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Diachronic variability in obsidian procurement patterns and the role of the cave-sheepfold of Getahovit-2 (NE Armenia) during the Chalcolithic period

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1. Introduction

In the South Caucasus, agriculture and herding appeared at the very beginning of the 6th millennium in the basins of the Arax and the Kura, with the populations of the late Neolithic ‘Aratashen-Shulaveri-Shomutepe’ culture (Hovsepyan and Willcox, 2008; Chataigner et al., 2014a; Sagona, 2018). This phenomenon of rapid neolithisation (within a century or less, according to the radiocarbon dates at Damjili Cave in north-eastern Azerbaijan) apparently involved both continuity and replacement between the local Mesolithic and the incoming Neolithic socio-economies (Nishiaki et al., 2019a).

The Late Neolithic culture developed broadly between 6000 and 5200 cal BC, then most of the settlements were abandoned, whereas new sites appeared in various geographic environments, from the plains to the mountains; these sites date to the Chalcolithic period, which covers the 5th millennium and the first half of the 4th millennium BC. The abandonment of most of the Neolithic villages and the changes that occurred during the Chalcolithic period in the different domains of material culture have been interpreted as an evolution of the populations towards more mobility, from permanent villages to seasonal camps and across a greater range of environmental zones, including those at higher altitudes (Sagona, 2018: 183).

The cave site of Getahovit-2, discovered in north-eastern Armenia in the foothills of the Lesser Caucasus, is original in two ways: it is the first known Chalcolithic occupation in the region of Tavush and is the first example of a cave-sheepfold in the South Caucasus of the 6th-4th millennia. Moreover, most of the tools are obsidian, although there is no nearby deposit of this volcanic glass, the closest outcrops being several days distant by foot.

The cross-studies of the provenance of the obsidian and the vestiges found in the cave provide indications concerning the mobility of the human groups who inhabited Getahovit during the Chalcolithic, the seasonality of the occupations as well as the cultural definition of these groups. The combination of the indications enables the establishment of hypotheses concerning the inter-regional network into which the inhabitants of Getahovit were integrated.

We will thus present the contexts of the occupation of the cave of Getahovit-2, then the obsidian industry. The analyses of provenance pose a certain number of questions; we will seek answers from examination of vestiges found in the deposits (fauna, flora, artifacts other than those in obsidian). Finally, based on ethnographic data, we will discuss the role of the cave of Getahovit-2 and the mobility of the human groups who occupied it in the 5th millennium BC.

Fig.1. Map showing locations of the principal sites mentioned in the text and the obsidian deposits exploited by the inhabitants of the cave of Getahovit-2.

2. Contexts

2.1. Environmental context

The mountainous province of Tavush, in north-eastern Armenia, overlooks the Azerbaijani part of the middle valley of the Kura (Fig. 1). It is a region of limestone massifs of average altitude (the highest summits rise to between 2500 and 3000 m) that contain numerous karstic cavities that could serve as shelters. The rivers that cross it (Aghstev, Hakhum, Tavush, Khndzorut) have in all periods served as ways of circulating between the valley of the Kura and the highlands of the Lesser Caucasus.

Getahovit is located in the middle valley of the Aghstev, where, at the present time, the climate is humid temperate with hot summers and mild winters; snow does not occur every year (Vardanyan, 2016). The average temperatures are close to +1° in January and +24° in July; the average annual precipitation is 430 mm, spread through the year with a peak in May-June. Dense forests of hornbeam (*Carpinus betulus*), beech (*Fagus orientalis*) and oak (*Quercus iberica*), cover the slopes. Vast pasture zones extend above the forests; cereal cultivation, market gardens and fruit production are well developed in the lowlands.

It is thus a region suitable for human occupation, but it is very poorly known archaeologically, because the forest cover inhibits the discovery of vestiges.

In 2010, a survey carried out by the Armenian-French mission 'Caucasus' enabled the discovery, northwest of Ijevan near the village of Getahovit, of two caves located on the same terrace (altitude 960 m) above the Khachakhpyur river, a tributary of the Aghstev. In this place, the river spreads in a meander which can be easily forded. It is possible to access the caves from the plateau that dominates the valley or from the valley itself, by following a steep path. The access to these caves is not easy and thus provides the place with natural protection. The caves face southward and their situation enables wide visibility over the valley (Fig.2).

Fig.2. View from the cave of Getahovit-2 over the meanders of the Khachakhpyur and the valley of the Aghstev in the background.

The cave of Getahovit-2 (N 40°54'38.5", E 045°05'59.7") opens with a porch measuring about 11 m in width and contains two spaces (Fig. 3); the first, about 6 m deep, is linked by a passage in the NW angle of the cave to the second, which is circular in shape and smaller. This second space has not been excavated yet. In front of the entrance of the cave, a terrace covering a surface of about 60 m² overlooks the valley. Collapsed blocks indicate that this forecourt area was partially covered.

Fig.3. The cave of Getahovit-2: a) Section W-E, squares A7 to J7; b) Section N-S, squares B1 to B7; c) Plan of the first space of the cave.

2.2. Stratigraphic context

The excavations carried out from 2011 to 2017 revealed at Getahovit-2 a cultural layer of more than 3 m in thickness comprising 3 phases of occupation (Upper Palaeolithic, Chalcolithic and medieval) separated by sterile strata (Tab. 1). In 2018, the excavations continued under I. Kalantaryan; except for the provenance of the obsidian tools discovered in that year, the data from 2018 will be published in another article.

Tab.1. C14 dates for Getahovit.

Level VII (Upper Palaeolithic)

The deepest level, reached in a deep sounding excavated in 2014 (Fig. 3 and Fig. 4), is an occupation of the Upper Palaeolithic (level VII). Situated in the northern part of the cave, it appeared at a depth of about 3.2 m and lies directly on the bedrock, which in this place has a strong slope. However, the virgin soil has not yet been reached on the terrace side, where other earlier levels probably remain to be discovered.

In the Upper Palaeolithic level (Beta-393561: 19770 ± 70 BP or 22020-21685 cal BC), faunal remains, charcoal and a lithic industry in obsidian were found. The obsidian artifacts present a microlithic bladelet technique, of which all the phases of production are present in the gathered corpus (Alhussain et al., 2014).

Level VI (sterile layer)

The Upper Palaeolithic occupation lies under a thick sterile layer of about 50 cm, with very compact and stony deposits, characteristic of a period of gelifraction (Fig. 4). This in all likelihood corresponds to the cold phases of the end of the Pleistocene, from the Late Glacial Maximum to the Younger Dryas.

Level V (sterile layer)

Level V, having a thickness equivalent to that of level VI (Fig.4), consists of a very compact clayey sediment characteristic of deposits that have accumulated under a warmer, more humid climate. This would have been the phase of warming that marked the beginning of the Holocene. This layer presents, as the preceding ones, a strong slope from the back of the cave towards the terrace.

Fig.4. Stratigraphy of the cave based on the excavation carried out in 2014.

Levels IV and III (Chalcolithic)

The Chalcolithic occupation is represented by two levels (IV and III). Level IV, reached only in the deep sounding, dates to the early Chalcolithic (LTL-14987A: 6174 ± 45 BP, that is 5289-4995 cal BC with a calibrated median value of 5127 cal BC), whereas most of the layers excavated in extension belong to level III and date to the middle-late Chalcolithic (between 4624 and 4171 cal BC, for the calibrated median values of the dates) (Tab. 1). These levels IV and III consist of superimposed deposits of the sheepfold, containing plant and animal remains as well as artifacts. The lower stratum of level IV (US 14A), which again presents a strong slope, was clearly covered with sediments, in order to render the interior surface of the cave more horizontal.

Level II (almost sterile layer)

The Chalcolithic occupation is sealed by a fill of generally sterile light-coloured clay, which covers the cave area to a depth of twenty centimetres (the altitude and thickness of this fill depend upon the location of the excavation squares and the slope of the archaeological layers) (Abbès and Kalantaryan, 2015).

This clayey layer is itself covered by a dark brown horizon, which is present over almost all the interior space of the cave. This dark horizon suggests by its aspect a decomposition that was natural or artificial (caused by fire) of residues of plant (dead leaves) or animal (coprolites) origin.

Level I (medieval)

The medieval occupation (level I) consists of more than a meter of stratigraphy in which pits, hearths, ovens and silos succeed each other in three stratigraphic units. This medieval occupation was attested in the cave and on the terrace; several tombs were discovered (Kalantaryan et al., 2012). The radiocarbon dating indicates an occupation of the early Middle Ages (between 987 and 1102 cal AD, for the calibrated median values of the dates) (Tab. 1).

The dark brown horizon of the top of level II probably corresponds to a cleansing of the cave by fire, before the first medieval occupation. But in the Chalcolithic levels, similar horizons are interposed with partly burned or unburned layers and form sequences that are well known in Mediterranean archaeology as accumulations of animal dung periodically destroyed by fire (Brochier et al., 1992).

2.3. Context of the occupation of the cave in the Chalcolithic

The Chalcolithic levels appear as a succession of fine black beds (between 1 and 3 cm) on which there always lies a grayish or whitish sediment that is very compact with a thickness that is sometimes considerable (between 2 and 10 cm); in certain cases, above this whitish sediment, there is a light brown layer of variable thickness (Fig. 4).

This cycle of alternating blackish, light grey/whitish and brownish clayey silty layers is indicative of the use of the cave as a sheepfold with periodic cleansing by fire (Brochier et al., 1992; Angelucci et al., 2009; Polo-Diaz et al., 2016):

- the black bed (grading to reddish brown downward) corresponds to the base of the episode of combustion of the animal dung
- the grey or white layers represent a level of mineralised ashes resulting from this combustion
- the light brown layers correspond to an accumulation of unburned dung, with variable quantities of recognizable plant matter, rich in spherulites, phytoliths, and detrital mineral particles.

According to Brochier et al. (1992), sometimes only blackish and greyish/whitish layers are present; this means that the layer of accumulated dung was relatively thin and burned through, leaving only the mineral residue. If the layer of dung is thick or its lower part is too humid, combustion stops at the black bed and the dung below (brownish layer) will lose its organic content through slow natural processes.

Intentional burning of pen residues was implemented to reduce the volume of waste material, control animal parasites and prepare the site for a new stabling episode (Polo-Diaz et al., 2014). The phases of combustion may be one approach to assessing the rhythm of occupation (Polo-Diaz et al., 2014). For a layer of dung to burn, it is necessary that the upper centimeters be thoroughly dry, and this requires a relatively long period after deposition. In Sicily, ethnographic records indicate that manure was burned at the end of the summer, long after the herd had departed and before its return (Brochier et al., 1992).

If the dozen burning episodes discernable in level III at Getahovit are compared to the chronological span represented by these deposits (about 400 years; Tab. 1), it would appear that the burning of residues was a recurrent activity, but carried out on a sporadic basis; this implies that either the use of the cave as a herding facility was discontinuous or that the combustion of waste occurred only when it was considered necessary for cleaning purposes (Polo-Diaz et al., 2014). It is likely that there were periods when the cave was not used, between abandonment and later reuse.

The sequence of the sheepfold layers of level III at Getahovit-2 thus suggests that the cave was used sporadically in the middle of and during the second half of the 5th millennium. The only structures brought to light in level III of Getahovit-2 are pits, stone-circled hearths and combustion areas; in addition, there are two spreadings of pottery sherds near the walls of the cave which remain to be interpreted.

2.4. Context of the South Caucasus in the Chalcolithic

The Chalcolithic period in the South Caucasus extends from the end of the 6th to the middle of the 4th millennium BC and corresponds to the Late Atlantic climatic phase, which is characterised by a climate that is generally warmer and more humid than today. Pollen analyses carried out in southern Georgia (Messenger et al., 2013) and in Armenia (Joannin et al., 2014; Leroyer et al., 2016) suggest that this period was characterised by a larger extent of forests and by a tree limit at a higher altitude than today.

In this period, which followed the late Neolithic (Aratashen-Shulaveri-Shomutepe culture), two distinct cultural entities characterised by their pottery production, 'Chaff-Faced Ware' and 'Sioni Ware', appeared (Sagona, 2018).

The first tradition (Chaff-Faced) originated in Mesopotamia and is characterised by rectangular habitations, jar inhumations, pottery that is mainly plant-tempered, and a substantial metallurgy. It is in particular represented by Leilatepe (Narimanov et al., 2007) and Büyük Kesik in Azerbaijan (Museybli and Huseynov, 2008), as well as Berikldeebi in Georgia (Dzhavakhishvili, 1998; Sagona, 2014).

The second (Sioni), of local origin, is characterised by villages represented generally by pits or circular structures, pottery that is mainly mineral-tempered and a lithic industry based on flake technology (it was blade technology in the Neolithic period). This tradition is attested at Sioni (Kiguradze and Sagona, 2003) and Damstvari Gora (Varazashvili, 1992) in Georgia, at Aratashen (level 0) (Badalyan et al., 2007) and Tekhut (Torosyan, 1976) in Armenia.

However, the two pottery traditions coexisted on most of the sites in various proportions (Lyonnet, 2018).

To these two dominant traditions may be added, in the south-east of the Caucasus isthmus (Nakhichevan, southern Azerbaijan), a pottery production with impressed or painted decoration, from northwestern Iran ('Dalma ware') (Bakhsaliyev et al., 2019; Abedi et al., 2015).

The mobility of the human groups that are represented in level III of Getahovit-2 can first be understood through the provenance determinations of the obsidian used in the cave.

3. The obsidian industry

In level III at Getahovit-2, obsidian is the predominant material in the lithic industry (about 85%). Flint is in second position (about 11%); some pieces are in limestone or dacite (Kalantaryan et al., 2012; Tardy, 2018).

3.1. Typo-technological study

The obsidian corpus is mostly composed of flakes (about 50%) (Fig. 5,5) and splinters (about 34%) (Fig. 5,6). Tools (about 10%) (Fig. 5,7-15), a few flake cores (Fig. 5,1-2) and splintered pieces (Fig. 5,3-4) are also found.

Fig.5. Obsidian industry from level III: 1-2) flake cores ; 3-4) splintered pieces ; 5) flakes ; 6) splinters; 7-8) end-scrappers on flake; 9) transverse arrowhead; 10) segments; 11-15) blades.

The tools are mainly retouched pieces, blades (Fig. 5,11-15) or flakes, notched pieces, numerous end-scrappers (Fig. 5,7-8), denticulated pieces, transverse arrowheads with bifacial retouch (Fig. 5,9) and segments (Fig. 5,10). A tanged arrow head, pressure-retouched, was found in a medieval pit that had cut into the Chalcolithic levels; it probably belongs to this period. In general, the tools indicate hunting and cutting activities (Abbès and Kalantaryan, 2015).

Three different techniques were revealed (Tardy, 2018):

- a production using direct percussion (protruding bulb, impact point on butt), illustrated by the presence of a few flake cores (Fig. 5,1-2). The methods used for this production can be termed expedient, with a low degree of control of final products ;

- the use of percussion on anvil for the production of small cutting flakes, suggested by the significant amount of splintered pieces (Fig. 5,3-4). Their presence is associated with a large quantity of splinters of less than 15 mm (about 34%) (Fig. 5,6). The splintered pieces thus have, in this context, the same technological status as the cores: they are matrices worked for the production of blanks ;
- pressure-flaking, evident on a small number of very regular blades and bladelets (Arimura et al., 2012b; Tardy, 2018) (Fig. 5,11-15). They appear to have been produced outside the site and brought into the cave in their raw form or retouched, as no nucleus for blades nor any element characteristic of the *chaîne opératoire* of pressure-flaking of blades were discovered (products from maintenance of the working surface, tablets or flakes from rejuvenation of the pressure platform...).

Thus, the only activities of knapping that appear to have been carried out within the cave are the resharpening of tools by retouch or their recycling, as well as the production of flakes by hard hammer or on anvil. The blades knapped by pressure were probably imported, as no element of the *chaîne opératoire* for this type of technique was found.

3.2. Analyses of provenance

3.2.1. Material and method

3.2.1.1. Material

The upper part of level III was excavated in 2011-2012 in the west sector of the cave (squares B6-B7 to E6-E7) on the edge of the terrace, then in 2015-2016 in the east sector of the cave (squares E2-E7 to J2-J7). This phase is dated to between 4406 and 4171 cal BC for the calibrated median values of the dates (Tab. 1) and belongs to the late Chalcolithic. Thirty-six artifacts in obsidian were sampled for analysis in the different squares, artifacts found *in situ* or during the sieving of the sediment (dry sieving with a 0.5 cm mesh). These are mostly flakes and splinters, knapped by percussion. Two pressure-flaked blade fragments were also analysed; they come from squares H7 and I6 (US 36) excavated in 2017 (Fig. 5,11-12).

In 2018, resumption of the work under I. Kalantaryan enabled reaching an earlier phase of the Chalcolithic, dated to between 4624 and 4474 cal BC for the calibrated median values of the dates (Tab. 1); this phase dates to the middle Chalcolithic. Twenty-three artifacts knapped by pressure or on anvil were analysed.

3.2.1.2. Analytical Method

The analysis of the sixty-one obsidian artifacts discussed here was conducted at the Center Ernest-Babelon of the IRAMAT (UMR 5060 CNRS / Univ. Orléans) using Laser Ablation - Inductively Coupled Plasma - Mass Spectrometry (LA-ICP-MS) a method which enables an almost non-destructive analysis, invisible to the naked eye, of the obsidian artifacts. The mass spectrometer is a double-focusing Element XR from Thermofisher Instruments. Three campaigns of analysis were performed.

For the first campaign (25 samples excavated in 2011-2012) the Element XR mass spectrometer was associated with a UV Microprobe laser ablation device, from VG Elemental, equipped with a frequency quadrupled Nd:li laser ($\lambda=266$ nm). The laser was operated at an energy of 2 mJ and at a pulse frequency of 6 Hz. An argon flow (1.15-1.35 l/min) carried the ablated material to the plasma torch. A pre-ablation time of 20 s was set in order to eliminate the transient part of the signal which was then acquired for 40 s corresponding to 20 mass scans from lithium to uranium. Compositions are calculated from two ablations carried out for each sample. The diameter of the ablation crater is 100 μm , and its depth is around 250 μm .

For campaign 2 and 3 (13 samples excavated in 2015-2016 and 23 samples excavated in 2018) the Element XR mass spectrometer was associated with a Resonetics RESolution M50e ablation device (Excimer ArF laser working at 193 nm). The excimer laser was operated between 5.5 and 6.5 mJ with

a repetition rate of 10 Hz. The beam diameter was adjusted to 100 μm . An argon/helium gas flow (1 l min⁻¹ Ar and 0.65 l min⁻¹ He) carries the ablated aerosol to the injector inlet of the plasma torch. A pre-ablation time of 20 s is set so as to remove any corrosion layer and the transient part of the signal, and then the sample is measured for 27 s corresponding to 12 mass scans from lithium to uranium. Only one ablation is carried out for each sample but, during analysis, live counts are monitored to identify inclusions that are not representative of the glass composition (Palumbi et al., 2014). In this case, results are discarded and a new ablation site is selected. Typical diameter and depth of the ablation crater are respectively 100 μm and 150 μm .

For all analyses, the signal in counts/second is measured in low resolution mode for 38 different isotopes. The ion beams generated by the double-focusing mass spectrometer are collected by a channel electron multiplier or a faraday cup according to their intensities. These include zirconium, yttrium, niobium, barium, strontium, cerium, lanthanum and titanium, which are particularly effective in classifying distinct geochemical populations amongst obsidian assemblages (Chataigner and Gratuze, 2014). The isotope ²⁸Si was used as an internal standard (Chataigner and Gratuze, 2014). Calibration was performed using 3 reference standard glass materials: NIST 610 from the National Institute for Standards and Technology and Corning B and D glasses from Corning laboratory. The standard reference materials glass NIST 612 was repeatedly analysed as an unknown sample to monitor for instrumental drift and to ensure compatibility between different sets of analyses. The reference materials were used to calculate the response coefficient (k) of each element (Gratuze, 1999). Concentrations were calculated according to the protocol detailed in Gratuze (1999) and Chataigner and Gratuze (2014), which enables reaching detection limits in the range of 0.01% to 0.1% for major elements, and of 20 to 500 ppb for minor and trace elements.

To be noted is that due to some changes in the calibration procedures between the first series of analyses and the other two, the concentrations calculated in 2012 are slightly inferior to those calculated more recently for some elements (Y, Zr, Nb, Ba and rare earths). These differences have been taken into account, but they do not affect the interpretation of the data, they just increase the compositional variability of the different obsidian groups.

3.2.2. Results

3.2.2.1. Sources of obsidian

If first of all we analyse the results obtained independent of the chronological phasing, the barium/strontium and the barium/zirconium ratios (Fig. 6) enable the obsidian from Getahovit to be distributed into six principal composition groups (Tab. 2 and Fig. 7). If we refer to recent published studies concerning the sources of obsidian for the South Caucasus and north-eastern Turkey (Chataigner and Gratuze, 2014; Chataigner et al., 2014b; Biagi et al., 2017), these groups correspond to the obsidian sources of the volcanos of Arteni (Arteni 3, 2 tools), Chikiani (Chikiani 2, 1 tool), Gegham (16 tools), Gutansar (14 tools), Sarıkamış (a more precise attribution to the outcrops of this zone will be discussed in more detail below, 1 tool) and Tsaghkunyats (27 tools).

Fig.6. Binary diagram of Ba/Zr-Ba/Sr ratios for the obsidian artifacts at Getahovit-2.

Tab.2. Provenance groups for obsidian artifacts: distribution

Fig.7. Spectra of contents in REE (Rare Earth Elements) in the obsidian artifacts at Getahovit-2, standardized to that of the earth's crust (Wedepohl 1995).

If we take into account the ratios of concentrations between light rare earths and heavy rare earths (lanthanum/ytterbium in terms of neodymium/samarium) (Fig. 8), the group of tools from Tsaghkunyats subdivides into three sub-groups which correspond to the flows of Damlik (25 tools), Tvakar (1 tool) and Kamakar/Aikasar (1 tool).

Fig.8. Binary diagram of La/Yb-Nd/Sm ratios for the obsidian artifacts at Getahovit-2.

With the exception of the tool attributed to the region of Kars/Sarikamiş, 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, 2014; Chataigner et al., 2014b; Biagi et al., 2017). For more information, reference may be made to the Appendix where the compositional data obtained from the tools are published (Appendix A1 to A3), as well as the numbers of analyzed artifacts according to their contexts / types / obsidian sources (Appendix A4) and the spectra of rare earths of the artifacts of Getahovit compared to those from identified obsidian sources (Appendix A5 to A9).

Concerning the tool Gthv I6 (Fig. 5,12), attributed to the region of Kars/Sarikamiş, the correspondence with a source of obsidian in this region was established in an indirect way. At the present time we have no geological sample of identical composition. From a geochemical point of view, the Gthv I6 piece has a composition which positions it on most of the diagrams used for the sources of localised obsidian around Sarikamiş and Yağlıca Dağ (Chataigner et al., 2014b). If the content in barium, strontium, zirconium and rare earths is considered, the composition of this piece is close to those from the outcrops of south Sarikamiş for the content in barium and strontium, to those of the outcrops of north Sarikamiş for the content in zirconium and rare earths and to those of Yağlıca Dağ for the content in barium, strontium and zirconium (Appendix A10). This tool is not however a unique example; 7 other obsidian pieces found in Azerbaijan (6 at Mentesh Tepe and 1 at Ismayilbey) have an identical composition (Appendix A11 to A15). The distinction between the zones of north Sarikamiş and south Sarikamiş is in fact more related to the geochemistry of the obsidian tools than their geographic locations, and more particularly to the content in barium and zirconium. The obsidian tools from north Sarikamiş are characterised by a high content of zirconium and a low content of barium, whereas inversely those of south Sarikamiş present a low content of zirconium and a high content of barium. The Gthv I6 piece has an intermediate composition, and until there is a more detailed survey of the volcanic zone of Sarikamiş, it will be attributed to this zone.

A second tool is particularly worthy of attention: this is piece E3a which comes from lava flows at Gegham. The results published in the annexes and obtained with the normal protocol do not permit a distinction between this artifact and the other tools from Gegham through their minor elements and traces. However, the contents measured for sodium (0.85%), potassium (9.51%), lithium (1.74 ppm) and rubidium (110 ppm) do not correspond at all to the average contents measured for the other artifacts of this group (Na₂O 4.21%; K₂O 4.47%; Li 66 ± 14 ppm and Rb 205 ± 5 ppm). These modifications in composition (enrichment in potassium, impoverishment in sodium and modifications in content of lithium and rubidium) have already been observed for obsidian pieces that have been used as temper for pottery (Palumbi et al., 2014). This is not the only particularity of this tool; its surface presents an aspect of partially melted glass (Appendix A16). This suggests that this object was subjected to strong heat within the zone of a hearth or a fire (probably around 950° C for a relatively long time; Palumbi et al., 2014). The profiles of concentrations made on a section of the tool show in fact that the composition of this obsidian piece was modified to a depth of about 1.35 mm (Fig. 9 and Appendix A17). Except for lithium, the concentrations measured at the centre of the tool (Na₂O 4.21%, K₂O 4.60%, Li 35 ppm and Rb 209 ppm) are concordant with the average contents measured for the other artifacts of this group.

The same phenomena as those observed for artifact E3a should exist on a lesser scale for other artifacts, such as E3d, for which slightly lower contents of lithium and sodium and slightly higher contents of potassium were measured. The measurements carried out for artifact E3a confirm the conclusions obtained during the study of the obsidian fragments used as temper for pottery, that is, the absence of modification of the chemical footprint in the obsidian pieces (rare earths and associated elements) subjected to a prolonged baking at high temperature.

This observation also concurs with the supposed practice of periodic cleansing by fire of the cave during the Chalcolithic.

Fig.9. Profiles of concentrations made on a section of the tool E3a. The y-axis represents the ratio between the concentration of the element "x" at the depth "d" and its average concentration measured at the center of the object.

3.2.2.2. Chronological phasing

For the chronological phasing, the distribution of the tools within the two phases is as follows (Tab. 3). For Tsaghkunyats, the only two artifacts from the outcrops of Ttvakar and Kamakar/Aikasar belong to the late Chalcolithic phase.

Tab.3. Distribution of the obsidian artifacts analysed in terms of their provenance and the occupation phases of the site of Getahovit-2.

The analysis of the artifacts from the two successive phases within the Chalcolithic occupation of level III reveals a difference in procurement according to the *chaîne opératoire* of production and of a development in the origin of procurements over time.

All the pieces that were knapped by percussion or on anvil came from deposits situated in Armenian territory (Arteni, Gutansar, Gegham, Tsaghkunyats), a provenance that can be termed 'regional', whereas the two pressure-flaked blade fragments came from distant deposits – Chikiani in Georgia and Sarikamis region in Turkey.

For the pieces of regional origin:

- in the middle phase, the obsidian came from Gutansar (47,8%), Gegham (21,7%), Tsaghkunyats (21,7%) and Arteni (8,7%)
- in the late phase, the obsidian pieces from Arteni and Gutansar clearly decrease, while Tsaghkunyats becomes preponderant (61.1%) and Gegham remains relatively stable (30.6%).

This permanence of Gegham, as well as the predominance in the early phase of deposits situated in southern Armenia (Gutansar, Arteni), suggest that the populations, that stayed at Getahovit, initially had strong links with the plain of Ararat. The sites of this region, from the Neolithic to the Bronze Age, took their obsidian supplies mainly from the deposits of Arteni, Gutansar and Gegham, with a clear predominance of Gutansar for the settlements of the eastern part of the plain (Badalyan, 2010).

The source of Chikiani was identified by an imported blade, but did not appear in the material knapped on site. However, this source was widely used from the Neolithic to the Iron Age in all the middle valley of the Kura (Badalyan et al., 2004: 443); it was predominant in the Georgian part of this valley (Gatsov and Nedelcheva, 2017; Badalyan, 2010) but also supplied 68.8% of the obsidian at the Late Chalcolithic-Early Bronze Age site of Padar in the north-west of Azerbaijan, 230 km from the source as the crow flies (Badalyan, 2010: 33).

The region of Sarikamis, identified as the source for the second imported blade, is well attested in the South Caucasus for the 6th and 5th millennia BC. This region was particularly important at the beginning of the 6th millennium BC in the Azerbaijani basin of the Kura (Mentesh period I; Göy Tepe levels 14-8), when it was a source for 50% of obsidian supply. Then it became rarer after the middle of the 6th millennium BC (13% at Göy Tepe levels 7-5), although it remained a source during the 5th millennium BC (Mentesh levels II-III) (Lyonnet et al., 2012; Nishiaki et al., 2019b).

3.2.2.3. Accessibility of the obsidian outcrops

For the sources situated in Armenian territory, it is notable that the three deposits that are the most represented at Getahovit-2 (Gutansar, Gegham and Tsaghkunyats) are located at time-distances from the cave that are almost equivalent: 31 hours for Gutansar, 33 hours for Tsaghkunyats and 36 hours for Gegham, based on the least-cost routes estimated from the GIS Cost Distance map. This corresponds to a walk of 4 or 5 days for about 7 to 8 hours a day (Castro et al., 2017), but 10 to 12 days if walking with a herd, which moves more slowly, with stops for the animals to eat and drink. The source of obsidian at Arteni is more distant, a walk of 6 to 7 days for a lone human, 16 days for a herd.

For these Armenian outcrops, the seasons when it is possible to procure obsidian differ (Badalyan et al., 2004: tab.1). The outcrops of Arteni and Gutansar are situated between altitudes of 1400 and 1800 m. The snow cover in thickness and in duration is moderate in winter; they are accessible for most of the year.

However, the outcrops of Tsaghkunyats are situated at altitudes of between 2000 and 2400 m, in a region (north-east of the Aragats massif) of harsh climate, where the snow cover is thick from mid-November to the end of April. The outcrops are thus difficult of access from the end of autumn to the beginning of spring. It is true that the river Kasakh in the south-western part of the Tsaghkunyats range and the river Marmarik in the north-east carry many obsidian blocks towards the neighbouring plains. But examination of the obsidian pieces from Getahovit show an absence of cortex of river pebbles, which would indicate that the blocks were taken directly from the outcrops (Arimura et al., 2012b). Nonetheless, as most of the knapping activity in the cave was the reshaping of tools and the production of flakes, the absence of cortex is not surprising.

As for the deposits in the mountains of Gegham, they are situated at high altitude, between 3000 and 3200 m, and are covered with a very thick layer of snow (about 2 m on average) from mid-October to the end of May; they are thus inaccessible in this period and it is only in summer that the outcrops can be exploited (Badalyan et al., 2004: 453).

This diversity in the regional procurement of obsidian gives rise to several questions: as the outcrops of Tsaghkunyats and Gegham are mainly accessible in summer, in which seasons was the cave of Getahovit occupied? Did the human group that occupied Getahovit leave the cave and move towards these different deposits or was it part of a network that enabled acquisition of obsidian collected by other people? Research on the seasonality of the occupations and on the cultural identity of the inhabitants of the cave may provide answers.

4. Evidence for seasonality

In level III at Getahovit-2, evidence for seasonality may be sought in the analysis of the plant remains and the animal bones that were found.

4.1. Plant remains

Plant remains were recovered from 69 sediment samples (altogether 478.3 liters) from the Chalcolithic levels excavated in 2011-2017. The concentration of archaeobotanical material was low, 1.0 units of carpological material per one liter of sediment on average. Most of the archaeobotanical remains came from combustion structures and a few pits. The recovered seed remains were mostly mineralized, but there were also charred remains and charcoal. The plant remains were recovered by flotation and water-sieving (0.25 mm mesh), then dried, sorted, counted and registered, identified, and the assemblages interpreted.

Recovered plant macro-remains (486 units) belong mainly to wild species, primarily tree species (fruits, seeds) and secondly, weeds. The cultivated plants are very few, some cereals were found in the form of charred grains. Thus the analyses provide the following assemblage:

Tree plants	81.3%	of which <i>Celtis</i>	80.0%
Weeds	8.2%	of which <i>Lithospermum</i>	5.8%
Cereals	7.6%	of which <i>Triticum</i> and <i>Hordeum</i>	3.1% 2.9%
Unidentified	2.9%		

4.1.1. Wild plants

Among the tree species, Caucasian hackberry (*Celtis caucasica*) is largely predominant: it represents 61.3% of the seed remains discovered on the site so far. This tree with edible fruits is still abundant today in the region of Tavush and grows near the site.

As this tree is present today in the surroundings of Getahovit, it is possible that unburned hackberry endocarps could have been brought and stored in the cave by rodents or other animals; but the discovery of carbonised endocarps suggests that at least part of them were gathered by the human occupants of the cave. The same conclusion is reached for the Late Chalcolithic levels (end 5th – 1st half 4th millennium BC) at the cave of [Areni-1](#) in southern Armenia, where “Given the vast number of *Celtis* finds, it is clear that hackberry fruits were intentionally collected at [Areni-1](#)” ([Smith et al., 2014: 237](#)). The harvest of hackberry fruits took place in the autumn, which implies the occupation of the cave particularly during this season.

According to botanical data, the leaves of the hackberry have in the past served as fodder; studies carried out on sheepfold caves in southern Europe have shown that use of the leaves as fodder occurred from the Neolithic onward ([Delhon et al., 2008](#)).

Besides the tree species are the weeds, represented primarily by field gromwell (*Buglossoides arvensis*), a plant that grows among crops and on fallow land on limestone soils. Also present are common gromwell (*Lithospermum officinale*) and bedstraw (*Galium*), known for their medicinal virtues, as well as some grasses (Poaceae gen. spp.) and dock (*Rumex*). The biomineralised nutlets of *Lithospermum* are very resistant to deterioration, which can lead to an over-representation of these plants.

4.1.2. Cultivated plants

The remains of cultivated plants are very few; only cereals are recorded so far.

The cereals have been identified based only on charred grains; no stem or glume, indicative of gathering of the ears, have been found on the site. The grains belong to species of hexaploid and/or tetraploid wheat (*Triticum aestivum/durum*). To these is added barley (*Hordeum vulgare*), of which at least a part is naked barley (*H. vulgare* var. *nudum*). Naked barley was the most widespread cereal during the Neolithic and Chalcolithic in Armenia ([Hovsepyan and Willcox, 2008](#); [Hovsepyan, 2014, 2015](#)).

4.1.3. Subsistence strategy

The predominance of fruits of wild trees and shrubs over the cultivated plants suggests that gathered plants were the principal source of vegetal food for the occupants of Getahovit-2 cave during the Chalcolithic. The small quantity of cereals found and the fact that they are only in the form of grains suggests that the human group that lived in the cave did not cultivate cereals, but rather brought them from a base village or acquired them from other populations.

If this assemblage of plant remains is compared to those of the contemporary sites of [Areni-1](#) (Horizons I-III, ca. 4300-3400 cal BC) ([Wilkinson et al., 2012](#); [Smith et al., 2014](#)) in Armenia and of Mentesh (period III, ca. 4360-4130 cal BC) ([Decaix et al., 2016](#)) and Ovchular (phase I, ca. 4350-

4250 cal BC) (Berthon et al., 2013) in Azerbaijan, a similarity in the species identified is observable, but also a clear difference in the relative quantities. On these three sites which have produced evidence for year-round occupation (basin-shaped clay structures and storage-type jars at Areni-1, architecture at Mentesh and Ovchular) (Areshian et al. 2012; Lyonnet 2017; Marro et al. 2014), the cereals consist, as at Getahovit, mainly of naked (bread) wheat (*Triticum aestivum*) and barley (*Hordeum vulgare*); however they are by far the most frequent plants and are found as both grains and chaff remains (glumes, rachis, segments). At Areni-1 and Mentesh, emmer (*Triticum dicoccum*) is also present. The pulses, whose presence is unverified at Getahovit-2, are attested on the three other sites and comprise peas, lentils and vetches. The fruits of *Celtis* are present on the three sites; they were found in great abundance at Areni-1, but are rare at Mentesh and Ovchular.

4.2. Faunal remains

According to the osteological analyses carried out in 2012 by A. Balasescu and in 2016-2017 by J. Chahoud on the fauna brought to light in level III, the bone remains are in a high state of fragmentation, which explains the very low rate (between 6% and 8%) of specific determination of the remains (Arimura et al., 2012b; Chahoud, 2018). The fragmentation of the bones is probably due to intense fire, which affected more than 40% of the remains analysed and gave them a dark brown or black colour, even white for the most intensely burned.

4.2.1. Faunal assemblage

In total, about 2900 faunal remains were collected, representing an overall weight of 10.6 kg. The faunal spectrum comprises mainly mammals, with rare examples of fish and birds.

Most of the mammals are ungulates, with a majority of caprines (*Ovis/Capra*) which represent 67.7% of the number of remains determined to species level; in addition are 16.4% of cervidae (*Cervus/Capreolus*), 6.3% cattle (*Bos*) and 6.1% pigs (*Sus*). Because of the state of fragmentation of the bones, it was not possible most of the time to determine the domestic or wild status of the caprines. Only a few bone remains permitted certain identification of an ibex, a domestic goat and a sheep. Among the bone remains of wild caprines are those of juvenile individuals (Chahoud, 2018). According to several studies (Grzimek, 1990; Nowak, 1991), the birthing season for the Caucasus ibex (*Capra caucasica*) is mainly in June, which suggests a hunting season in autumn or winter.

In addition to the ungulates are carnivores, which represent 3.1% of the number of remains determined to species level. This is mainly the dog, the presence of bear and badger being attested by a few remains. No cut marks, which could indicate the consumption of dog, are visible on the bones, which suggests that dogs were companions, probably used to guard the herd.

4.2.2. Subsistence strategy

The archeozoological analyses carried out on the faunal remains found in level III thus show that the subsistence economy of the human group at Getahovit was based on hunting (mainly ibex, stags, deer, wild boar). The domestic animals clearly did not constitute the first choice of meat for consumption. This predominance of hunting corresponds to the industry in obsidian and flint which indicates hunting and butchering activities (Abbès and Kalantaryan, 2015).

Such a subsistence strategy based on hunting has been observed for transhumant pastoralists or nomads in different contexts, whether for the Neolithic in Jordan (Rollefson, 2011) or Slovakia (Lichardus, 1974) or for the present time in Tibet (Naess et al., 2004). As stated by Makarewicz (2018: 143), “pastoralists seek wild prey in order to conserve their livestock herds as part of strategies designed to avert catastrophic herd losses caused by adverse weather and disease or accumulate livestock wealth. In these cases, livestock are only occasionally slaughtered...” Another reason is that the herbivores were hunted because they provided the shepherds with a secondary source of meat,

skins and furs, while carnivores such as bears and wolves were hunted because they prey on livestock (Naess *et al.*, 2004). Moreover, Huber (2012: 203) points out that autumn and early winter were also the best hunting seasons, when wild animals were fat and in good condition.

The cave was occupied episodically by herds, as the sheepfold deposits have shown, but it is highly possible that it was also frequented in the intervals by groups of hunters.

Thus, the archaeobotanical remains suggest occupation of the cave during the autumn (e.g. the abundance of nutstones of *Celtis* species). This hypothesis is supported by the faunal remains, which reveal the importance of hunting in the subsistence strategy, and by the remains of wild juveniles which would indicate that hunting occurred during autumn or winter.

5. Evidence for cultural belonging

In the cave of Getahovit-2, the evidence for cultural belonging is seen in the objects, which comprise, besides the obsidian artifacts, flint and limestone tools, objects in bone or antler and pottery.

5.1. Tools in flint and limestone

In level III of Getahovit-2, the artifacts in flint number 83 (that is, 11.4% of the lithic objects) and those in limestone 22 (that is, 3.0%). In addition, there is a piece in dacite and another in an undetermined material.

In this region of north-eastern Armenia, siliceous rocks outcrop in several places in the valley of Aghstev. On the heights dominating the cave of Getahovit, during a survey near the village of Yenokavan, the Franco-Armenian excavation team collected in 2010 numerous blocks of different varieties of agate, jasper and chalcedony, as well as some artifacts (blades, points...) (Ollivier *et al.*, 2010). Near this deposit, on the slope of a small hill, are Bronze Age cist tombs.

In the lower valley of the Aghstev, immediately next to the frontier with Azerbaijan, is the bentonite mine at Sarigyugh, reputed for the large variety of siliceous rocks that may be extracted: chalcedony, cornaline, agate, in various colours (yellow, violet, orange, grey...) (Fig. 10,2-3). This deposit is located only twenty km from Getahovit, that is, about 4 hours' walk (Fig. 10,1).

Fig.10. Flint: 1-3) Deposits at Sarigyugh: location (1) and outcrops (2-3); 4-8) artifacts from Getahovit-2: transverse arrowhead (4); fragments of projectile point (5); 'Kmló tool' (6); core (7) and end-scraper (8).

At Getahovit, most flint artifacts are of high quality and reddish brown in color (10R4/4) (Fig. 10,4,6-8). There are some flakes with a white calcareous cortex, indicating that they come from nodules (Kalantaryan *et al.*, 2012). The flint pieces were knapped using direct percussion or indirect percussion with a punch, or percussion on anvil. The presence of splintered pieces and a few nuclei (Fig. 10,7), associated with debris and splinters, strongly suggests a production on the site of blanks from flakes and from small blocks brought into the cave (Tardy, 2018). Among the pieces produced are endscrapers (Fig. 10,8), transverse arrowheads (Fig. 10,4) and artifacts that resemble projectile points (Fig. 10,5). The tools in flint were also, at least in part, intended for hunting. There is also a heavily burned tool with one edge formed by parallel retouches (Fig. 10,6); this artifact evokes the 'Kmló tools', which were a cultural marker of the Early Holocene in the Aragats massif and continued to be used in Armenia until the 5th millennium BC (Arimura *et al.*, 2012a).

5.2. Bone and antler industry

In addition to awls made from caprine long bones, several elements made from antler were found in the cave. When parts of bases are present (Fig. 11), they indicate that the tools were made from fallen antlers (Christidou, 2015). Deers lose their antlers mainly in winter, the best time to gather them.

Fig.11. Antler industry: proximal part of a shed left antler (US 32; late Chalcolithic; 2015 excavations).

5.3. Pottery

The pottery found in level III at Getahovit is very homogenous; it suggests that the human groups that frequented the site belonged to the same cultural tradition.

5.3.1. Characteristics of the pottery

Fig.12. Pottery from Getahovit-2: 1-2) upper parts of large cylindrical vessels; 3-6) different types of rims; 7-8) fragments of vessel bodies; 9-10) bases of large vessels.

The sherds are all from the same category of pottery, shaped by hand, with a mineral temper that is quite coarse (Fig. 12,3,7), a plant and mineral mix being rare. The clay body is well fired, the heart is often light in colour (Fig. 12,4,6,10), sometimes grey or black (Fig. 12,3, 8); the interior and exterior surfaces are usually covered with a light brown slip and polished (Fig. 12,3-4,6,8,10); sometimes they are a reddish colour, without a slip (Fig. 12,1). However, a certain number of sherds had been burned; they are blackish in areas and the surfaces are flaking (Fig. 12,5); it is thus difficult to determine their original aspect.

The rims have a flattened upper edge (Fig. 12,3-6); they are straight (Fig. 12,3-4), sometimes everted or rolled over (Fig. 12,5-6), or forming a wide ledge (Fig. 12,2). The bases are flat (Fig. 12,9-10), often slightly raised (Fig. 12,10). One of the sherds has a horizontal lug (Fig. 12,4); no decoration was revealed.

Few shapes could be reconstructed; they are open shapes, large recipients having thick subvertical walls and a wide rim (Fig. 12,2) and little vessels with finer walls (Fig. 12,3-6).

5.3.2. Regional comparisons

In the context of the South Caucasus in the 5th millennium, it is interesting to compare this production with that of neighbouring regions, because similarities in ceramics are widely seen as proxies for the communication and movement of people in communities of practice, social and exchange networks (Wright and Makarewicz, 2015).

It must be emphasized that no sherd attributable to 'Chaff-Faced ware' was brought to light at Getahovit-2. The pottery of this site is similar to 'Sioni ware', with which it shares a very large preponderance of mineral temper. But at Getahovit, no decoration (notches on the rim) or technique (combed surfaces) has been found, that would be characteristic of 'Sioni ware' (Sagona, 2018).

The recent excavations carried out on 5th millennium sites in the South Caucasus (Fig. 1 and Fig. 14) have provided interesting elements of comparison:

- In southern Georgia (province of Javakheti), the rock shelter of **Bavra-Ablari**, situated at an altitude of 1660 m in the valley of the river flowing from Lake Paravani, has produced, among the occupations dating from the Mesolithic to the Bronze Age, two levels relevant to the Chalcolithic: level 2, Middle

Chalcolithic, dating between 4600 and 4418 cal BC (calibrated median values of the dates) and level 1, late Chalcolithic, dating between 3910 and 3871 cal BC (calibrated median values) (Varoutsikos et al., 2018). In the two levels, the sherds are of a brown/dark-brown/black ware, mainly mineral tempered, and possess in several cases perforations beneath the rim (Fig. 13,1); in level 1, notches on the rim are present. The pottery from this rock shelter thus presents the characteristic features of the Sioni cultural complex.

Fig.13. Chalcolithic pottery: 1) Bavra-Ablari rockshelter (Javakheti, South Georgia); 2) Tsaghkahovit rockshelter (north of Aragats massif, Armenia): a) outer surface; b) inner surface.

- In western Armenia, the rock shelter of **Tsaghkahovit**, located at an altitude of about 2000 m on the last foothill of the northern flank of the Aragats massif, was occupied by groups of hunters between 4391 and 4231 cal BC (calibrated median values) (Arimura et al., 2008, 2012a). The pottery (about 90 sherds), having an often coarse mineral temper and generally fired in an oxidizing atmosphere, has orange-to-brown-coloured walls, sometimes covered with a brown slip (Fig. 13,2). Some fragments of rims and bases enable reconstruction of cylindrical vessels with a straight rim and flat base. No decoration was revealed. This production is close to that of Getahovit in technique, shapes and absence of decoration. Moreover, the shelter of Tsaghkahovit, where a ‘Kmlö tool’ in obsidian was found (Arimura et al., 2012a), is near the Tsaghkunyats range, from which came a large quantity of the obsidian found at Getahovit; the outcrops closest to Tsaghkahovit are those of Damlik and Ttvakar, from which come 26 of the 27 samples attributed to the Tsaghkunyats range.
- In southern Armenia, the cave of **Areni-1** situated at an altitude of about 1050 m in the Arpa river valley, was occupied from 4300 to 3500 cal BC (Late Chalcolithic) by populations which constructed sustainable installations (Areshian et al., 2012). The pottery consists mostly of Chaff-Faced ware, including some pots with painted decoration made with bitumen; grit-tempered ware (Sioni ware ?) is also present (Wilkinson et al., 2012).
- In Nakhichevan, in the lower valley of the Arpa river, the Late Chalcolithic level of the settlement of Ovçular was occupied between 4466 and 4011 cal BC (calibrated median values of the dates published in 2014 for Phase II –after Phase I in the stratigraphy, but before this phase I in the C14 dating) (Marro et al., 2014: 142). Chaff-Faced ware is largely predominant including vessels painted with bitumen, Sioni ware is attested.
- In western Azerbaijan, on the right bank of the middle Kura, the site of **Mentesh** presents two phases of the Chalcolithic: period II between 4775 and 4503 cal BC (calibrated median values), and period III between 4360 and 4129 cal BC (calibrated median values) (Lyonnet, 2017, 2018). Most of the pottery is Chaff-Faced including vessels painted with bitumen, the Sioni ware comprises no more than 5% of the material (Lyonnet, 2018: 562). In period II, the latter was characterised by a mixed temper and the presence of ‘mangal’ vessels presenting rows of perforations beneath the rim. In period III, the mineral temper (especially obsidian) becomes frequent, as do impressed decoration on the rims.
- In the neighbouring province of Kakheti (north-eastern Georgia), in the valley of the Alazani, several Chalcolithic sites (Damtsvari Gora, Tsiteli Gorebi 1 and 2, Kviriatskali) characterised by Sioni ware were excavated in the 1970s (Varazashvili, 1992). In 2018, new excavations were carried out in this region at **Tsiteli Gorebi 5** (Rova, 2018). The pottery, in general similar to that described by Varazashvili, is characterised by abundant mineral temper to which was occasionally added plant material, and by a majority of sherds with an external surface that is orange, red or brown, often covered by a smoothed red-brown slip. ‘Mangal’ vessels with rows of perforations are well attested, but decoration of the rims is rare. No fragment of Chaff-Faced ware was found. The radiocarbon dating is in progress and will enable determination of the phase of the 5th millennium corresponding to Tsiteli Gorebi 5.

Fig.14. Chronological comparison with the principal sites of the South Caucasus in the 5th millennium BC (see Appendix A18 for the sources of the dates).

Thus, the pottery of the cave of Getahovit is above all similar to that of the shelter of Tsaghkahovit, which was a hunters' camp, and to that of Tsiteli Gorebi 5 which was a settlement with constructed architecture. On these three sites with quite different functions, Chaff-Faced ware is completely absent and the pottery with mineral temper presents similar characteristics (notably the brown slip). At Tsiteli Gorebi 5, the rows of perforations and some elements of decoration are evidence for the integration of this pottery production within the 'Sioni cultural complex'; the absence of these elements at Getahovit and Tsaghkahovit could be explained by the very nature of these occupations, which were temporary and concerned small mobile groups (shepherds, hunters).

6. Discussion

6.1. During which period of the year did Getahovit-2 serve as a shelter for herds?

The cave of Getahovit-2 is located in a valley situated at an altitude of 960 m, in a forested zone, far from the first grazing lands that lie above 1700-1900 m. Ethnographic data provide interesting information on the use of the different mountain stages in this region.

6.1.1. Ethnographic data on the Tavush

As Brochier et al. (1992) and Arbuckle and Hammer (2019) have emphasized, any ethnographic study of the recent past should be taken with great caution in an archeological study, because the landscape has usually changed (deforestation, introduction of new species...) and because the complex structure of present-day pastoralism cannot be extrapolated to prehistoric periods. These observations are evident.

Nonetheless, in the particular case of the Tavush region, the persistence of a wooded environment and the tradition of transhumance can be examined for several reasons.

First of all, for the South Caucasus, archeobotanical and palynological studies provide evidence for the extension of leafy forests in the 6th and 5th millennia (Messager et al., 2013; Joannin et al., 2014), and in parallel with historical data, for a deforestation initiated in the Bronze Age which accelerated in the Middle Ages (Moreno-Sanchez and Sayadyan, 2005). However, the province of Tavush and particularly the region of Getahovit have remained among the last forested zones in Armenia. The tree species have changed very little (mixed oak, beech and hornbeam forests) and the hackberry, the fruits of which were found in abundance in the Chalcolithic levels, still grow on the slopes near the cave.

Secondly, the ethnographic study published by Mkrtumyan (1974) concerning different regions of Armenia including the Tavush, concerns pastoral practices in the second half of the 19th century and the beginning of the 20th, that is, before the profound transformations related to the collectivisation of the Soviet period.

The high-altitude meadows in the Tavush region were used in past centuries as a zone of summer pasture by the local populations, but also by Azeri and Kurdish populations that came from the middle basin of the Kura, because of the arid and hot summer climatic conditions in this valley (Mkrtumyan, 1974: 55; Bennigsen, 1960: 515). The shepherds followed itineraries well-known to them, including one that went up the valley of the Aghstev (Mkrtumyan, 1974: 55).

The caves situated in a forested environment at a lower altitude permitted the practice of wintering (Mkrtumyan, 1974: 47-51). These caves would have been located in protected places, facing the sun and near a spring or river. They were used for herds of goats and sheep that could reach a hundred head. During the day, the herd grazed on the nearest pastures or in the forest to eat seedlings. For the night they entered the cave, which offered a shelter that was always dry and warm. The animals came out even when snow was abundant, on condition that it did not prevent movement. It was only when cold temperatures came with the snow that the animals were fed on grain. If the climatic conditions

became too severe, the shepherds took their herds to the banks of the Kura, where usually there was little snow, and the herd could graze with no need for fodder.

The maps of the Soviet period, on which the wintering places ('zimnye') are indicated, confirm the retention of this practice, notably very near Getahovit.

6.1.2. Cave of summer pasturage or of wintering?

The cave of Getahovit-2 is situated at low altitude, away from summer pastures, which excludes its use for summer transhumance. The mild climate in winter, snow cover that was usually not abundant and the forest environment are advantageous factors for insuring the survival of the herd during the cold period.

In her thesis on pastoralism in southeastern Turkey during the last 500 years, Hammer (2012: 67) mentions that the use of caves for animal and human shelter was common among pastoralists of the Taurus and Zagros areas. Similarly, Kurdish agro-pastoralists in northern Iraq frequently housed themselves and their animals in limestone caves during the winter (Solecki, 1979, 1998).

In the different regions where caves were used to shelter herds during the winter, the criteria are the same: location on a south-facing slope, sheltered from dominant winds, good dry living conditions, defensive qualities and access to water (in Kirgystan: Taylor et al., 2018; in Greece: Trantalidou and Andreasen, 2011; in Armenia: Mkrtumyan, 1974).

The cave of Getahovit-2 is located in a recess in a cliff, a place protected from winds, and its porch is only visible when one is in immediate proximity. It looks over a river that is easily forded. In front of the entrance to the cave, which faces south, is a vast terrace. The cave was not humid during the Chalcolithic, as the drapery-like formations seen today on the walls stop above the medieval level and are thus posterior to the Chalcolithic occupation.

The indications of seasonality found in the cultural layer of level III at Getahovit-2 suggest that occupation occurred during autumn and possibly also during winter:

- gathering of the fruits of *Celtis* species in the autumn
- hunting of juvenile ibex in autumn or winter, as these were born at the beginning of summer
- use of deer antlers, which fall in winter.

The assemblage of these data supports the hypothesis of an episodic use of the cave of Getahovit-2 to shelter caprine herds during the cold seasons (autumn-winter).

6.2. Was the cave of Getahovit-2 used by local populations?

Although research in the region of Tavush has been limited by the abundant forest cover, surveys carried out over the last ten years have enabled the discovery of a few prehistoric sites (Arimura et al., 2014).

For the Chalcolithic period, this research has revealed the existence of a settlement on a terrace of the left bank of the Aghstev, near its confluence with the Getik; but road construction works have greatly damaged the site. Only several artifacts in obsidian and a few in flint, faunal remains and charcoal were recovered (Arimura et al., 2014: 263 and fig. 9). One sample of charcoal was dated by radiocarbon to the beginning of the 5th millennium (UGAMS-2288: 5880 ± 50 BP, that is, 4896–4610 Cal BC).

On the heights dominating the valley, at an altitude of about 1800 to 2000 m, the two rock shelters of Hovk-1 and Hovk-3 were test-excavated. Several phases of occupation were revealed, but C14 dating was not carried out. The earliest phase produced artifacts in obsidian, including segments. According to the excavators, the latter could belong to the 5th millennium BC (Arimura et al., 2014: 263).

Not far from there, in the valley of a tributary of the Getik, the small cave of Barepat-1 produced objects in obsidian similar to those of Getahovit: a few pressure-flaked blades, numerous artifacts on

flakes and a segment, the back of which is shaped by bidirectional retouch (Arimura et al., 2014: 262). The radiocarbon dates place Barepat-1 in the final third of the 5th millennium BC (UGAMS-2818: 5360±40 BP, that is, 4328-4054 cal BC).

These data, although fragmentary, indicate that populations were definitely present in the valley of the Aghstev and its tributaries during the 5th millennium BC (Fig. 1).

Moreover, according to ethnographic evidence, the burning of dung in the cave could not occur until the dung was dry, that is, a lapse of time after the departure of the herd; as the dung could burn for several days, even several weeks, the burning had to occur well before the return of the herd. It would thus have been necessary for persons related to the shepherds to carry out this operation during the summer, which suggests the presence of a base village in the region.

6.3. Was the cave of Getahovit-2 used by populations that came from the Kura basin?

The location of the cave of Getahovit is almost equidistant between the obsidian deposits of Armenia and the valley of the Alazani in Georgia. From Getahovit, 31 to 36 hours are necessary to go to the outcrops of Gutansar, Tsaghkunyats or Gegham, and about 35 hours to reach the region of Tsiteli Gorebi (according to the 'least-cost path' analysis) (Chataigner and Barge, 2008).

6.3.1. Material from the site of Tsiteli Gorebi 5 (Rova, 2018)

Pottery

The similarities that exist between the pottery of Getahovit-2 and that of Tsiteli Gorebi 5 are strong:

- almost exclusive predominance of more or less coarse mineral temper
- often light-coloured clay section, well-oxidised, rarely black
- walls often covered with smoothed brown/red slip
- open shapes, large vessels having thick walls or small vessels having finer walls, with straight or everted rims and flat bases
- absence of decoration at Getahovit and rareness of decoration at Tsiteli Gorebi 5.

But above all, these shared characteristics are accompanied by a total absence of Chaff-Faced ware, present during the same period (5th millennium BC) on most of the other sites of the central part of the South Caucasus (Mentesh, Ovçular, Areni-1).

Lithics

The similarity suggested by the study of the pottery is confirmed by that of the lithic industry. At Tsiteli Gorebi 5, the lithic assemblage (Rova, 2018: fig. 13) is almost exclusively composed of obsidian, with a small component of quartzite and flint. The majority of the assemblage consists of unretouched flakes; the remaining items are irregular tools on flakes or blades, mostly end-scrapers. The presence of a few nuclei and of numerous small flakes suggests *in situ* processing of the raw material.

Thus we find here the same industry on flakes in obsidian, taking place on site, as that observed in the cave of Getahovit.

6.3.2. Provenance of the obsidian from the site of Tsiteli Gorebi excavated by Varazashvili (1992)

During the excavations carried out in the 1970s in the region of Tsiteli Gorebi, 7 artifacts taken from one of the sites were analysed (Badalyan, 2010). The obsidian of these artifacts came from Gegham (3 pieces), Tsaghkunyats (2 pieces) and an undetermined provenance (2 pieces). These sources of Gegham and Tsaghkunyats echo the sources for the obsidian tools from Getahovit.

These provenances differ from those of the other Late Chalcolithic sites established in the same valley of the Alazani (Padar, Minberek). Badalyan (2010: 33) was surprised by this difference and pointed out that while Padar received most of its obsidian from the source of Chikiani in southern Georgia, Tsiteli Gorebi was oriented towards the sources of Tsaghkuniats and probably also the plateau of Kars

(Sarıkamış). In the absence of radiocarbon dates for the Chalcolithic occupations of these two sites, this is difficult to confirm, but it is possible that this difference in provenance was related to a difference in chronology – that Tsiteli Gorebi dates to the 5th millennium and Padar to the 4th millennium.

6.3.3. Tradition of the great transhumance of the shepherds of Kakheti

The province of Kakheti consists of alpine meadows on the southern slopes of the Greater Caucasus and winter pastures in the lower valley of the Alazani. Studies of present-day pastoralism (Mercy Corps, 2011) in this region show that the shepherds practise long-distance transhumance, as much for summer pastures as well as for wintering, in order to not over-exploit the local pasture lands. Thus, one of the main transhumance routes today in Georgia leads from the winter pastures in Kakheti in eastern Georgia to the summer pastures in the high upland plateaux of central (Kvemo Kartli) and southern (Samtskhe-Djavakheti) Georgia. An analysis of the vegetation based on Landsat images has enabled tracing this itinerary, which is characterised by over-grazing in comparison to neighbouring lands (Mercy Corps, 2011: fig. 3).

In Kakheti in the Soviet period, a phenomenon of double migration for sheep existed: sheep were based in villages in the foothills, climbed to the mountain pastures in summer and descended to the lowland pastures in winter, up to the shores of the Caspian Sea in Daghestan (UNDP Georgia, 2014: 41). When this practice became forbidden to them, the herds grazed on local lands, but this caused degradation of pasture zones and erosion of the soil.

This contemporary transhumance, on foot over long distances, from the region of Kakheti where Tsiteli Gorebi 5 is located, shows that such movements are possible (in spite of modern constraints on the circulation of herds) and supports the hypothesis that they took place in the past. In the 5th millennium, the populations of Getahovit-2 and Tsiteli Gorebi 5 belonged to the same cultural group, the Sioni cultural complex, and the practice of transhumance over long distances could have been the main basis for contact and exchanges between the different components of this group.

7. Conclusion

The excavation of level III in the cave of Getahovit-2 thus shows that, in the middle and the second half of the 5th millennium BC, the cave several times served as a sheepfold. These occupations were created by human groups who belonged to the same culture, the Sioni cultural complex, characterised notably by pottery with a high content of mineral temper, with walls often covered by a smoothed light brown or reddish-brown slip. Human groups came periodically to the cave with herds of caprines to stay the autumn (gathering of *Celtis* fruits) and at least part of the winter. Subsistence was mostly based on hunting. It is also possible that, alternating with the wintering of the herd, hunters belonging to the same cultural group stayed in the cave.

The analyses of provenance of the obsidian artifacts, corroborated by the techno-typological study of the artifacts, have enabled the differentiation of two assemblages: the first, coming from deposits situated in Armenia and consisting of blanks knapped by percussion (flakes above all), and the second coming from deposits situated in Georgia or Turkey and consisting of pressure-flaked blades.

In the first assemblage, obsidian pieces of ‘regional’ origin, most of the blanks were brought to the site already knapped; the pre-forms could have been worked at the outcrops or another place, in particular the village from which the shepherds came. The diversity of the sources represented at Getahovit-2 can in fact be explained, either by direct acquisition from the outcrops frequented during the summer, which ones depending on the year, or by procurement in the base village of the shepherds, to which had been brought rough blocks obtained during their movements. On the spot, in the cave, the artifacts were retouched, refreshed, and small elements intended for projectile points for hunting could be produced.

The provenance of these obsidian artifacts reveals a development over time. Around the middle of the 5th millennium, between 4624 and 4455 cal BC (calibrated median values), most of the obsidian

(47.8%) came from Gutansar, a deposit situated in the northern part of the plain of Ararat, like Arteni (8.7%). The two other sources, Gegham and Tsaghkunyats (21.7% each) are situated at altitude and accessible only in summer. These provenances suggest that the populations that brought their herds to winter at Getahovit had strong links with the plain of Ararat from which they probably originally came. They could have collected blocks of obsidian in this region inter-seasonally, between the summer pastures at high altitude (Gegham, Tsaghkunyats), imposed by the aridity of the Ararat plain in summer, and the winter pastures in the Tavush (Fig. 15).

Fig.15. Exchange network within which the Chalcolithic occupation of Getahovit-2 was situated.

In the second half of the 5th millennium, between 4406 and 4171 cal BC (calibrated median values), the source of Gutansar became much less important (8.3%), while that of Tsaghkunyats became preponderant (61.1%) and Gegham increased (30.6%). The source of Arteni seems no longer represented. This development in the procurement of obsidian suggests a movement of these populations towards the north, but also their integration into a network of circulations over long distances.

This movement towards the north could have been related to the penetration of Mesopotamian influence into the southern parts of Armenia (Areni-1) and Azerbaijan (Ovchular), where in the same period Chaff-Faced ware clearly predominated. On these sites, Sioni ware, considered to be a local production in the South Caucasus (Lyonnet, 2018: 564), remained in use, but minimally. At Mentesh, in north-western Azerbaijan, it is also in the last third of the 5th millennium (period III, between 4360 and 4129 cal BC in calibrated median values) that an intrusion from northern Mesopotamia is revealed in the architecture (tripartite buildings) and in the Chaff-tempered pottery with specific features, such as incisions on the interior of bowls (Lyonnet, 2018: 562). The human groups that lived in the cave of Getahovit used only Sioni ware and thus belonged to the local substratum which did not mix with the new arrivals, but were pushed northward.

The local populations did nevertheless maintain in the last third of the 5th millennium BC a network of circulations over long distances, probably thanks to inter-regional relations that they had previously established. The similarities in the pottery production, the lithic tools and the provenance of the obsidian between Getahovit and the region of Tsiteli Gorebi in north-eastern Georgia (valley of the Alazani) suggest that related groups circulated between the basin of the middle Kura and the highlands of Armenia, crossing the Lesser Caucasus through the valley of the Aghstev (Fig. 15).

Such an inter-regional network would have stimulated exchange, as seen in the second assemblage of obsidian artifacts from Getahovit, a few pressure-flaked blades and bladelets (an elaborate technique not practised at Getahovit) whose material came either from Chikiani in southern Georgia (region of Javakheti), or from Sarıkamış in north-eastern Turkey (region of Kars). These artifacts, imported in a finished state to Getahovit, probably came from exchanges with the populations of the Kura or the Arax basins where these two sources of obsidian supply were well attested.

These conclusions echo the remarks of Arbuckle and Hammer (2019: 430) for the neighbouring regions of the Caucasus in the 5th millennium BC: “a shift to more intensive and specialized caprine pastoralism did occur in the fifth millennium BC, but rather than representing a shift to nomadism, this change seems to have occurred primarily in the context of mixed agropastoral communities... On the Anatolian plateau, caprine pastoralism was increasingly dispersed, including a more diverse array of summer and winter pastures spread over a wider geography than in previous periods, yet herders were still fundamentally part of village settlements (Makarewicz et al., 2018)... This system of increasingly mobile, but anchored, caprine pastoralism also was likely practiced in the central Zagros, where caves and small campsites were used by herders with material culture connections to nearby agricultural villages (Potts, 2014).”

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Conflict of interest

The authors have no competing interests to declare.

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CAPTIONS

Figures

Fig.1. Map showing locations of the principal sites mentioned in the text and the obsidian deposits exploited by the inhabitants of the cave of Getahovit-2.

Fig.2. View from the cave of Getahovit-2 over the meanders of the Khachakhyur and the valley of the Aghstev in the background.

Fig.3. The cave of Getahovit-2: a) Section W-E, squares A7 to J7; b) Section N-S, squares B1 to B7; c) Plan of the first space of the cave.

Fig.4. Stratigraphy of the cave based on the excavation carried out in 2014 (in Roman numerals: Layers; in Arabic numerals: Stratigraphic Units (US)).

Fig.5. Obsidian industry from level III: 1-2) flake cores ; 3-4) splintered pieces ; 5) flakes ; 6) splinters; 7-8) end-scrapers on flake; 9) transverse arrowhead; 10) segments; 11-15) blades.

Fig.6. Binary diagram of Ba/Zr-Ba/Sr ratios for the obsidian artifacts at Getahovit-2 (*).

Fig.7. Spectra of contents in REE (Rare Earth Elements) in the obsidian artifacts at Getahovit-2, standardized to that of the earth's crust (Wedepohl 1995).

Fig.8. Binary diagram of La/Yb-Nd/Sm ratios for the obsidian artifacts at Getahovit-2 (*).

Fig.9. Profiles of concentrations made on a section of the tool E3a. The y-axis represents the ratio between the concentration of the element "x" at the depth "d" and its average concentration measured at the center of the object.

Fig.10. Flint: 1-3) Deposits at Sarigyugh: location (1) and outcrops (2-3); 4-8) artifacts from Getahovit-2: transverse arrowhead (4); fragments of projectile point (5); 'Kmla tool' (6); core (7) and end-scraper (8).

Fig.11. Antler industry: proximal part of a shed left antler (US 32; late Chalcolithic; 2015 excavations).

Fig.12. Pottery from Getahovit-2: 1-2) upper parts of large cylindrical vessels; 3-6) different types of rims; 7-8) fragments of vessel bodies; 9-10) bases of large vessels.

Fig.13. Chalcolithic pottery : 1) Bavra-Ablari rockshelter (Javakheti, South Georgia); 2) Tsaghkahovit rockshelter (north of Aragats massif, Armenia): a) outer surface; b) inner surface.

Fig.14. Chronological comparison with the principal sites of the South Caucasus in the 5th millennium BC (see Annex A17 for the sources of the dates).

Fig.15. Exchange network within which the Chalcolithic occupation of Getahovit-2 was situated.

(*) The groups are named based on the sources of obsidian published in the following works: Chataigner and Gratuze 2014, Chataigner et al. 2014, Biagi et al. 2017.

Tables

Tab.1. C14 dates for Getahovit.

Tab.2. Provenance groups for obsidian artifacts: distribution

Tab.3. Distribution of the obsidian artifacts analysed in terms of their provenance and the occupation phases of the site of Getahovit-2.

APPENDIX

A1: Compositional data obtained by LA-ICP-MS for the 61 obsidian artifacts from Getahovit. Data are expressed in wt. % of oxides for the main major and minor elements (Na₂O to Fe₂O₃).

A2: Compositional data obtained by LA-ICP-MS for the 61 obsidian artifacts from Getahovit. Data are expressed in parts per million for trace elements (Li to Pr).

A3: Compositional data obtained by LA-ICP-MS for the 61 obsidian artifacts from Getahovit. Data are expressed in parts per million for trace elements (Nd to U).

A4: Distribution of the analyzed artifacts according to their contexts, types of artifact and sources of obsidian.

A5: Spectra of rare earths in obsidian artifacts of Getahovit for the sources of Arteni, Gutansar, Chikiani and Kars/Sarikamiş.

A6: Spectra of rare earths in obsidian artifacts of Getahovit for the sources of Gegham and Tsaghkunyats.

A7: Spectra of rare earths in obsidian artifacts of Getahovit attributed to Chikiani and Arteni, compared to the spectra of these two sources.

A8: Spectra of rare earths in obsidian artifacts of Getahovit attributed to Gegham and Gutansar, compared to the spectra of these two sources.

A9: Spectrum of rare earths in obsidian artifacts of Getahovit attributed to Tsaghkunyats, compared to the spectra of the different outcrops of this source.

A10: Spectrum of rare earths in obsidian artifacts of Getahovit attributed to Kars/Sarikamiş, compared to the spectra of the sources of North Sarikamiş, South Sarikamiş and Yağlıca Dağ.

A11: Spectrum of rare earths in obsidian artifacts of Getahovit attributed to Kars/Sarikamiş, compared to the spectra of artifacts whose provenance is Ismayilbey Tepe or Mentesh.

A12: Distribution of obsidian tools of Getahovit, Ismayilbey Tepe and Mentesh attributed to Kars/Sarikamiş, in terms of the ratios of concentration of barium/zirconium and barium/strontium.

A13: Distribution of obsidian tools of Getahovit, Ismayilbey Tepe and Mentesh attributed to Kars/Sarikamiş, in terms of the ratios of concentration of zirconium and barium.

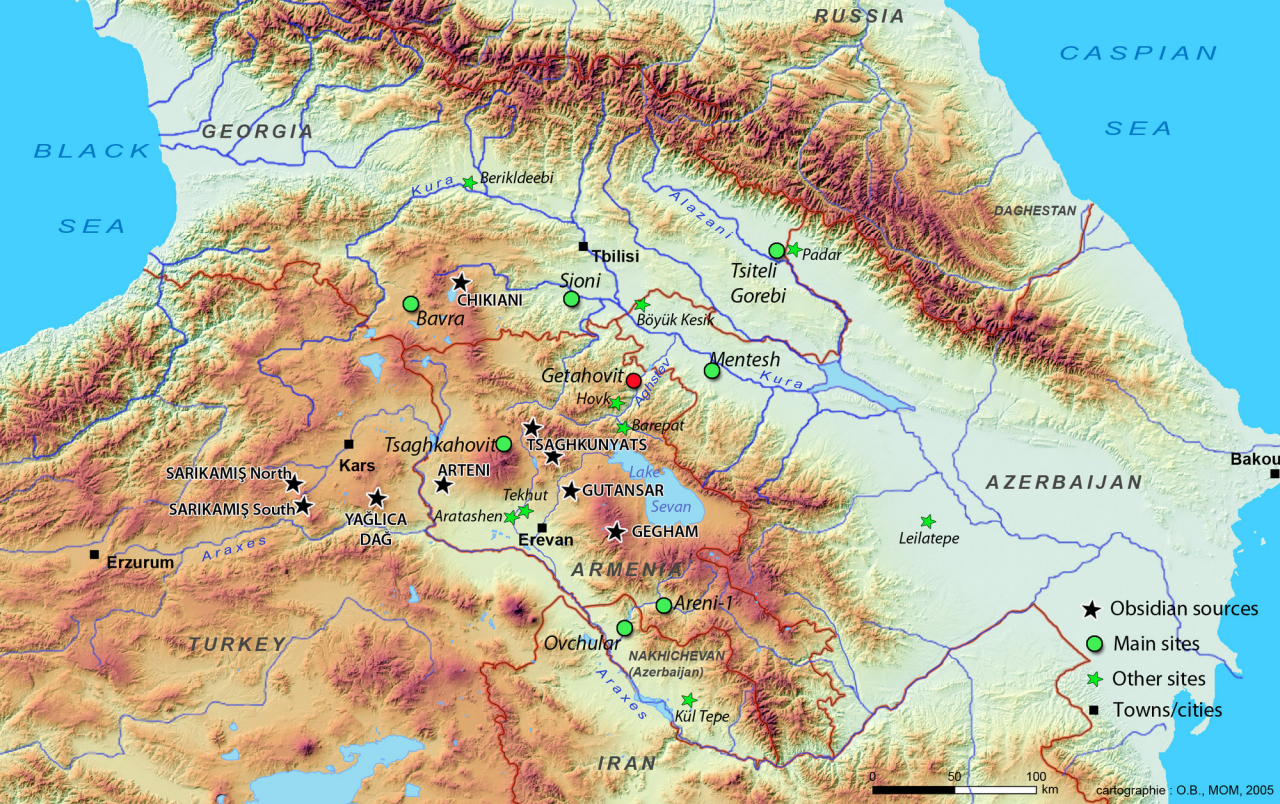
A14: Distribution of obsidian tools of Getahovit, Ismayilbey Tepe and Mentesh attributed to Kars/Sarikamiş, in terms of the ratios of concentration of niobium/zirconium and yttrium/zirconium.

A15: Distribution of obsidian tools of Getahovit, Ismayilbey Tepe and Mentesh attributed to Kars/Sarikamiş, in terms of the ratios of concentration of lanthanum/ytterbium and neodymium/samarium.

A16: Condition of the surface of sample E3a (a and c) compared to the condition of the surface of sample J6b (b and d).

A17: Succession of samples taken from the section of tool E3a.

A18: Radiocarbon dates for the principal sites of the 5th millennium in the South Caucasus.

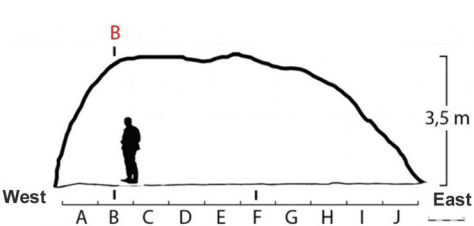


- ★ Obsidian sources
- Main sites
- ★ Other sites
- Towns/cities

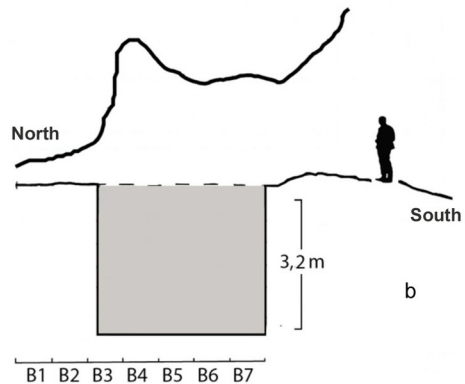


cartographie : O.B., MOM, 2005

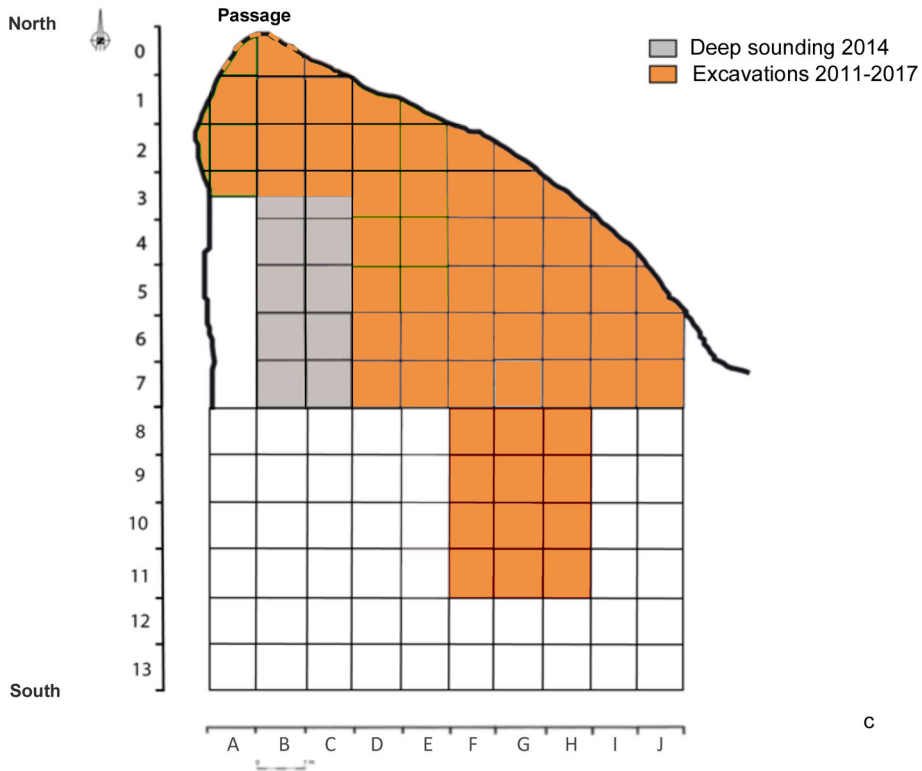




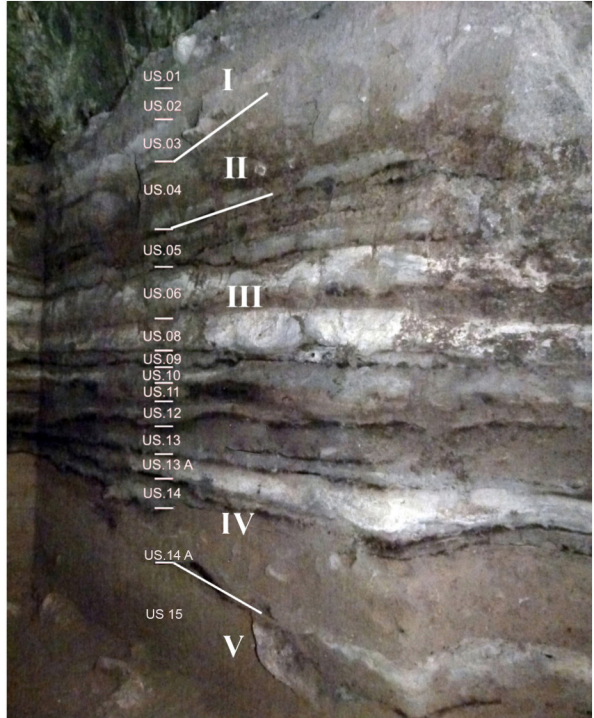
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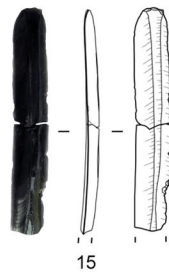
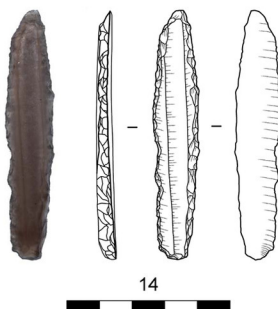
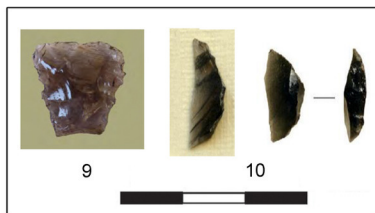
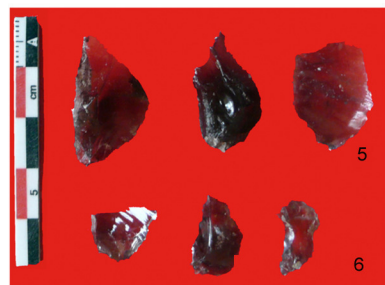
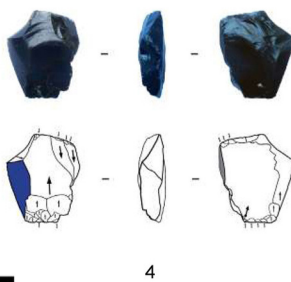
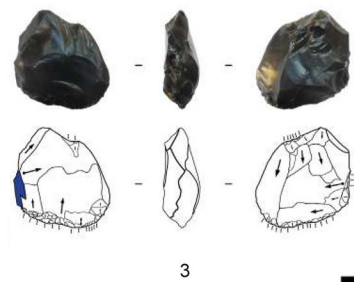
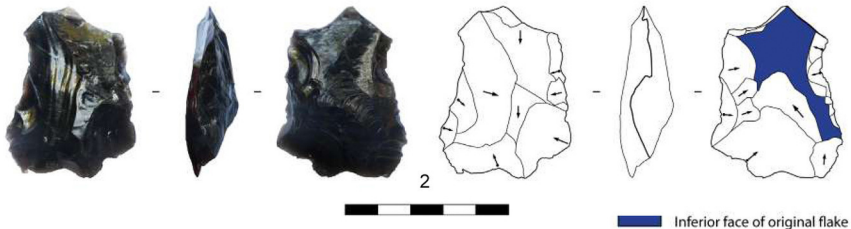
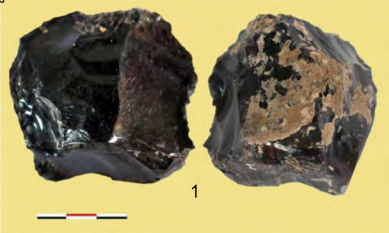


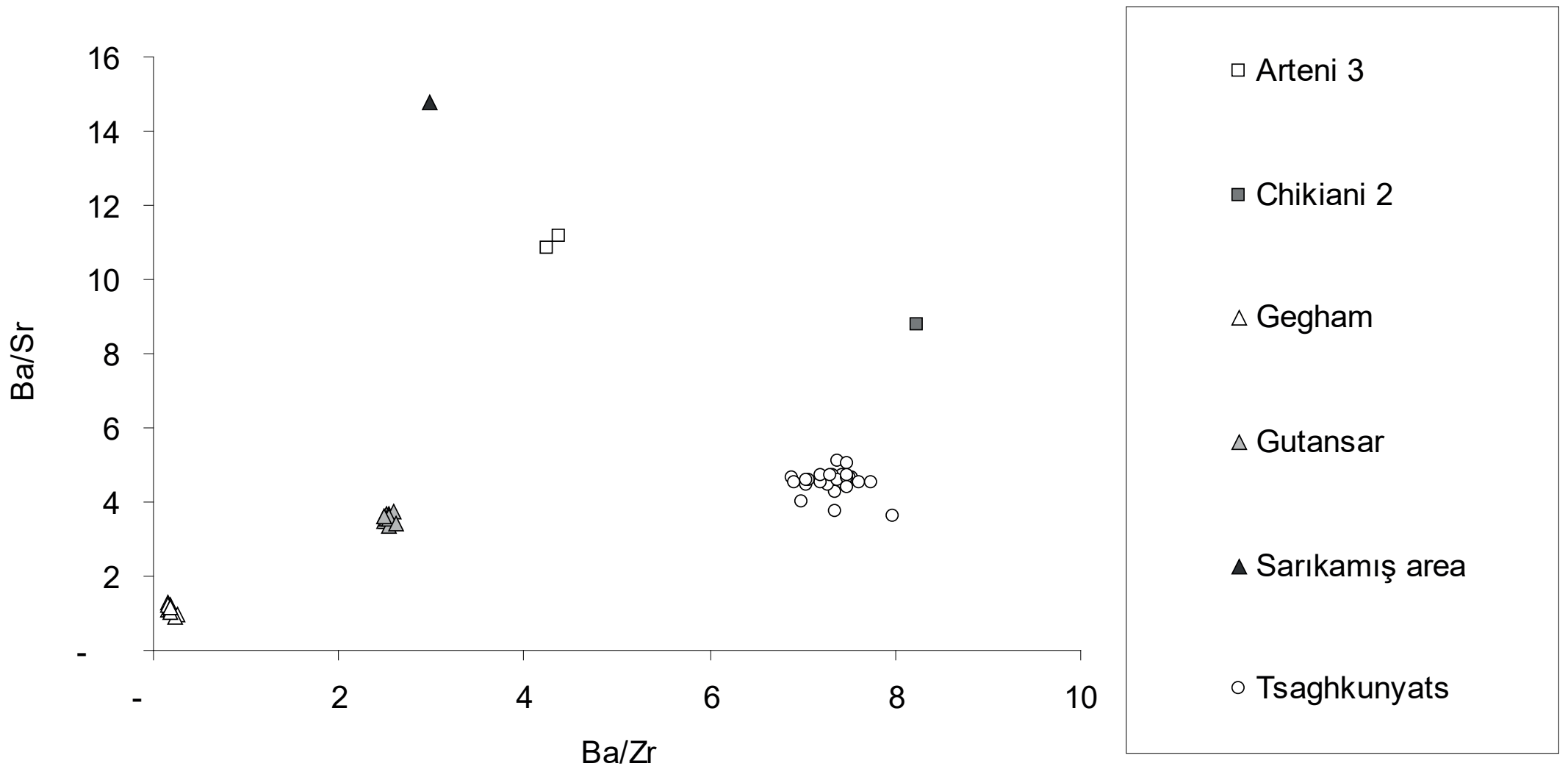
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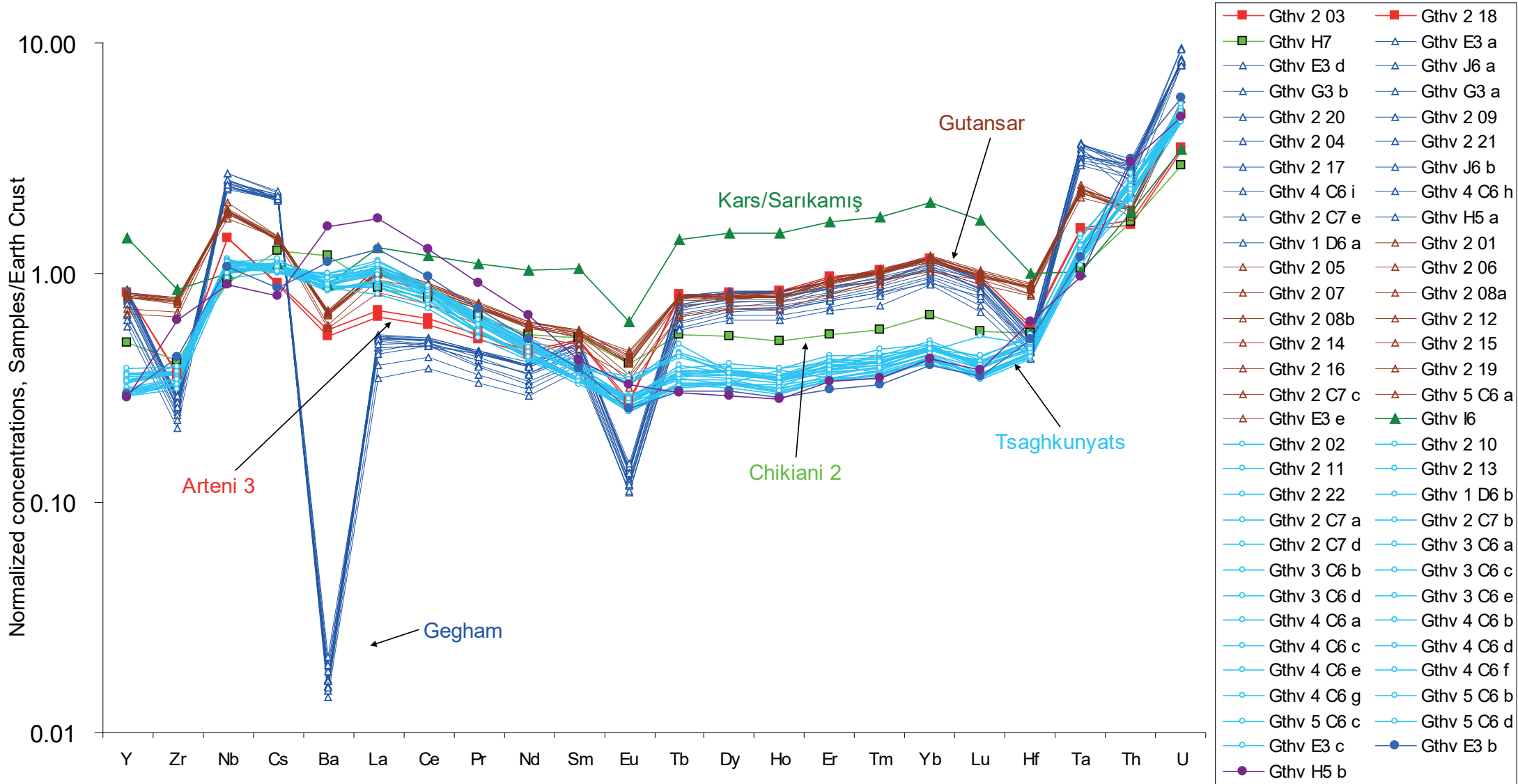


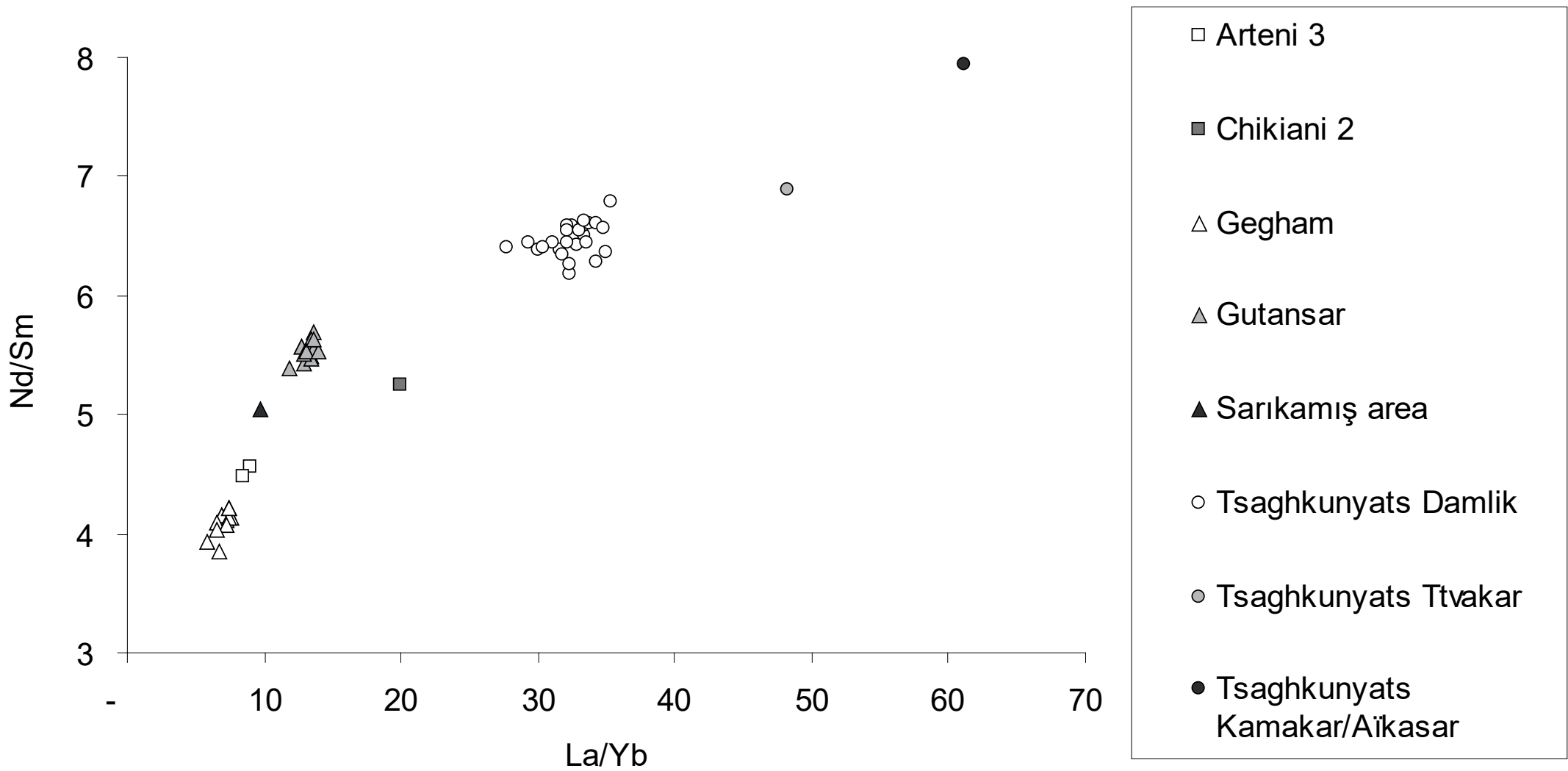
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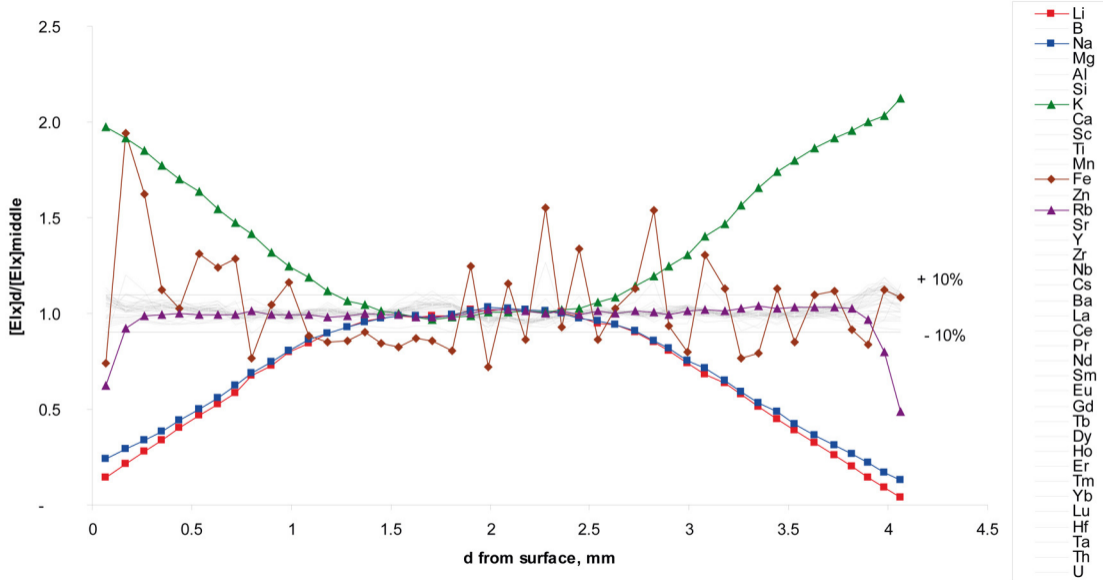














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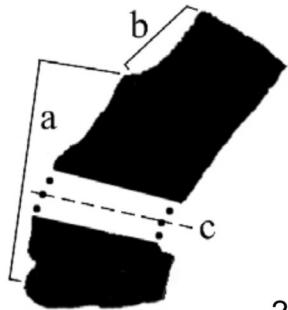
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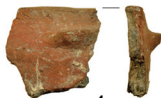
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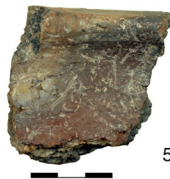
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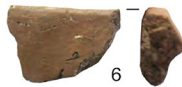
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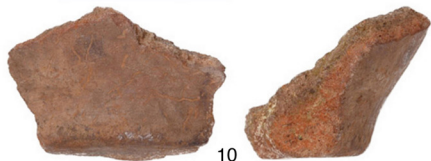
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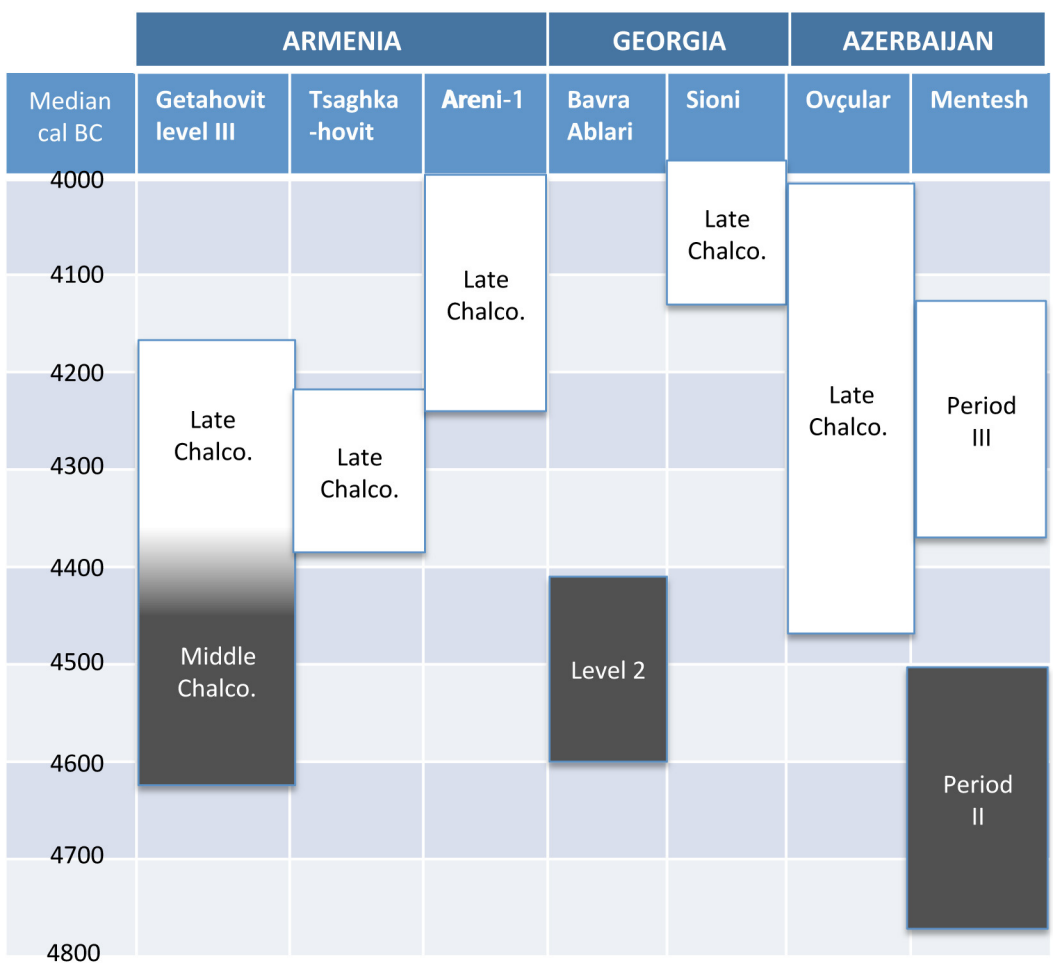


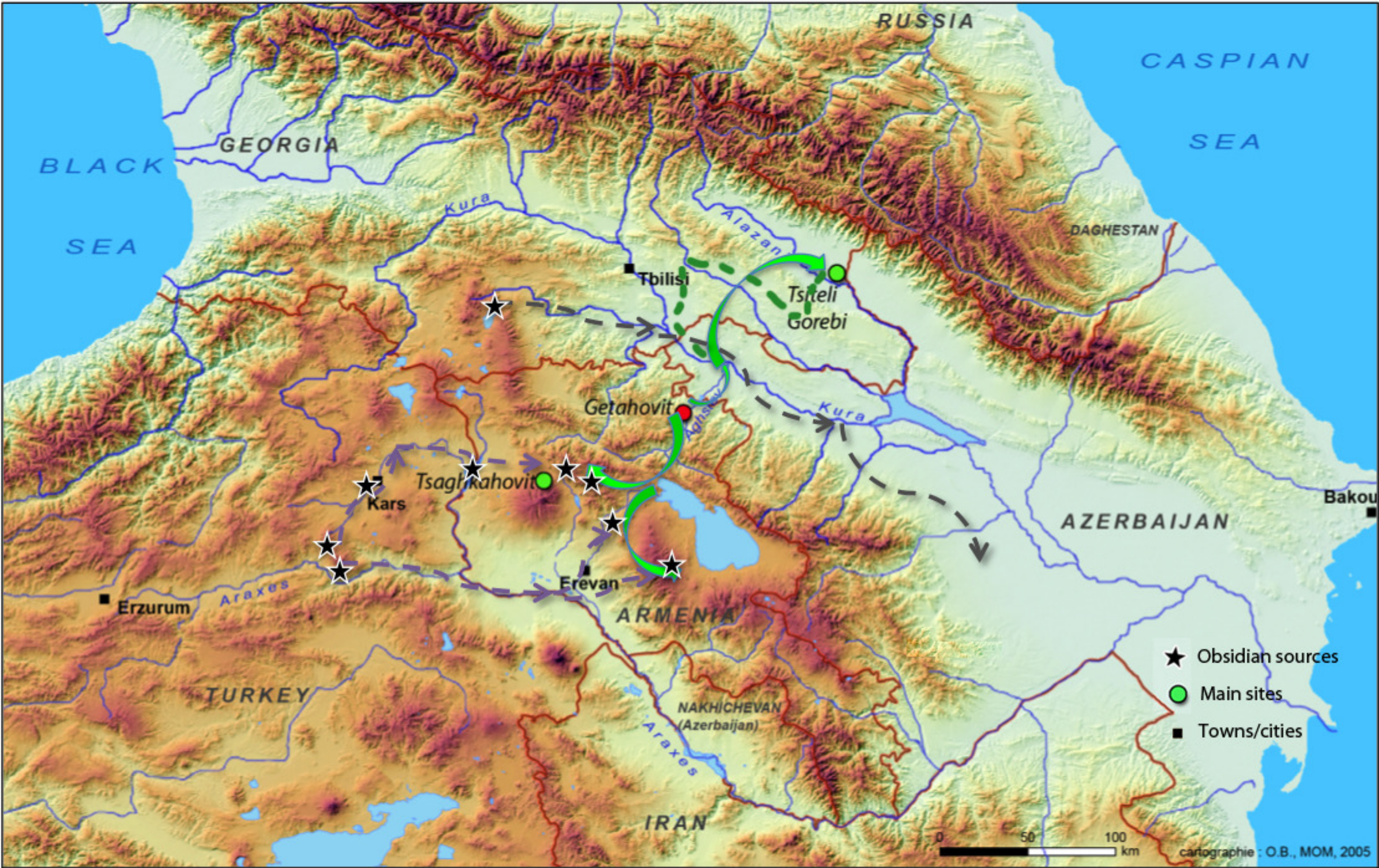
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- ★ Obsidian sources
- Main sites
- Towns/cities

0 50 100 km

cartographie : O.B., MOM, 2005

<i>Code Lab.</i>	<i>Year</i>	<i>Square</i>	<i>Context *</i>	<i>Material</i>	<i>Date BP</i>	<i>Cal AD (95%)</i>	<i>Median</i>	<i>Level</i>	<i>Phase</i>
Lyon-10370 (SacA-34117)	2012	D7	US 03 (tomb)	charcoal	1060 ± 30	897-1024 AD	987	I	Middle Ages
Lyon-13486 (SacA-47796)	2015	G3	US 03 (child tomb)	charcoal	980 ± 30	993-1155 AD	1076		
LTL12043A	2011	C7	US 03	charcoal	933 ± 45	1021-1206 AD	1102		
								II	sterile
<i>Cal BC (95%)</i>									
Lyon-13484 (SacA-47794)	2015	I6	US 05	charcoal	5340 ± 35	4316-4051	4171	III	C h a l c o l i t h i c
Lyon-13483 (SacA-47793)	2015	I6	US 05 / 30	charcoal	5400 ± 35	4341-4077	4276		
Lyon-13482 (SacA-47792)	2015	E3	US 05 / 32	charcoal	5420 ± 35	4346-4179	4287		
Lyon-13485 (SacA-47795)	2015	I4	US 05	charcoal	5435 ± 35	4347-4050	4291		
Lyon-11540 (SacA-38689)	2013	B5	US 06	charcoal	5485 ± 40	4447-4258	4339		
BETA-306022	2011	C7	US 06	charcoal	5490 ± 30	4445-4262	4342		
Lyon-10368 (SacA-34115)	2012	D6	US 06	burnt bone	5520 ± 30	4449-4331	4363		
Lyon-10369 (SacA-34116)	2012	D6	US 06	charcoal	5575 ± 30	4458-4353	4406		
LTL-14985A	2014	B4/ B5	US 08	charcoal	5626 ± 45	4541-4360	4455		
BETA-510630	2018	H6	US 11 / 52	charcoal	5640 ± 30	4542-4371	4474		
LTL-14986A	2014	C7	US 12	charcoal	5719 ± 40	4683-4463	4562		
BETA-510631	2018		US 13 / 57	charcoal	5770 ± 30	4703-4545	4624		
LTL-14987A	2014	D7	US 14A	charcoal	6174 ± 45	5289-4995	5127	IV	
								V	sterile
								VI	sterile
BETA-393561	2014	B6	US 18	sediment	19750 ± 70	22020-21685	21834	VII	Upper Palaeo.

* Context = US according to the 2014 stratigraphy / unit according to the following excavations
US 11 / 52 = US 11 (in 2014) / unit 52 (in 2018)

Getahovit-2	Tsaghkunyats	Gegham	Gutansar	Arteni3	Chikiani2	Sarıkamış
N samples	27	16	14	2	1	1
%	44,3%	26,2%	23,0%	3,3%	1,6%	1,6%

Getahovit-2	Tsaghkunyats*	Gegham	Gutansar	Arteni3	Chikiani2	Sarikamiş
N Late Chalcolithic	22	11	3	0	1	1
N Middle Chalcolithic	5	5	11	2		
% Late Chalcolithic	57,9%	28,9%	7,9%		2,6%	2,6%
% Middle Chalcolithic	21,7%	21,7%	47,8%	8,7%		