of deforestation with the goal of acquiring more open space to feed domestic animals or for agriculture, which would have had repercussions on the presence/absence of certain wild taxa. Indeed, in H III and H II the animals that prefer open spaces are preponderant, 57% and 61% respectively.

The fish inform us concerning the fluvio-lacustral component of the environment. Almost all the species consumed live in well-oxygenated waters. The large individuals lived in rivers, in fairly deep lakes or a network of canals with very deep areas that enabled them to survive the winters or dry summers. The rivers would have had enough flow, at least during floods, to enable large reproducing individuals to migrate towards the Araxes.

Comparisons with other Neolithic sites in the Caucasus

The number of Neolithic sites contemporary to Aknashen (confirmed by 14C dating) that have produced studies on fauna in the last 10-12 years are relatively limited. In Armenia the only site is Aratashen (Vila *et al.* 2017; Bălășescu *et al.* 2010), in Georgia, Arukhlo, and in Azerbaïdjan the settlements of Mentesh Tepe, Hasansu I, Kamiltepe (Benecke 2015) and Hacı Elamxanlı Tepe (Nishiaki *et al.* 2015b; Nishiaki *et al.* 2013; Arai unpublished). The fact that these sites have been recently studied (since 2005) represents the advantage and the guarantee that they were treated with the same archaeozoological methodology, which enables comparison of data that are reliable and pertinent. Because in most of these Neolithic settlements the mammal remains dominate the faunal spectrum with percentages that are higher than 97.5%, our discussion stresses their contribution to the animal palaeoeconomy.

The two sites in Armenia are situated in the Ararat valley, in the valley of the Kasakh river, which is a tributary of the Araxes, in an environment that is open today and fairly homogenous. The basin of the Kura river contains very different regions, especially in regard to vegetation, which is strongly influenced by climate. Thus, in the middle basin, the climate varies between temperate at Arukhlo to semi-arid at Kamiltepe (the sites situated at the extremities of the basin, 350km apart). All the sites of the Kura basin provide samples representative of thousands of remains, from 2078 at Hasansu I to 25,026 at Arukhlo. Mentesh Tepe is an exception, with only 877 determined mammal remains.

Comparison of the proportions of domestic mammals and wild mammals show that the first are preponderant with percentages higher than 95% at Aratashen up to 99.6% at Mentesh Tepe (Figure 31). This signifies that herding held great importance and that hunting was limited.

When the contributions of the main domestic taxa (cattle, caprines and pigs) are compared from the point of view of the NISP, it shows that between the sites of the Araxes basin (the Ararat valley) and those of the Kura basin there are notable differences. In the Ararat valley, caprines largely dominate with 90% of the remains, while cattle hardly reach 9%. (Figure 32). In the Kura basin caprines prevail, but to a lesser extent, with only one exception in the site of Hacı Elamxanlı Tepe where the caprines reach 86%. On the other sites their contribution varies between 53% at Arukhlo and 78.8% at Mentesh Tepe. Cattle present fairly high

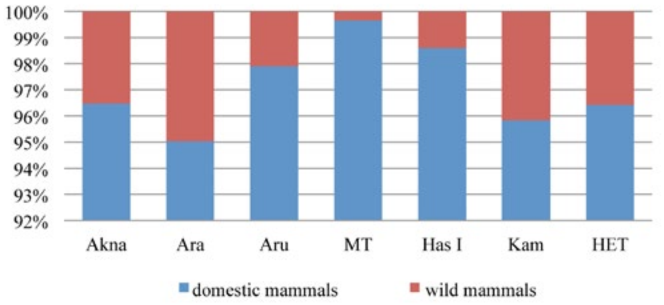


Figure 31. Relative frequencies of domestic and wild mammals in the Neolithic faunal assemblages in the Caucasus based on fragment counts (NISP).
Key: Akna - Aknashen, Ara - Aratashen, Aru - Arukhlo, MT - Mentesh Tepe, Has - Hasansu I, Kam - Kamiltepe, HET - Hacı Elamxanlı Tepe.

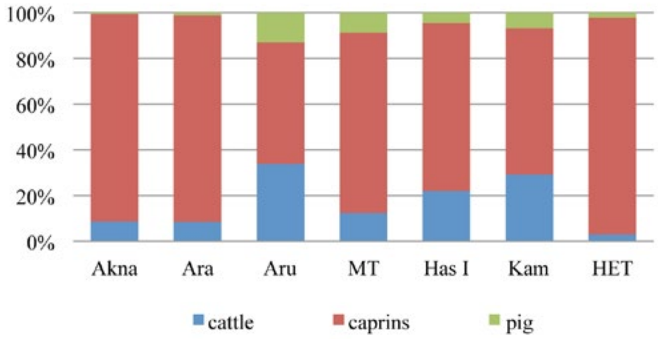


Figure 32. Relative frequencies of cattle, caprines and pigs in the Neolithic faunal assemblages in the Caucasus based on fragment counts (NISP).
Key: Akna - Aknashen, Ara - Aratashen, Aru - Arukhlo, MT - Mentesh Tepe, Has - Hasansu I, Kam - Kamiltepe, HET - Hacı Elamxanlı Tepe.

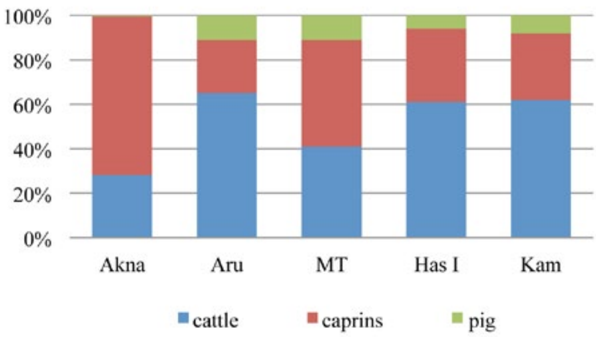


Figure 33. Relative frequencies of cattle, caprines and pigs in the Neolithic faunal assemblages in the Caucasus based on bone weights (W).
Key: Akna - Aknashen, Ara - Aratashen, Aru - Arukhlo, MT - Mentesh Tepe, Has - Hasansu I, Kam - Kamiltepe, HET - Hacı Elamxanlı Tepe.

percentages, from 12.4% at Mentesh Tepe to 33.8% at Arukhlo, with again an exception, only 4% at Hacı Elamxanlı Tepe. Another striking difference concerns the contribution of the pig, which is very low in the Araxes basin (< 1%) whereas in the Kura basin the percentages vary between 4.4% at Hasansu I and 12.9% at Arukhlo (Figure 32).

The data concerning the mass of bone remains (W) significantly reduce the importance of the caprines. Unfortunately, at Aratashen the faunal remains were not weighed, thus in Figure 33, this site is not taken into account. In the settlements of the Kura basin, the presence of cattle is higher than 60% on most of the sites, except at Mentesh Tepe, where it is only 41% and Hacı Elamxanlı Tepe where we have 28.7%. This could indicate that on the sites of Arukhlo, Hasansu I and Kamiltepe cattle provided more than half of the quantity of meat. The caprines are situated in second place with a weight that varies between 24% and 33%, with the exception of course of Mentesh Tepe and Hacı Elamxanlı Tepe, where they occupy first place with 48% and respectively 62.9%. The presence of suids varies between 6% and 11% in the Kura basin. At the site of Aknashen, the proportions observed for NISP are also valid for W. Thus caprines dominate with more than 71%, cattle are in second place (28%) and suids count for less than 1% (Figure 33).

The hunted mammals contribute less than 5% of the total remains (Figure 31), but in compensation they present a taxonomic richness in the majority of settlements, which shows that around the sites there was a high availability and variety of wild animals (Aknashen – 17 species; Aratashen and Arukhlo – 13; Kamiltepe – 10). The site of Hacı Elamxanlı Tepe presents only seven wild taxa and this situation is highly similar to the earliest horizons at Aknashen (H VII and H VI). The remains of wild mammals (NISP) vary between 23 at Hasansu I and 718 at Aknashen (the site of Mentesh Tepe has only three remains of wild mammals and has not been included in our discussion). On the two sites in the Ararat valley cervid prevail, in particular the red deer, especially at Aratashen (75% of all the wild mammals), whereas at Aknashen they count for only 32% (Figure 34). Hare and wild boar were hunted preferentially at Aratashen, while at Aknashen gazelle, hare and wild boar were preferred.

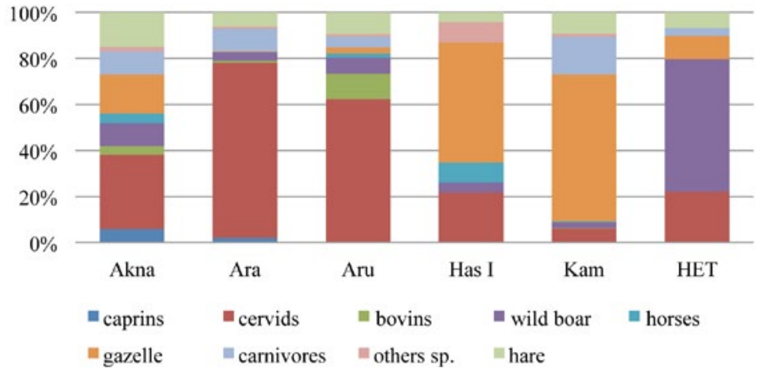


Figure 34. Relative frequencies of wild mammals in the Neolithic faunal assemblages in the Caucasus based on fragment counts (NISP). Legend: caprines – wild sheep and wild goats; cervids – red deer and roe deer; bovines – aurochs and bison; carnivores – wolf, fox, badger, otter, marten, big cat, wild cat, indet. mustelids; other sp. –beaver and hedgehog

In the Kura basin the situation is relatively different, if we take into account that on two of the sites, the gazelle is predominant with percentages of 63.8% at Kamiltepe and 52.2% at Hasansu I; at Arukhlo and Hacı Elamxanlı Tepe red deer are the most important hunted mammals. Among the hunting choices were also wild bovines (aurochs and bison), hare and wild boar at Arukhlo, cervid and wild horse at Hasansu I, hare and cervid at Kamiltepe.

In conclusion, we observe that there was a wide variety of species hunted and of preferences for one or another, related to the type of environment and the interest of these communities in hunting particular wild mammals.

Conclusions

In this study we have identified 33 taxa belonging to various classes of animal: mollusks, fish, reptiles, birds and mammals. The mammals dominate with 97.6% of the total remains, evidence of their importance for the Neolithic community at Aknashen. Among the mammals, the domestic animals are preponderant, which is evidence that animal husbandry was a dominant activity. Caprines and cattle are the most common, while pigs have a low presence in the samples (less than 1% of NISP). In the development of the tell of Aknashen, between horizons VII and II the importance of caprines decreases while that of cattle, pigs and wild mammals increases, especially if the weight of the remains is taken into account.

The kill-off profiles of the caprines for the earliest horizons demonstrate an exploitation that was principally for meat (animals between 6 months and 2 years), and secondarily for milk. Exploitation for milk increases little by little, and becomes dominant in Horizon II. For the caprines, the presence of individuals of all age classes, determined as much by remains of teeth as by remains of appendicular skeletons, suggests that the site was inhabited throughout the year. The exploitation of cattle was mixed, as much for meat as for milk, and perhaps for their strength as draught animals.

The remains of wild mammals are no higher than 3.5% of NISP, but present higher values from the point of view of weight (7.3 %) and in the large number of species (17). The red deer, the gazelle, the wild horse and the wild boar are the best-represented species in number of remains. During the chrono-cultural development of the site, hunting increases in importance and the weights of the taxa fluctuate. Thus the red deer, which has the highest frequencies in the early levels, is surpassed by the gazelle and the wild horse in horizons III and II. Concerning the surrounding environment, the domestic mammals (caprines and cattle) and the wild mammals (hare, gazelle, wild caprines, wild horses, etc.) indicate that open spaces predominated around the tell, but that nearby were forests that harboured species such as the red deer, the wild boar, the bear, the marten and the wild cat.

Fishing was a summer activity that contributed to diversification in food of animal origin. Cyprinids and catfish were the preferred species. The fished individuals were for the most part large or very large, and according to present data, it would appear that this was a natural choice. The other animals, such as the turtles and the birds, were to a lesser degree part of the diet of the Neolithic inhabitants. They also provided raw materials for various useful objects.

The characteristics of the animal palaeo-economy discovered at Aknashen are similar to those of the tell at Aratashen, a fact which distinguishes the sites of the Ararat valley from those of the Kura river basin on the other side of the chain of the Lesser Caucasus (Arukhlo, Hasansu I, Mentesh Tepe and Kamiltepe).

Acknowledgements

We wish to thank Ruben Badalyan, Christine Chataigner, Emanuelle Vila and Remi Berthon for their invaluable contributions to our understanding of the Neolithic and the archaeozoology of the Caucasus.

Appendix 1. Anatomical elements distribution for the mammals by horizons in NISP and Weight (only for *Bos taurus* and *Ovis aries/Capra hircus*)

H VII	NISP																		Weight	
Anatomical element	*Bos taurus*	*Ovis aries*	*Capra hircus*	*Ovis/Capra*	*Canis familiaris*	*Ovis orientalis*	*Capra aegagrus*	*Ovis/Capra wild*	*Bos primigenius*	*Cervus elaphus*	*Gazella sp.*	*Vulpes vulpes*	*Felis sp.*	*Lepus sp.*	*Bos sp.*	*Ovis/Capra/Gazella*	*Sus sp.*		*Bos taurus*	*Ovis/Capra*
Cranium					1															
Neurocranium	3	1	7	27	1						1								19	305
Viscerocranium	1			14															4	103
Dentes sup.	5			60				1											48	312
Mandibula	5	12	2	35	2					1			1				2		140	430
Dentes inf.		27	2	52	1															350
Dentes				10																8
Hyoid				2																5
Atlas				8																118
Epistropheus	1			12						2									24	139
et Vert. cv.	4			28						1				1					47	209
Vert. thor.	2			21															36	69
Vert. lumb.	2			31															30	176
Sacrum				1																5
Costae	33			85	1										5	171	1		358	276
Sternum				1																7
Scapula	1	15		68		2		1						1					30	608
Humerus	2	12	6	86			1												55	861
Radius	1	6		82	1			1		1									15	635
Ulna		5		14				2								1				79
Radio–Ulna				1																5
Carpalia	4			20						1									41	29
Metacarpus	1	3	1	25						1									6	222
Pelvis	2	1		30	1							1		1			1		38	255
Femur	3	1	1	89		1		1											67	567
Patella				3																16
Tibia	2	4	1	100				2											42	661
Fibula					1															
Talus	1	16	1	23						1									12	240
Calcaneus	2	5		19				1						1					78	171
et Tarsalia	1			7															10	19
Metatarsus	1	4	1	48						1									30	291
Metapodalia	3			78				2	1	1									48	263
Phalanx 1	4	3		35						3									41	101
Phalanx 2	2			18						3									42	35
Phalanx 3	5			15						1									110	26
Os sesamoideus	1			1															5	1
TOTAL	**92**	**115**	**22**	**1149**	**9**	**3**	**1**	**11**	**1**	**17**	**1**	**1**	**1**	**4**	**5**	**172**	**4**		**1376**	**7597**

H VI	NISP													Weight	
Anatomical element	*Bos taurus*	*Ovis aries*	*Capra hircus*	*Ovis/Capra*	*Sus domesticus*	*Canis familiaris*	*Ovis/Capra wild*	*Cervus elaphus*	*Capreolus capreolus*	*Gazella sp.*	*Lepus sp.*	*Ovis/Capra/Gazella*		*Bos taurus*	*Ovis/Capra*
Cranium						1									
Neurocranium	2		8	37						1				4	378
Viscerocranium				21		2	1								126
Dentes sup.	3			53										17	237
Mandibula	6	15	2	43		1								65	628
Dentes inf.	2	21		46				1						5	193
Dentes				16	1										27
Hyoid				2											4
Atlas	2			10		1								42	97
Epistropheus	1		1	11										55	130
et Vert. cv.	4			13										52	117
Vert. thor.	1			34										6	110
Vert. lumb.	3			48							2			50	156
Sacrum	1			5										24	23
Costae	24			175		2						221		288	506
Sternum				2											4
Scapula	8	12		36			1							312	462
Humerus	4	4	2	49										267	475
Radius	1		1	74							1			58	478
Ulna	3		3	19							1			22	74
Radio–Ulna	1			1										14	47
Carpalia	3			19		1								65	26
Metacarpus	2	3	1	29										71	211
Pelvis	11	1		53										614	429
Femur	4	1		94			1							99	459
Patella				11											48
Tibia	3	3		107		1								59	776
Talus	2	1		30				1						75	190
Calcaneus	1	1		16		1								10	105
et Tarsalia				6								1			14
Metatarsus	3			43				1	1					66	250
Metapodalia	4			69							2			44	243
Phalanx 1	9			34		1						1		64	68
Phalanx 2	2			9										37	17
Phalanx 3	4			9										82	14
Os sesamoideus	2													7	
TOTAL	**116**	**62**	**18**	**1224**	**1**	**11**	**3**	**3**	**1**	**1**	**6**	**223**		**2574**	**7122**

H V	NISP																								Weight	
Anatomical element	*Bos taurus*	*Ovis aries*	*Capra hircus*	*Ovis /Capra*	*Sus domesticus*	*Canis familiaris*	*Ovis/Capra wild*	*Bos primigenius*	*Cervus elaphus*	*Gazella* sp.	*Capreolus capreolus*	*Sus scrofa*	*Canis lupus*	*Vulpes vulpes*	*Martes* sp.	*Mustela* sp.	*Felis* sp.	*Castor fiber*	*Lepus* sp.	*Bos* sp.	*Ovis/Capra/Gazella*	*Sus* sp.	*Erinaceus* sp.		*Bos taurus*	*Ovis /Capra*
Neurocranium	15	5	16	203		2			1	3		2									1	1			146	1505
Viscerocranium	8			155		1			1			2				1						1			127	878
Dentes sup.	24			322					1	1		1			2							1			476	1524
Mandibula	26	62	3	293		2			3			5		1					1			3	2		1081	2678
Dentes inf.	26	103	5	221		1			4	1		9		1								3			245	1032
Dentes	9			222		1			1					1								3			36	346
Hyoid				15																		1				15
Atlas	3			59			1																		217	537
Epistropheus	2			70			1																		61	586
et Vert. cv.	26			206					1																489	1528
Vert. thor.	21			366		3																			488	1185
Vert. lumb.	22			369		3																			443	1491
Sacrum				47																						224
Vert. caud.	4			2																					25	3
Costae	160			1243		4	1					1								1	784	2			2279	3052
Sternum	8			26																					41	88
Scapula	21	80	3	351					3										2	1	4				976	3767
Humerus	6	57	12	343			1					2				1	1		1						319	3443
Radius	13	16	1	538		2			3		1	2													486	3164
Ulna	8	7		131		1			1		1								1						244	470
Radio–Ulna	1	9		6																					35	323
Carpalia	29			149					4			2													542	209
Metacarpus	5	15		167										1								1			170	1217
Pelvis	18	11		303		2			1						1				2			2			659	2430
Femur	27	25	1	620		1	1		2			2				1		1	3						1403	4235
Patella	4			43			1		2													1			122	135
Tibia	31	32	1	602		1		1	4			1								1					1234	4536
Fibula												3														
Talus	9	29		173				1	1																597	1219
Calcaneus	12	40		101															1	1					414	815
et Tarsalia	5	1		80		1		1	2											1					132	393
Metatarsus	7	12	1	251					6	1									3			1			166	1653
Metapodialia	18			515		2			6			3				1			3		2	15			243	1750
Phalanx 1	23	2	1	220		1			8			2	1	1			1					1			246	472
Phalanx 2	16	1		104					5	1		3													261	169
Phalanx 3	5			63	1					1												2			116	100
Os sesamoideus	4			7																					13	8
TOTAL	**616**	**507**	**44**	**8586**	**1**	**28**	**6**	**3**	**60**	**8**	**2**	**40**	**1**	**5**	**3**	**4**	**2**	**1**	**17**	**5**	**791**	**38**	**2**		**14532**	**47180**

H IV	NISP																										Weight	
Anatomical element	*Bos taurus*	*Ovis aries*	*Capra hircus*	*Ovis /Capra*	*Sus domesticus*	*Canis familiaris*	*Equus* sp.	*Ovis/Capra wild*	*Bos primigenius*	*Cervus elaphus*	*Capreolus capreolus*	*Gazella* sp.	*Sus scrofa*	*Ursus arctos*	*Canis lupus*	*Vulpes vulpes*	*Meles meles*	*Martes martes*	*Mustela* sp.	*Felis* sp.	*Erinaceus* sp.	*Castor fiber*	*Lepus* sp.	*Bos* sp.	*Ovis/Capra/Gazella*	*Sus* sp.		*Bos taurus*	*Ovis /Capra*
Neurocranium	14	5	13	77		1		1				12																105	676
Viscerocranium	11			83		4				13		4	2			3		1			1							308	452
Dentes sup.	14			228						7		4				1										1		147	655
Mandibula	32	49	4	168		7	1		1	18		15	2		1	4					2		1		2	1		530	1319
Dentes inf.	29	63	6	162		1				4		4	2			2									1	4		218	469
Dentes	12			92		1				10			2			1						2			4	1		16	117
Hyoid				11																									11
Atlas				28		1																							201
Epistropheus	8			22																								122	151
et Vert. cv.	18	1		137		3				4																		157	372
Vert. thor.	22			125		2				2						2							2					218	429
Vert. lumb.	19			118		1										2	1						1					171	287
Sacrum	2			12																								35	47
Vert. caud.	2			8																								10	8
Costae	79			459		1				3													2	1	117	1		1418	1208
Sternum	9			6																								17	13
Scapula	31	16	1	152						1		4	1									1	1	1	4			618	851
Humerus	19	16	5	237				1		3						2			3	1			1	1	2			646	1164
Radius	10	5	2	354				1		2			1		1		1						1		3			304	1315
Ulna	8	2		95		1				4						1			1				1		1	1		90	291
Radio–Ulna	2	1		13					1																1			12	143
Carpalia	29			100					2	5							1											565	693
Metacarpus	12	6	1	61				1	2	1		4													1	2		376	1040
Pelvis	11			170		1		1		2		2	1										3	1	1			70	81
Femur	21	3	1	272		1				3									2						3			552	1525
Patella	3			29						1																			
Tibia	15	11	2	299				1	1	2													6		6			325	138
Fibula																1												243	378
Talus	12	16	1	55		1	1	4	1	4		1											1			1		530	310
Calcaneus	5	13		61			2	1		2													3			2		130	332
et Tarsalia	8			35								2																136	121
Metatarsus	7	10		105		1					1	8											9		2			268	768
Metapodialia	22	1		399		2				10			2						1	1		1	10	1	5	4		129	1131
Phalanx 1	24	2	3	136	1				3	5		3											3	2				135	300
Phalanx 2	15	3	3	61					1	5		4	1											1				135	159
Phalanx 3	18	16	1	35						4		2	3	1												2		141	78
Os sesamoideus	7			7																								10	9
TOTAL	**550**	**239**	**43**	**4412**	**1**	**29**	**4**	**11**	**12**	**115**	**1**	**69**	**17**	**1**	**2**	**19**	**3**	**1**	**7**	**2**	**3**	**4**	**45**	**8**	**153**	**20**		**8887**	**17242**

H III	NISP																						Weight	
Anatomical element	*Bos taurus*	*Ovis aries*	*Capra hircus*	*Ovis /Capra*	*Sus domesticus*	*Canis familiaris*	*Ovis/Capra wild*	*Equus* sp.	*Bos primigenius*	*Cervus elaphus*	*Capreolus capreolus*	*Gazella* sp.	*Sus scrofa*	*Vulpes vulpes*	*Mustela* sp.	*Castor fiber*	*Lepus* sp.	*Erinaceus* sp.	*Bos* sp	*Ovis/Capra/Gazella*	*Sus* sp.		*Bos taurus*	*Ovis /Capra*
Neurocranium	8		6	13				1				1								1	2		91	192
Viscerocranium	5			18		2			1	1		10	1	3						1			65	79
Dentes sup.	7		1	97						4				1						2	1		124	402
Mandibula	11	11	7	45	1	2				1		9	2	1			2	1		5			161	423
Dentes inf.	16	24	1	47		2		1	1	1		3									7		89	198
Dentes	5			5									2				1			4	1		7	9
Atlas				5						1														46
Epistropheus	2			4																			8	17
et Vert. cv.	2			16		1	1													1			15	50
Vert. thor.	1			24						1					1					1			60	68
Vert. lumb.	8			12																			69	25
Sacrum	1			5																			24	17
Costae	33			24					1	1										45	1		230	41
Sternum				2																				2
Scapula	12	18	1	50			1	1				2					2			1	1		295	438
Humerus	7	4	2	57				1	1	1	1	1					1			1	1		142	286
Radius	4	2	2	113	1	1		2		2	1	1	1				1		1	2			55	387
Ulna	5			17		1	1					1	2										40	60
Radio–Ulna		1		6													1							69
Carpalia	12			12				1		1							1						114	13
Metacarpus	8	2	1	22		1						2	1								1		168	125
Pelvis	5			24		2	2										1						132	132
Femur	5	1		55			1								1					2			69	214
Patella	1			7				1															30	12
Tibia	9	2	2	90				1	1			1					3						505	467
Fibula																	1							
Talus	8	13	1	12						1							1						328	168
Calcaneus	1	4		23			1										2						40	134
et Tarsalia				6								2												8
Metatarsus	6	2		39							2	1	1				3		1	2			128	155
Metapodialia	9			80		1				1			1	1	3	1	3				1		81	150
Phalanx 1	13			20	1				1		2	5			3		1				1		139	41
Phalanx 2	3			11						1	1	2	2								2		61	10
Phalanx 3	4			11		2				2													30	13
Os sesamoideus	2			1																			5	1
TOTAL	**213**	**84**	**24**	**973**	**3**	**15**	**7**	**9**	**6**	**19**	**7**	**41**	**13**	**6**	**8**	**1**	**24**	**1**	**2**	**68**	**19**		**3305**	**4452**

H II	NISP																			Weight	
Anatomical element	*Bos taurus*	*Ovis aries*	*Capra hircus*	*Ovis /Capra*	*Sus domesticus*	*Canis familiaris*	*Equus* sp.	*Bos primigenius*	*Cervus elaphus*	*Capreolus capreolus*	*Gazella* sp.	*Sus scrofa*	*Vulpes vulpes*	*Mustela* sp.	*Lepus* sp.	*Bos* sp.	*Ovis/Capra/Gazella*	*Sus* sp.		*Bos taurus*	*Ovis /Capra*
Neurocranium	3	2		2																71	49
Viscerocranium	2			10			1													130	107
Dentes sup.	10			33			1									1		1		170	252
Mandibula	1	6	1	8		1	1	1					1		1	2		1		7	329
Dentes inf.	8	8	1	14	2	1	9		1									1		164	105
Dentes	3			9	1	1	1						1					3		8	19
Epistropheus				2																	18
et Vert. cv.	3			3																105	6
Vert. thor.	2			5																30	22
Vert. lumb.				8									1		1						36
Vert. caud.				1																	1
Costae	11			20													2			103	61
Scapula	6	1		14							2	1				1		2		380	114
Humerus	6	2	1	31		1	1								1					591	233
Radius	3			33		1			1							1		1		176	156
Ulna				9		1									1						26
Radio–Ulna				2						1											9
Carpalia	3			1												1				42	1
Metacarpus	5	1		4			1			1										133	32
Pelvis	5	1		2					1				1							110	23
Femur	1		1	15												3		2		10	139
Patella	1			2																30	8
Tibia	6			15											5					250	67
Talus	1	2		4				1												2	45
Calcaneus	3			5				1	1			1				1				132	53
et Tarsalia	2			1																76	4
Metatarsus	3			10		1			1		1				2					156	50
Metapodialia	6			29										1	1	2				81	95
Phalanx 1	10		1	8			1													118	22
Phalanx 2	5							2												112	
Phalanx 3	4													1						63	
Os sesamoideus	4																			18	
TOTAL	**117**	**23**	**5**	**300**	**3**	**7**	**16**	**5**	**5**	**2**	**3**	**2**	**4**	**2**	**12**	**12**	**2**	**11**		**3268**	**2082**

Current results of archaeobotanical studies at the Neolithic settlement of Aknashen (Ararat valley)

Roman Hovsepyan

Introduction

The earliest evidence for agriculture in the South Caucasus comes from sites of the Aratashen-Shulaveri-Somutepe culture, which are situated in the alluvial plains of the Kura and Araxes river basins. These sites of the Aratashen-Shulaveri-Somutepe culture are tell-type settlements belonging to the Late Neolithic period, dated to the 6th millennium BC. There are no stone constructions in these settlements; the dwellings built of clay and the multifunctional structures are circular in form. The earliest layers of these settlements appear to be aceramic, the Aknashen settlement being one of these sites (Badalyan *et al.* 2007, 2010). In Armenian territory, the settlements of the Aratashen-Shulaveri-Shomutepe culture are situated in the Ararat valley. Thus far there are only three properly investigated sites of this period in Armenia: Aknashen (Badalyan *et al.* 2010), Aratashen (Badalyan *et al.* 2007) and Masis Blur (Martirosyan-Olshansky *et al.* 2013). These three settlements are close to each other (the distances between these sites are less than 10km).

The Neolithic settlement of Aknashen is a small mound situated on altitude ca. 840m above sea level (Badalyan *et al.* 2010). Nowadays, it is surrounded by semi-desert vegetation where species of *Alhagi*, *Glycyrrhiza* and *Zygophyllum* predominate. There are no native arboreal plants in the surroundings except few poplars and willows growing along the artificial canals for irrigation. The climate of Aknashen is a cold semi-arid climate (BSk according to the Köppen-Geiger climate classification). There is not much rainfall at Aknashen all year long: it is around 289mm per year. The average temperature at Aknashen is 12.4 °C (climate-data.org; National Atlas of Armenia 2007). Occupation of local people nowadays are vegetable cultivation, gardening and animal (mostly cattle) husbandry. Some field crops and fodder crops such as common bread wheat, hulled barley, emmer and *Medicago* are being cultivated as well. Agriculture in the surroundings of the studied site nowadays is highly dependent on artificial irrigation.

In this article we present a summary of the present archaeobotanical studies at the Neolithic settlement of Aknashen. It provides data about the earliest cultivated plants in the region and about the dynamics of agricultural preferences in the beginning of formation and establishment of the agricultural societies in the region.

Materials and methods

Flotation (sieves with 0.3mm mesh size) and wet-sieving (1mm) were the methods used to recover plant remains from the cultural sediments of the Aknashen settlement. 262 samples with total volume of 4,868 liters were processed. The sediments chosen for sampling were situated in a variety of contexts such as hearths, the fill of various structures, areas where there was a concentration of bone, pottery, stone tools or other artefacts and floors. In order to provide a picture of the diffusion of plant remains, we also sampled layers in which the context was unclear.

Charcoal remains are scarce among the recovered plant remains. Most of the archaeobotanical material consists of charred seed remains. Mineralized seeds remains are not frequent and are characteristic only for the nutlets of the representatives of Boraginaceae family and the nutstones of hackberry.

The recorded taxa and the types of preservation (charred, mineralized, etc.) of the archaeobotanical material are the same for all horizons of the excavation. But the degree of preservation of the plant remains differs; those are better preserved in the deeper layers, except the lowermost layer (Horizon VII), whereas material from the uppermost layer (Horizon II) is much lesser, fragmented and eroded. Therefore the number of samples studied and the quantity of findings vary according to the stratigraphical horizons of the site. In the uppermost layers (Horizons I and II) the major problem was the disturbance by later human activities (cemetery, etc.). The best preserved archaeobotanical material comes from Horizon V (between the depths of 2.8/3.0 and 3.8/4.0m in the centre of the mound). Unfortunately, the concentration of cultivated plant remains recovered from Horizon VII is the lowest at the site, especially for the lowermost layers, where the finest clay washed down and accumulated over millennia. The low quantity of plant remains in Horizon VII could be because of the method used to separate them from wet clayey sediments (flotation and wet-sieving). The problem is that fine wet clay does not dissolve in water and can remain for many days without breaking apart.

During the flotation and wet-sieving procedures the sediments had to be loosened manually to solve this problem, but some of the remains did not survive this manipulation (newly fragmented and eroded fragments were also recorded).

The morphological, anatomical and biometric features of the plant remains were used to identify the recovered material (Jacomet 2006; Lukyanova *et al.* 1990; Zohary *et al.* 2012; Takhtajyan and Fedorov 1972; etc). Zohary *et al.* (2012) was used for the nomenclature of the recovered cultivated plants (Lukyanova *et al.* (1990) for barley), and Takhtajyan and Fedorov (1972) and the online database www.theplantlist.org for the wild plants.

Results

More than ten thousands of carpological remains were studied and around fifty taxa of Flowering Plants were identified, representing cultivated plants, edible fruits and wild/weedy plants.

Remains of cultivated plants

The assemblage of cultivated plants is similar for all stratigraphic horizons of the site (Figure 1).

Grains of cultivated cereals (Triticeae) prevail throughout (averages for horizons). Free-threshing wheat (*Triticum aestivum/durum*), emmer (*Triticum dicoccum*), einkorn (*T. monococcum*), naked and hulled varieties of barley (*Hordeum vulgare*), among which the naked variety prevails, were the principal cultivated cereals for the Neolithic settlement of Aknashen. The second largest group of cultivated plants are pulses (Vicieae): small-seeded lentil (*Lens culinaris* subsp. *microsperma*), bitter vetch (*Vicia ervilia*) and pea (*Pisum* sp./ *Pisum sativum*).

Remains of edible fruits

Remains of edible fruits are few amongst archaeobotanical findings from the Neolithic settlement of Aknashen: nutstones of species *Celtis* (Ulmaceae), *Rubus*, *Crataegus* (Rosaceae) and *Elaeagnus angustifolia* (Elaeagnaceae) were recovered.

Wild plants

Biomineralized nutlets coming from the species of Boraginaceae family, particularly *Buglossoides arvensis* [=*Lithospermum arvense*] are the most common in terms of the number among the recorded weedy taxa. Other species of this family were also recovered: *Lithospermum officinale*, *Echium* sp., *Heliotropium* sp. (Figure 1).

The second most frequent weeds are from the Chenopodiaceae (Amaranthaceae) family; two unidentified species of *Salsola* and a species of *Chenopodium* are very frequent on the site, however it is possible that they were gathered and accumulated by insects during the Neolithic period[1] (Figure 1). It is also possible that the small accumulations of *Polygonum aviculare* discovered were gathered by insects during the Neolithic. Other species of the Polygonaceae family also present at the site: *Rumex crispus*, *Persicaria* sp. and *Polygonum convolvulus* [=*Fallopia convolvulus*] (Figure 1).

Species of the Poaceae family were not possible to identify because of poor preservation. However, *Bromus* sp., *Lolium* sp., cf. *Aegilops* sp., cf. *Festuca* sp. and Panicoideae gen. sp. were identified, and the remaining seeds were mostly grouped into larger-seeded (>2mm) grasses (Poaceae gen. spp.L) and small-seeded (<2mm) grasses (Poaceae gen. spp.S) (Figure 1).

The situation was more or less the same for the finds of the Fabaceae family. It was possible to identify *Alhagi* sp., *Sophora* sp., *Vicia* sp., *Medicago/Melilotus* sp., *Trifolium* sp. and the rest of the remains were grouped in Vicieae gen. spp. and small-seeded Fabaceae gen. spp. 2 (Figure 1). Species of *Galium* (Rubiaceae) were very common weeds for the region beginning in the Early Bronze Age period, but very few remains of this plant were found at the Aknashen site (Figure 1).

Carex sp. and *Bolboschoenus maritimus* are the most common representatives of the Cyperaceae family. The recorded species of Cyperaceae, along with *Alisma* sp. (Alismataceae) indicate the presence of water-related eco-niches in the area surrounding the site during the Neolithic period. The species of Ranunculaceae, *Adonis* sp., *Ranunculus* spp., and Caryophyllaceae, e.g. *Silene* sp., as well as *Calystegia sepium* (Convolvulaceae) may present additional evidence for a moist environment. But the presence of certain taxa such as *Capparis spinosa* (Capparidaceae), *Salsola* sp. (Amaranthaceae), *Alhagi* sp., *Sophora* sp. (Fabaceae), *Hyoscyamus* sp. and *H. niger* (Solanaceae), *Convolvulus arvensis* (Convolvulaceae), *Alyssum desertorum, Camelina microcarpa, Thlaspi* spp., *Brassica/Sinapis* sp. (Brassicaceae), etc. (Figure 1), suggests environments with dry soil. This evidence supports the hypothesis that different ecosystems co-existed in the surroundings of the site. This situation is also true today: at present the vicinity of the site is dry environment with semidesertic vegetation penetrated with hygrofilous and hydrofilous vegetation along and in the canals.

[1] Accumulations of the abovementioned seeds have been uncovered during excavations and they were covered by thick (up to several ten cms) layer of deposits. No alive insects were recorded with these seeds. The recovered seeds were very fragile and light as the inside part of complete seeds were missing. There were no evidence for these seeds for being modern.

Horizon		**II**	**III**	**IV**	**V**	**VI**	**VII**
Samples		***8***	***27***	***10***	***90***	***8***	***98***
Volume of the sample processed (Liter)		***55***	***312***	***316***	***2,228***	***68***	***1,889***
Concentration of carpological material (units/liter)	*Total*	*16.1*	*3.2*	*1.6*	*1.8*	*3.9*	*2.1*
	Cultivated plants	*15*	*2.3*	*1.4*	*1.3*	*1.6*	*1.2*
Plant Taxa	Finds	**876**	**985**	**500**	**3,954**	**268**	**3,955**
CEREALS (Poaceae)	/ All cultivated plants =	**87%**	**87%**	**74%**	**46%**	**74%**	**84%**
Triticeae gen. spp.	grains and fragments	528	555	230	696	64	1,156
	internodes	0	0	1	0	0	0
Wheats (*Triticum*)	/ (wheat+barley) =	**99%**	**78%**	**66%**	**76%**	**75%**	**39%**
cf. *Triticum* sp.	grains	0	0	8	21	2	44
Triticum sp.	grains	19	32	20	94	1	27
	internodes	0	0	0	1	0	1
	glumes	0	0	0	2	0	0
Triticum aestivum/turgidum	grains	111	18	15	76	3	95
Triticum aestivum/durum	grains	49	2	1	19	0	35
Triticum cf. *dicoccum*	spikelets bases	0	0	8	0	0	0
	grains	3	0	7	53	0	8
Triticum dicoccum (Schrank) Schuebl. [=*T. turgidum* L. subsp. *dicoccum* (Schrank) Schuebl.]	grains	2	1	2	33	0	5
Triticum cf. *monococcum* L. [=*Triticum monococcum* L. ssp. *monococcum*]	grains	1	0	0	1	0	2
Barleys (*Hordeum*)	/ (wheat+barley) =	**1%**	**22%**	**34%**	**24%**	**25%**	**61%**
cf *Hordeum vulgare*	grains	0	0	9	10	1	66
Hordeum vulgare L.	grains	2	15	14	48	0	131
Hordeum vulgare cf. var. *nudum*	naked grains	0	0	0	0	1	55
Hordeum vulgare var. *nudum*	naked grains	0	0	8	30	0	83
Hordeum vulgare L. subsp. *vulgare* convar. *coeleste* (L.) A. Trof.	asymetric grains of triplets	0	0	1	4	0	4
Hordeum vulgare (hulled)	hulled grains	0	0	0	3	0	1
PULSES	/ All cultivated plants =	**1%**	**11%**	**26%**	**50%**	**23%**	**15%**
Fabaceae							
Vicieae gen. spp. (cultivated?)	seeds fragments	3	7	42	386	9	91
Lens culinaris Medik. subsp. *microsperma* (Baumg.) Bar.	seeds	3	65	72	543	10	205
Vicia ervilia (L.) Willd.	seeds	0	2	2	272	3	3
Pisum sativum L.	seeds	0	6	0	0	0	0
OIL-PRODUCING PLANTS	/ All cultivated plants =	**12%**	**2%**	**0%**	**4%**	**3%**	**1%**
Brassicaceae							
Camelina microcarpa Andrz. ex DC. [=*C. sativa* (L.) Crantz subsp. *microcarpa* (DC.) Hegi & Em.Schmid]	seeds	97	0	0	48	3	7
	capsules valves	1	16	0	3	0	1
cf. *Alyssum* sp.	seeds	0	0	0	40	0	0
Alyssum sp.	seeds	0	0	0	10	0	0
Alyssum desertorum Stapf	seeds	0	0	0	3	0	0
FRUIT trees & shrubs	/ All plants =	**0%**	**0.3%**	**0.4%**	**0.3%**	**0.4%**	**0.4%**
Ulmaceae							
Celtis spp.	nutstones and fragm. / m	0	1	1	2	0	10
Rosaceae							
Rubus sp.	nutstones / m	0	0	0	0	0	4
Crataegus sp.	nutstones	0	0	1	0	0	0
Elaeagnaceae							
Elaeagnus angustifolia L.	nutstones	0	1	0	0	0	0

Horizon		II	III	IV	V	VI	VII
Capparidaceae							
Capparis spinosa L.	seeds	0	1	0	8	1	2
	seeds / m	0	0	0	2	0	0
WEEDS & WILD HERBS	/ All plants =	**7%**	**27%**	**8%**	**28%**	**60%**	**44%**
Boraginaceae							
Boraginaceae gen. spp.	erems / m	0	2	0	0	0	0
Buglossoides arvensis (L.) I.M.Johnst. (= *Lithospermum arvense* L.)	erems / m	1	31	9	231	28	868
Lithospermum officinale L.	erems / m	0	0	0	3	0	8
Echium sp.	erems / m	0	0	0	1	0	0
Heliotropium sp.	erems	0	0	0	14	0	10
Lappula sp.	erems / m	0	0	0	0	0	1
Poaceae							
Poaceae gen. spp.	grains, fragments	1	5	0	8	1	1
Poaceae gen. spp.L (larger-seeded grasses)	grains, fragments	0	0	0	2	0	2
Poaceae gen. spp.S (small-seeded grasses)	grains, fragments	0	0	0	76	0	8
cf. *Bromus* sp.	grains	0	0	0	2	0	0
Bromus sp.	grains	0	1	0	7	2	6
Lolium sp.	grains	0	1	0	1	0	0
cf. *Aegilops* sp.	grains	0	0	0	0	0	1
Paniceae gen. sp.	hulled grains / m	0	0	0	5	0	0
Fabaceae							
Fabaceae gen. spp. (unid.)	seeds	0	32	1	11	0	2
Fabaceae gen. spp. 1 (Vicieae gen. spp.)	seeds	0	0	0	1	0	6
Fabaceae gen. spp. 2 (small seeded)	seeds	0	0	1	3	23	14
Medicago/Melilotus sp.	seeds	0	0	0	12	0	9
Rubiaceae							
Galium sp.	mericarps	0	1	0	2	0	0
Brassicaceae							
cf. Brassicaceae gen. sp.	seeds	0	0	0	43	3	3
Thlaspi spp.	seeds	0	0	0	1	0	0
Neslia sp.	capsules	0	0	0	0	0	2
Brassica/Sinapis sp.	seeds	0	0	0	0	11	0
Convolvulaceae							
Convolvulus arvensis L.	nutlets	0	5	0	0	0	0
	nutlets / m	0	0	0	2	0	0
Calystegia sepium (L.) R. Br.	nutlets / m	2	0	0	1	0	1
Chenopodiaceae							
cf. *Chenopodium* sp.	seeds	0	0	0	7	0	0
Chenopodium sp.	seeds	1	0	0	14	33	24
Salsola sp.	seeds	46	136	13	331	19	260
Thymelaeaceae							
Thymelaea passerina (L.) Cosson and Germain	seeds	0	0	0	1	0	0
Solanaceae							
Hyoscyamus sp.	seeds / m	0	0	1	0	0	0
Hyoscyamus cf. *niger* L.	seeds	0	29	0	0	0	0
Caryophyllaceae							
Caryophyllaceae gen. sp.	seeds	0	0	0	0	0	1
Silene sp.	seeds	0	0	0	1	1	0
Ranunculaceae							
Adonis sp.	seeds	0	0	1	13	1	6

Horizon		II	III	IV	V	VI	VII
Ranunculus sp.	seeds	1	0	0	0	0	0
Polygonaceae							
Polygonaceae gen. spp.	nutlets	0	0	0	1	0	0
cf. *Rumex* sp.	nutlets	0	0	0	1	0	2
Rumex sp.	nutlets	0	3	0	7	0	10
	nutlets	0	0	2	0	0	0
Rumex crispus L.	nutlets	0	0	0	6	3	163
Polygonum spp.	nutlets	0	0	0	1	0	4
	nutlets / m	0	0	0	0	1	0
Polygonum cf. *aviculare* L.	nutlets	0	0	0	33	0	1
Polygonum cf. *convolvulus*	nutlets	0	0	0	1	0	0
Fallopia convolvulus (L.) Á.Löve [=*Polygonum convolvulus* L.]	nutlets	0	0	0	1	0	0
Persicaria sp.	nutlets	0	0	1	1	0	1
Polygonaceae/Cyperaceae gen. spp.	nutlets, seeds	0	0	0	7	0	21
	nutlets, seeds / m	0	0	0	1	0	0
Cyperaceae							
Cyperaceae gen. spp.	nutlets	0	0	0	1	0	0
cf. *Carex* spp.	nutlets	0	2	0	19	0	2
Carex spp.	nutlets	0	0	0	2	0	62
Carex sp. (elongated seeds)	nutlets	0	0	0	0	0	2
Cyperus sp.	nutlets	0	0	0	0	0	15
Bolboschoenus maritimus (L.) Palla	nutlets	1	0	1	3	1	0
Unidentified group	/ All plants =	**0%**	**1%**	**6%**	**17%**	**16%**	**9%**
Unidentified species	seeds	4	15	9	233	30	228
	seeds / m	0	0	2	3	4	4

Notes: The majority of finds are charred except the ones that are marked with "/ m".

Figure 1. Preliminary data on the proportions of cultivated plants for certain stratigraphical horizons of the site at Aknashen.

There are also many seeds (up to almost one hundred) of oil-producing cruciferous plants (Brassicaceae family) in certain samples, but they are not present in the upper horizons (Figure 1) (probably because of bad preservation conditions caused by human disturbance and strict changes of temperature and humidity). As the seeds of crucifers such as camelina are small and fragile, they tend to survive only in better-protected deposits of the site such as Horizon V. Contrary to seeds, imprints of pod valves of alyssum and sometimes also camelina present in the building clay from all studied Horizons. Other plants recorded from the imprints in building clay are cultivated cereals and pulses (Hovsepyan and Willcox 2008).

Discussion

Agricultural practices

Relatively stable values and differences concerning the proportions of cultivated plants were preliminarily recorded (Figure 1). Presumably, these values reflect the situation with the agricultural practices in the different stages of the Late Neolithic Aknashen.

The wheat-barley ratio appears to be 3:1 on average for Horizons II-VI, whereas for the earliest Horizon VII it is 4:6, i.e., barley prevails in comparison to later horizons. Emmer and free-threshing wheat are attested from Horizon VII to Horizon II, without one clearly prevailing over the other. Concerning the ratio of cultivated pulses to cereals (Figure 1), we may presume that at the beginning of the Aknashen settlement the pulses comprised only 15% of the cultivated cereals and pulses, then the proportion of pulses increased to about 50% in Horizon V, then decreased in later occupation periods.

The oldest remains of cultivated plants

The oldest archaeobotanical remains from the site were recovered from Horizon VII. The taxonomical assemblage of recovered plants repeats that of the upper horizons. A frequent presence of hackberry (*Celtis* sp.) is observed, the endocarps of which are also present in upper horizons but not as frequently. As the remains of hygrophilous plants (such as species of the Cyperaceae family) in the same layers (Figure 2) indicate the presence of wetland ecosystems, the

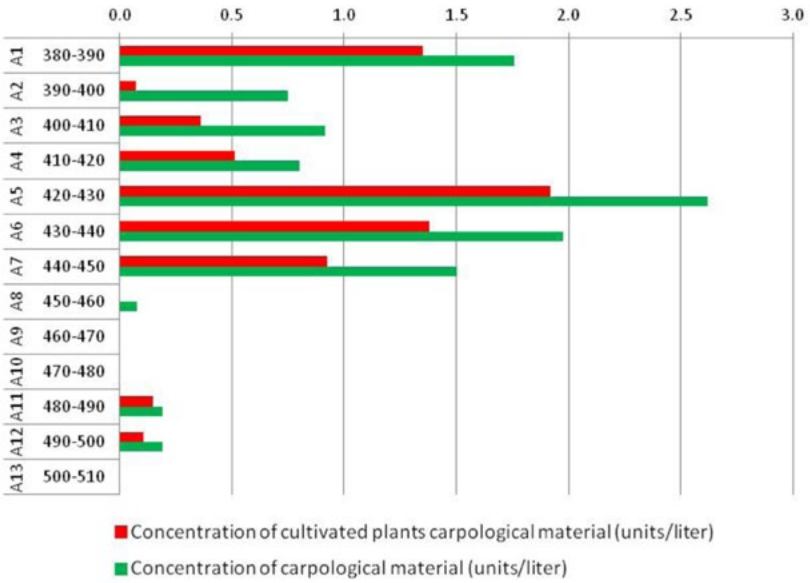


Figure 2. Distribution of archaeobotanical material in the southern section of Trench 1a, Aknashen Neolithic settlement.

presence of hackberry trees growing near the site is improbable. It is more likely that hackberry fruits were intensively gathered from the rocky and relatively dry foothills surrounding the Ararat valley (Takhtajyan and Fedorov 1972).

The assemblage of cultivated plants in Horizon VII includes wheats, particularly tetra- or hexaploid wheats (*Triticum aestivum/turgidum*), emmer (*T. dicoccum*) and barley (*Hordeum vulgare*), probably all free-threshing varieties, and small-seeded lentil (*Lens culinaris* ssp. *microsperma*). Plant remains recovered from below the archaeobotanically sterile layer (450-480cm depth in Trench 1a) are exceptionally important in that they provide botanical material for comparing agriculture before and after flooding. In addition, these are probably the oldest remains of cultivated plants in Armenian territory. All the plant species found in these layers - naked barley (*Hordeum vulgare* var. *nudum*; Figure 3: Hv,Hl), emmer (*Triticum turgidum* ssp. *dicoccum*; Figure 3: Tv,Tl; Figure 2), naked wheat (*Triticum* cf. *aestivum* L. ssp. *vulgare* (Vill) MacKey*)*, small-seeded lentil (*Lens culinaris* ssp. *microsperma*; Figure 3: L) and hackberry (*Celtis sp.*) - are also common in the upper horizons of the site. It may indicate continuation of the same agricultural economy. It may also indicate that the flood was not of long duration and that the same community was able to return to the settlement afterward.

Abundance of pulses

It is to be mentioned that no special taphonomical processes that might cause differences in the preservations of pulses and cereals were noted at the site. The predominance of pulses over cereals in the preserved archaeobotanical material in all probability reflects the original agricultural economy. The high proportion of pulses among the cultivated plants up to an almost equal ratio of pulses to cereals is notable, as in the region cereals were the main plant food of agriculturalists starting in the Chalcolithic period (cf. Hovsepyan 2015). It is to be noted that according to present archaeobotanical data, the cultivation of pulses decreased during the Chalcolithic period in the South Caucasus and finally fell between the Early Bronze Age and the Middle Iron Age. It is possible that the rise of pulse cultivation in the Neolithic settlement at Aknashen was a particular phenomenon (a single situation in the regional context). Pulses are recorded at many Aratashen-Shulaveri-Shomutepe culture sites in the South Caucasus and beyond (Lisitsyna and Prischepenko 1977; Lisitsyna 1978, 1984; Janushevich 1978, 1984; Wasylkowa *et al.* 1991; Hovsepyan and Willcox 2008; Kadowaki *et al.* 2015; Decaix *et al.* 2016; Ollivier *et al.* 2018; Zohary *et al.* 2012; etc.), but there very high proportion of pulses was not documented anywhere. If so it could be explained by a specialization in the cultivation of pulses by the Neolithic community for the purpose of trade, although it might have been caused by environmental conditions, cultural or culinary preferences or multiple other reasons. More investigation into near and more distant contemporary sites is necessary to prove or disprove this theory.

Agriculture of the Neolithic Aknashen in the context of contemporary agriculture in the South Caucasus

The first definite signs of domesticated plants appear in Early Pre-Pottery Neolithic B (PPNB) farming villages in south-west Asia dated to ca. 8500-8100 cal BC. The earliest domesticated plants are grouped under the term of 'south-west Asian Neolithic crop assemblage': emmer, einkorn, barley, lentil, pea, bitter vetch, chickpea and flax (Zohary *et al.* 2012). Although according to present data the Aratashen-Shulaveri-Shomutepe sites (including Aknashen) are the earliest

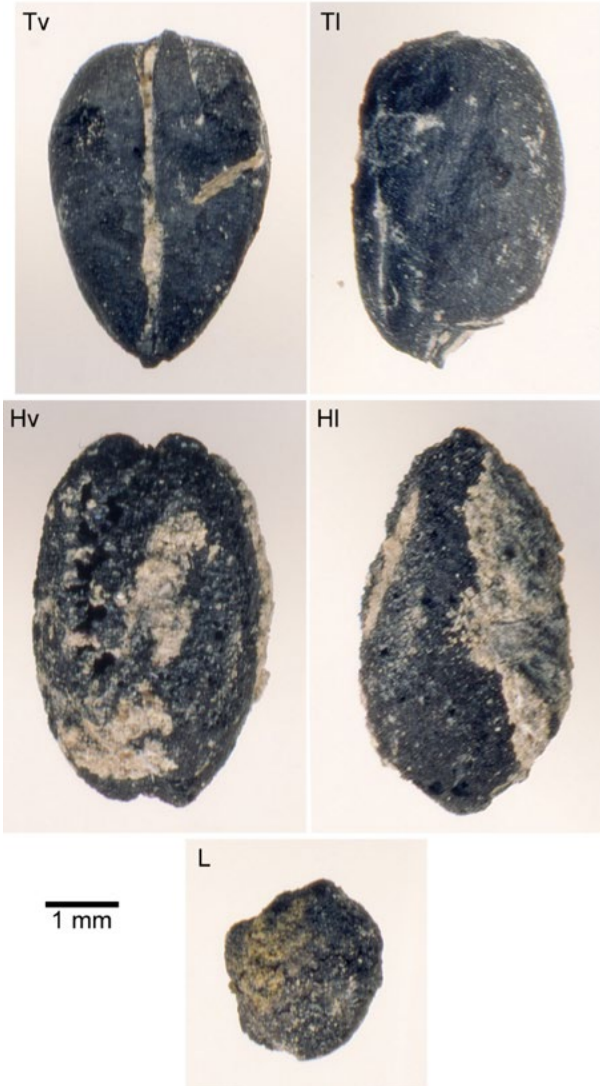


Figure 3. Some remains of cultivated plants from the deepest (earliest) layers of Aknashen Neolithic settlement. Tv, Tl – charred grain of emmer (*Triticum turgidum* cf subsp. *dicoccum*): Tv - ventral side, Tl – left side; Hv, Hl – charred grain of cultivated barley (*Hordeum vulgare* cf var. nudum): Hv – ventral side, Hl – lateral side; L – eroded charred seed of lentil (*Lens culinaris*).

agricultural settlements in the South Caucasus, their appearance was 'delayed' for about 2100-2500 years compared with early agricultural sites situated farther south in the 'Fertile Crescent' (cf. Zohary *et al.* 2012). Once agriculture developed in the South Caucasus around the beginning of the 6th millennium cal BC, it quickly spread (in less than two centuries) over the plains of the Kura and Araxes rivers. The taxonomical assemblages of cultivated plants recorded on various sites of the Aratashen-Shulaveri-Shomutepe culture are more or less similar[2] to each other (Lisitsyna and Prischepenko 1977; Lisitsyna 1978, 1984; Janushevich 1978, 1984; Wasylkowa *et al.* 1991; Hovsepyan and Willcox 2008; Kadowaki *et al.* 2015; Decaix *et al.* 2016; Ollivier *et al.* 2018; etc.). If all 'suspicious' taxa/identifications (possible intrusions, misidentifications and identifications not yet confirmed by recent studies) of cultivated plants in this culture are excluded and common names used for the rest, we have the following assemblage for cereals: free-threshing tetraploid and/or hexaploid wheats, emmer, naked barley, naked six-rowed barley, hulled barley; for pulses: lentil, pea, bitter vetch; and grape.

The prevalence of naked barley over the hulled variety, the abundance of cultivated pulses and the two cruciferous plants, alyssum and camelina, which were possibly cultivated (discussed below), are the characteristic features of agriculture at Aknashen as well as for other Neolithic sites in the Ararat valley (Aratashen and Masis Blur).

Useful wild plants and weeds

Some of the wild and weedy plants recorded for the Aknashen site are edible and possibly have been used also by the Neolithic inhabitants of the settlement. Fruits of caper (*Capparis spinosa*) could have been eaten as snack. Roots of cosmopolitan bulrush (*Bolboschoenus maritimus*) are rich in starch and may be eaten raw or cooked. Large seeds of leguminous plants (Vicieae gen. spp.) may be eaten after cooking. Species of *Chenopodium*, *Salsola*, *Thlaspi*, *Brassica/Sinapis*, *Silene*, *Rumex* (including *Rumex crispus*), *Polygonum* and *Convolvulus arvensis* also are edible herbs used usually in cooked state.

Wild cultivated crucifers?

In addition to the recorded cultivated plants, the abundance and ubiquity of alyssum and camelina pod valves in the building clay of the Aknashen, Aratashen and Masis Blur Neolithic settlements may serve an evidence that these plants have been used. As both alyssum and false flax belong to Brassicaceae family and have oleiferous seeds,[3] which gives us a base to suppose that these plants have been used as oil plants in the Ararat valley (Hovsepyan and Willcox 2008 and current archaeobotanical data from Masis Blur and Aratashen sites at the time of writing). Nowadays, alyssum forms stands in some areas in the vicinity of Aknashen and other two Neolithic sites in the Ararat valley, but plants are tiny and bear only several pods each unless they appeared in the arable land and have

[2] Some of the taxa recorded for Shulaveri-Shomutepe sites in the 20th century (Lisitsyna and Prischepenko 1977; Lisitsyna 1978, 1984; Janushevich 1978, 1984; Wasylkowa *et al.* 1991) are now considered to be later intrusions (e.g. millets), and the identifications of others (e.g. *Triticum compactum, T. spelta, T. durum, T. turgidum, T. macha, T. palaeocolchicum, Hordeum lagunculiforme*) are considered as not trustworthy, because of similar features of these taxa with those of other wheat and barley species.

[3] *Camelina microcarpa*, the species recorded for the above-mentioned three Neolithic settlements at the Ararat valley, is the progenitor of *Camelina sativa*, an oil-crop (Zohary *et al.* 2012; etc.).

enough sun (i.e. are not shadowed) where they grow much bigger and produce several hundreds of pods. Unlike the alyssum camelina was not observed forming stands in the studied area. The observed ecological specifics of alyssum and camelina make it doubtful that these plants have been productively gathered from the wild. It is possible that these two cruciferous plants have been cultivated for their oleiferous seeds during the Late Neolithic period in the Ararat valley.[4]

Wild fruits

The few remains of fruits of trees and shrubs recovered from the Aknashen site suggest that fruit-gathering was of minor importance for the Neolithic population of the site: fruits of hackberry (*Celtis* (Ulmaceae)), berries of *Rubus*, hawthorn (*Crataegus* (Rosaceae)) and oleaster (*Elaeagnus angustifolia* L. (Elaeagnaceae)) probably have been gathered for food consumption.

Conclusion

A diversity of crops was cultivated at Aknashen. The main agricultural activity at Neolithic Aknashen was the cultivation of cereals, but the cultivation of pulses also had an important role in the agriculture and diet of its Neolithic inhabitants. Alyssum and false flax have been used probably for their oil rich seeds. The recorded wild and weedy plant taxa nowadays grow in the vicinity of the site as a part of the local native vegetation and weeds of cultivation. Some of these wild species are edible (hackberry, oleaster, *Rubus*, hawthorn, caper bush, species of *Rumex*, *Polygonum*, *Chenopodium*, *Brassica*, *Bolboschoenus*, etc.) and might have been gathered for food consumption. The plants cultivated at Neolithic Aknashen were the same as those at simultaneous neighboring settlements of Aratashen and Masis Blur. The assemblage of cultivated plants is also similar to those at other Aratashen-Shulaveri-Shomutepe sites situated in the territories of Georgia and Azerbaijan: free-threshing wheat, naked barley, emmer, lentil, bitter vetch, pea, hulled barley and einkorn. The only difference being the use of alyssum and false flax in the Ararat valley.

[4] An article dedicated to these two cruciferous plants in the Neolithic Ararat valley is in preparation.

Conclusion: The Neolithic of the Ararat valley and the South Caucasus

Ruben Badalyan, Christine Chataigner and Armine Harutyunyan

The fifteen articles in this volume present different studies of the data gathered during the excavation of the Neolithic site of Aknashen between 2004 and 2015. The scale of the excavations and the multidisciplinary approach undertaken have shed light on most of the characteristics of the site – the environmental conditions and geomorphology of the hill, its stratigraphy, absolute chronology, material culture, agriculture and animal husbandry, local and regional relations. Thus, the necessary elements are present to correct the situation of the last decades, when the very poor level of studies on the Neolithic period in Armenia contrasted sharply with those of other periods or cultures in this country, as well as with the level of studies of the Neolithic in other regions of the South Caucasus.

The large volume of material from the Aknashen excavations and the presence in the Ararat valley, near this settlement, of the contemporary sites of Aratashen and Masis Blur enable, first of all, a comparative study of these sites, then an analysis of the data from the Ararat valley in comparison with the occupations of the same period in the South Caucasus. The study of the common as well as the particular features of these settlements, together with their analysis both synchronic and diachronic, has shown the importance of questions of similarities and differences between the sites and the problems of synchronization and periodization. Finally, they allow us to analyze the question of the Neolithization of the central part of the South Caucasus in the light of the relations between the 6th millennium sites of this region and the local Mesolithic culture that preceded them, as well as with the Neolithic cultures of the 7th-6th millennia in the Near East.

The concept of the 'Aratashen-Shulaveri-Shomutepe culture': similarities and differences in the material culture and the economy of the sites of the 6th millennium BC in the basins of the Araxes and the Kura rivers

The identification, in the archaeological sequence of the South Caucasus, of the 'Shomutepe culture' (Narimanov 1965), then later of the 'Shomutepe-Shulaveri' or 'Shulaveri-Shomutepe' culture (below *ShSh*) (Kiguradze 1976) was the first step towards the differenciation of the concept, widely used but quite indeterminate, of the 'cultures of the first farmers'. The area of distribution of the sites of this new culture (Figure 1) was essentially limited to the right bank of the middle Kura river; the other complexes of the 'first farmers', including those of the Ararat valley, were placed together in a purely conventional way in a group of sites called 'southern' or 'of Kültepe'/ 'of Mil-Karabakh-Nakhichevan'/ 'of Nakhichevan-Mil-Mugan'. The two groups of sites were considered to be either two distinct cultures, or local variants of the same culture (for more details see Kushnareva and Chubinishvili 1970; Munchaev 1975; Kiguradze 1976; Masson *et al.* 1982; Narimanov 1987; Javakhishvili *et al.* 1987). Subsequent fieldwork and its interpretation led to the distinction of two chrono-cultural entities among the sites of the 'southern' group: late sites, now defined as Chalcolithic (Teghut), and older sites, more or less similar to the settlements of the *ShSh* culture (Aknashen, Masis Blur). The sites of the Mil steppe, which were previously considered to have shared the same culture with the lower level of Kültepe I of Nakhichevan (Iessen 1965), now appear, according to extensive recent excavations, to be another quite distinct cultural complex (Mil steppe culture) (Lyonnet *et al.* 2012; Helwing *et al.* 2017).

The results of the Aratashen and Aknashen excavations confirm, in our view, the 'high similarity', already noted by Kiguradze (1976), between the sites of the Ararat valley and those of the *ShSh* culture, with each group having at the same time its own 'particularities'. This leads to the question of the existence in the South Caucasus in the 6th millennium of a single culture with two main regional variants (Chataigner *et al.* 2014a).

Because of the fundamental unity of the material culture, we think quite justified to consider the 6th millennium sites of the Kura and Araxes basins as a sufficiently homogenous complex: the Aratashen-Shulaveri-Shomutepe culture (*AShSh* below). As stated repeatedly in the previous chapters, the sites of the Ararat valley - Aratashen, Aknashen, Masis Blur– are highly similar to the *ShSh* culture in the main elements of their material culture and in their chronology: they share similar assortments of domesticated plants and animals, an identical degree of development of agriculture and herding, similar developments in technology (pottery, metal, etc.).

Topography and architecture of the settlements

First of all, it must be noted that the sites of the Shulaveri-Shomutepe group and those of the Aratashen-Aknashen

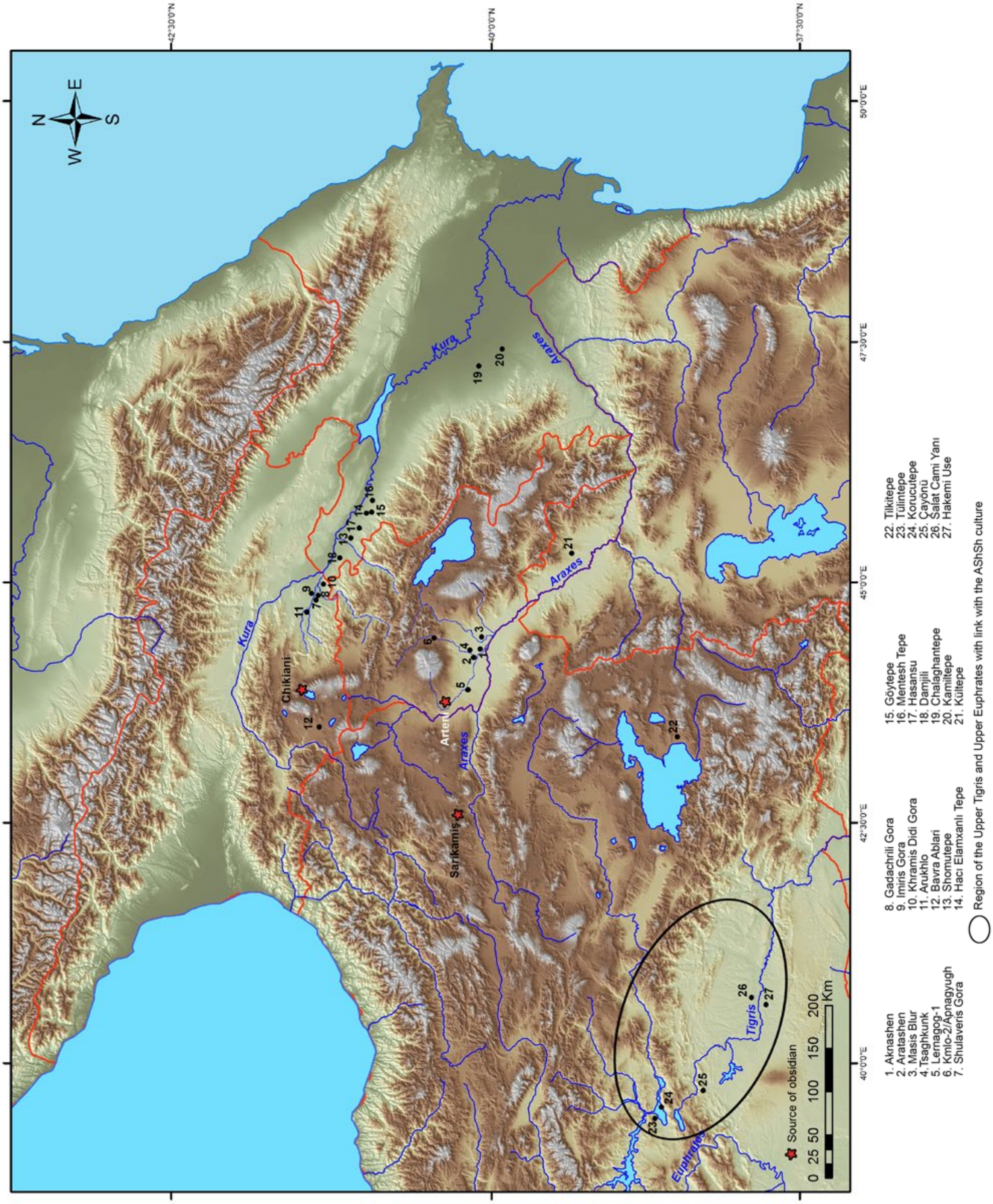


Figure 1. Map of the main sites mentioned in the text.

group are located in similar landscapes, i.e. low-altitude alluvial valleys with dense watercourse networks; these are the plains of Marneuli and Ganja-Gazakh in the middle course of the Kura, and the Ararat valley in the middle course of the Araxes. The sites of the two groups consist mainly of settlements corresponding to small anthropogenic hills (generally covering about 1 hectare) or 'tells', formed by successive layers of construction levels. It is important to note that all the sites were established in previously uninhabited areas.

Moreover, it is necessary to note that, besides the tells, other types of sites, permanent or temporary, existed in the territory of the *AShSh* culture. In our present state of knowledge, the only example of a settlement of the *AShSh* culture established on a natural hill is the site of Molla Nagi Tepesi in the lower valley of the Aghstev (Museibli *et al.* 2011),[1] while temporary occupations have been identified in two rock shelters, Damjili unit 4 (Nishiaki *et al.* 2019b) and Bavra-Ablari level 3 (Varoutsikos *et al.* 2018).

Such types of temporary occupation, where caprines make up the absolute majority of the faunal remains, could reflect the establishment, beginning in this period, of the practice of transhumant and/or semi-transhumant herding. Thus, the presence of such sites not only augments the number of categories or types of habitat (which include 'tells', settlements on rocky alluvial terraces, natural hills and rock shelters), but also highlights the presence of populations of the *AShSh* culture in various natural contexts and their practice of a rather complex economy.

Returning to the question of the similarities and differences between the sites of the Shulaveri-Shomutepe group and the Aratashen-Aknashen group, to be noted is the domination almost everywhere of a single architectural form: buildings of circular plan (Figure 2). However, this dominant conception of the plan was carried out with different construction techniques in the north and in the south. On the sites of the Araxes basin (Aknashen, Aratashen, Masis Blur, Kültepe I of Nakhichevan level 2), the walls of the buildings were made of lumps or clods of clayey mud to which was added a large quantity of organic temper. As we have indicated, this technique corresponds to a particular variant – lumps and layers of mud/cob (Baudouin 2019: 124). On the sites of the Kura basin, the cob technique was found at Gadachrili Gora in horizon I (Hamon *et al.* 2016; Baudouin *et al.* 2018) and at Mentesh Tepe (Lyonnet and Guliev 2017: 128-129). In the Kura basin, the absolutely predominant construction technique is the use of more or less standardized plano-convex mud bricks (Javakhishvili 1973; Baudouin *et al.* 2018).

Based on his analysis of the architecture, Baudouin (2019: 116) distinguishes in the Neolithic of the South Caucasus several *well-defined 'techno-cultural' groups***,** leading him *to reconsider the model of a unique 'Shulaveri-Shomu' culture*: '*...recent research on the architectural variability among these communities argues for the existence of at least four specific techno-cultural entities, each of which is located in a well circumscribed spatial area: SSC, in the Kvemo-Kartli Plain, the Middle Kura Valley and the Karabagh Plain; Aratashen culture (hereafter AC), in the Ararat Plain; Kültepe, in the Nakhichevan; and Kamiltepe, in the Mil Plain.*' At the same time, Baudouin (2019:145-146) stresses: '*First of all, common architectural techniques link all the Southern Caucasus communities; this is the case of the stretcher bond, the circular plan and the recurrent lack of quoin bonding.... Privileged relationships were maintained between the Ararat Plain and the Kvemo-Kartli Plain.*' Moreover, he '*noticed regional features characterizing the Araxes (cob), the Kura Valley (plano-convex mud-bricks, semi-subterranean buildings) and the Mil Plain (terrace)*'. According to him (Baudouin 2019:146), '*these regional differences question the presumed integrity or unity of the Neolithic phenomenon in the Araxes, Kvemo-Kartli and Middle Kura valleys suggested by Badalyan and Harutyunyan (2014: 161).*'

However, first of all, the latter authors never considered that the Mil steppe was part of the *AShSh* culture and fully agree with the statement of Lyonnet *et al.* (2012: 177-178) that '*both ends of the Middle Kura River did not participate in the same networks*' and that the Mil steppe sustained relations with neighboring Iran. Secondly, the model of a widely shared Neolithic culture in the South Caucasus (Chataigner *et al.* 2014a: 11) is not only based on the almost simultaneous adoption of a sedentary way of life with a farming and herding economy at the beginning of the 6th millennium BC and on the building techniques, as Baudouin seems to believe, but also on the assemblage of the economic activities, the various aspects of the material culture and other components of the technological productions.

Finally, it is necessary to mention that, besides the preponderant role of the circular plan over all the area of distribution of the *AShSh* culture, buildings of rectangular plan are also present. Parallel to the rectangular building brought to light in the earliest horizon at Aknashen (horizon VII), fragments of rectangular constructions were found in the lower level of Hasansu I (basin of the Kura), above the virgin soil (Museibli 2017). According to the excavator, the rectangular buildings preceded those of circular or oval plan. It should be stressed that, as we will demonstrate below, the 14C dates confirm that the lower levels of the two sites are contemporary. Thus, it clearly appears

[1] It seems that Chubinishvili and Chelidze (1978) have written an article on this subject, but unfortunately we have not been able to obtain it.

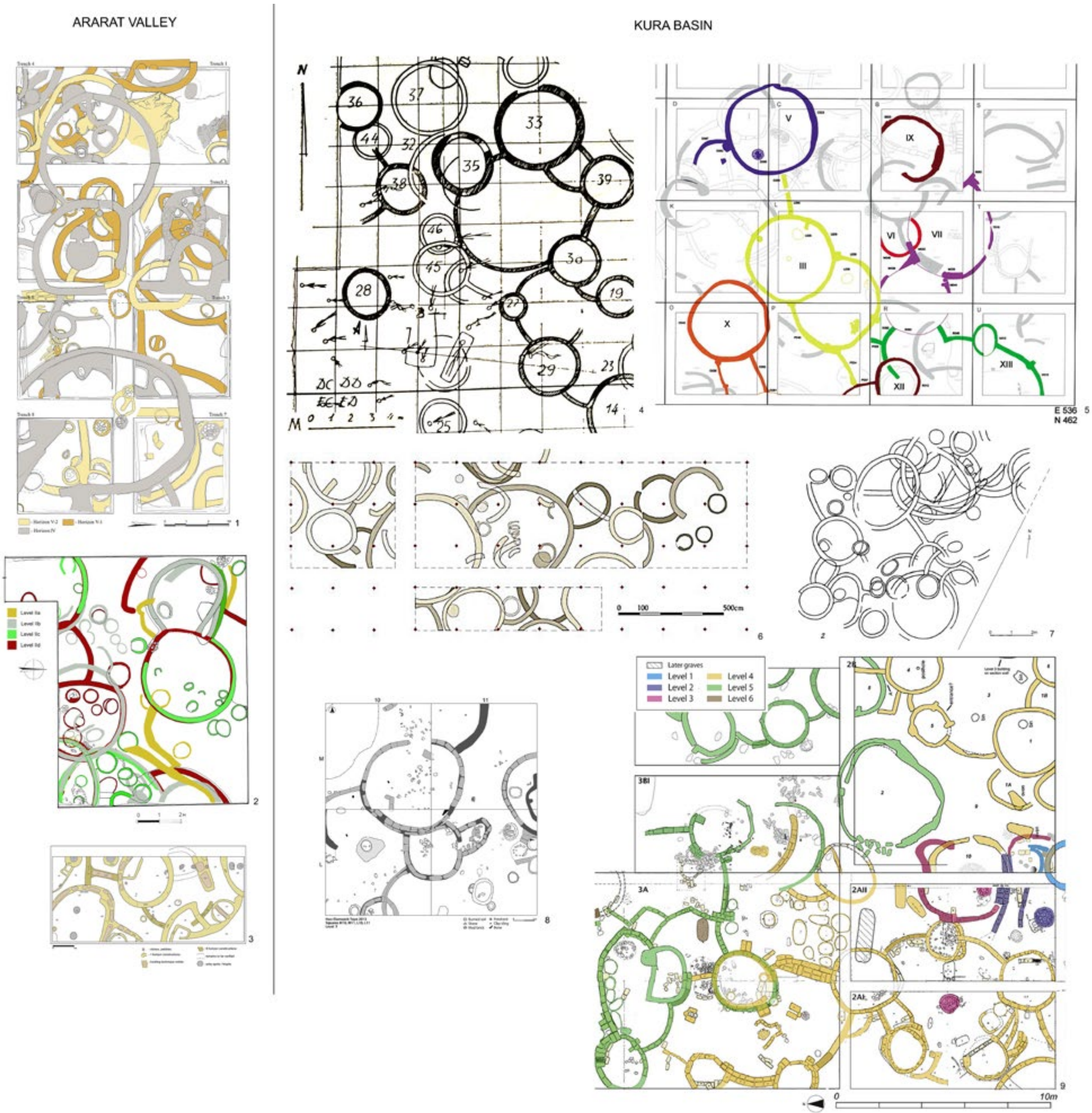


Figure 2. Architecture: 1) Aknashen; 2) Aratashen; 3) Masis Blur (Hayrapetyan *et al.* 2014: fig. 6); 4) Imiris Gora (Javakhshvili *et al.* 1975: fig. 23, fragment); 5) Arukhlo (Lyonnet *et al.* 2012: fig. 81, fragment); 6) Gadachrili Gora (Batiuk *et al.* 2019: fig. 2, fragment); 7) Shulaveri (Javakhshvili *et al.* 1975: fig. 4); 8) Hacı Elamxanlı Tepe (Nishiaki *et al.* 2015b: fig. 9); 9) Göytepe (Nishiaki *et al.* 2018: fig. 3, fragment).

that the rectangular plan is characteristic of the earliest phase of the *AShSh* culture (the formation phase) and that it was used more or less at the same time in the valley of the Ararat and in the basin of the Kura.

In conclusion, regarding the architecture, the similarity of the construction plans appears to be a determining cultural characteristic, allowing us to see a real unity between the sites of the basins of the Araxes and the Kura, whereas the differences in the construction techniques are most probably related to local particularities.

Chipped stone

In the basin of the Araxes as in that of the Kura, the essential material for the lithic industry in the Neolithic is obsidian. Variations between sites appear in the percentage of obsidian in relation to flint, dacite and other materials. In the Ararat valley, obsidian constitutes 97%-99% of the lithic industry[2] (Gratuze *et al.* in this volume), but in the Kura basin the range of variation is wider, from 70% at Hacı Elamxanlı and Göytepe (Nishiaki and Guliyev 2019), to 86%-87% at Mentesh Tepe (Guilbeau *et al.* 2017) and Shomutepe (Akhundov 2013: 31) and up to 99% at Arukhlo (Gatsov and Nedelcheva 2017). Clearly, these variations depend on the distance of the sites from obsidian sources as well as on the size of the assemblages, but in all cases they reflect the complete dominance of obsidian.

It is evident that for obsidian supply to the Neolithic sites of the different regions of the South Caucasus, different sources predominated in relation to the location of the sites: Arteni and Gutansar in the Ararat valley, Chikiani in the Georgian part of the Kura basin (for example, at Arukhlo), the Armenian sources (Geghasar in particular) and the deposits of Sarıkamış in the Azerbaijani part of the Kura basin (Göytepe, Mentesh Tepe). The latter deposits are however integrated in the same network linking the sites of the basins of the Araxes and the Kura.

The lithic assemblage of Aknashen, Aratashen and Masis Blur is essentially an industry on standardized long blades, although a flake *chaine operatoire* has also been identified but can be described as opportunistic. According to the data of Chabot, tools on flakes account

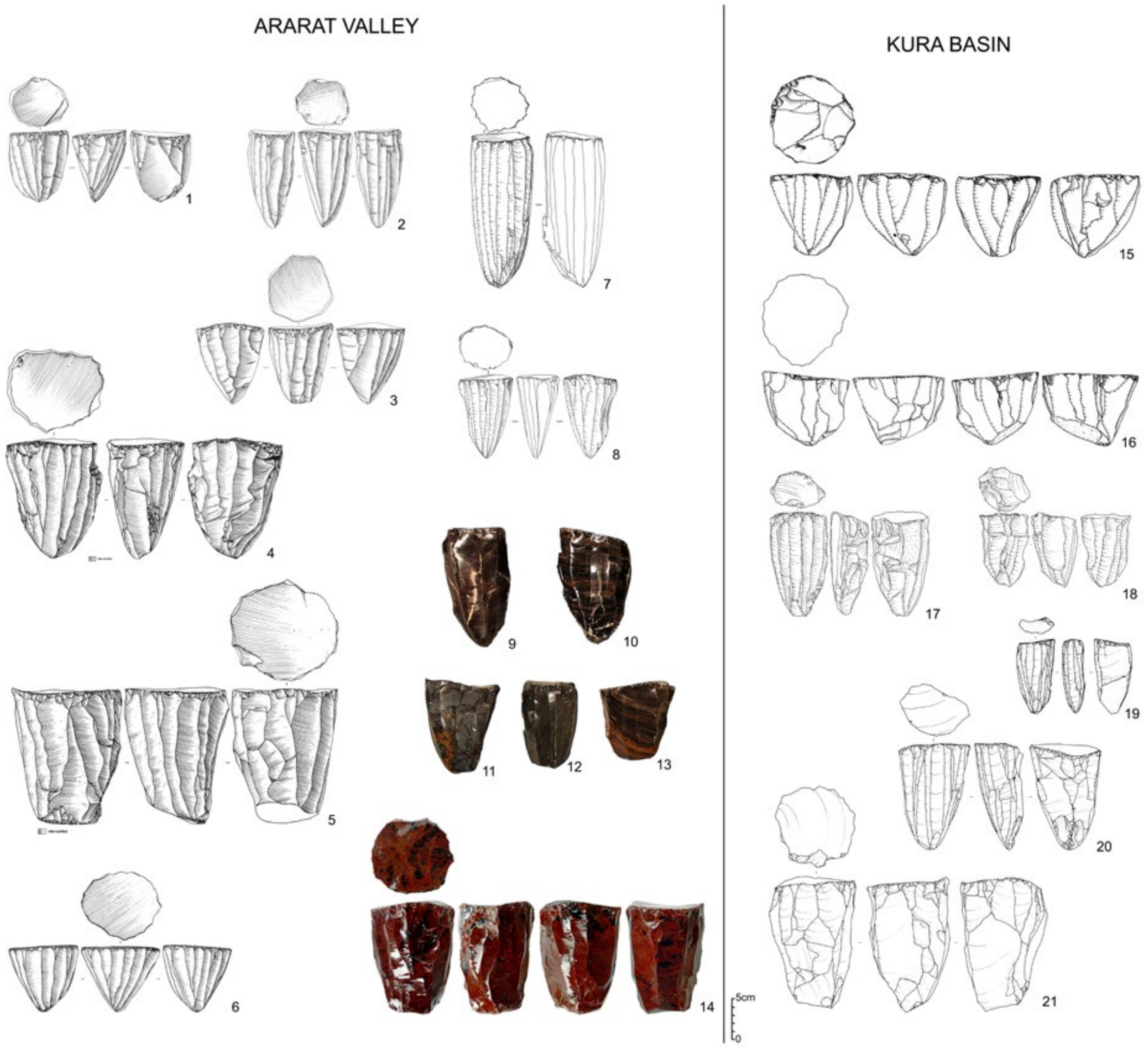


Figure 3. Cores: 1-6, 14) Aknashen; 7-8) Aratashen; 9-13) Masis Blur (Martirosyan-Olshansky 2014: slide 1); 15-16) Arukhlo (Gatsov and Nedelcheva 2017: fig. 1-2); 17-18) Göytepe (Nishiaki and Guliyev 2019: fig. 2: 1-2); 19-21) Hacı Elamxanlı Tepe (Kadowaki *et al.* 2016: fig. 3: 5-7).

[2] The situation on the other Neolithic sites of the basin of the Araxes is apparently similar. In any case, for Kültepe I of Nakhichevan, it is indicated that '*The lithic industry is mostly composed of obsidian artefacts and debris, with a small minority of flint pieces...*' (Marro *et al.* 2019: 95).

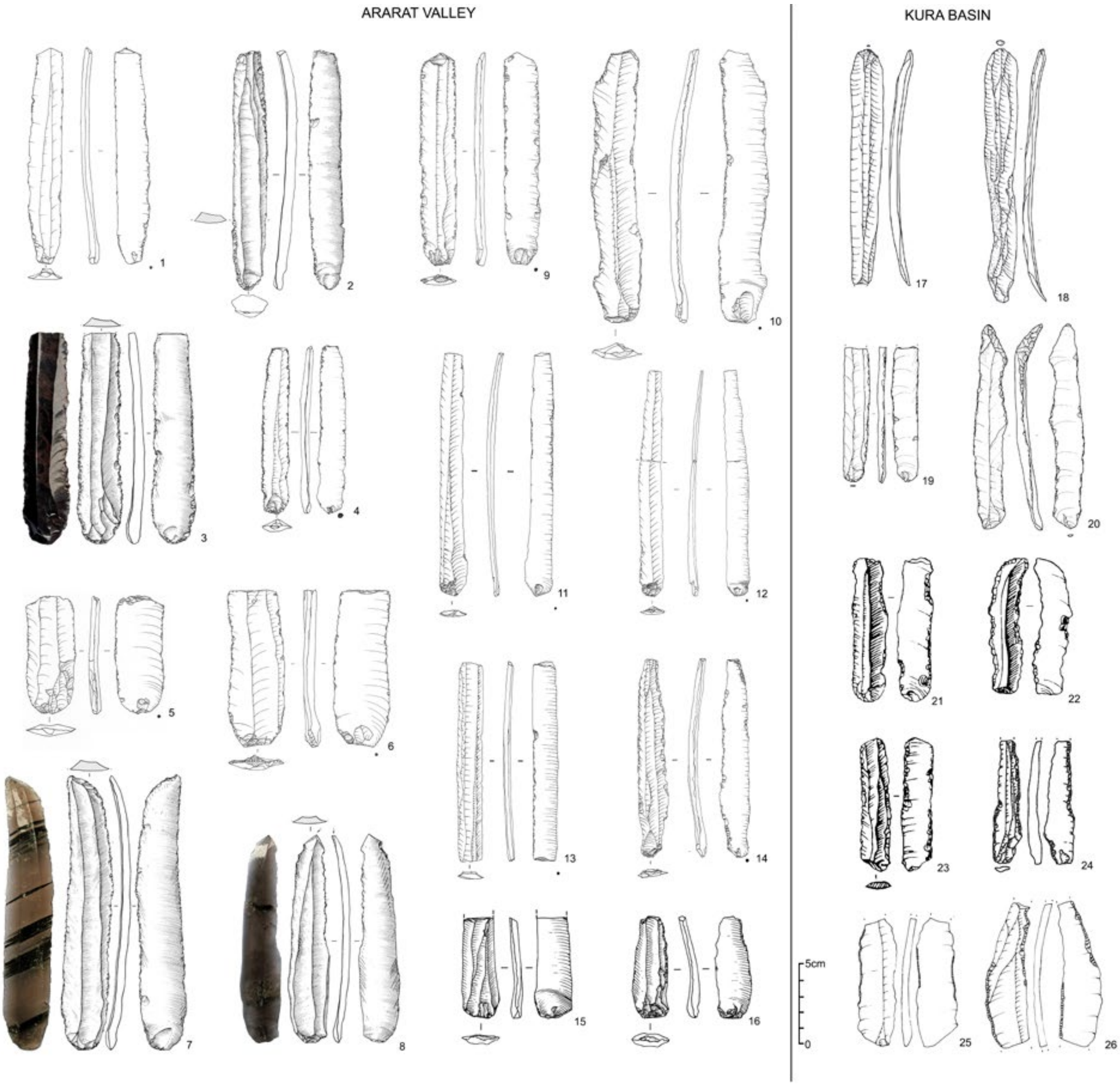


Figure 4. Obsidian blades made by pressure technique: 1-8) Aknashen; 9-14) Aratashen; 15-16) Tsaghkunk (Varoutsikos and Petrosyan, in this volume: fig. 3: 3, 6); 17-18) Göytepe (Nishiaki and Guliyev 2019: fig. 2: 6-7); 19-20) Hacı Elamxanlı Tepe (Kadowaki *et al.* 2016: fig. 5: 11-12); 21-22) Imiris Gora (Masson *et al.* 1982: tab. XXXII: 11-12); 23) Shulaveri III-I (Masson *et al.* 1982: tab. XXXI: 36); 24-26) Arukhlo (Hansen *et al.* 2007b: Abb. 50: 6; Hansen *et al.* 2006: Abb. 59: 2,1).

for only 2.3% of the total tool assemblage at Aratashen and 6.5% at Aknashen, as opposed to 97.7% and 93.5% for the tools on blades respectively (Badalyan *et al.* 2007; Chabot *et al.* in this volume). Three different techniques connected to the production of blade blanks have been identified at Aknashen and Aratashen: pressure with a crutch, pressure with a lever, and indirect percussion.

The intention for the blade technology at Aknashen was to obtain regular and standardized blanks that were to be used, retouched or not, in specialized activities, agricultural in particular. Eight types of retouch patterns have been identified, not taking into account the variations in the retouch itself. Four categories of formal tools (retouched) are represented in significant proportions: notches (7.2%), denticulates (4.6%), burins (5.1%) and microliths (3.6%).

The contemporary sites of the Kura basin present in general the same situation – practically everywhere chipped stone industry can be described as mainly laminar, primarily characterized by the production of obsidian blades from single-platform prismatic cores (Kadowaki *et al.* 2016; Varoutsikos and Petrosyan 2019: 466) (Figures 3 and 4). In contrast, at Kamiltepe and MPS 04 in the Mil steppe, the proportion of flakes is higher in comparison to the blades; according to Guilbeau *et al.* (2017), the ratio of obsidian blades to obsidian flakes

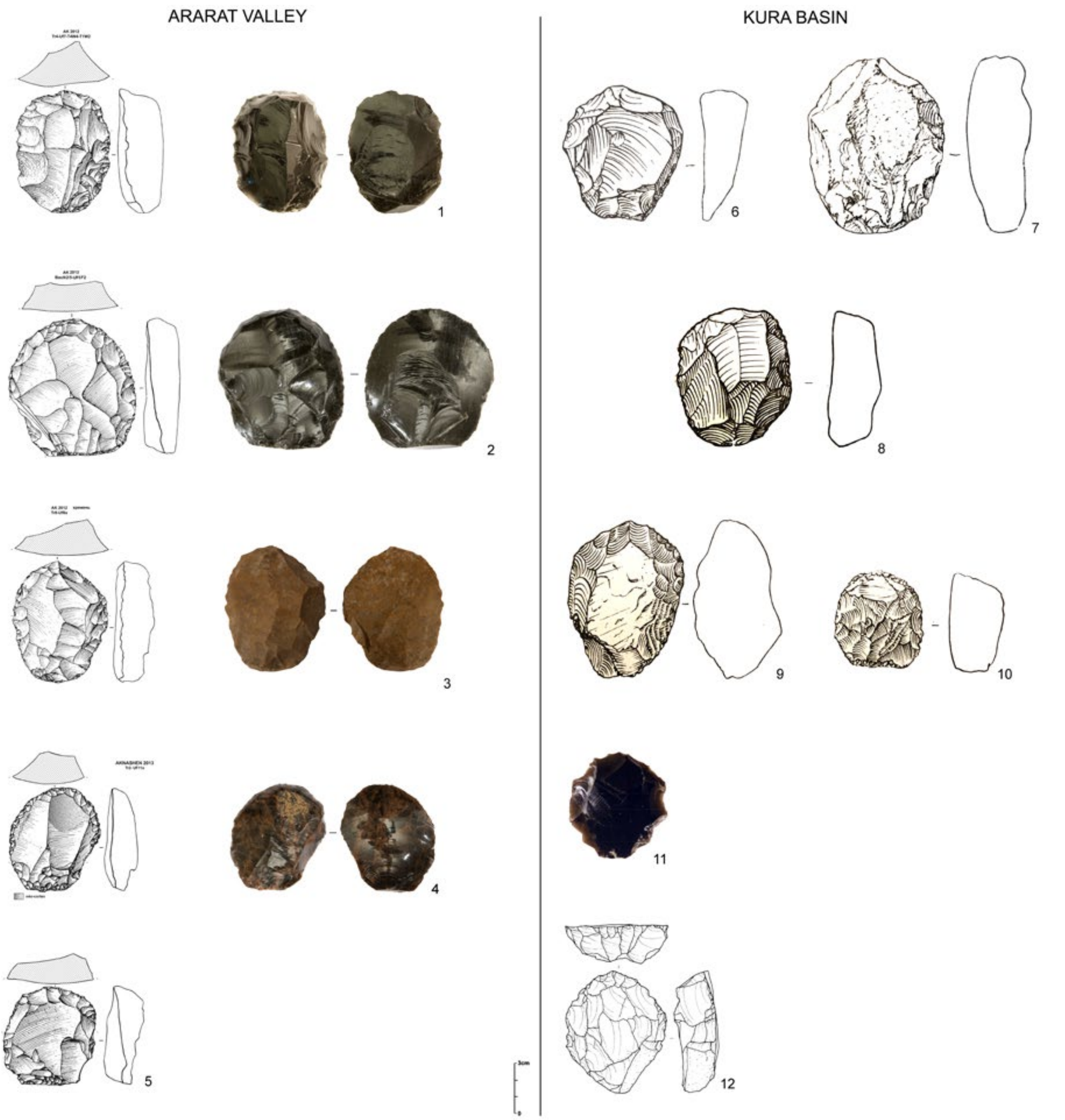


Figure 5. Scrapers: 1-5) Aknashen; 6-10) Shulaveri (Kiguradze 1976: tab. 6: 6; tab. 4: 15-16; Javakhishvili *et al.* 1975: fig. 13: 13, 17); 11) Arukhlo (Gatsov and Nedelcheva 2017: fig. 7); 12) Hacı Elamxanlı Tepe (Kadowaki *et al.* 2016: fig. 5: 14).

at Kamiltepe is two blades to ten flakes, at MPS 04 – six blades to ten flakes. Debitage techniques, found on the sites of the Ararat valley, are also attested on the sites of the group of Shulaveri-Shomutepe, at Arukhlo (Gatsov and Nedelcheva 2017), Mentesh Tepe (Guilbeau *et al.* 2017) or Göytepe (Nishiaki and Guliyev 2019). The tool types represented in all assemblages also show some consistency, with a high presence of 'retouched blades' (including retouched and used blades), burins, notches and denticulates and an extremely large majority of tools made on blade blanks rather than flakes, along with a specific type of trapezoid microliths often defined as 'transverse arrowheads'. Another characteristic tool is the large round scraper, made on a large flake that is sometimes detached from the debitage surface of a blade core, then retouched on up to 80% of its circumference (Figure 5).

Tool-type representation varies from one site to another: for example, at Hacı Elamxanlı, burins and retouched blades represent respectively about 34% and 11% of the tools, whereas at Aknashen they comprise respectively about 5% and 55% (all horizons); the quantity of microliths is extremely variable; etc.

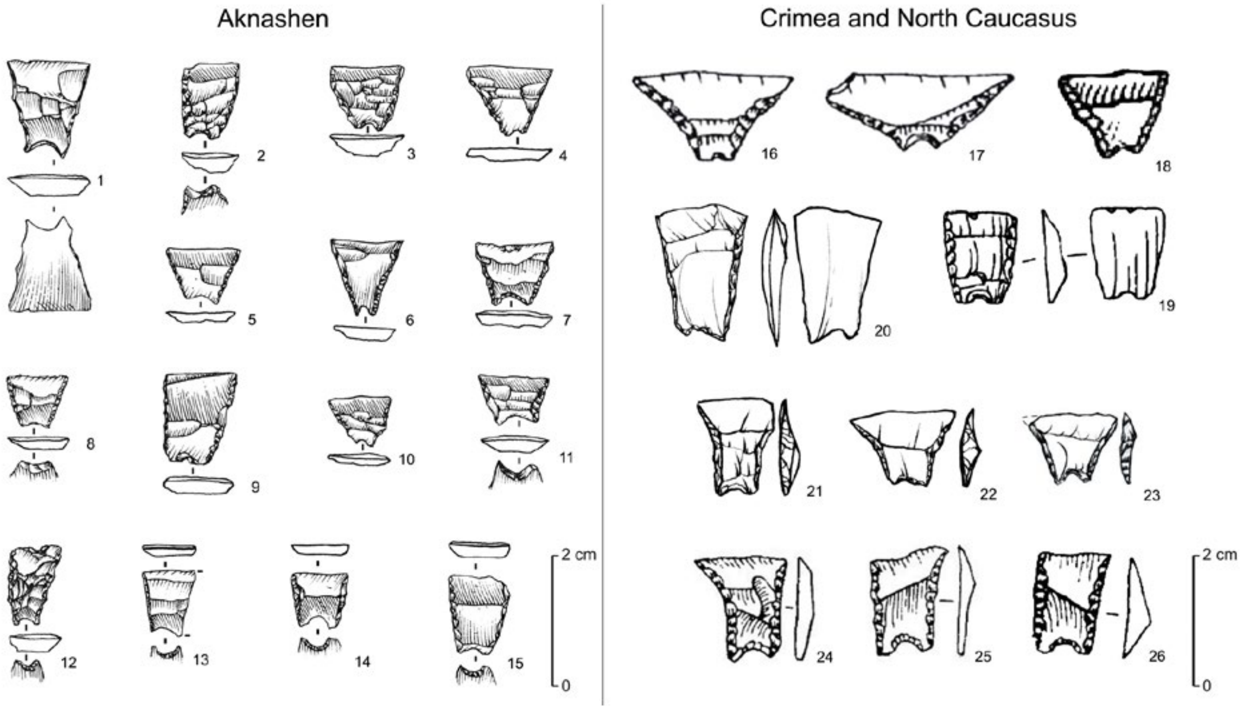


Figure 6. Microliths: 1-15) Aknashen, Horizons V-VII; 16-17) Shan-Koba Layer 3 (Biagi 2016: fig. 3: 12, 15); 18) Gubskij rockshelter 7 (Formozov 1965: fig. 20: 8); 19) Gubskij rockshelter 7 (Nedomolkin 2020b: fig. 106: 3); 20) Chygaj rockshelter (Leonova 2009: fig. 4: 5); 21-23) Dvojnaya cave (Leonova 2009: fig. 7: 6-7; Leonova 2019: fig. 3: 3); 24-25) Chokh, level 3 (Amirkhanov 1987: fig. 19: 3-4); 26) Chokh, level 4 (Amirkhanov 1987: fig. 17: 1).

However, it is evident that these differences (some of which are most probably due to the extension of the excavated areas which are not always comparable and thus to volumes of lithic industry that are not statistically comparable) could also be due to the importance of specific, secondary, economic activities, that is, to the existence of one or another specialization of the agro-pastoral community as a whole or of some of its members. As seen farther on, a similar situation may be observed for the bone and ground stone industries.

The geometric microliths comprise an integral part of the obsidian industry at Aknashen. Among the 293 examples (2019 data) recovered from all the horizons (VII-I), there are no segments, the number of triangles is absolutely insignificant, but high, short trapezes are in absolute predominance; they are made on small fragments of blades, with direct retouch on both 'proximal' and 'distal' ends, certain of them having the dorsal surface retouched. On some examples, the little base is formed of two teeth ('horned trapezes'); such trapezoids have no parallels on contemporary sites in the South Caucasus, although they are widespread in the Crimea and on the north slope of the Greater Caucasus at the end of the Upper Palaeolithic (Epipalaeolithic) and in the Mesolithic (Golovanova and Doronichev 2020; Biagi 2016; see below) (Figure 6).

Previously it was considered that microliths were not characteristic of the lithic industry of the *AShSh* culture. According to Kiguradze (1976), in the first three phases of this culture, geometric microliths were absent; they are represented by only a few examples in the two late phases and only at Imiris Gora and Khramis Didi Gora. This absence of microliths has also been noted for the earliest settlements in Azerbaijan (Narimanov 1987: 104). However, the excavations of recent years on several sites of the Kura basin have produced a certain quantity of typologically similar microliths (trapezes): Arukhlo (3 stratified examples and 8 undated) (Gatsov and Nedelcheva 2017: tab. 6); Hacı Elamxanlı (21 finished examples and 23 unfinished) (Kadowaki *et al.* 2016: tab. 1); Göytepe (12 finished examples and 3 unfinished) (Nishiaki and Guliyev 2019: tab. 4); Mentesh Tepe (1 example) (Guilbeau *et al.* 2017: tab.10).

Nevertheless, microliths do not appear to be an obligatory element in the obsidian industry of the Neolithic sites of the South Caucasus. It is notable that microliths are present in the material from Masis Blur (personal observation, 2013), which consists of 11,500 pieces (Martirosyan-Olshansky 2018a), whereas they are totally absent at Aratashen, where more than 20,000 pieces of obsidian have been recovered. Given the close similarity in material culture and techno-typological characteristics of the obsidian assemblages from the three sites mentioned above, it may be assumed that the presence or absence of microliths and their number are related to a specific, secondary, economic activity, probably hunting. Geometric microliths such as small trapezes or lunates are absent from the Neolithic assemblage of Kültepe I (Marro *et al.* 2019); on this site, as on those of the Kura basin, sling projectiles were found (Narimanov 1987: 49).

In any case, chronologically, the frequent presence of microliths shows the same tendency for the sites of the basins of the Araxes and the Kura. The stratigraphic distribution of the microliths at Aknashen shows a progressive decrease from horizon VII towards the upper horizons. In comparing the corresponding data from the site of Hacı Elamxanlı dated to the beginning of the 6th millennium and the later site of Göytepe, Nishiaki and Guliyev (2019: 481) note that *'the production of trapezes could have been more common in the earlier stage of the ShSh culture*.' Microliths have also been found on the sites of the Mil steppe. However, these are mainly segments (at Kamiltepe, 19 lunates and five trapezes), and the examples in flint are more numerous (Guilbeau *et al.* 2017).

On the whole it appears that the main characteristics of the lithic industries of the 6th-millennium sites in the basins of the Araxes and the Kura present '*a remarkable degree of homogeneity in techniques and chaines operatoires*' (Varoutsikos and Petrosyan 2019: 467). It is obvious that the existing differences appear to be quite specific and reflect the economic trends of the sites rather than their main cultural features.

Pottery

In the Ararat valley, the emergence of pottery and its development in the first half of the 6th millennium occurred 'before our eyes', as the data from Aknashen show: the lower horizons (VII-VI, *ca.* 6000/5950-5850/5800 cal BC) are characterized by the absence of local pottery production and by a large quantity (in comparison to the horizons above) of imported pottery, painted or monochrome; in the upper part of horizon V (*ca.* 5780-5750 cal BC) pottery sherds with mineral temper that were locally produced (predominance of group Grit II) appear, in relatively low amounts; in horizon IV (*ca.* 5750-5690 cal BC), the quantity of local pottery with mineral temper clearly increases, with group Grit II predominating slightly over group Grit I; in horizons III (*ca.* 5690-5600 cal BC) and II (*ca.* 5600-5450/5400 cal BC) the quantity of pottery is multiplied by two, and group Grit I becomes the majority. The upper horizon (I) is characterized by the absolute predominance of pottery with plant temper, of which the very first sherds appeared in horizon III.[3]

[3] Small-sized sherds found in Horizons V and IV are probably associated with animal burrows or other kinds of disturbance (intrusive burials of Late Bronze Age or modern period) (see Harutyunyan in this volume).

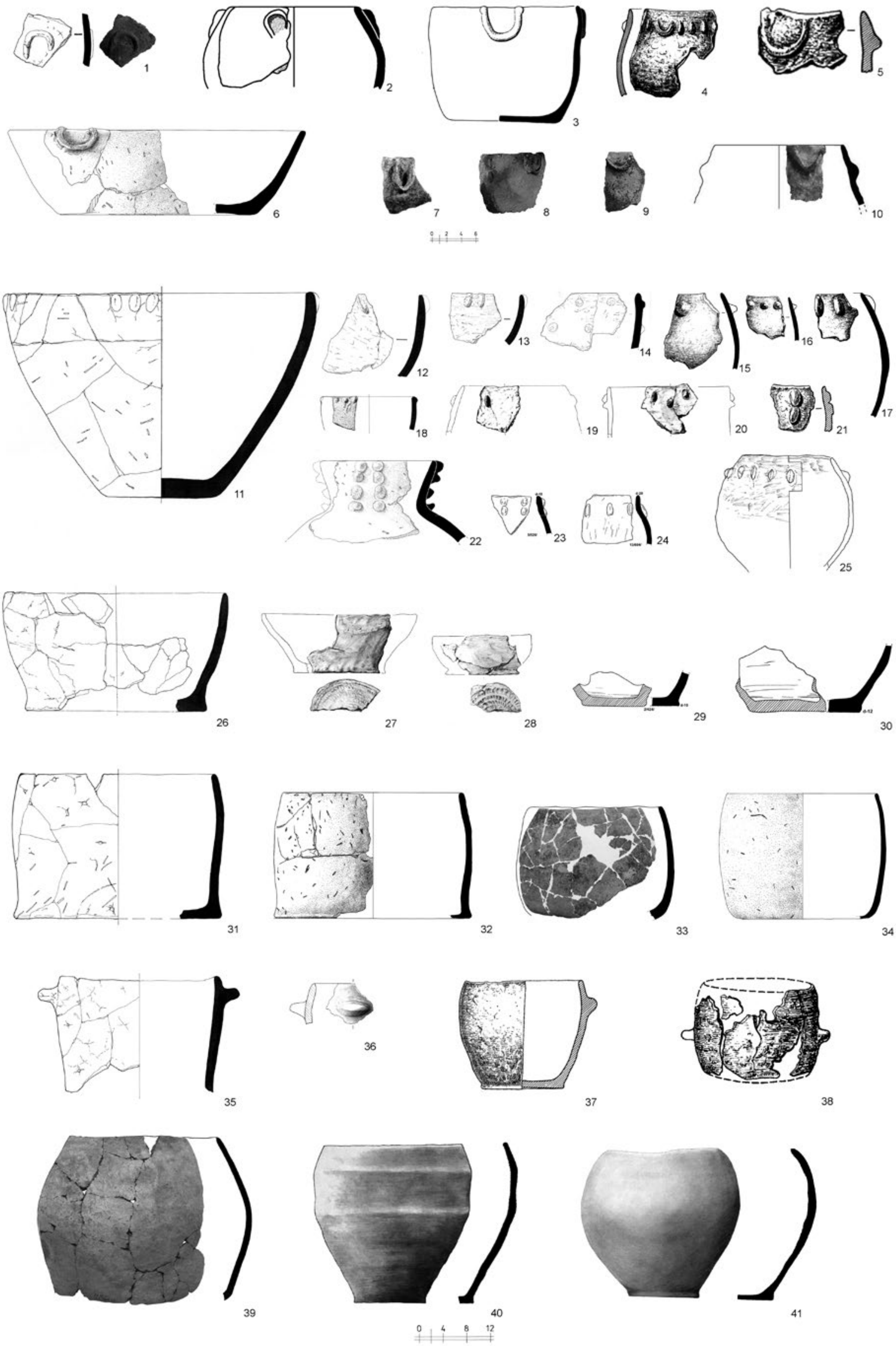
In the lower levels (IIb-d) of Aratashen (*ca.* 5905-5775 cal BC), the situation is generally the same: three sherds having mineral temper were found, but are probably intrusive.

In the Neolithic layers of Masis Blur, pottery is practically absent, except for 1 or 2 fragments in each trench, whose presence is most likely the result of disturbance (e.g. animal burrows). A large quantity of sherds collected on the surface and from the topsoil, originally in the upper destroyed levels of the tell, represent pottery with both mineral and organic inclusions (Hayrapetyan *et al.* 2014).

The same tendencies were observed on the sites of the first half of the 6th millennium in the plains of Marneuli and Gandja-Gazakh, which indicates that there were common rules for the emergence and diffusion of pottery in the Araxes and Kura basins. Indeed, comparative analysis of the data from the early site of Hacı Elamxanlı (*ca.* 5950-5800 cal BC) and the later site of Göytepe (*ca.* 5650-5450 cal BC) shows that '*pottery was rare in the lowest levels, but rapidly increased from the middle part of the sequence onward. The earlier pottery assemblages are also characterized by the almost exclusive use of mineral-tempered pottery, while the later ones showed more prevalent use of plant-tempered*' pottery (Nishiaki *et al.* 2015a: 283). To these may be added the two sherds of imported pottery from Hacı Elamxanlı which belong, like those from Aknashen, to Samarra/ Early Halaf pottery (Nishiaki *et al.* 2015a: 284; 2015b). At Hasansu, the upper cultural layer contains relatively abundant fragments of pottery vessels made of clay with inorganic inclusions and clay with a plant temper. Below this layer, sherds are extremely rare, being very small fragments of vessels (intrusions?). In the above-subsoil horizon, no fragments of pottery were found (Museibli 2017; for the 14C dating of this site, see Nishiaki *et al.* 2015a: tab.6 and Museibli 2017: 49).

A tiny quantity of sherds, mainly with mineral temper, were found in the lower levels of Shulaveri (IX-III) and of Imiris Gora (VII-VI) (Kiguradze 1976; Batiuk *et al.* 2017: 196). At Gadachrili Gora (5920-5650 cal BC; Hamon *et al.* 2016) mineral-tempered pottery is predominant; a very small quantity of pottery with organic temper appears at the extreme end of Phase I and increases from 1% in the Neolithic up to 19% in the Late Neolithic/ Early Chalcolithic (Batiuk *et al.* 2019). At Kültepe I of Nakhichevan, where only level 2 can be placed in parallel with the *AShSh* culture (see below), the pottery is mainly plant-tempered (Marro *et al.* 2019), as on the sites of the Azerbaijani part of the Kura (Mentesh Tepe) and in the upper horizon of Aknashen.

Morphologically there is quite a high level of resemblance between the vessels of the Shulaveri-Shomutepe group and those of Aknashen-Aratashen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(Figure 7: 26-41). In the Araxes and Kura basins, the dominant forms are the cylindrical and barrel-shaped vessels with flat bases, with a little projection between the body and the base; the latter is wide on examples from the Ararat valley and narrow on those in the Shulaveri-Shomutepe group. In spite of the fragmentation of the pottery and the low number of sherds, the presence of oval vessels in the two groups is confirmed. The vessels were shaped using coils and/or by the coil-slab technique.

While on the sites of the Kura basin, there are numerous examples of basketry impressions, at Aknashen they are not characteristic. Also striking is the difference in the decoration of the vessels (Figure 7: 1-25). The mineral-tempered pottery of Aknashen and Aratashen, as well as the plant-tempered pottery of Kültepe, are not decorated, whereas the mineral-tempered pottery of the Kura basin is richly decorated: about a third of the sherds at Arukhlo (Lyonnet *et al.* 2012: 77; Hansen *et al.* 2006; 2007b) and two thirds at Gadachrili Gora (Batiuk *et al.* 2017). Decorations in relief of circular and oval motifs, of horseshoe shapes, of rings and zigzags, are frequent on the exterior edge of the rim. A few cases of anthropomorphic representations in relief also occur on the pottery of Arukhlo, Imiris Gora and Khramis Didi Gora (Lyonnet *et al.* 2012: 78-82). At Shomutepe, similar decoration of circular and vertical protuberances on the rims of the vessels is only found on sand-tempered pottery. At Mentesh Tepe, such applied decoration is very rare, either on the vegetal tempered ('group 1') or on the grit tempered ('group 3') pottery (Lyonnet 2017: 142-143), whereas on the neighboring and later site of Göytepe, relief decoration is commonly present on the mineral-tempered pottery ('type VI'), but rare on the plant-tempered sherds ('type III') (Arimatsu 2020: 263). At Aknashen and Aratashen, such decoration is characteristic of plant-tempered pottery in the upper horizons.

We consider that these similarities and differences in the pottery production of the *AShSh* culture, whether in technology, morphology or decoration, are the result of a rapid and independent development in local pottery production, for which the main stages can be distinguished as follows:

1. In the formation phase of the *AShSh* culture, the local population became familiar with pottery because of vessels imported from the Near East. Like Nishiaki *et al.* (2015a; 2015b), we are inclined to consider the absence of local pottery in this phase to be a chronological phenomenon, and not a conscious cultural and social choice (such as attention concentrated on the extraction of obsidian, the production of objects in obsidian and bone, etc.) suggested by Iserlis (2017/2020: 40).

2. Moreover, the local development of pottery production followed the same pattern as has been documented for the first centres of pottery production in the Near East. Indeed, we observe the same evolution in pottery technology – '[...] *pottery with mineral temper preceded pottery with plant temper, the use of which was to develop progressively*' (Le Mière 2009: 73)[4] –although there was clearly a chronological difference between the sites of the Jazira and the northern Levant, the western regions of the Armenian Highlands / the Tigris Basin on the one hand and the sites of the late Neolithic in the Ararat valley and the South Caucasus on the other hand.

3. 3. From 5800-5600 cal BC onward, there existed a relatively massive production of local pottery, for which each community favored some

[4] Cf. Nishiaki *et al.* (2019b: 5): '*While pottery was very rare at the beginning, it began to increase in the second quarter of the 8th millennium cal BP: the initial mineral-tempered pottery soon gave way to plant-tempered pottery*'.

Figure 7 (page 266). Pottery:
1-10) Pottery with crescent decoration:
1) Aknashen; 2) Gadachrili Gora (Batiuk *et al.* 2017: fig. 14: 8); 3) Khramis Didi Gora (Kiguradze 1986: Abb. 69: 7); 4) Imiris Gora (Masson *et al.* 1982: tab. XXXVIII: 30); 5) Khramis Didi Gora (Masson *et al.* 1982: tab. XXXVI: 2); 6) Kültepe (Marro *et al.* 2019: fig. 15: 3); 7) Arukhlo (Lyonnet *et al.* 2012: fig. 114); 8) Arukhlo (Hansen *et al.* 2006: Abb. 47); 9) Mentesh Tepe (Lyonnet 2017: fig. 5); 10) Göytepe (Alakbarov 2018: fig. 8a);

11-25) Pottery with knob decoration:
11-14) Aknashen; 15-17) Imiris Gora; 18) Aratashen; 19-20) Arukhlo (Bastert-Lamprichs 2017: Abb. 4: 4, 6); 21) Khramis Didi Gora (Masson *et al.* 1982: tab. XXXVI: 6); 22) Kültepe (Marro *et al.* 2019: fig. 15: 2); 23-24) Shomutepe (Akhundov 2013: tab. 209); 25) Göytepe (Nishiaki *et al.* 2015a: fig. 3c);

26-41) Pottery morphology:
26, 31, 33, 35, 39) Aknashen; 27-28) Arukhlo (Bastert-Lamprichs 2017: Abb. 4: 8; Abb. 5: 3); 29-30) Shomutepe (Akhundov 2013: tab. 215 and 214); 32, 34) Kültepe (Marro *et al.*2019: fig. 13: 3-4); 36) Arukhlo (Hansen *et al.* 2007: Abb. 27); 37) Khramis Didi Gora (Masson *et al.* 1982: tab. XXXVI: 5); 38) Kültepe (Masson *et al.* 1982, tab. XLIII: 9); 40-41) Arukhlo (Bastert-Lamprichs 2017: Abb. 1: 4, 6).

technological and stylistic features – either common or specific (Iserlis 2017/2020: 40).

Bone industry

As already indicated, the collection of artefacts in bone and horn is exceptionally rich and varied in morpho-typology and function, and constitutes an integral part of the cultural complex of Aknashen, as well as for all the contemporary sites in the Ararat valley. The same observation is even more pertinent for the sites of the Kura basin. As has been recently stated, '*the well-developed bone industry, comprising a large diversity of tool types such as awls, points, hammers, dibbles, arrowheads, and palettes, may be regarded as a unique feature of the ShSh culture*' (Nishiaki *et al.* 2015b: 25). Moreover, for almost every category of tool from Aknashen and Aratashen, there are stable morpho-typological comparable examples on the synchronous sites of the Kura basin (Figures 8 and 9), which, among other indicators, is one of the criteria that bring them closer to one other. It must also be pointed out that the variety and the exceptional number of bone artefacts are not only distinctive features of all the settlements of both the Aratashen-Aknashen and Shulaveri-Shomutepe groups, but also a criterium for differentiation from the other Neolithic cultures of the region. Thus, although a number of similarities are also observed with the later Mil plain settlements, the latter do not present the above-mentioned diversity in their bone artefacts. In the neighboring region of northern Mesopotamia, where Halaf culture developed in the 6th millennium, the bone industry is also characterized by a limited number of objects and less typological variety. It is remarkable that similar assemblages, including types (round-headed palettes) that are widespread in the Ararat valley, existed at Tilkitepe (lower level III; Korfmann 1982), on the eastern shore of Lake Van, where one of the northernmost Halafian settlements

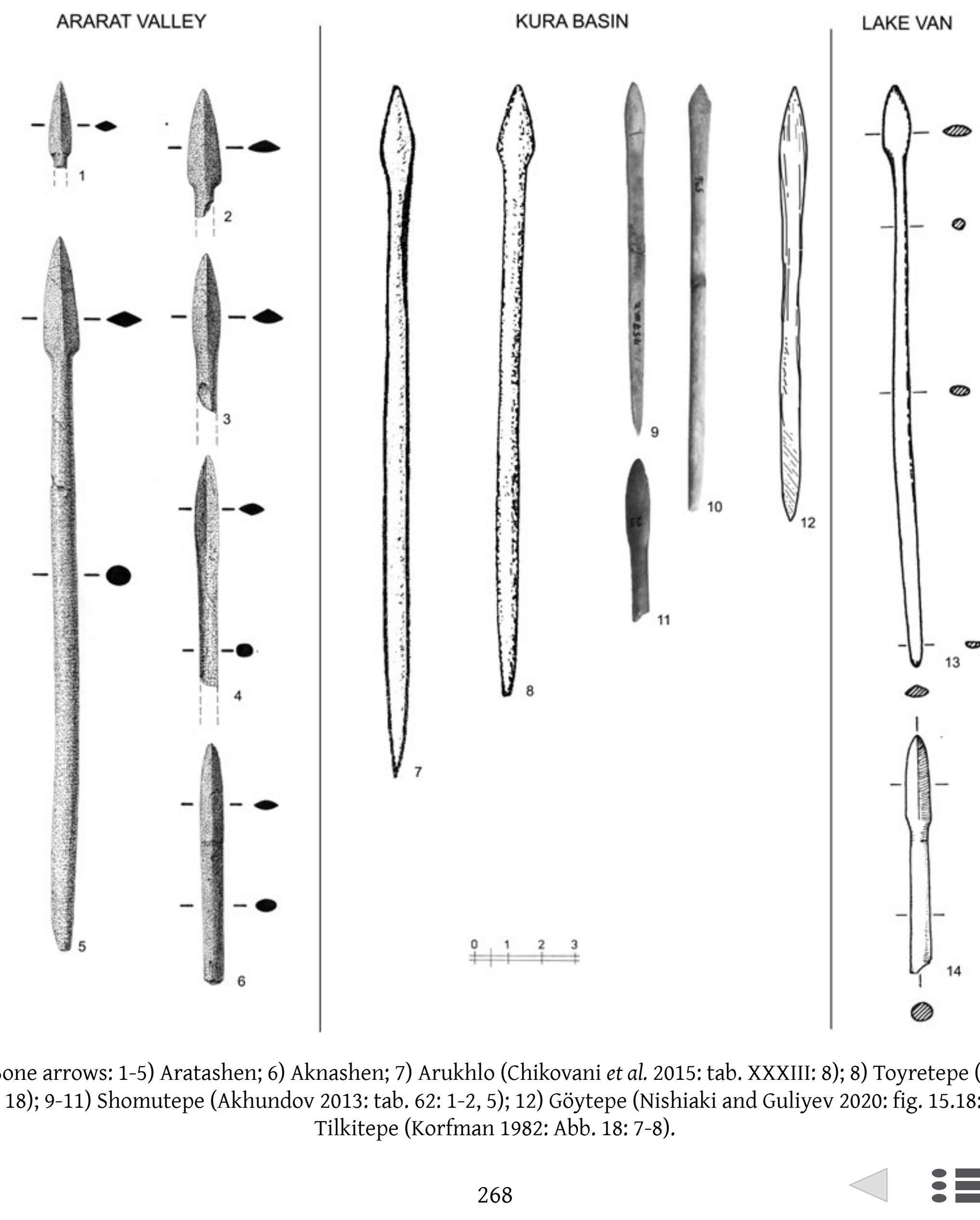

Figure 8. Bone arrows: 1-5) Aratashen; 6) Aknashen; 7) Arukhlo (Chikovani *et al.* 2015: tab. XXXIII: 8); 8) Toyretepe (Narimanov 1987: fig. 18); 9-11) Shomutepe (Akhundov 2013: tab. 62: 1-2, 5); 12) Göytepe (Nishiaki and Guliyev 2020: fig. 15.18: 1); 13-14) Tilkitepe (Korfman 1982: Abb. 18: 7-8).

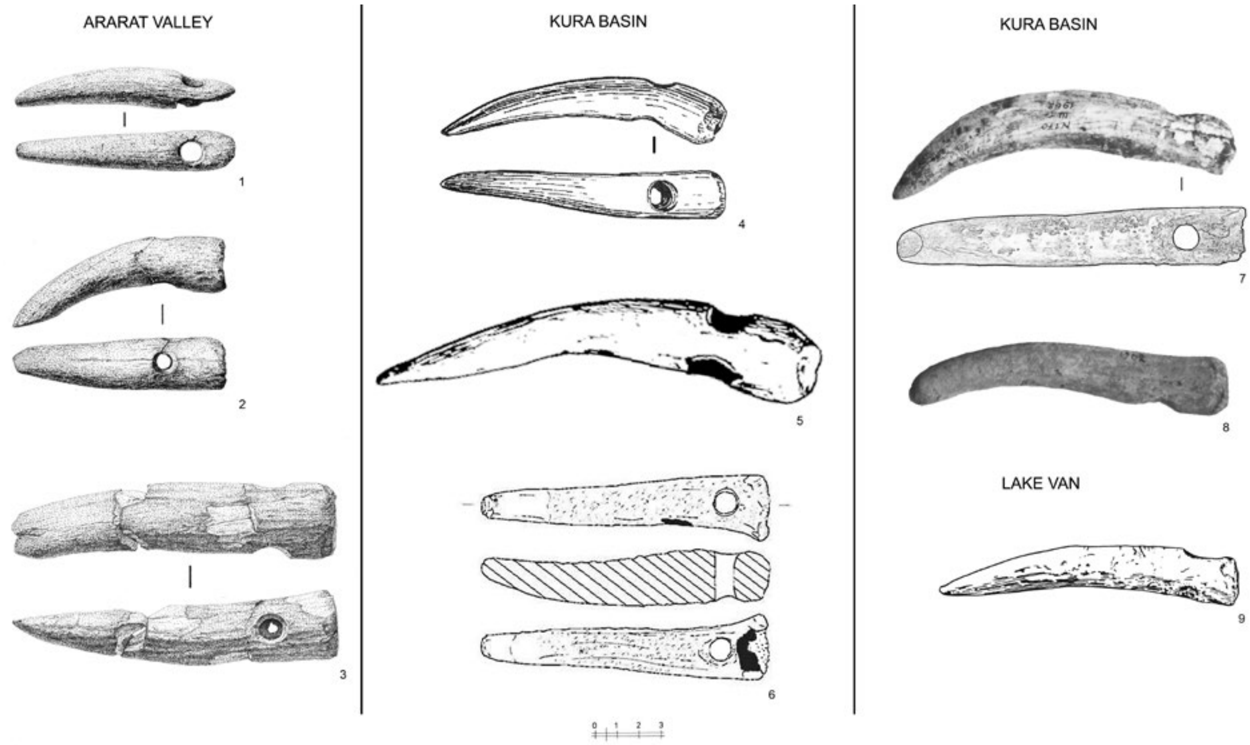

Figure 9. Bone 'pick hammers': 1) Aknashen; 2-3) Aratashen; 4) Arukhlo (Chikovani *et al.* 2015: tab. XXXVIII: 2); 5) Khramis Didi Gora (Masson *et al.*1982: tab. XXXVI: 13); 6) Göytepe (Nishiaki and Guliyev 2020: fig. 45.15: 5); 7-8) Shomutepe (Akhundov 2013: tab. 73: 4; tab. 72: 1); 9) Tilkitepe (Korfman 1982: Abb. 15: 2).

has been identified (Nishiaki *et al.* 2015b; Chataigner *et al.* – Neolithic bone tools – in this volume).

Ground stone, axes and polishers

An enormous quantity of ground stone objects makes up an important part of the complex of Aknashen. In addition to used *ad hoc* natural pebbles, there are a notable number of tools with morpho-typological and functional characteristics whose analysis (Hamon and Meliksetian in this volume) has enabled determination of the circle of similar examples as well as the sphere of their utilization in the economy. In conclusion, the authors have stated that '*important similarities between the middle Araxes basin and the middle Kura basin are visible through the study of the Neolithic macrolithic assemblages. They contribute to reinforce the close cultural links between both areas during the 6th millennium BC. Nonetheless, the cultural entity including Aknashen and Aratashen shows clear regional specificities, with the intensive use of very particular tools (grinders, pumice-abraders, etc.) unknown in the rest of the southern Caucasus*.'

In the evaluation of the similarities and differences between the macrolithic assemblages of the sites of the South Caucasus in the 6th millennium, it must be taken into account that '*despite a common economic basis, real specificities can be isolated in the activities of the different occupations*' (Hamon 2008: 108). Thus the beveled sharpeners in pumice, unknown in the Kura basin, appear to have played a particular role in Aknashen's technical system (Hamon and Meliksetian in this volume). In the economy of the sites of the Marneuli plain (Shulaveri group), differences in the roles of this or that production have already been recognized by Hamon (2008).

The absence of flat axes at Aknashen in horizon VII and the presence of a single example at Hacı Elamxanlı contrast with their much larger number in the upper horizons at Aknashen (horizon IV) and on the late site of Göytepe; if confirmed by future excavations, this distinction could clearly serve as a chronological indicator, illustrating yet again the similarity of the development of material culture in the basins of the Araxes and the Kura, between the first and the last stages of its development.

As previously mentioned, polishers have very few direct comparisons in other assemblages in the southern Caucasus. As noted above, on the sites of the Kura basin the sharpeners (Figure 10) are rare and have one single groove (Imiris Gora, Khramis Didi Gora, Hacı Elamxanlı). Their presence in higher numbers at Aknashen would rather indicate more intense influences or exchanges between the Ararat valley and other regions from northern Iran to eastern Anatolia.

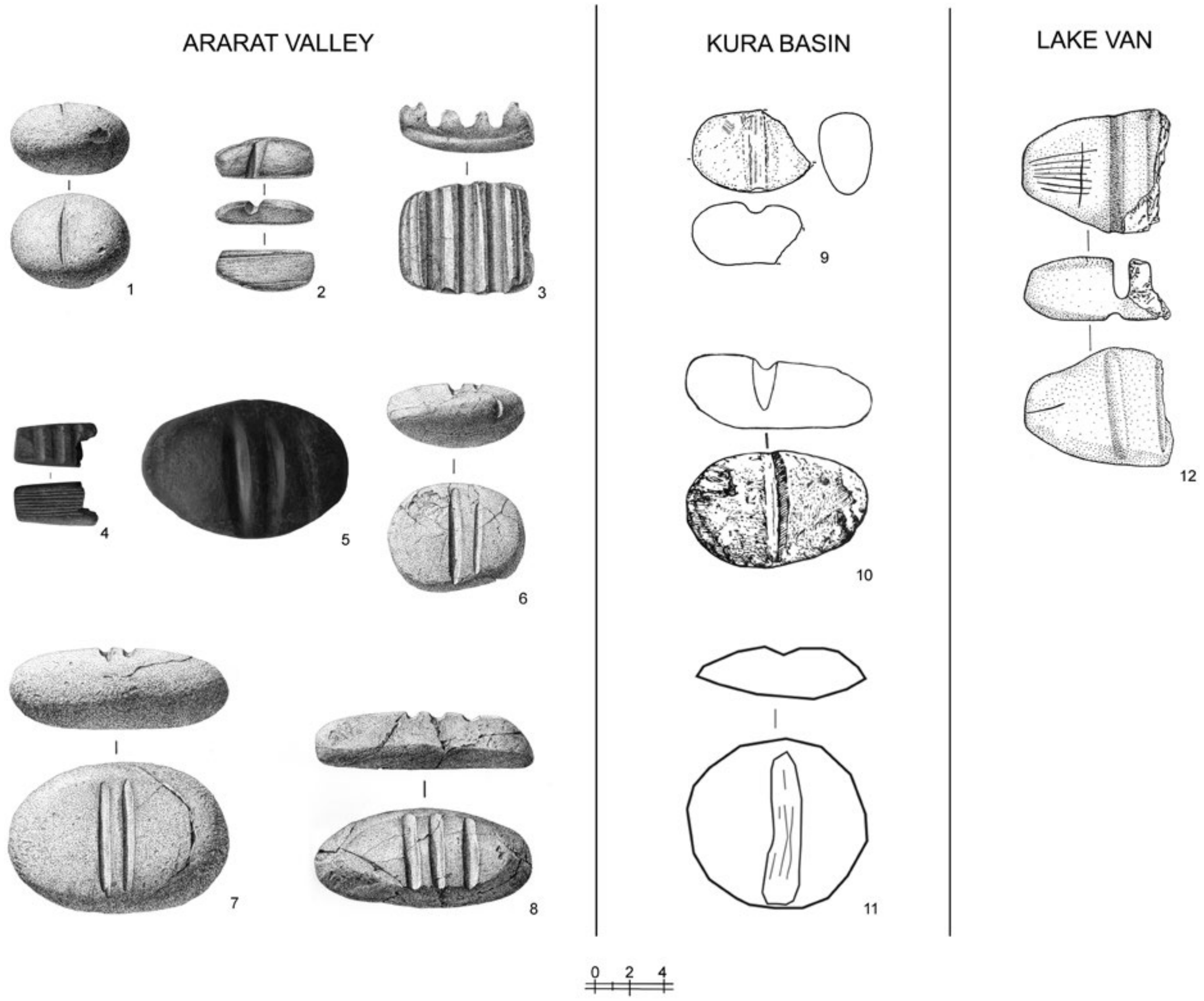

Figure 10. Grooved tools: 1-4) Aknashen; 5) Masis Blur (Martirosyan-Olshansky 2014, slide 12); 6-8) Aratashen; 9) Hacı Elamxanlı Tepe (Nishiaki *et al.* 2015b: fig. 15: 1); 10) Imiris Gora (Javakhishvili *et al.* 1975: fig. 21: 2); 11) Khramis Didi Gora (Hamon 2008: fig. 17f); 12) Tilkitepe (Korfman 1982: Abb. 20: 1).

Small finds

The assortment of small finds at Aknashen contains all the categories represented in the contemporary cultures: pieces and crumbs of malachite and azurite, cylindrical beads made from rolled copper leaves, pendants made from animal teeth or their imitations in bone, etc. Among these categories of artefacts, none are characteristic of the *AShSh* culture. The assortment of these categories, as much as the morphology of the objects within each category, is characteristic of both the Neolithic of the South Caucasus and that of the Near East.

The only difference between the sites of the Ararat valley and those contemporary sites of the Kura basin and of the Near East in general is the absence of anthropomorphic statuettes in the Ararat valley, whereas these are attested in more or less large numbers the Kura basin (Khramis Didi Gora, Arukhlo, Shulaveri, Gargalar Tepe, Göytepe).

Fauna and flora

In the evaluation of the similarities and the differences between the economies of production in the Ararat valley and the Kura basin, it is necessary above all to observe that there is a fundamental unity. The two groups of sites are characterized at the very beginning of the 6th millennium by a fully developed agro-pastoral economy, of which the two components include almost all the spectrum of domestic plants and animals, whereas, in the present state of our knowledge, the sites that chronologically precede the *AShSh* culture – Damjili unit 5 (*ca.* 6400-6000 cal BC) (Nishiaki *et al.* 2019b) and Lernagog (7000-6600 cal BC) (Arimura *et al.* 2018) – present a mobile way of life of hunter-gatherers, having no element indicative of an economy of production.

However, within the context of the agro-pastoral economy of the *AShSh* culture, it is clear that the cultural, chronological and/or environmental factors have led to a certain degree of similarity or of difference between the sites.

In the formative phase of the *AShSh* culture, particular similarities between the economic systems of Aknashen VII and Hacı Elamxanlı can be noted; this may be seen in the quantitative predominance of barley over wheat, the predominance of caprines raised mainly for meat, the increase in cattle as the site develops and the limited role of hunting, which indicate again their chronological and cultural similarity and their belonging to the same phase. At the same time, the two sites differ from the 'classic' settlements of the *AShSh* culture, which themselves reflect differences, as much regional (notably the presence of pigs, very low in the basin of the Araxes (<1%) whereas in the Kura basin the percentage reaches 12.9% at Arukhlo) as local (within the Kura basin; see Berthon 2014).

The general tendencies in the evolution of the economy, which may be followed in the development of the tell of Aknashen, appear to be widely common on the sites of the Ararat valley and those of the Kura basin: between horizons VII and II, the importance of caprines decreases while that of cattle, pigs and wild mammals increases. The exploitation of caprines and cattle, mainly for their meat, gives way to exploitation for milk starting at horizon II, also observed at Aratashen (Bălăşescu and Radu in this volume). Emmer and free-threshing wheat are attested at Aknashen from horizon VII to horizon II (Hovsepyan in this volume), like in the Kura basin, for instance at Hacı Elamxanlı and Göytepe, where an evolution towards a predominance of naked wheat is clearly perceptible (Nishiaki *et al.* 2015b: 20).

Discussion

Thus, from our point of view, for the 6th-millennium sites of the basins of the Araxes and the Kura, a fundamental similarity exists in the basic parameters of the material culture, and differences exist in the secondary parameters. '*General similarities among the Neolithic sites of the northern and southern sides of the Lesser Caucasus*' have also been noted by Nishiaki *et al.* (2019b: 12), who also stress the regional variability in the architecture, the material culture and the economy.

Conversely, Marro *et al.* (2019: 108) comparing the results of the new excavations at Kültepe of Nakhichevan with the data from Hacı Elamxanlı, conclude that the Neolithic of the South Caucasus was heterogeneous: *The variety perceptible in the material assemblages of the Kura and Araxes valleys questions the very concept of a 'Shomu-Shulaveri culture', and even more so of an 'Aratashen-Shomu-Shulaveri culture' (Chataigner et al. 2014a: 12) currently used in Caucasian archaeology, since in most fields differences appear to be at least as numerous as similarities.*

In fact, the reasons for the heterogeneity observed are rather more chronological in nature. At Kültepe, the Neolithic occupation is subdivided into two levels – lower level 1 and upper level 2 – and '[...] *certain changes [are] observed in the archaeological assemblages between Levels 1 and 2*' (although Level 1 had only been studied '...*over a very small area: 12.5m²*.') (Marro *et al.* 2019: 88).

At Kültepe, level 1, dated to *ca.* 6200-5800 cal BC, provides evidence for the arrival of a Neolithic population that constructed semi-buried buildings with 'fire-pits', made plant-tempered pottery,[5] produced lithic tools by percussion (Marro *et al.* 2019) and, according to earlier excavations, possessed biconical spindle whorls (Abibullaev 1959: 450 and fig. 14: 9-10). All these elements are known for the northern part of the Near East in the second half of the 7th millennium, where architecture was mainly rectangular (Sabi Abyad, Hakemi Use, etc.) (Akkermans and Schwartz 2003; Tekin 2011), but have no parallel at Hacı Elamxanlı, where the buildings are circular, the hearths have wide flat bottoms, pottery is not produced *in situ*, the lithics are knapped mainly by pressure, and biconical spindle whorls are unknown.

On the other hand, Kültepe level 2, dated to *ca.* 5800-5100 cal BC, presents analogies with sites of the *AShSh* culture settled after 5800 cal BC. In this level 2, the buildings are circular in plan and built in cob (Marro *et al.* 2019: 91) as in the Ararat valley, where the buildings are also single-roomed. Hearths lined with river pebbles are here built on a flat surface, as at Arukhlo in the Kura basin (Hansen *et al.* 2013: fig. 35.14). In the pottery, buff, light buff and brown-coloured vessels become predominant, as in the *AShSh* culture, and among the relief motifs, two vertical bands of knobs have exact parallels at Arukhlo (Marro *et al.* 2019: 95). Plant-tempered pottery is predominant in the Kura basin at Mentesh Tepe and becomes so in the Ararat valley in the upper horizon (I) (see Harutyunyan in this volume). As we have seen, the variety in technique, morphology and decoration of pottery at the sites of the Kura basin (Iserlis 2017/2020) is probably the result of a rapid and independent development in local pottery production. At Kültepe, the lithic assemblage is clearly dominated by obsidian, as at Aknashen or Arukhlo. Trapezoids are unknown at Kültepe, as on most sites of the *AShSh*

[5] It should be noted that the data from Kültepe I of Nakhichevan clearly contradict the models observed for the appearance and the development of pottery in the South Caucasus (see above, section Pottery). According to Marro *et al.* (2019: 92), the pottery, of which the absolute majority is plant-tempered, was already present in large quantity at the very beginning of the Neolithic sequence, dated to between 6200 and 6000 cal BC. The frequency was quite stable throughout the sequence, the fabrication technique had not changed, nor had the vessel shapes, except for the disappearance of carinated bodies in level 2. At the same time, to be noted is the significant morphological similarity of the Kültepe pottery with the Grit group of Aknashen and the rarity of decoration, inherent to both assemblages.

culture (Aratashen, Göytepe...) (see above). As Marro *et al.* (2019: 108) point out, '*the obsidian industry from Kültepe I actually finds its best parallels in the assemblages from Göytepe and Arukhlo*'.

Therefore, the statement that '*the overall differences between Kültepe I and Hacı Elamxanlı are at least as significant as the similarities*' is based on a chronological mistake, because, on the one hand, Kültepe levels 1 and 2 must be distinguished and, on the other hand, level 2 must be compared with the *AShSh* sites that are contemporary to it. Kültepe level 1 is not part of the *AShSh* culture; Kültepe level 2 has many parallels with the *AShSh* culture.

Thus, we estimate that there exist sufficient reasons to consider the sites of the Shulaveri-Shomutepe and Aratashen-Aknashen groups to be local variants of the same culture; the name 'Aratashen-Shulaveri-Shomutepe' (Chataigner *et al.* 2014a), which was proposed to designate this community, has as a first objective the definition of its area of distribution and to show that it includes the sites of both the Araxes and the Kura basins.

The periodization and chronology of the 'Aratashen-Shulaveri-Shomutepe culture' and the problem of synchronization of sites

The relative 'pre-Kura-Araxes' position of the *ShSh* culture, revealed by the excavations at Kültepe, has long automatically determined its appartenance to the Chalcolithic, at least in its early stage. The inertia of this approach persisted long after Kiguradze 1976 had attributed this culture to the late Neolithic.

The sporadic finds of imported pottery, mostly Halaf, have long served as criteria for the absolute dating of the *ShSh* culture. Following the placing of the Halaf culture earlier, the chronological framework of *ShSh* was revised. Initially, it had been dated to the 5th millennium (Munchaev 1975: 99), then the beginnings of this culture were shifted to the 6th millennium and the final phase to the 5th millennium (Kiguradze 1976: 169); then, a dating to within the second half of the 6th millennium was suggested (Narimanov 1987: 137). Finally, in spite of the rarity and the fragmentary character of the 14C dates published at that time (Masson *et al.* 1982; Kavtaradze 1983; Kiguradze 1986; Javakhishvili *et al.* 1987; Narimanov 1987; Chataigner 1995), they enabled dating of the *ShSh* to the 6th millennium. It was also noted that the origins of the culture could date to the 7th millennium (Kavtaradze 1983: 43).

In the last ten years, the *AShSh* sites, as much in the basin of the Araxes as in that of the Kura, have not only been assigned a new series of radiocarbon dates, of which the absolute majority lies between 6000-5250 cal BC (Chataigner *et al.* 2014a), but based on the results of their excavation have also led to attempts at statistical analysis of the data and construction of a chrono-periodic scale of the culture (Nishiaki *et al.* 2015a).

The previous attempt at periodization of this culture (Kiguradze 1976) was clearly not successful (Masson *et al.* 1982). Indeed, the new data do not always confirm the model of development of the material culture which served as the basis for this periodization.

Parallel with a high increase in the number of 14C dates obtained, the many statistical and stratigraphical observations resulting from much more intensive field work and especially the discovery of complexes with characteristics clearly different from the standard data (i.e. Hacı Elamxanlı and Aknashen horizon VII, the latter being integrated into a stratigraphic sequence), indicate that the question of the periodization and chronology of the *AShSh* sites must be reconsidered.

In the Ararat valley, the longest sequence of Late Neolithic levels (*ca.* 5950-5400 cal BC), the most complete and the most differentiated, is to be found at Aknashen. In this sequence, two complexes are distinguished, separated by the hiatus of horizon VI (episode of flooding), and are differentiated by an entire series of important indicators.

Aknashen horizon VII

This earliest horizon, lying on virgin soil, is dated to *ca.* 5950-5850 cal BC (median dates) according to the 14C dates currently available, which do not concern the deepest strata. It is characterized by the coexistence of circular and rectangular buildings, by the absence of local fabrication of mineral-tempered or plant-tempered pottery, by a strong presence (compared to adjoining upper horizons) of sherds of imported painted and monochrome pottery and of bladelets/microblades, bullet cores, nuclei on pebbles and microliths, as well as by the predominance of barley. According to this evidence, the complex of horizon VII is on the one hand distinguished from the succeeding upper horizons (V-II/I), which represent the completely developed form of *AShSh*, and on the other hand presents a significant degree of similarity with the contemporary site of Hacı Elamxanlı (*ca.* 5950-5800 cal BC; Nishiaki *et al.* 2015a; 2015b) in the basin of the Kura. We consider that the complex formed by these two sites constitutes the initial, formative stage of the *AShSh* (Badalyan and Harutyuntan 2014). 14C dates indicate that settlements of this complex appeared and developed simultaneously in both the Kura and the Araxes basins (Chataigner *et al.* 2014a).

The dates of Aknashen horizon VII and of Hacı Elamxanlı are synchronous with the dates of the lower level (VI) of Masis Blur,[6] with those of Hasansu (5930-5750 cal BC, median dates, according to Museibli 2017: 49) and with the lower levels of Gadachrili Gora (5920-5650 cal BC according to Hamon *et al.* 2016; 5985-5685 according to Batiuk *et al.* 2019); however, we have no data concerning the specific character of these complexes that would allow comparison to those of Aknashen VII and Hacı Elamxanlı (other than the extreme rarity of pottery).

In this regard, it should be noted that, in the present stage of research, attempts to push back the age of the sites of the Araxes basin and thus the lower limit of the *AShSh* culture seem premature to us, in that they are only based on a few 14C dates, with no accounting for either their statistical viability or the overall archaeological context.

It is the case for the dates from the lower level (VI) of Masis Blur, based on a single date (6245-6205 cal BC), which appears as an outlier in the assemblage of other dates for this horizon, grouped between 5980 and 5835 cal BC (Martirosyan-Olshansky 2018a).

As for level 1 of Kültepe I of Nakhichevan (dated to 6200-5800 cal BC; median dates), we saw above that it does not belong to the *AShSh* culture and thus cannot be taken into account for dating the appearance of this culture. The same statement applies to the rock shelter of Bavra-Ablari in southern Georgia, where the beginning of level 3, in which the caprines are domesticated, is dated to between 6300 and 6000 cal BC (Varoutsikos *et al.* 2018). The microlithic type of the lithic industry shows that the population was of Mesolithic origin and had acquired the practice of herding by acculturation. During the 6th millennium, the occupants of this rock shelter came into contact with the Neolithic populations of the Shulaveri group, who obtained their obsidian from the Chikiani volcano, a few hours walk from the rock shelter.

Aknashen horizon V-II/I

The second complex of Aknashen, the latest, consists of horizons V-II/I which present a ‘classic’ form of the *AShSh* culture, already fully developed. During all the interval of time between *ca.* 5810 cal BC and 5450/5400 cal BC (at a minimum), the development of the culture consisted of above all a gradual change in the quantitative indicators, in one way or another. For example, a progressive decrease is observed in the quantity of microliths and bone tools; between horizons VII and II the frequency of caprines decreases, while that of cattle, pigs and wild mammals increases, exploitation for milk increases little by little and becomes dominant in horizon II. The qualitative and quantitative development of pottery constitutes a particularly significant element in the sequence of Aknashen:

– horizon V (*ca.* 5810 to 5750 cal BC; median dates): in the upper level of this horizon, for the first time, a relatively low amount of mineral-tempered pottery of local fabrication appears (with a predominance of group Grit II);

– horizon IV (*ca.* 5750 to 5690 cal BC; median dates): the quantity of local mineral-tempered pottery increases greatly, group Grit II remains predominant over group Grit I, but with a low margin;

– horizons III (*ca.* 5690 to 5600 cal BC; median dates) and II (*ca.* 5600 to 5450/5400 cal BC; median dates): the quantity of pottery sherds doubles, group Grit I is now predominant; in horizon III plant-tempered pottery appears for the first time;

– horizon I, highly disturbed, has produced no 14C date for the Neolithic period; it is characterized by a total predominance of plant-tempered pottery.

It is precisely in this second period that the absolute majority of the dates of the *AShSh* sites is situated: Aratashen II– 5800-5580/5550 (median dates) (Badalyan *et al.* 2007; Nishiaki *et al* 2015a: tab. 4); Gadachrili Gora – see above; Mentesh Tepe – 5993-5537 cal BC or in median dates 5800-5650 cal BC, the earliest and latest dates having been excluded by the excavators (Lyonnet and Guliyev 2017: 127 and tab. 1); Arukhlo – the range of dates extends at the maximum between 5877 cal BC and 5296 cal BC (Hansen *et al.* 2017: 291), which, by excluding the two somewhat isolated extreme dates, can be reduced to 5800-5500 cal BC (Helwing *et al.* 2017: 5); Hasansu – the upper level– *ca.* 5700-5300 cal BC (Nishiaki *et al* 2015a: 292); Göytepe – 5650-5460 cal BC (median dates) (Nishiaki and Guliyev 2019: 471); Damjili, unit 4: 5700-5300 (median dates) (Nishiaki *et al* 2019b: 5 and tab. 1).

The comparison between these dates enables the observation, within the period 5830-5450/5400 cal BC, of the existence of two critical dates, about 5800 cal BC and about 5650 cal BC, and thus the subdivision of the period into two phases: Period IIa 5800-5650 cal BC and Period IIb 5650-5450 cal BC.

Periodization of the Aratashen-Shulaveri-Shomutepe culture

Consequently, in the periodization and the chronology of the *AShSh* culture the following appear:

[6] The authors are grateful to one of the co-directors of the excavation of Masis Blur, P. Avetisyan, who granted permission for access to unpublished dates for the site.

Period I: 6000/5950 – 5800 cal BC - Aknashen VII; Hacı Elamxanlı; Masis Blur horizons VI (dates unpublished). When all the data are published, the lower levels of Hasansu, Gadachrili Gora and Shulaveri could probably also be included.

Period IIa: 5800 – 5650 cal BC - Aknashen V–III; Aratashen IId-b; Masis Blur horizons IV-III (?); Mentesh Tepe period I; Gadachrili Gora; Arukhlo.

Period IIb: 5650 – 5450/5400 cal BC – Aknashen II; Aratashen IIa (at least in part), Masis Blur horizon II (?); Göytepe; Damjili unit 4, Hasansu; Arukhlo; Khramis Didi Gora.

Thus, as we have already pointed out several times, we observe not only that the formation phase of the *AShSh* occurred contemporaneously in the basins of the Araxes and the Kura, but also for the following period we observe *'the similarities'* [...] and *'the close synchronicity of cultural developments in the Middle Kura and Araxes Valleys'* (Nishiaki *et al.* 2015a: 292).

Data on the Neolithization of the South Caucasus

On a theoretical level, the transition from Mesolithic hunter-gatherers to Neolithic farmers is understood through two factors: (a) migration, or the spread of agricultural societies; and (b) diffusion, in which indigenous hunter-gatherers adopted ideas, material components and practices associated with agricultural society (e.g. domestic plants and animals, pottery) (Budja 2005). Migration and diffusion represent the two ends of a variegated spectrum of mechanisms, including folk migration, demographic spread, elite dominance, community infiltration, leapfrog colonization, exchange in frontier zones and regional exchange (Zvelebil and Lillie 2000).

Concerning the Caucasus, radiocarbon dates obtained in recent excavations indicate that the Neolithization of the whole region was very rapid. Indeed, for the period between the 10th and the end of the 7th millennium, Mesolithic sites are attested throughout the South Caucasus and on the northern slope of the Greater Caucasus (Figure 11).

The Mesolithic sites, spread over the entire territory of the Caucasus, present certain regional particularities (location in lowlands or highlands; different types of habitat...) but share common features (economy based on hunting and gathering; lithic industry of microlithic tradition; absence of pottery...).

Then, at the transition between the 7th and 6th millennium, Neolithic occupations with fully developed domestication of animals and/or plants appeared over the whole of this territory (Figure 12).

Thus between 6300 and 5900 cal BC interactions occurred (the nature of which remains to be defined) throughout the Caucasus between Mesolithic populations and Neolithic populations that had mastered domestication.

Archaeological data suggest that the change was not a simple replacement of the local Mesolithic communities by Neolithic farmers coming from the Near East (Nishiaki *et al.* 2019b: 12). Indeed, on these new Neolithic

Country	Region	Site	Habitat	Levels	cal BC (95.4%)	References
Armenia	Foothills of the Aragats massif	Kmlo-2	cave	IV-III	10400-7500	Arimura *et al.* 2009; 2014
Armenia	Foothills of the Aragats massif	Lernagog	open air	7-6,4	7000-6600	Arimura *et al.* 2018
Georgia	Imereti (northwest)	Kotias Klde	cave	B A2	10650-8300 7900-7500	Meshveliani *et al.* 2007 Jones *et al.* 2015
Georgia	Javakheti (south)	Bavra-Ablari	rockshelter	4	9100-7500	Varoutsikos *et al.* 2018
Georgia	Colchis (Black Sea)	Kobuleti	open air	4-2	8100-7600	Chkhatarashvili and Manko 2020
Azerbaijan	Gobustan (Caspian sea)	Ana Zaga Gaya Arasy 1 Firuz 2	cave rockshelter rockshelter		8540-7600 7800-6640 6820-6600	Farajova 2015 Farajova 2015 Farajova 2015
Azerbaijan	Kura basin	Damjili	rockshelter	5	6400-6000	Nishiaki *et al.* 2019b
Russia (northern flank of the Greater Caucasus)	Kuban basin (northwest)	Chygai	rockshelter	5-4	10700-8640	Leonova 2014
Russia (northern flank of the Greater Caucasus)	Kuban basin (northwest)	Dvoinaya	cave (test pit)	lower middle	10730-9310 8240-7090	Leonova 2014
Russia (northern flank of the Greater Caucasus)	Baksan valley (centre)	Sosruko	rockshelter	4	8290-7540	Golovanova *et al.* 2020
Russia (northern flank of the Greater Caucasus)	Baksan valley (centre)	Badynoko	rockshelter	7-2	6800-6400	Seletskiy *et al.* 2017
Russia (northern flank of the Greater Caucasus)	North Ossetia (centre)	Cmi	open air	1	6500-6350	Rostunov *et al.* 2009

Figure 11. The Mesolithic sites of the South Caucasus and the northern flank of the Greater Caucasus, whose dating is supported by 14C dates.

Country	Region	Site	Habitat	Levels	cal BC (95.4%)	References
Armenia	Ararat valley	Aknashen	settlement	hor. VII	5950-5800	this volume
		Masis Blur	settlement	hor. VI	5980-5835	Avetisyan pers. comm.
Azerbaijan	Nakhichevan	Kültepe	settlement	1	6200-5800	Marro *et al.* 2019: table 1
	Kura basin	Hacı Elamxanlı	settlement	4-1	5950-5800	Nishiaki *et al.* 2015a: 291
		Hasansu	settlement	lower	5930-5750	Museibli 2017: 49
Georgia	Javakheti	Bavra-Ablari	rockshelter	3 (lower part)	6200-5800	Varoutsikos *et al.* 2018: fig.4b
	Kura basin	Gadachrili Gora	settlement	2-1	5920-5650	Hamon *et al.* 2016: 157
Russia	North Ossetia	Cmi	open air	2-3	6000-5740	Rostunov *et al.* 2009: 55-56
	Kuban basin	Mezmayskaya	cave	1-2B	5950-5800	Golovanova *et al.* 2016: tab.1

Figure 12. The oldest Neolithic sites in the South Caucasus and the northern flank of the Greater Caucasus, whose dating is supported by 14C dates.

sites in the South Caucasus, the habitat was essentially circular, whereas it was mostly rectangular in the Near East (Badalyan and Harutyunyan in this volume); there is no pottery in the earlier levels (Harutyunyan in this volume), while pottery was widespread in the Near East; a blade-making tradition dominated in the lithic industry, while a flake-based production developed in northern Mesopotamia (Varoutsikos and Petrosyan in this volume). In fact, no culture is known in the Near East that could be directly linked to the Neolithic that developed in the South Caucasus, suggesting that *'the process of neolithization was not due to an endemic migration but rather to the transfer of technologies'* (Özdoğan 2018: 24).

In order to better understand the roles that the Neolithic populations of the Near East and the local Mesolithic may have played in the development of the culture represented at Aknashen, we will analyze the data provided by genetic analyses of the populations of the 10th-5th millennia in the Caucasus, then the archaeological evidence for contacts between Aknashen and the Near East, and finally the possible borrowings from the Mesolithic.

Analyses of ancient DNA

Although it is necessary to remain cautious because the results from ancient DNA analyses are for the moment based on a very small number of samples and that some areas, like Mesopotamia, are still completely blank, genome-wide DNA analysis of ancient human skeletons retrieved from archaeological excavations has provided a powerful new tool for the investigation of past populations and migrations (Eisenmann *et al.* 2018). For the South Caucasus and the surrounding regions (Anatolia, northern Mesopotamia, Iran, northern Caucasus) the study of ancient DNA provides insight into the composition of the populations at the beginning of the Holocene and thus enables us to better understand the interactions that may have taken place between the different regions.

Jones *et al.* (2015) found evidence of genetic continuity between the Late Upper Palaeolithic populations that lived in western Georgia in the 12th millennium (Satsurblia; *ca.* 11380-11130 cal BC) and the Mesolithic groups occupying the same region in the 8th millennium (Kotias Klde, level A2; *ca.* 7900-7530 cal BC). The individuals of Satsurblia and Kotias Klde constitute the Caucasus Hunter-Gatherers (CHG), genetically different from all other ancient genomes of the early Holocene (Mesolithic and Neolithic).

In the A2 level at Kotias Klde, the lithic assemblage includes 'Kmlo tools' or 'hooked tools', artefacts that spread at this time from northern Georgia (Paluri) to the Aragats massif (Kmlo-2) and which characterized the local Mesolithic culture (Arimura *et al.* 2010). These artefacts are present in the 7th millennium at Lernagog in Armenia (Arimura *et al.* 2018) and Damjili unit 5 in Azerbaijan (Nishiaki *et al.* 2019b); the inhabitants of these sites were therefore probably part of the same CHG community.

Subsequent studies showed that this CHG group was genetically very close to the 8th millennium populations of the Zagros (Ganj Dareh, Abdul Hosein, Wezmeh cave) (Gallego-Llorente *et al.* 2016; Broushaki *et al.* 2016). A process of domestication of goats and an incipient agriculture based on barley was then occurring in this region (Zeder 2008; Riehl *et al.* 2013). The autonomous character of the Neolithization of the Zagros is confirmed by DNA analyses, which indicate that the first farmers of the Zagros mountains differed greatly genetically from those of the southern Levant (Israel and Jordan), and that each descended from local hunter-gatherers (Lazaridis *et al.* 2016).

Other centres of domestication developed in the regions of the upper Tigris, upper Euphrates, middle Euphrates and central Anatolia (see animal domestication). In the latter region, the long-term persistence of the local Anatolian Hunter-Gatherers (AHG) gene pool has been demonstrated throughout the transition from foraging to farming, as it constitutes 80% to 90% of the gene pool of early Neolithic Aceramic Anatolian farmers (AAF) from Boncuklu in Turkey (*ca.* 8300-7800 cal BC) (Feldman *et al.* 2019). In addition to this local genetic contribution from earlier Anatolian populations (AHG), Anatolian Aceramic farmers (AAF) inherited about 10% of their genes from a gene pool related to the Neolithic Iran/Caucasus (Feldman *et al.* 2019). This would indicate contacts between the Mesolithic populations of the South Caucasus and the first farmer-herders of central Anatolia, as confirmed in the following millennium by the strong genetic affinity observed between an individual from Tepecik-Çiftlik in Cappadocia (*ca.* 6635-6475 cal BC) and the Caucasus Hunter-Gatherers (CHG) (Kılınç *et al.* 2016). These contacts could have enabled the dissemination of technical knowledge from this region to the Caucasus, particularly in the bone industry ('palettes' made from scapulae; Chataigner *et al.* – Neolithic bone tools – in this volume), but also in animal domestication.

It is precisely at that time, *ca.* 6500 cal BC, that another study (Skourtanioti *et al.* 2020) situates the admixture event that biologically connected north/central Anatolia and the South Caucasian lowlands. Indeed, genome sequencing of two Late Neolithic individuals from Azerbaijan (Mentesh Tepe in the Kura Basin, *ca.* 5770-5600 cal BC; Polutepe in the Mughan steppe near the Caspian Sea, *ca.* 5500-5380 cal BC) shows that mid-6th millennium populations from the South Caucasian lowlands were closely connected to those from north/central Anatolia (Büyükkaya, *ca.* 5625-5515 cal BC): they formed a genetic gradient (cline) that ran from western Anatolia to the South Caucasus and the Zagros. The Neolithic population of the South Caucasus, such as that of Büyükkaya in north/central Anatolia, shared more alleles with Caucasus Hunter-Gatherers (CHG) and Neolithic Iranians (Ganj Dareh in the Zagros mountains) than with the Neolithic Anatolian ancestry (Barcin in northwestern Turkey) (Skourtanioti *et al.* 2020: 1160).

This genetic proximity between the populations of the South Caucasus and north/central Anatolia may be related to the filling of the Black Sea by the waters of the Mediterranean in the second half of the 8th millennium (Marret *et al.* 2019). Populations that were established on the shores of the old lake may have moved inland, which may have encouraged contact and genetic mixing. Moreover, the emergence of a larger marine water body probably played a major role in modifying the nature, quantity, and rhythm of rainfall in the neighboring regions (Messager *et al.* 2017). In the Black Sea region as well as in southern Georgia (Lake Paravani, Nariani wetland), an abrupt increase in deciduous tree pollen is recorded for between 7000 and 6000 cal BC (Shumilovskikh *et al.* 2012; Messager *et al.* 2013; 2017).

Dating the formation of the west-to-east cline during the 7th millennium BC enables the contextualization of the genetic signals with the archaeological evidence of human mobility and changes (Skourtanioti *et al.* 2020). The time around 6500–6400 BC marks a significant point in the Anatolian Neolithic because there occurred a sudden and massive expansion of sedentary communities into areas (Lakes region, Aegean Anatolia) that had previously contained no or very few food-producing communities (Brami 2015; Düring 2013). It should also be noted that in the middle of the 7th millennium climate anomalies began that occurred over a span of 400–600 years; more sudden climate changes that occurred around 6200 cal BC (8.2 ka BP event) appear to have been superimposed on this long-term cooling (Van der Plicht *et al.* 2011; Rohling and Pälike 2005). Although it was not an abrupt change (the archaeological data of the second half of the 7th millennium in the northern Near East show no rupture in the occupation of sites), this worsening of the climate with colder winters would have been felt more severely in the mountainous areas (such as in the South Caucasus), where local groups may have faced difficult times (Düring 2013), which could have favoured a process of acculturation, especially for herding.

The Anatolian ancestry observed in the Neolithic genomes of the South Caucasus populations is also attested in the Chalcolithic and Bronze Age populations of this region, in Armenia (Lazaridis *et al.* 2016), most probably as a result of Late Neolithic admixture (Skourtanioti *et al.* 2020). According to Lazaridis *et al.* (2016: 424), this CHG/Anatolian mixed ancestry would make it possible to reject the hypothesis of the dispersal of a single farming population that displaced the hunter–gatherers and to suggest a spread of ideas and farming technology.

In conclusion, it appears that the Neolithic populations of the South Caucasus possessed a genetic component inherited from local Mesolithic groups, as well as a minor component from Anatolian farmers. Such a situation has also been observed in Western Europe for Neolithic farmers settled west of the Rhine river (in France, Spain, Great Britain), which implies a process of late and local admixture (Rivollat *et al.* 2020).

Thus, in the South Caucasus the abrupt appearance of a Neolithic lifestyle and the introduction of exogenous domesticated animal and plant species *ca.* 6000 cal BC suggests interaction with, and eventually intrusion of, Neolithic populations from the neighboring regions (Skourtanioti *et al.* 2020).

Relations between Aknashen and the Near East

The relations between Aknashen and the Near East can be presented in three ways: the introduction of the domestication of animals and plants, the use of certain techniques that originated in the Near East and the presence of artefacts or materials exotic for the Caucasus.

Domestication of animals

At Aknashen, from the earliest horizon (VII), animal husbandry is attested: sheep (*Ovis aries*) predominate, followed by cattle (*Bos taurus*) and goats (*Capra hircus*); the presence of pigs (*Sus domesticus*) in the earliest horizon is not certain, but they are attested in the following levels (horizons VI and V) (Bălăşescu and Radu in this volume).

Several authors have considered that the South Caucasus could have been a place of animal domestication, because the wild ancestors of all four primary meat-producing herbivores were present in the wild at the beginning of the Holocene: bezoar (*Capra aegagrus*), mouflon (*Ovis orientalis*), wild boar (*Sus scrofa*), and aurochs (*Bos primigenius*) (Munchaev 1975; Shnirelman 1989; Kushnareva 1997…). Other favourable elements for a local domestication were the varied ecological conditions, a certain population density, and the degree of development of empirical knowledge of animal and plant life that the hunter-gatherer groups possessed.

However, the fact that Neolithization took place over the entire territory of the Caucasus within a short period of time, and that so far none of the Caucasian sites show the transition from hunter-gathering to farming economies (Akashi *et al.* 2018), suggests that domestication emerged either through the acquisition of knowledge about animal husbandry along with domesticated animals, or through the settlement of populations that mastered animal husbandry.

Recent DNA studies of faunal remains from Neolithic sites in the Caucasus and surrounding regions provide insight into whether domesticated animals were transferred directly from a specific region (as was the case for Europe from western Anatolia), or whether the introduction of animal domestication has a more complex history.

*Goat (**Capra hircus**)*

For the goat (*Capra hircus*), six mitochondrial divergent DNA (mtDNA) haplogroups called A, B, C, D, F, and G were identified (Naderi *et al.* 2008).

In the South Caucasus, mitochondrial DNA (mtDNA) analyses were conducted on seven goats from Hacı Elamxanlı (5950-5800 cal BC) and Göytepe (5650-5450 cal BC) in the Kura river basin in Azerbaijan, as well as on five modern goats from this region. All were found to be grouped in the haplogroup A (Kadowaki *et al.* 2017).

Another analysis (Naderi *et al.* 2008) shows that modern domestic goats of the South Caucasus belong to the mtDNA haplogroup A, or rarely B, while these two haplogroups have not been found in modern wild goats (*Capra aegagrus*) in the same area, which instead belong to the haplogroup F or other minor lineages.

The same haplogroup F was found in a wild goat (Capra aegagrus) from the Palaeolithic cave of Hovk-1 in northeastern Armenia, dated to >47,000 BP (Daly *et al.* 2018).

Thus the South Caucasus bezoar (haplogroup F) does not appear to be the ancestor of the goats of this region. Goats belong to haplogroup A, which is widely distributed in the Near East: it is found in five 8th-millennium individuals from East Chia Sabz in the central Zagros (Mazdarani *et al.* 2014), and in ten late 6th-millennium individuals from Asagı Pınar in western Anatolia; three other individuals from this site are of haplogroup C (Scheu 2012).

The oldest examples of domestic goats actually come from several centres in southeastern Anatolia (Nevali Çori, Çayönü) and the central Zagros (Ganj Dareh), all dated to the late ninth – early eighth millennium BC (Arbuckle and Atici 2013). According to Daly *et al.* (2018), the existence of these two centres of domestication, as well as a third in the Levant, suggests the sharing of techniques rather than large-scale migrations of populations in the period of early domestication.

*Sheep (**Ovis aries**)*

Mitochondrial DNA sequence analyses have identified in sheep five maternal lineages (A, B, C, D, and E), implying multiple maternal origins and possibly independent domestication events (Tapio *et al.* 2006; Meadows *et al.* 2007; Singh *et al.* 2013).

MtDNA analyses were carried out on ten sheep from the Neolithic site of Arukhlo (*ca.* 5800-5500 cal BC) in the Kura basin of Georgia (Scheu *et al.* 2012; Geörg 2013; Benecke 2017). Morphologically, these sheep represent animals which were in a well-advanced stage of domestication, obviously having been under human control for a long period. The DNA studies show a high variability in mitochondrial haplotypes in sheep from Arukhlo, with six individuals possessing haplogroup A, three possessing haplogroup C, and one possessing haplogroup D (Scheu *et al.* 2012: 51; Benecke 2017: fig. 4). This last lineage (D), which is very rare, may represent late genetic introgressions from wild ancestors, rather than an independent domestication event (Lv *et al.* 2015: 2525-2526).

Archaeological evidence indicates that sheep management was already practiced by 9000-8000 cal BC in an area ranging from central Turkey (Aşıklı Höyük) to southeastern Anatolia (Çayönü, Nevalı Çori) (Arbuckle *et al.* 2014). A mtDNA analysis of 8th-6th millennium sheep from western and central Anatolia indicates that haplogroup B largely predominates (>90%), particularly at Boncuklu and Tepecik-Çiftlik. Beginning in 7000 cal BC, the haplogroups C and D are added, which may herald the modest-scale introduction of domestic sheep lineages from elsewhere, possibly from another region east of the Fertile Crescent that may have harboured independent domestication events (possibly southeast Anatolia ?), or through ongoing introgression from wild sheep (Yurtman *et al.* 2021).

Beginning in 7000 cal BC, the domestication of sheep is also attested in the Zagros (Tepe Guran, Sarab and Jarmo), but it appears that the animals introduced there were in an already domestic state (Zeder 2008).

Today, Lineage A is widespread in the South Caucasus and the region around Lake Van, as well as in Eastern Europe (north of the Black Sea, the Urals) and Central Asia (Tapio *et al.* 2006; Meadow *et al.* 2007). Lineage C, which was also identified at Arukhlo, is present in the steppes and semi-deserts around the Caspian Sea, the Caucasus, Iran and Central Asia (Tapio *et al.* 2006).

*Cattle (**Bos taurus**)*

Although the earliest signs of the domestication of wild aurochs are observed in the upper Euphrates basin (Dja'de) and the upper Tigris basin (Çayönü) as early as the 9th millennium, their appearance in other parts of SW Asia is chronologically heterogeneous (Bollongino *et al.* 2012; Arbuckle *et al.* 2016). They appeared with the first Neolithic settlements in SW Turkey in the first half of the seventh millennium and spread into NW Turkey a few centuries later, as well as onto the central Anatolian plateau. However, they appeared suddenly in Iraq and Iran without any transitional forms in the early-to-mid sixth millennium BC (Arbuckle *et al.* 2016).

For the South Caucasus, mtDNA analyses conducted on five Arukhlo individuals (5800-5500 cal BC) show the presence of the haplogroups T2 and T3 (Scheu 2012: 107 and Tab. 7.18; Benecke 2017: 360).

In central Anatolia, a *Bos taurus* from Çatal Höyük, dated to the 7th millennium, presents the haplogroup T/Q (Bollongino *et al.* 2006); other western Anatolian domestic cattle from Uluçak (*ca.* 6400-5700 cal BC) and Asağı Pınar (*ca.* 5300-5000 cal BC) present haplogroup T3 and, more rarely, haplogroup Q; haplogroup T3 then spread widely in Europe (Scheu *et al.* 2015).

In Iran, Neolithic samples of *Bos* (status undetermined) from the southern Zagros at Qaleh Rostam (sample dated to *ca.* 6450 cal BC) and Jari (*ca.* 5930 cal BC), as well as from the northeast of the country at Sang-e Chakhmaq (*ca.* 5990 cal BC), present haplogroups T and T/T1; however for the latter site, among the individuals dated to 5670-5360 cal BC and considered possibly domestic, haplogroups T2 and T3 were also found (Bollongino *et al.* 2012: tab. S1).

This genetic diversity points to the existence of several domestication centres in the Near East. The haplogroup T3 probably originated in Anatolia, but the haplogroup T2 appears to be attested in the first half of the 6th millennium only in the Caucasus and Iran; it appeared in the SE of Europe (Bulgaria) towards the end of the 6th millennium (Scheu *et al.* 2015 tab. s4). This haplogroup is present in the modern races of Anatolia and the Near East (Troy *et al.* 2001), and is particularly frequent (>34%) in Asian countries (Mongolia...) (Mannen *et al.* 2004). Lineages T1 and T3 illustrate unimodal mismatch distribution, while T2 presents a multimodal distribution, which would be explained by high variation and divergent sublineages within the T2 haplogroup (Mannen *et al.* 2004).

*Pigs (**Sus domesticus**)*

Domestic pigs first appeared in the late 9th millennium cal. BC in the Upper Tigris basin (Çayönü) and in the early 7th millennium along the Zagros flanks (Jarmo) (Price and Arbuckle 2013; Price and Evin 2017); however they are identified only for the very beginning of the 6th millennium in northwest Iran (Hajji Firuz) (Price and Arbuckle 2013).

At the same time they are attested in the South Caucasus, at Aknashen where they are rare (<1%) and at Arukhlo where they represent about 13% of the livestock (Benecke 2017). Although there is a size overlap between the wild and domestic stocks of pig, the morphological characteristics observed on the bones of the pigs from Arukhlo are indicative of a quite advanced stage of domestication.

Several haplogroups were revealed for the pigs: Y1, Y2, ArmT, EU (Frantz *et al.* 2019). MtDNA analyses were carried out on a wild boar from Aknashen (former name 'Khatunarkh'; excavations by Torosyan) and on seven domestic pigs from Arukhlo (Frantz *et al.* 2019). All possess haplogroup ArmT.

For the end of the Epipaleolithic in the upper Tigris basin, at Hallan Cemi, the haplogroup ArmT is attested in a wild boar, but another boar presents the haplogroup Y1 and an animal of undetermined status the haplogroup Y2 (Frantz *et al.* 2019). The haplogroup ArmT is the only one present at Çayönü in the 7th millennium (*ca.* 6800-6500 cal BC) (Ottoni *et al.* 2013). ArmT has a wide distribution and is dominant in southeastern Anatolia, Armenia, Georgia, Iran and Syria, whereas Y1 is significantly more frequent in western Anatolia (Ottoni *et al.* 2013). In Crimea, the haplogroup Y2 was dominant during the Mesolithic and Neolithic (9th-6th millennia) in ancient wild boars (Frantz *et al.* 2019).

An*imal domestication: conclusion*

Genetic data for the first domesticated animals in the South Caucasus are incomplete (there are no direct data from Aknashen, with the exception of a wild boar from old excavations), as are those from domestication centres in the Near East.

However, we note that the history of domestic animals at Neolithic sites of the South Caucasus is complex. The mtDNA analyses carried out on animals from Hacı Elamxanlı, Göytepe and Arukhlo, three sites of the *AShSh* culture, show that the sheep and cattle present high genetic variability, evidence for their origin in different domestication centres, or for a phenomenon of introgression due to crossbreeding with wild animals.

Secondly, it appears that in the Upper Tigris region (Çayönü), neighboring the South Caucasus, the four species were domesticated between the end of the 9th and the beginning of the 8th millennium. Unfortunately we do not know the genetic signature of the animals domesticated at Çayönü, with the exception of a 7th millennium pig, which possesses the haplogroup ArmT, like the pigs at Arukhlo. It is therefore possible that this region of Ergani-Maden, where Çayönü is located and with which other clear contacts with the Ararat valley have been attested (malachite; see Badalyan *et al.*, Miscellaneous objects, in this volume), was one of the centres from which domestic animals were imported.

The hypothesis of an importation of domestic animals and their breeding by the populations of the South Caucasus, in environments where the wild progenitors of these same species were present, is supported archaeologically by the study of the Bavra-Ablari rock shelter, located in southern Georgia at an altitude of 1700m above sea level. The human groups who occupied intermittently this shelter, between 6200 and 5800 cal BC had preserved Mesolithic traditions (tools essentially of microlithic type, no pottery, no domestication of cereals) but practiced sheep and goat herding (Varoutsikos *et al.* 2018; Chahoud 2020). The acculturation of local populations thus appears to have played a significant role in the spread of agro-pastoralism in the Caucasus, as has been recently pointed out for the Neolithization of Europe (Lemmen *et al.* 2011; Rivollat *et al.* 2020).

Cultivation of plants

The plant remains from Aknashen show that the agriculture was based on a wide spectrum of domestic crops, cereals and pulses. The absence of wild relatives of cultivated cereals and pulses at *AShSh* sites clearly implies that these plants were imported from the neighboring regions of the northern Near East, where they had been cultivated for at least two millennia.

At Aknashen, emmer and naked wheat are attested from horizon VII to horizon II without one clearly prevailing over the other (Hovsepyan in this volume). In northern Mesopotamia in the 7th-6th millennia, emmer was abundantly cultivated and naked wheat was rarer, whether in Sabi Abyad in Syria, Domuztepe in south-eastern Anatolia or Çatal Höyük in central Anatolia (Van Zeist and Waterbolk 1996:522; Kansa *et al.* 2009; Bilgic *et al.* 2016).

Naked hexaploid wheat (*Triticum aestivum,* genomes AABBDD) originated by spontaneous hybridization of the hulled tetraploid emmer (*Triticum turgidum,* genomes AABB) with *Aegilops tauschii* (genomes DD). The species *Aegilops tauschii* is widely distributed, however genetic studies have identified two evolutionary lineages and sublineages, which are geographically isolated. One population (sublineage 2E), located in the region southwest and south of the Caspian Sea, appears genetically to be the main source (ca. 99%) of the wheat D genome (Wang *et al.* 2013; Dvorak *et al.* 1998). The clear preponderance of free-threshing wheat on Neolithic sites of the eastern part of the *AShSh* culture (Kültepe I of Nakhichevan level 2; Göytepe in the Kura basin) (Marro *et al.* 2019: 107; Akashi and Tanno 2020: 328) supports the hypothesis of an origin in the SW region of the Caspian Sea, which could have led to its rapid spread throughout the South Caucasus.

Techniques

In addition to architecture (see above 'Topography and architecture'), three techniques are generally considered to have originated in the Near East, pressure flaking with a lever, knapping of transverse arrowheads and use of grooved stones with transverse grooves.

Pressure flaking with a lever

The emergence of the use of the pressure knapping technique during the Early Holocene in Central Asia and the Caucasus was associated with the appearance of microblade technology and, to some extent, bladelet production (Brunet 2012). This technique was known in the South Caucasus and the northern Caucasus in Mesolithic contexts, in Armenia, at Kmlo-2 and at Lernagog (Chataigner *et al.* 2014a; Arimura *et al.* 2018), in Azerbaijan at Damjili unit 5 (Nishiaki *et al.* 2019b), in Georgia at Bavra-Ablari level 4 (Varoutsikos *et al.* 2018), in the northwest Caucasus at Mezmaiskaya (Nedomolkin 2020a) as well as northeast of the Azov Sea (Gorelik *et al.* 2016).

However, pressure flaking with a lever only appeared at the beginning of the 6th millennium at Aknashen as on the other sites of the *AShSh* culture (Chabot *et al.* in this volume). This knapping method, which requires a high level of technical knowledge and enables the production of wide and long blades, was practiced around 7500-7300 cal BC at Çayönü in the upper Tigris valley (Altınbilek-Algül *et al.* 2012), then around 6800-6700 cal BC at Sabi Abyad I in upper Mesopotamia (Astruc and Russell 2013). However, for both Çayönü Tepesi and Sabi Abyad, no evidence of the *in situ* production of large blades has been identified; instead, these blades appear to have been introduced to the settlements as finished products (Astruc and Russell 2013: 340). We could consider that a few specialists having easy access to obsidian and/or working seasonally on the outcrops could each produce several hundred large blades per year. One or a few little groups of such knappers could thus have been at the origin of direct or indirect diffusion on a large geographical scale.

At Aknashen, pressure knapping with a lever is attested beginning with horizon VII, and given the large number of blades involved, it seems likely that knapping would have taken place on site (Chabot *et al.* in this volume). In this hypothesis, given the complexity of the technique, three modes of transmission could be envisaged (Brunet 2012: 318): (a) the diffusion of preformed cores, implying contact between an expert and apprentice knappers; (b) the transmission of this specific knowledge by itinerant experienced knappers; or (c) the technique was carried out *in situ* by foreign experienced knappers.

Trapezes (transverse arrowheads)

The microliths in the form of short trapezoids, which widen to a cutting edge and were hafted onto an arrow shaft at their narrowest point, probably served as transverse arrowheads. Such artefacts are numerous at Aknashen, from the deepest horizon (VII) to the upper level (I), while other geometric microliths (segments, isosceles triangles) are very rare.

Among these trapezes in the VII-IV horizons, several present a notch on the small base and thus belong to the category of 'horned trapezes'. These are totally unknown in the Near East, whereas they are widespread in the Epipaleolithic and Mesolithic cultures of the northern Caucasus; they will therefore be studied below under the Mesolithic loans.

As for the short trapezes with a small rectilinear base, oblique sides and a fine abrupt retouch, these are attested in the Pottery Neolithic of the Near East from the middle of the seventh millennium to the early sixth millennium BC, i.e. from the Zagros (Jarmo with pottery, J-II,1-3) (Braidwood *et al.* 1983:239 and fig.112) to northern Mesopotamia (Sabi Abyad, levels 5-4) (Copeland 1996:292 and fig.4.17).

Short trapezes, similar to those of Aknashen, are also known at many Mesolithic sites in the northern Caucasus, from the Black Sea to the Caspian Sea, and will be described under the possible Mesolithic loans.

Grooved stones with transverse grooves

Very distinctive grooved stones were present in the Near East from the 11th millennium cal BC onward, and two regional variants can be distinguished: in the Levant and western Mesopotamia, the groove generally follows the longitudinal line of the tool, whereas in northeastern Mesopotamia and the Zagros (Zawi Chemi, Karim Shahir, Jarmo, etc.), the groove more often follows the transverse line (Solecki 1981; Howe 1983; Moholy-Nagy 1983). The grooved stones of Aknashen (Figure 7) find extremely rare comparisons throughout the whole South Caucasus, and belong to this latter variant (Arimura *et al.* 2010), suggesting direct import or filiation from these regions.

Artefacts

The artefacts and exotic materials found on the Aknashen site are pottery sherds and various miscellaneous objects: a stamp-seal, copper ore (malachite), a copper bead, shells (*Conus* and *Spondylus*), a diamond-shaped chalcedony bead, clay cones...

Imported pottery

At Aknashen a small amount of painted (25 ex.) and monochrome (30 ex.) pottery sherds of high quality was found; these were obviously imported, which is confirmed by the clay analyses (Harutyunyan in this volume). This imported pottery is the only pottery represented in horizons VII, VI, and V lower stratum, and remains present up to horizon III.

In horizons VII-V, the painted pottery is of the Samarra type, while in horizons IV-III it is of the Halaf type (Harutyunyan in this volume). Among the monochrome pottery sherds, we note two sherds of vessels with a biconical body that could be related to productions (Grey Black ware and Dark Faced Burnished ware) attested in the upper basins of the Euphrates and Tigris rivers at the end of the 7th millennium (6200-6000 cal BC) (Harutyunyan in this volume).

Miscellaneous objects

A few exotic objects are other evidence of the implication of Aknashen in a network of long-distance exchange (see Badalyan *et al.* – Miscellaneous objects – in this volume).

These objects of ornament or prestige (copper bead, chalcedony bead, clay cones...) were widespread in the northern part of the Fertile Crescent between the

9th and 6th millennia. However, some of them have a more precise origin: two samples of malachite from horizon IV come from the Upper Tigris region (Ergani-Maden); shells (*Conus, Spondylus*) probably came from the Mediterranean Sea; a stamp-seal has very close parallels on two sites (Domuztepe and Amuq-Judaideh) (Campbell *et al.* 1999: fig. 14.5; Braidwood and Braidwood 1960: fig. 66), pointing to a network of exchange leading towards the Mediterranean Sea.

Possible loans from the Mesolithic

Genetic analyses have shown that the Mesolithic hunters-gatherers, who occupied the Caucasus between the 10th and 7th millennia, were not 'replaced' at the beginning of the 6th millennium by Near Eastern populations but were assimilated within the new Neolithic populations, in a process of acculturation.

At Aknashen, elements of the way of life of the Mesolithic populations of the South Caucasus can be found in the circular plan of the architecture, in the 'horned trapezes' (a particular type of transverse arrowhead), in the use of large round scrapers and in the absence of evidence for pottery-making in the oldest horizons of the site.

Circular-plan architecture

At Lernagog (7000-6600 cal BC), the lower levels, located under the collapse layer, are the richest in material and show evidence of an installation on a flat location beside the river (Arimura *et al.* 2018). A circular earthen construction (str.1) is present in these levels; the walls are 30 to 40 cm wide and include a series of joint lines formed from visible bonding clay clumps.

This discovery would indicate that the Mesolithic populations living at the beginning of the 7th millennium in the foothills of the Aragats, within the confines of the Ararat valley, were already familiar with circular architecture. The lithic assemblage of this site ('Kmlo tools' in particular) is very different from Aknashen and other *AShSh* sites; nevertheless, it appears that the local population built circular earthen buildings before the Neolithic sites developed.

Horned trapezes

Among the trapezoids of Aknashen (Figure 3: 1-15), most have a small straight base that is untouched, but in the lower horizons (VII-IV), some have a notch on the small base, which gives the microlith the appearance of a 'horned trapeze', similar to those common at sites on the northern slope of the Caucasus dated to the end of the Epipaleolithic and the Mesolithic period.

Indeed, such 'horned trapezes' were found, together with straight-based trapezes, on the northwestern slope of the Great Caucasus (Figure 3: 18-23) at Chygaï rockshelter, layer 9 (*ca.* 13,500 cal BC) (Leonova 2009: 97-98 and fig. 4), Satanai rockshelter, horizon 3 (*ca.* 11,250-10,900 cal BC) (Golovanova and Doronichev 2020: 230 and fig. 3-15), Mezmaiskaya cave, top of layer 1-3 (*ca.* 10,500-10,000 cal BC) (Golovanova and Doronichev 2020: fig. 3-2) and Dvoinaya cave, layers 4 and 5 (*ca.* 9300-8200 cal BC) (Golovanova and Doronichev 2020: 235 and fig. 3-21: 1-7,12-13).

In neighboring Crimea, the early 'blade-and-trapeze technology' with short trapezes and 'horned trapezes' appeared in the second half of the 8th millennium (Myrna; *ca.* 7590-7090 cal BC) (Biagi 2016: fig. 3: 1-10) and spread through the peninsula during the 7th millennium (Shan-Koba layer 3; *ca.* 6800-6580 cal BC) (Biagi 2016: tab. 1 and fig. 3: 11-21) (Figure 3: 16-17).

Some 'horned trapezes' have also been found on sites on the Black Sea coast in addition to trapezoids with straight bases (Apiancha; Gabunia *et al.* 2015: 377). In this region, transverse arrowheads were present in the 'Early Neolithic' (Anaseuli 1) and became more frequent in the Late Neolithic along with pottery (Anaseuli 2) (Korobkova 1996: 60). Unfortunately the absence of published 14C dates means that the absolute chronology of these sites is unknown.

Northeast of the Great Caucasus at Chokh, in level D (Late Mesolithic), short trapezes (Amirkhanov 1987: fig. 22: 1-2) and 'horned trapezes' are attested (Amirkhanov 1987: fig. 17: 1; Kozlowski 1996: fig. 3) (Figure 3: 24-26).

'Horned trapezes' were also widespread in the Kel'teminar culture in Central Asia (Derevyanko and Dorj 1992: fig. 3) as early as the Early Neolithic (*ca.* 6500-5500 cal BC) (Brunet 2005: 90-93; Brunet 2012: fig. 12: 5), as well as on the edge of the Caspian Sea in the Lower Volga region in the second half of the 6th millennium (Prikaspiiskaya culture; *ca.* 5500-4800 cal BC) (Vybornov 2016: 164-165 and fig. 4).

The notch on the small base of the trapezoid may have been made to facilitate the fitting of the microlith. But, according to Brunet (2012: 320-321), the 'horned trapezes' may have had a value not only functional but also symbolic, as a way to define social identity.

Large round scrapers

Large round scrapers (Figure 2), found at Aknashen and at the sites of the *AShSh* culture, mainly in the lower levels (Hacı Elamxanlı, Shulaveri lower levels...) (see Varoutsikos and Petrosyan in this volume), have parallels at the Mesolithic sites of the South Caucasus in the 7th millennium (Damjili unit 5) (Nishiaki *et al.* 2019b).

Pottery

Two different hypotheses have been put forward to explain the absence of pottery in the oldest levels of Aknashen and other sites of the *AShSh* culture (Hacı Elamxanlı, Masis Blur, Shulaveri…).

The first hypothesis considers it to be a matter of '*cultural and social choices*': the inhabitants of Masis Blur accepted some components of the Neolithic 'package', but rejected the idea of pottery production and use (Iserlis 2017/2020: 40). However, this explanation appears surprising, because if the people who created the village of Masis Blur possessed the 'Neolithic package' including pottery, it is difficult to understand how they could suddenly do without it, presumably an indispensable element in the preparation of food. On the other hand, if most of the inhabitants of Masis Blur were of local, Mesolithic origin, and had other techniques for the preparation and preservation of food (wooden containers, skins…), it may have been unnecessary for them to adopt pottery.

This second hypothesis the persistence of a Mesolithic way of life, was put forward by other researchers: '*The almost aceramic nature may suggest the persistence of a local Mesolithic tradition in the earliest stage of the Shomutepe-Shulaveri culture*' (Akashi *et al.* 2018: 78). '*Given that pottery making flourished among the contemporaneous Neolithic societies of Southwest Asia (e.g., Halaf and Haji Firuz), a continuity scenario of the local Mesolithic way of life appears more likely*' (Nishiaki *et al.* 2019b: 13).

Conclusion and summary

In this concluding chapter, we have discussed two important elements for understanding the Late Neolithic culture represented on the site of Aknashen: the validity of the *AShSh* culture and the Neolithization of the South Caucasus.

The examples taken from the material culture and the economic activities clearly show the great similarities that existed in the 6th millennium between the sites of the Kura basin (plain of Marneuli, regions of Kazakh and Tovuz, steppe of Karabagh) and those of the Araxes basin (Ararat valley, Nakhichevan beginning at 5800 cal BC). The existing differences concern the secondary parameters (building materials, pottery decoration…), both within each region and between regions.

This *AShSh* culture thus occupied the central part of the South Caucasus in the 6th millennium and differed from the cultures that developed at that time in the west, on the coast of the Black Sea (Anasueli I and II) (Nebieridze 1972; 1986; Meshveliani 2013), in the east, on the steppes of Mil and Mugan (Kamiltepe…) (Helwing and Aliyev 2012; Helwing *et al.* 2017) and along the Caspian Sea (Qobustan) (Farajova 2011; 2018).

The problem that arises then is that of the Neolithization of the Ararat valley and the South Caucasus in general.

Two opposing scenarios can be proposed. One is that in the northern Near East a balance was disturbed for one reason or another, triggering an exodus of farmers to adjacent regions (Düring 2013). The alternative model would be that predominantly local groups in the South Caucasus took up farming around 6000 cal BC. But neither of these models corresponds to the archaeological evidence: on the one hand, no culture from which the Neolithic could have developed in the South Caucasus is known in the Near East; on the other hand, Neolithization took place over the entire territory of the Caucasus within a short period of time and none of the Caucasian sites show a transition from a hunter-gathering to a farming economy.

However, the genetic analyses show that the Neolithic populations of the South Caucasus were largely of local ancestry (Caucasus hunter-gatherers) with a secondary admixture of early Anatolian farmers. The domesticated animals (sheep, goats, cattle, pigs) possessed high genetic variability, evidence for a complex history rather than a direct importation from a centre of domestication. Parallels in the material culture between the *AShSh* and the Near East point to the region of the 'upper valleys', that of the upper Tigris for the Ararat valley (imported painted pottery, malachite…) and that of the upper Euphrates for the Shulaveri group (pottery with relief decoration, including anthropomorphic representations…) (Özdoğan 2018). Given the presence of a large palaeolake in the middle valley of the Araxes, the pathways could have been situated more to the west, passing through the region of Sarıkamış, which remained a favoured source of obsidian for the first populations inhabiting the eastern part of the Kura basin.

The pattern of Neolithization in the South Caucasus which emerges could thus be a combination of local hunter-gatherer groups that adopted farming and a small-scale migration of groups from southeastern Anatolia, the migrants contributing farming expertise and the hunter-gatherers knowledge of the local environment and its resources.

Such a dual ancestry of Neolithic societies in the South Caucasus, attested by the DNA studies, could explain the continuities that existed with the earlier Mesolithic (especially the absence of pottery in the earliest levels), the cultural specificities that characterize the different Neolithic groups of the *AShSh* culture, but also the innovative agriculture and land use (McGovern *et al.* 2017; Ollivier *et al.* 2018) that were practiced in these Neolithic societies. A similar development has been suggested for the Neolithization of western Anatolia in the middle of the 7th millennium from the centre-south of Anatolia (Düring 2013), as well that of Greece from western Anatolia (Reingruber 2017).

This Neolithic expansion, involving the adoption of new farming techniques by groups that consisted of both migrant farmers and local hunter-gatherers, was a creative episode, leading simultaneously to the development of a lithic industry adapted to the new demands of the agricultural economy (Chabot *et al.* in this volume) and to that of a new 'culture' in a more general sense (*AShSh*) that consisted of distinctive settlement forms and material culture (Düring 2013).

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