Multiple origins of Makhvilauri obsidian and mobility patterns of early humans in Western Georgia in the Middle Holocene

Guram Chkhatarashvili[a], James A. Davenport[b], Michael D. Glascock[b], Merab Khalvashi[c], Teona Zoidze[c]

[a]*Batumi Shota Rustavelis State University, 6010, Batumi, Rustaveli/Ninoshvili 32/35, Georgia*
[b]*Research Reactor Center, University of Missouri, Columbia, MO 65211, USA*
[c]*Batumi Shota Rustavelis State University, 6010, Batumi, Rustaveli/Ninoshvili 32/35, Georgia*

A B S T R A C T

The Caucasus, situated strategically in terms of natural geography and abundant raw materials, has been attractive to the interest of prehistoric hunter-gatherers throughout ancient times. Recent discoveries at the Neolithic site of Makhvilauri in the Ajara region, affirm this historical focus. The Makhvilauri flaked stone tool assemblage encompasses various lithic resources, of which ~11% (n=59) comprise obsidian, a raw material whose closest sources are 170 km away. Using the XRF method at the Archaeometry Laboratory at the University of Missouri Reactor Research (MURR) to elementally characterise 23 of the obsidian artifacts (~39 % of the total) we can demonstrate that the Makhvilauri assemblage was made from at least five geochemically distinct sources". This analysis not only sheds light on the mobility patterns of ancient communities but also underscores the extensive contacts established during the Neolithic period Age (6th millennium BC).

Keywords: Caucasus, obsidian, XRF, mobility, Holocene

1. Introduction

Obsidian, among various types of stone like flint, basalt, argillite, cobblestone, etc., served as a crucial raw material for crafting a diverse array of tools such as endscrapers, burins, perforators, retouched knives, chisels, arrowheads, and more. The geographical distribution of obsidian is closely linked to volcanic mountainous regions, where these sources originated from volcanic activity. Notably, each obsidian source possesses its distinctive "geochemical signature," a term referring to a unique chemical composition. The identification of these chemical elements allowing us to unravel the mobility patterns and contacts of ancient communities.

The earliest evidence of obsidian use in the Caucasus is associated with the Lower Paleolithic (Panicchkina, 1950; Liubin, 1998; Adler et al., 2014). In the Middle Paleolithic, obsidian became more frequently used (Djafarov, 1999; Liubin, 1989; Pinhasi et al., 2011; Frahm et al., 2016). It should be noted that in some cases, obsidian raw materials were brought to archaeological sites from several hundreds of kilometers away (Glauberman et al., 2016; Doronicheva and Shackley, 2014; Kandel et al., 2017; Doronicheva, 2015; Golovanova and Doronicheva 2012).

In the territory of modern Caucasus, the main sources of obsidian are located in Georgia, Kabardino-Balkaria (Northen Caucasus), Armenia, Azerbaijan, and Eastern Turkiye (Fig. 1). Numerous open-type settlements, dating back to the Mesolithic/Neolithic period, have been unearthed along the Black Sea coast, foothills, and mountainous regions of southwestern Georgia (Ajara-Guria). The lithic artifacts from these sites often contain a substantial quantity of obsidian. Unfortunately, the specific origins most of these obsidian artifacts remain undetermined. Notably, recent publications on this matter (Badalyan et al. 2004; Chkhatarashvili and Glascock 2022) provide valuable insights, though the overall picture remains incomplete.

Certainly, obsidian makes an early appearance in Western Caucasia during the Palaeolithic period, albeit seemingly in limited use. In the exploration of cultural layers spanning the Lowe, Middle and late Palaeolithic, obsidian constitutes approximately 1-2% of the lithic assemblages (Adler et al., 2006, 2008; Bar-Yosef et al., 2011; Meshveliani et al., 1999; Pinhasi et al., 2014; Tsereteli, 1973; Tushabramishvili, 1960; Tushabramishvili et al., 1999, 2012). However, a noteworthy transformation occurs towards the end of the Paleolithic and the beginning of the Mesolithic periods. In specific archaeological sites, obsidian becomes a dominant component, comprising 40-45% of the entire lithic assemblages (e.g., Kobuleti, Anaseuli I, Khutsubani, Kvirike, etc.). This suggests that Lower and Middle Palaeolithic people initially relied on locally available high-quality flint, content with the resources at hand. Conversely, Upper Palaeolithic population exhibited a gradual adaptation to the environment, leading to a substantial increase in obsidian usage during the Upper Palaeolithic and Mesolithic periods. In many instances, the presence of obsidian cores in the lithic inventory indicates that *Homo sapiens sapiens* not only transported raw materials but also engaged in on-site craftsmanship. Consequently, *Homo sapiens sapiens* demonstrated greater mobility in resource acquisition compared to Neanderthals.

The current paper delves into a exploration of the outcomes derived from the geochemical analysis of obsidian discovered at the Neolithc settlement of Makhvilauri in the Ajara region. This investigation promises to provide an insight into the mobility and contacts of ancient people across the entirety of Western Caucasia during the middle Holocene.

2. Geographical position and Archaeological Background

The village of Makhvilauri is situated in the Ajara region (Fig. 2) of western Georgia, approximately 8 km southeast of Batumi, along the Chorokhi River. Positioned on a medium-height hill, it is flanked by the Makhvilauristskali river to the north and the Mejinistskali river to the southeast. The hill stands 5-6 m above the river level, exhibiting a rounded configuration with a relatively sloping eastern part and straight western and northern sides.

Geographically, the village Makhvilauri is situated in the Colchis plain, occupying the far eastern expanse of the Black Sea region. This area experiences a subtropical climate, fostering the growth of plants endemic to the mentioned geographical zone. While the Colchis plain is notably swampy, it maintains an elevation above sea level. Consequently, the soil composition in this region reflects the distinct characteristics of such topography. The climate in the Colchis plain is characterized by consistently high temperatures and robust conditions. Notably, abundant precipitation is a defining feature of this climate.

The current archaeological site is situated in the residence plot (tangerine garden) of the Tsulukidze family, a local resident of the village Makhvilauri in Khelvachauri Municipality. Originally intended for the construction of a residential house, the site's discovery occurred by chance in 1968 when the landowner initiated foundation work. Noteworthy stone artifacts, including flint and obsidian tools, a polished stone axe, and a hoe-like tool, were uncovered. Archaeological investigations commenced in 1969 (Fig. 3), initially encompassing the entire settlement area. The excavation process involved removing the upper humus layer, yielding a significant amount of archaeological material within a 30-40 cm thickness. Subsequently, a reddish-yellow clay layer (40-60 cm) was revealed (Fig. 4), containing a comparatively lesser amount of material. Three control trenches were established in the study area, unveiling the utilization of the settlement for storage in its later period, as indicated by the presence of cobblestones (a total of 17 recorded). The cairns identified as Bronze Age pit burials had intersected with and entirely obliterated the underlying Neolithic cultural layer.

Field archaeological excavations were conducted at the Makhvilauri settlement in 2001 and resumed in 2014-2015. Regrettably, the cultural layer had been significantly disrupted due to frequent land cultivation. The focus of the excavations were primarily centered on the southern part of the previously explored area (Kakhidze et al., 2017:85-112). The objective was to investigate and explore tombs dating from the Late Bronze-Early Iron Age.

During the years 2022-2023, concurrent with the archaeological excavations in the village of Kobuleti, reconnaissance and search operations were carried out. Multiple control trenches were excavated, with only the third trench uncovering an undisturbed cultural layer. In this area, approximately 14 m^2 was meticulously studied, revealing a compelling inventory of stone artifacts, pottery fragments, and charcoal. The observed stratigraphic layers provided valuable insights into the historical context of the site. The following stratigraphic picture was observed:

1 - green layer, 0-5 cm
2 - humus, 5-20 cm
3 - light-brown layer, 20-50 cm
4 - yellow clay layer, 50 cm and below

The light brown layer corresponds to the cultural layer of the Neolithic age. Within this layer, a substantial quantity of artifacts was discovered, including flint and obsidian tools, cobblestone and basalt stone tools, along with numerous ceramic fragments. Additionally, charcoal was carefully collected from the undisturbed cultural layer for subsequent laboratory analyses.

Stone artifacts and pottery stand as the sole remnants providing insights into the life of early humans during that period. The subtropical climate of the Ajara region, characterized by excessive rainfall, posed significant obstacles to the preservation of osteological materials. As a result, no traces of bone and/or wood remains have been identified. The absence of palynological data further complicates our understanding of the past. To reconstruct the paleoenvironment of that period, we rely on the contemporary village of Makhvilauri. Palynological studies conducted on Kobuleti settlements from the Atlantic period revealed the presence of heat-loving plants (Chkhatarashvili et al., 2020). It is presumed that similar climatic conditions would have prevailed in the vicinity of the Makhvilauri settlement during that time.

The archaeological campaigns yielded an approximate total of 2,000 artifacts, including 552 pieces of flint and obsidian (see Table 1), 643 cobblestones, 714 ceramic fragments, etc. Archaeologist Sergo Gogitidze, the initial investigator of the site, assigned the finds to the late Neolithic period, specifically dated to the 7th-6th millennia BC based on Georgia's archaeological periodization. To verify these dates, radiocarbon analysis of charcoal (C^{14} AMS) was conducted, confirming the previously mentioned chronological attribution (see Table 2: 1-2). It is noteworthy that this marks the first absolute date in the history of Makhvilauri studies, offering crucial information for the periodization of Neolithic archaeology.

3. Chipped stone assemblage of Makhvilauri

The analysis of the chipped stone inventory reveals that lithic production in the settlement of Makhvilauri was accomplished through hand pressure techniques. This is evident from the presence of conical cores (Fig. 5, 1) all made of pinkish-reddish flint. Notably, the majority of these cores were exhausted indicating the proficiency and thoroughness of the hand pressure techniques employed.

Table 1. Makhvilauri. Flint and obsidian complexes.

Types of artifacts	Total Number			Percentage	
Cores and products of knapping	**Flint**	**Obsidian**	**Total**	**Flint**	**Obsidian**
Core	18	0	18	3.65	0.00
Flake	114	3	117	23.12	5.08
Blade/microblade	92	16	108	18.66	27.11
Chunk	150	15	165	30.42	25.42
Tools	**120**	**24**	**144**	**24.34**	**40.67**
Burins	7	4	11	1.41	6.77
Scrapers	24	10	34	4.89	16.94
Retouched blades	20	5	25	4.05	8.47
Notched blades	11	2	13	2.23	3.38
Perforators	6	1	7	1.21	1.69
Arrowhead	4	0	4	0.81	0.00
Geometric microliths	41	3	44	8.31	5.08
Backed bladelets	2	0	2	0.40	0.00
Combined tools	4	0	4	0.40	0.00
Total	**493**	**59**	**552**	**100 %**	**100 %**

The Makhvilauri stone inventory comprises 144 tools, with a particularly intriguing subgroup consisting of scrapers (Fig. 5, 17-20) in various shapes and sizes. The scrapers can be categorized into several distinct groups, including oval, round, and other variations.

Retouched and notched blades (Fig. 5, 2-10) constitute the second category among the tools (see Table I). The prevalent usage involves of blades. The tools are primarily fashioned on the distal and proximal parts of the blades. The retouch exhibits a predominantly subtle and thin character, applied to the dorsal side. Instances of retouch traces from both surfaces are relatively infrequent. In the case of notched blades, the notching is primarily executed from the ventral face, and it tends to be narrow.

Within the assemblage, burins (Fig. 5, 11-16) are represented by relatively diminutive specimens. Typologically, they do not exhibit a wide range of forms. Predominantly, simple one-sided burins dominate, with double-sided burins being infrequent.

The most significant and abundant subgroup within the tools collection consists of geometric microliths (Fig. 5, 21-25), totaling 44 units. These tools are crafted from narrow and thin flint/obsidian bladelets.

Within the collection of other types of tools, various types are represented, including perforators, arrowheads, sidescrapers, and other combined tools are relatively scarce, with notable examples being burin-scraper, scraper-perforator, and similar variations.

Backed microblades are notably small in size. Regrettably, during the field excavations, the prepared soil was not sifted, preventing the observation of micro-tools. It is anticipated that future field excavation endeavors, conducted with meticulous methodology, will enhance our comprehension of these tools and microliths in general.

A portion of the stone inventory from the Makhvilauri settlement comprises debitage, including fragments and unprocessed blades and flakes. The scarcity of the stone inventory suggests that there are minimal traces of prolonged occupation at the settlement.

Table 2. Radiocarbon dates the Makhvilauri site.

№	Dates (BP)	Dates (BC)	Lab. Index	Sample	Site	Referrence
1.	7070±32	6018-5851	FTMC-JU83-2	Charcoal	Makhvilauri	First published
2.	6802±39	5744-5627	FTMC-JU83-3	Ceramic	Makhvilauri	First published

4. The Elemental Characterization and Sourcing of the Makhvilauri Obsidian

In the recent period, the expedition of the Batumi Archaeological Museum, led by Guram Chkhatarashvili, conducted research aimed at determining the origin of obsidian artifacts discovered during excavations at Early Holocene sites in the Ajara region (Chkhatarashvili and Glascock, 2022). Additionally, in 2023, with financial support from the Shota Rustaveli National Science Foundation of Georgia, we initiated a comprehensive project dedicated to the investigation of obsidian artifacts obtained through field archaeological research at Early/Middle Holocene sites in Western Caucasia. The primary objective was to determine the origin and chemical composition of these artifacts. As part of the project, 23 pieces of obsidian flakes and chunks were gathered from the Makhvilauri stone collection. Notably, the ongoing geochemical analysis of the obsidian from Makhvilauri marks the inaugural instance in the site's study history. The significance of this work holds great scientific importance.

The study was conducted by submitting 23 artifacts from Makhvilauri samples to the Archaeometry Laboratory at the University of Missouri Reactor Research (MURR). Analysis was performed using a Thermo Quantx ARL lab-based XRF spectrometer. The instrument has a rhodium-based X-ray tube which was operated at 35 kV with a current to measure the emitted X-rays with a silicon diode detector. The instrument was specifically calibrated for obsidian by measuring a set of 40 very well-characterized obsidian source samples using data acquired by neutron activation analysis (NAA), inductively coupled plasma-mass spectrometry (ICP-MS), and XRF. For more information about this calibration see a publication by Glascock (2020).

The artifacts were non-destructively analyzed by XRF. Samples were counted for one minute each. The elements measured include K, Ca, Ti, Mn, Fe, Zn, As, Rb, Sr, Y, Zr, Nb and Th. However, due to the variation in sizes, shapes and thicknesses of the artifacts, the most reliable data is usually only possible for Rb, Sr, Y, Zr, and Nb. Sample size and thickness can be problematic for small artifacts which was solved by examining element ratios (Sr/Rb, Rb/Zr, etc.) as recommended by Hughes (2010). Multiple elements were used to determine differences between sources where ratio values would otherwise overlap.

5. Results

Results of XRF analysis were compared to a database of obsidian source samples which were also analysed at MURR using the same Thermo Quantx ARL lab-based XRF spectrometer. Analysis revealed a total of five sources (see Table 3) for the 23 obsidian artifacts from Makhvilauri (Figures 6, 7). These sources are Chikiani (Fig. 1, 11), Sarıkamış (Fig. 1, 5), Pasliner (Fig. 1, 4), Pokr Arteni (Fig. 1, 6), and an additional unknown source designated as “Akhtsu Type” (Fig. 1, 14). Data are available in Supplemental Table 1.

6. Discussion

Chikiani is a volcanic mountain situated in South Georgia, within the Javakheti region, near Paravani Lake. It stands as the exclusive source of high-quality obsidian in Georgia. Research, as documented in the literature (Badalyan et al., 2004; Biagi, P., Nisbet, R., 2018; Biagi et al., 2017; Gratuze and Rova, 2022), confirms that Chikiani supplied obsidian to archaeological sites spanning various periods, including the Mesolithic/Neolithic, Chalcolithic, Bronze Age, and others, across the territory of Georgia.

The Chikiani obsidian deposit is 170 km away in a direct line from the settlement of Makhvilauri. For a early human, traveling several hundreds of kilometers to replenish their obsidian supply was not an insurmountable problem. This is how obsidian from Chikiani was found in the Meznainskaya cave on the territory of the North Caucasus (Doronicheva, 2015: 221).

Chikiani obsidian exhibits notable diversity, with prevalent types including black, brownish, and reddish obsidians. Chikiani is likely one of the important volcanic mountains in the Caucasus, with an estimated age of 2.2-2.6 million years, as determined by research (Frahm, 2023).

Sarıkamış is a small town situated in the Kars province in the eastern region of modern Türkiye, known for its predominantly mountainous terrain. The area encompasses several mountains of volcanic origin, containing a significant deposit of obsidian. Studies confirm that Sarıkamış obsidian has been actively utilized for making tools since the Palaeolithic period (Le Bourdonnec et al., 2012). The obsidian itself is of high quality, primarily characterized by black and brownish varieties. Specialists classify Sarıkamış obsidian into "northern" and "southern" groups. The southern group, located near the modern cities of Mescitli and Sehitemin, is distinguished by a high concentration of barium and a relatively low concentration for zirconium (Chataigner et al., 2014). Its age is estimated to be 4.9-4.4 million years (Bigazzi et al., 1998). In contrast, the "Northern group," situated near modern cities such as Kizil Kilisa, Handere, and Hamamli, is relatively younger, with an age range of 3.8-3.5 million years (Bigazzi et al., 1998). This group is characterized by a high concentration of zirconium and a low concentration for barium.

It is worth noting that this marks the second identification of Sarıkamış obsidian on Early Holocene sites in southwestern Georgia (Ajara). Prior to this discovery, Sarıkamış obsidian was documented at the village of Kobuleti (Chkhatarashvili and Glascock, 2022).

Pasinler is situated 39 km east of the modern Erzurum province, at an elevation of 1740 m above sea level. The region, nestled between the Deveboinu volcanic mountain and the Aras plain, is referred to as Pasin/Hasankale. Geomorphic features of the Pasin plain and its surroundings were shaped by tectonic movements during the late Pliocene and Pleistocene ages. The Pasin plain is divided into upper and lower parts, with the Lower Pasin plain encircled by mountains and influenced significantly by the Arax River in its formation. The Pasinler region of interest is the Upper Pasin plain, where numerous pyroclastic flows have been discovered, along with relatively fewer lava formations. The age of the Pasinler volcano is estimated at 7.8 million years (Keskin, 1996-1997: 61; Keskin, 1998: 143). Significant quantities of obsidian have been documented in and around Pasinler, with thick layers of Pliocene-age obsidian combined with andesite lavas and tuffs at the volcanic cones (Bozkuş, 1993: 32, Bigazzi et al., 1997: 64; Ceylan and Akçelik, 2021: 1964-1988).

Akhtsu Type – the source referred to as “Akhtsu Type” is an unknown source of obsidian that was first identified from the site of Akhtsu near Sochi, Russian Federation. Artifacts of this type were first reported by Kuzmin, who suggested the source may be located in the North Caucasus (Kuzmin et al. 2023). This source is compositionally distinct from all other known sources in the Caucasus, including Zayukovo (Baksan), thus far the only other known source in the North Caucasus.

Pokr Arteni is a significant obsidian source situated in modern Armenia, encompassing two groups: Mets-Arteni ("Big," 2047 m) and Pokr-Arteni ("Small," 1953 m). The artifact sourced to Pokr Arteni was determined to be from the Pokr Arteni-1 subsource (Frahm 2014) based on its values of and ratios between Sr and Zr. Formed through a series of rhyolite eruptions, both centers yield relatively high-grade obsidian and massive perlovite sediments (Karapetian et al., 2001). The age of the obsidian source is estimated to be 1.2-0.1 and 1.4-0.2 million years (Komarov et al., 1972; Wagner and Weiner, 1987; Oddone et al., 2000; Chernyshev et al., 2006; Frahm, 2023). Specialists emphasize that 50% of the stone collection from Prehistoric sites in Armenia, located within a 60 km radius of the Arteni obsidian source, comprises Arteni obsidian (Badalyan et al., 2004: 447-448). Consequently, Pokr Arteni obsidian played a pivotal role for the ancient population of the Caucasus (Frahm, 2014).

Table 3. Summary of obsidian sources in this sample listed by site.

Site	Chikhiani	Sarıkamış	Pasinler	Akhtsu Type	Pokr Arteni	Total
Makhvilauri	5	4	11	2	1	23

7. Conclusion

Recent studies have firmly established that Western Georgia, specifically the Ajara region, was a highly active area in terms of migration processes during the early and middle Holocene era. This phenomenon is corroborated by evidence not only in the Middle East during the early Holocene (Chkhatarashvili et al., 2020; Chkhatarashvili and Manko, 2020; Manko and Chkhatarashvili, 2022;) but also in Asia Minor (Meshveliani et al., 2007; Bar-Oz et al., 2009) and the beginning of the middle Holocene (Manko and Chkhatarashvili, 2023). According to our hypothesis, the emergence of the transverse arrowheads in the Ajara region by the beginning of the 6th millennium BC occurred due to active migration processes and/or contacts. Nevertheless, further research is being conducted on this topic, and we will discuss it in more detail in the future.

The research conducted sheds light on the first inhabitants of Makhvilauri, who utilized both flint and obsidian for crafting stone tools. Obsidian supplies were sourced from various independent locations. Notably, the Chikiani mountain in the Javakheti region emerged as a recent and prominent supplier of high-quality obsidian, affirmed by the discovery of obsidian artifacts spanning not only the Mesolithi/Neolithic period but also subsequent periods. The residents of Makhvilauri demonstrated familiarity with the oldest obsidian deposits in modern-day Turkiye, namely Sarıkamış (Hamamli) and Erzurum, as evidenced by the presence of their obsidian in Makhvilauri stone collection. A distinctive illustration of ancient human mobility and active contacts is provided by the obsidian samples from Pokr Arteni, verified in the Makhvilauri collection. However, the matter of obsidian transportation extends further. Our research has demonstrated that these resourceful individuals also sourced obsidian from the North Caucasus, indicating heightened interactions with this region. This is underscored by the significant percentage of obsidian in the Makhvilauri collection originating from the North Caucasus, emphasizing the dynamic contacts and mobility of ancient people.

Thus, the Makhvilauri settlement provides unique insights, offering a clear understanding of the active interactions between Neolithic people’s in the Ajara region and various neighbouring territories, leading to the replenishment of obsidian stocks. The absolute dates indicate that these significant events unfolded in the territory of Ajara during the Neolithic period (6th millennium BC).

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Description of Figures:

Fig. 1. Map showing Makhvilauri archaeological site and the main sources of obsidian in Caucasus. 1 - Satanakar, Sevkar and Bazenk; 2 - Khorapor; 3 - Kel'Bedzaar; 4 - Erzurum Pasinler; 5 - Sarıkamış; 6 - Arteni; 7 - Gegham; 8 - Gatansar and Hatis; 9 - Tsaghynyats; 10 - Ashotsk; 11 - Chikhiani; **12 -Makhvilauri Archaeological Site**; 13 - Zayukovo (Baksan); 14 – Akhtsu Grotto

Fig. 2. The location of Ajara region and Chorokhi basin.

Fig. 3. General plan of excavations of Makhvilauri site.

Fig. 4. Stratigraphy picture of excavation trench in 1969 (Gogitidze, 1978, fig, XLII).

Fig. 5. Makhvilauri. Flint and Obsidian tools (Gogitidze, 1978, fig. XLIV, XLV, XLVII, XLVIII)

Fig. 6. Scatterplot of strontium versus rubidium showing samples from Makhuilauri with ellipses representing source compositional groups. Ellipses are drawn at 90% confidence.