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THE FIRST ARCHAEOMETRIC CHARACTERIZATION OF OBSIDIAN ARTEFACTS FROM THE ARCHAEOLOGICAL SITE OF SAMSHVILDE (SOUTH GEORGIA, CAUCASUS)

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THE FIRST ARCHAEOMETRIC CHARACTERIZATION OF OBSIDIAN ARTEFACTS FROM THE ARCHAEOLOGICAL SITE OF SAMSHVILDE (SOUTH GEORGIA, CAUCASUS)

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Abstract

This paper presents the first results about the provenance of obsidian shards recovered in the archaeological site of Samshvilde (South Georgia, Caucasus) with the aim to obtain knowledge related to the network distribution and procurement of obsidian in Georgia. The geochemical characterization of thirty archaeological finds was obtained by the LA-ICP-MS method, an almost non-destructive technique capable of chemically characterizing the volcanic glass. A comparison of geochemical results obtained on archaeological artefacts and geological obsidian collected from Chikiani outcrop in Georgia, together with bibliographic data of southern Caucasus and eastern Turkey, allowed us to define the source of the archaeological obsidians of Samshvilde site. The majority of archaeological samples (28/30) shows a local provenance, precisely from Chikiani (Georgia) on the contrary the other two samples suggest a provenance from two different Armenian sources respectively Gegham and Akhurian2 volcanic system.

Keywords**:** obsidian, trace elements, LA-ICP-MS, Samshvilde, Georgia

Introduction and archaeological background

Samshvilde is an archaeological complex situated in Kvemo Kartli province, in the southern-central part of Georgia. It occupies a long basalt cape that rises above the confluence of two important rivers - the Khrami and Chivchava (Fig. 1). The medieval city covered the entire length of the cape and its layout was arranged according to the occupations and status of the population: the western part of the city, which may has been the residential area of the lower classes, was separated from the central part where nobles resided by a 4 m high and 2.5 m wide stone wall. The central district was separated from the easternmost part of the city, where high-status structures were located, by a 12 m high and 7 m wide fortification wall, forming a citadel. Such heavily fortified well-preserved defensive systems are characterized only for most important sites in the southern Caucasus.

Georgian historic tradition associates the foundation of Samshvilde with the Hellenistic period, while current archaeological project has detected proof of occupation dating back to the Neolithic times. Anyway, it is recognized that Samshvilde was founded as an urban political-economic centre only in the early medieval period, in particular, during the 5th-6th centuries (Sanadze 2016).

As the Arabs appeared in Transcaucasia during the mid-8th century, a substantial part of eastern Georgia, including Samshvilde, was placed under the jurisdiction of the Arab Emir. This arrangement continued until the mid-9th century when the region fell under influence of the Armenian royal Bagratuni dynasty of Shirak. In the 10th century, Samshvilde was the capital of the Armenian Kingdom of Tashir-Dzoraget, which was a vassal of the Kingdom of Ani. From the second half of the 11^{th} century Samshvilde was under the influence of Seljuk Turks, and this continued until 1110, when it was liberated by King of Georgia - David IV (the Builder) and placed under the jurisdiction of the Georgian State.

Various Georgian feudal families controlled Samshvilde in the late medieval and post-medieval period. First the influence of the Orbeli family was dominant and later the Baratashvili-Kaplanishvili, whose tenure continued up to the 17th-18^{th} centuries. In the second half of the 18^{th} century the ethnic situation in Samshvilde and Kvemo Kartli in general changed significantly. From the beginning of the 19^{th} century, Turkish-speaking populations, Germans (1818) and Greeks (1829) were settled in this region by the Russian Imperial government.

Samshvilde is a complex and multicultural archaeological site. It is perhaps surprising, therefore, that this site has never before been the subject of a full-scale archaeological and interdisciplinary investigation. Only small-scale fieldwork was carried out during the Soviet and post-Soviet period which did not provide details on the site's stratigraphy and chronology or on the distribution of cultural features and monuments.

The Samshvilde Archaeological Expedition of the University of Georgia, which has so far conducted six seasons of fieldwork from 2013-2018, is working to redress this situation. By adopting a variety of approaches to the archaeological remains at Samshvilde and its surroundings, new information on this multi-period complex could be attained. Such comprehensive surveys, involving archaeology, geophysics, anthropology, palynology, remote sensing, osteology and archaeometry are now being conducted in Samshvilde (Berikashvili 2017). In particular, excavations have been carried out at two locations of the site. The first is inside the main fortification wall of the city, namely within the citadel (Fig. 2); the other is near the 8^{th} century Sioni Church.

Excavations of 6 archaeological trenches (5x5 meters each, n. 59, n. 60, n. 66, n. 67, n. 68, n. 69) at the citadel have so far unearthed archaeological deposits of 1.3 m depth belonging to the high-late medieval centuries (11^{th}-13^{th} centuries). The Archaeological deposits of this period overlap Islamic and pre-Islamic archaeological contexts, but on the other hand, they also are overlapped by the deposits of Ottoman periods. The archaeological finds fully correspond the mentioned historical periods and give a clear understanding for the stratigraphy of the site. It is noteworthy, that in 2018 an archaeological context (trench n. 68, Context 21) representing pit-burials have been explored under the mentioned historical deposits. According to the black polished fragments of pottery decorated with various geometric motifs, the date of the burial is defined as Late Bronze-Early Iron Age and goes back to the 13th-12th centuries B.C. Artefacts from the citadel trenches are diverse and include numismatic hoard (11-13 centuries A.D.) consisting of 285 copper and bronze coins, ceramics, stone, glass and bone items that date from the high and later medieval centuries, as well as, the pottery of Late Bronze Age – Early Iron Age.

Excavations at the Sioni section (Fig. 2), where two trenches have been opened, have already produced important results. Remnants of a stone mortar structure and graves of the later medieval centuries were discovered to the north of the 8^{th} century church. It is noteworthy that the thickness of archaeological deposits, at 1 m, is lower here compared to the citadel. The date of this layer is assigned to the 10^{th}- 8^{th} centuries on the basis of finds. An initial interpretation of the graves is that they are later and belong to Samshvildian citizens murdered during the invasion of the Turkmen leader, King of Tabriz – Jahan Shah in the 15^{th} century.

Important results were gained from the test trenches on the same area, where obsidian and flint tools were discovered. Forms include scrapers, burins, points, arrowheads and notched sickle blades, attributed to the final stage of the Caucasian Neolithic and chronologically placed within the Tsopa culture of Kvemo Kartli (8-6 millennia B.C.) (Berikashvili and Grigolia 2018).

The discovery of Neolithic tools in the site is a significant novelty and raises the prospect of identifying more extensive prehistoric deposits here. The oldest artefacts come from the lowest stratigraphic layers and are composed of opaque and semi-transparent black obsidian, flint and argillite tools. The major part of this assemblage is composed of short, wide flakes fragments of different shape. Different forms of scrapers are well preserved in this complex: end scrapers, side scrapers and thumbnail scrapers being the most common. Micronuclei, drills, cutting tools, arrowheads and various lamellas are also represented here (Fig. 3).

The most significant among Samshvilde Neolithic materials are flint and argillite sickle blades, found in the so called "midden pits" cut in the basalt bedrock. It is assumed that such tools must have been used in agricultural activities such as harvesting. Even though the Neolithic tools from Samshvilde did not come from intact archaeological strata, but rather derive from disturbed ones, the authors are confident that, because of the very specific location of the site, and the similar materials discovered in surrounding areas, the context of origin, or the location of the former Neolithic settlement, is located nearby. The next archaeological stage in Samshvilde is the Bronze Age. The excavations in the years 2016-17 revealed a large amount of the pottery fragments characteristic for the Middle and Late Bronze periods in Georgia. The last phase is the Medieval period, whose archaeological contexts are best preserved on the site. The complex fortification system, religious and civil buildings, the hydrological net and organized urban parts are the witnesses of the city's active life. Excavations inside the citadel walls revealed artefacts from the 10-14th centuries, representing various types of locally made and imported pottery, stone tools and glass items. The Sioni section yielded a rich collection of metal artefacts, including arrowheads, knives and needles. The most notable item of the medieval artefacts is the numismatic horde discovered in 2018 containing more than 280 local and imported copper and bronze coins.

In 2018 the joined project of the University of Calabria and the University of Georgia started with the main goal to investigate the provenance of Samshvilde obsidian archaeological finds (obsidians tools), comparing them with the geological obsidian sources in the area.

The geological outcrop of obsidian sources

Georgia country is dominated by the Caucasus Mountains at the junction of the Eurasian Plate and the Afro-Arabian Plate, and rock units from the Mesozoic and Cenozoic are particularly prevalent (Adamia et al. 2011). The nearest obsidian outcrop for Samshvilde is the place called Chikinai ("Chika" in Georgian language means – glass, Chikiani – the place with plenty of glass) from which the field survey has started. Located about 85 km west-southwest of Tbilisi, Chikiani volcano reaches 2.417 m (Fig. 4).

This flow belongs to an eruptive phase dated some 2.8 Ma (Lebedev et al. 2008) and corresponds to a trachy-rhyolitic dome (2400 m high) located northeast of the Paravani lake (2081 m asl) (Blackman et al., 1998 and Badalyan et al., 2004). Obsidian is spread all over the area, and extends in a large flow to the northeast appearing as segregations inside the 1 m thick rhyolitic flows which outcrop around the dome. They display very good quality black homogeneous obsidian, which can also turn into brown, red or green variants. The black variety is usually translucent with no visible spherulites to the naked eyes. There are numerous obsidian boulders on the dome slopes, which are then broken down into pebbles that are carried downslope and downstream by the Paravani River to the Krami River (near Samshvilde site) which constitutes the main secondary sources (Biagi and Gratuze 2016). At Chikiani, obsidian is abundant and easy to access. The only limit to exploitation being the thick snow cover that lasts more than six months.

The Chikiani outcrop has been the object of several studies (Chataigner and Gratuze 2014a; 2014b; Le Bourdonnec et al. 2012; Tushabramishvili 2012; Keller 1996) that showed the possible existence of at least two obsidian chemical groups, a medium barium and high barium (Biagi and Gratuze 2016).

Samples and Analytical Methods

Geochemical analyses of archaeological finds and geological samples (Table 1) were carried out at the Department of Biology, Ecology and Earth Sciences, University of Calabria, Italy, using the scanning electron microscope equipped with an EDS system (EDAX GENESIS 4000) to determine the major element composition and the LA-ICP-MS for the trace element composition. The LA-ICP-MS equipment was an Elan DRCe (Perkin Elmer/SCIEX), connected to a New Wave UP213 solid-state Nd-YAG laser probe (213 nm). Samples were ablated by laser beam in a cell, and the vaporised material was then flushed (Gunther and Heinrich 1999) to the ICP, where it was quantified. Each ablation crater was generally 50 μm in diameter and nearly invisible to the naked eye. The procedures for data acquisition were those normally used in the Mass Spectroscopy Laboratory of the Department of Earth Sciences, University of Calabria (Barca et al. 2007; 2008; 2011).

Only two point analyses were carried out on portions of archaeological fragments without roughness or alterations, and were sufficient to assign provenance. In order to remove any trace of soil, each find was cleaned by ultrasound in Millipore water. Calibration was performed on glass reference material SRM612–50 ppm by NIST (National Institute of Standards and Technology) in conjunction with internal standardisation, applying SiO_2 concentrations (Fryer et al. 1995) from SEM-EDS analyses. In order to evaluate possible errors within each analytical sequence, determinations were also made on the SRM610–500 ppm by NIST and on BCR 2G by USGS glass reference materials as unknown samples, and element concentrations were compared with reference

values from the literature (Pearce et al. 1997; Gao et al. 2002). Accuracy, as the relative difference from reference values, was always better than 10%, and most elements plotted in the range +/-5%.

Results and Discussion

Chemical analyses of major oxides were reported in the TAS diagram (Figure 5, after Le Maitre et al. 2002). As shown, chemical compositions of geological obsidian samples show a homogeneous distribution; all the samples fall into the rhyolite field, with an evident enrichment in alkalis relatively and a constant SiO_2 level, confirming the provenance from trachy-rhyolitic dome reported in literature data (Blackman et al. 1998 and Badalyan et al. 2004).

Table 2 lists the composition of trace and rare earth elements, determined by LA-ICP-MS, both for the geological samples and archaeological finds; each trace element quantity, in the table, represents the mean value of two/three analyses.

The main potential sources for archaeological obsidians found in Georgia can be traced to different volcanic systems: obsidian from the near sources of Paravani (Chikiani) in Georgia and from the Armenian and Caucasian obsidians erupted in a collisional tectonic setting (Keller et al. 1996).

After the pioneering work of Keller et al. (1996), the knowledge about geological sources of obsidian of the Armenian and Caucasian areas has undergone significant development (Blackman et al. 1998; Le Bourdonnec et al. 2012; Chataigner and Gratuze 2014).

The study of Keller et al. (1996) provided a detailed reconstruction of the volcanological history of the Armenian and Caucasian region together with geochemical characterization of the major obsidian sources. After, many authors (Blackman et al. 1998; Le Bourdonnec et al. 2012; Chataigner and Gratuze 2014) performed a chemical characterization of the different obsidian sources using different analytical approaches (PIXE, INAA and LA-ICP-MS). Even if acquired with different analytical methods, data are quite comparable and overlapping. All these data represent a key database to refer for assigning the provenance of archaeological obsidians.

The results obtained on the archaeological shards of Samshvilde site were compared with bibliographic geological data of Georgian, Armenian and Caucasian sources (Keller et al. 1996; Blackman et al. 1998; Le Bourdonnec et al. 2012; Chataigner and Gratuze 2014) and with new Georgian geological data here presented. The diagram Zr vs Ba, as suggested by Keller et al. (1996), permits the separation among geological Armenian and Caucasian sources. In the diagram Zr vs Ba (Fig. 6) twenty-eight archaeological shards fall into the area of the Chikiani and Tsaghkunyats sources.

The remaining two finds plot in two different areas of the diagram, indeed the find n. 519 shows low contents of Zr (54 ppm) and Ba (10 ppm), while the artefact n. 575 shows concentrations of Zr (155 ppm) and Ba (32 ppm) respectively higher and lower than the Chikiani source.

Concerning the sample n. 519, numerous Armenian geological sources (Arteni, Gegham and Syunik) plot in the same area of the diagram, for this reason, it is difficult to assign a sure provenance. The sample n. 575 plots near to two sources Akhurian (Armenia) and Tendurek (Turkey).

The diagram Ba/Zr vs Ba/Sr (Fig. 7) confirms undoubtedly the geochemical similarity between the twenty-eight artefacts and the Chikiani source indicating a clear Georgian provenance.

Also it confirms the double provenance for the other two analysed shards, which again plot in two distinct areas. In detail, the sample n. 575 plots very near to the geological Armenian source of Akhurian, on the contrary the sample n. 519 is of doubt provenance. The diagram Y/Zr vs Nb/Zr (Fig. 8) was used in order to determine a more clear source. In particular, this geochemical diagram allowed to discriminate the correct source of the n. 519 archaeological find, showing a clear similarity with the geological Gegham source.

In conclusion, the majority of analysed finds shows a clear Chikiani provenance, only two samples overlaps, respectively, the geological obsidian of Gegham analysed by Keller et al (1996) and by Chataigner and Gratuze (2014), and the Akhurian2 source (Chataigner and Gratuze 2014).

Conclusions

Generally, South Caucasus, especially South Georgia and Armenia are rich in obsidian. Since 1990s more than twenty obsidian sources and outcrops, stretching across more than 300 km of the rugged Lesser Caucasus ranges, have been identified (Keller at al 1996). Equally significant are the studies that propose exchange models, which attempt to explain the social and economic patterns behind the procurement and consumption of raw materials (Badalyan 2004). The present study confirms that the prehistoric populations of Samshvilde and surroundings supplied themselves with several obsidian' sources.

It is not surprisingly, that in ancient times communities procured obsidian from the source closest to their base. This "time-distance'' model argues that the distance factor should not be calculated as the crow flies, but instead, on the maximum time acceptable to procure the raw materials (Sagona 2018).

It is also notable, that the Khrami River, which cuts a course through the Chikiani Range, distributes large quantities of obsidian cobblestones down its course, so communities in the surrounding of Samshvilde and in nearby villages did not have to visit the source itself, but collect obsidians, brought by the river in the local ravines.

Anyway, most of the obsidian explored here derives from the Chikiani source, but some also are exported from Armenian sources. From the Neolithic period some clear pattern of obsidian procurement and consumption are beginning to emerge. Although communities may have preferred obsidian from a specific source, their artefacts show a more varied procurement pattern. This pattern changed later, during the Early Bronze Age, when villagers in the Caucasus increasingly exploited Hatis obsidian.

Long-distance trade networks and a formative organisational system to cope with the demand for raw materials were actively functioning, and it seems, that the obsidian was one of the important raw material among others.

It is quite likely that the Samshvilde inhabitants, as well as the villagers around, were actively drawn into the trade interaction with southern regions. Indeed, the nature of this interaction has yet to be determined more accurately.

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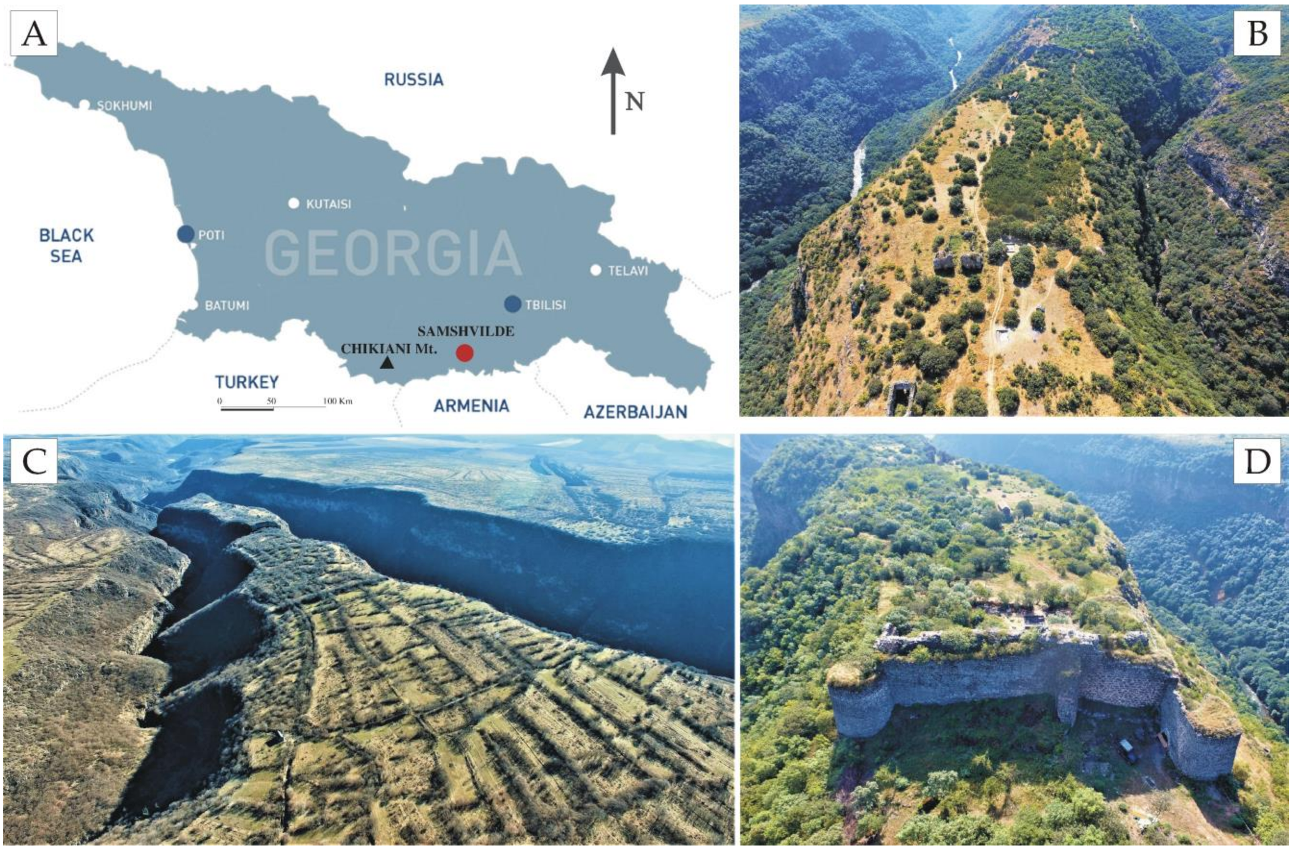

Figure 1. A) Georgia schematic map with indication of the archaeological site of Samshvilde (red circle); B-D) panoramic view of the site.

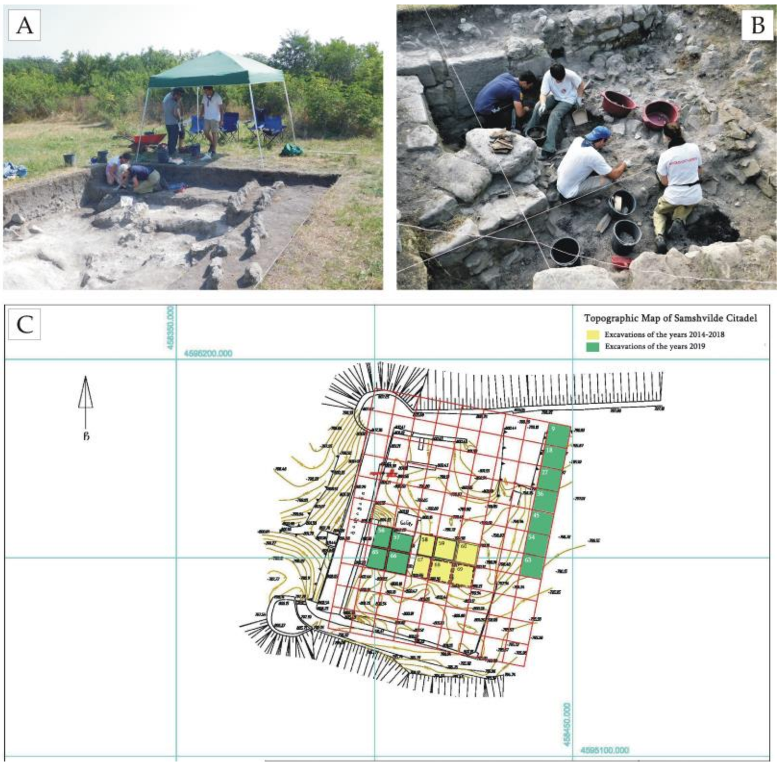

Figure 2. (A-B) Excavations inside the main fortification wall of the city; C) Topographic map of the City's Fortress.

Figure 3. Some representative samples of obsidian shards.

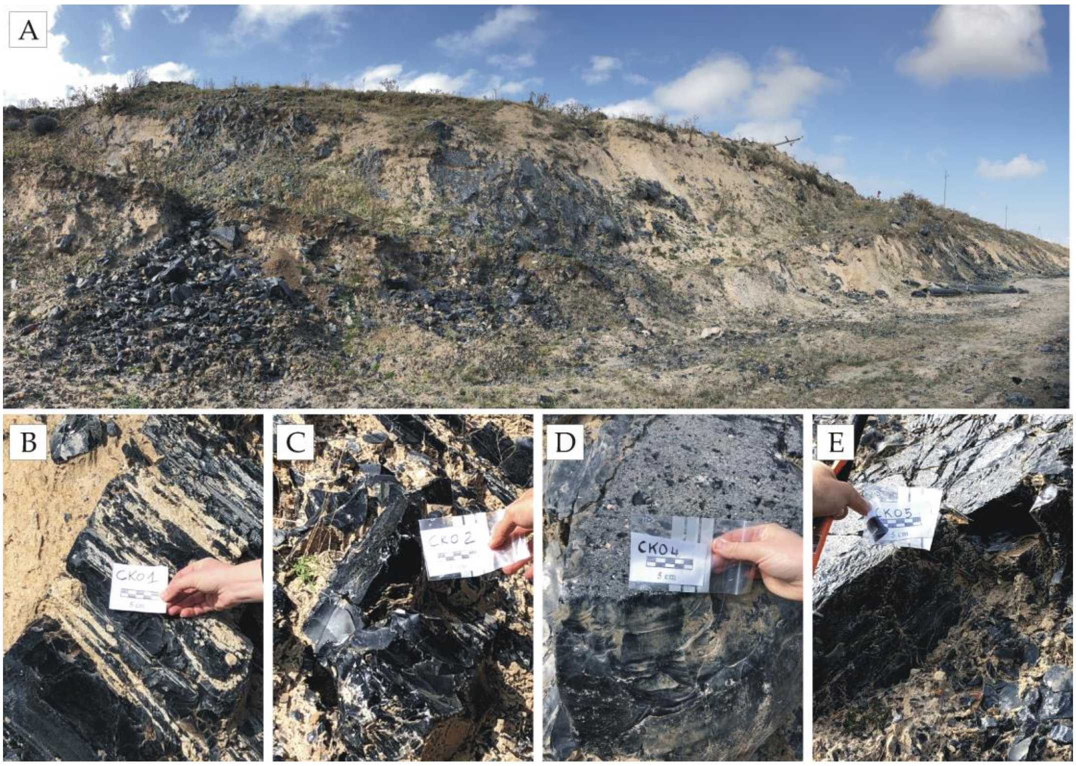

Figure 4. A) Chikiani obsidians outcropping; (B-D) examples of obsidian sampling points.

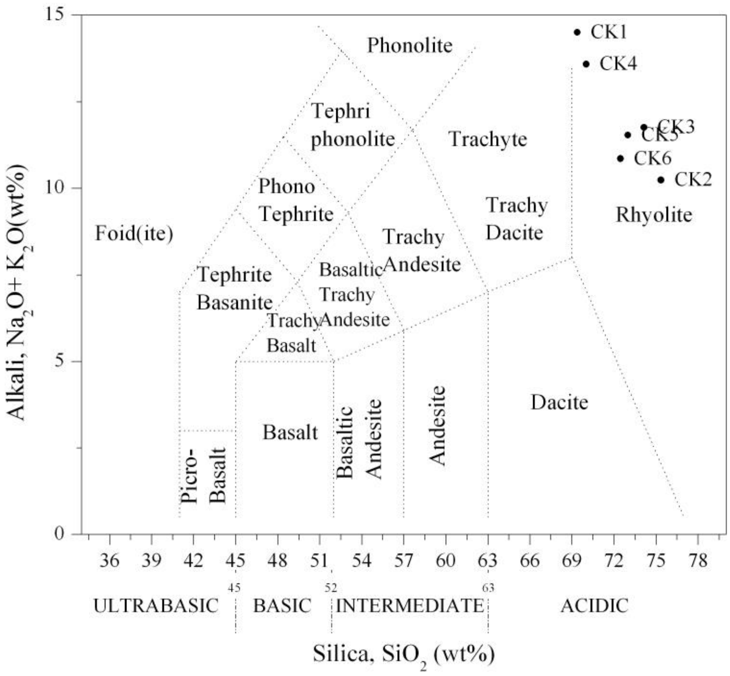

Figure 5. Plot of obsidians chemical composition into the Total Alkali Silica (TAS) diagram (Le Maitre et al. 2002).

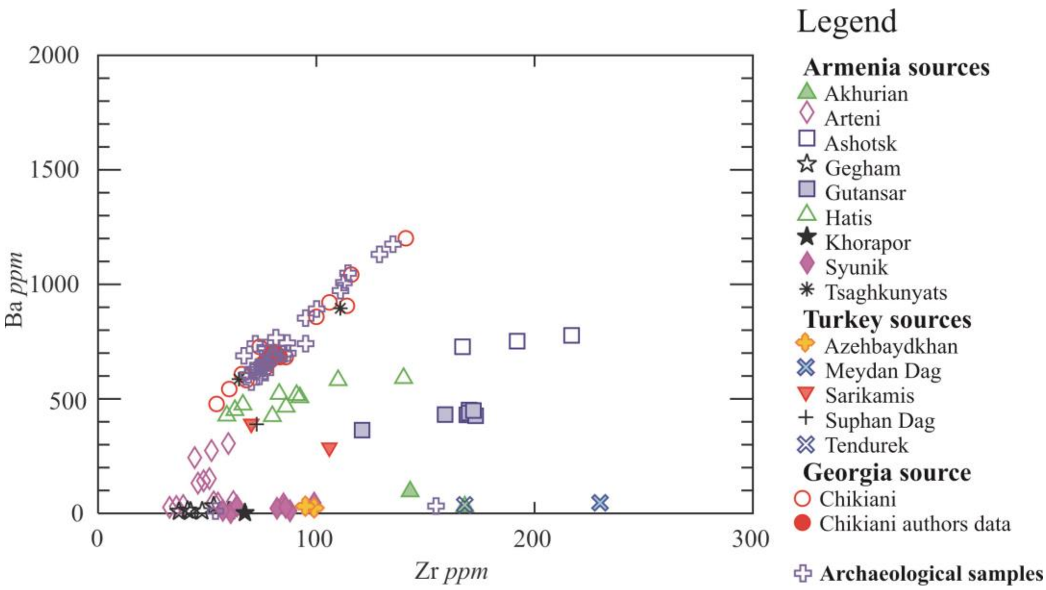

Figure 6. The binary diagram of the Zr–Ba contents of archaeological finds and geological sources.

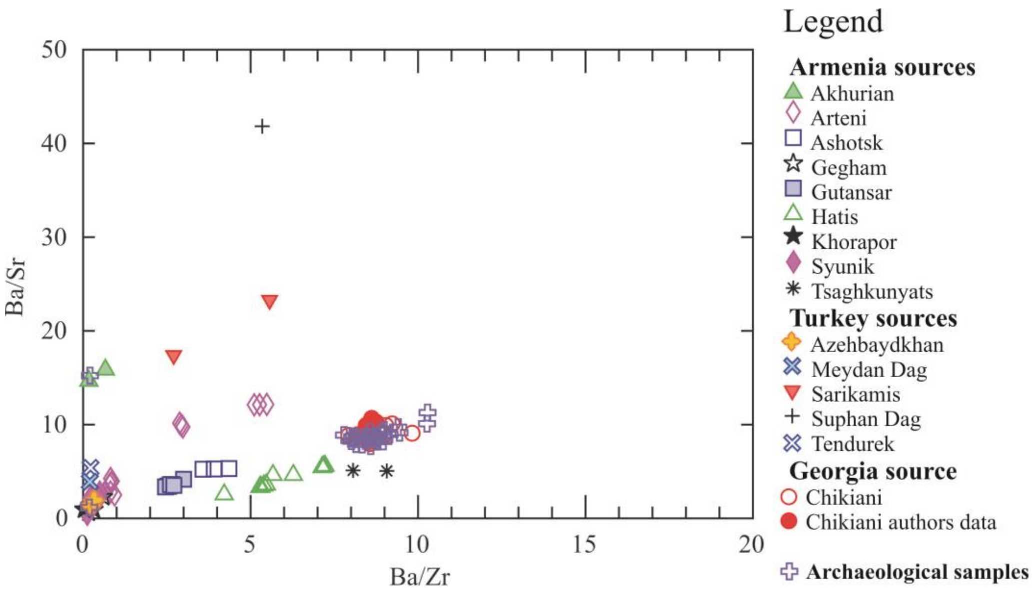

Figure 7. The binary diagram of the Ba/Sr–Ba/Zr ratios of archaeological finds and geological sources.

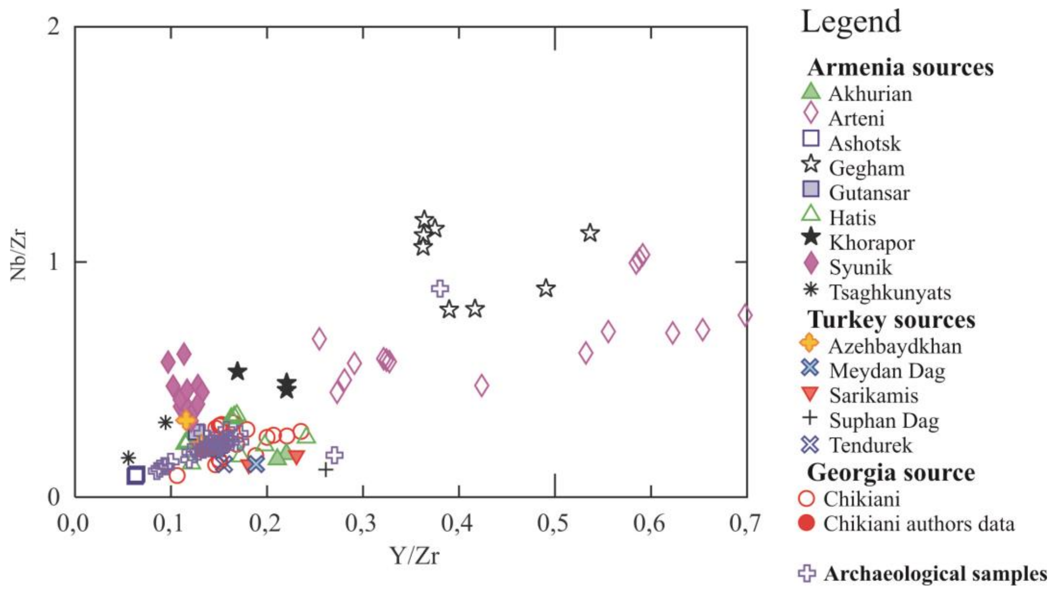

Figure 8. The binary diagram of the Nb/Zr-Y/Zr ratios of archaeological finds and geological sources.

Table 1. List of the investigated samples and details about sampling location

Sample code	Typology	Sampling Location	Stratigraphic Level/Unit
Artefact N. 576	Archaeological sample	Samshvilde	Trench-N8. Context-19.
Artefact N. 401	Archaeological sample	Samshvilde	Trench- N8. Context-1.
Artefact N. 496	Archaeological sample	Samshvilde	Trench-N8. Context-1.
Artefact N. 481	Archaeological sample	Samshvilde	Trench-N8. Context-1.
Artefact N. 592	Archaeological sample	Samshvilde	Trench-N8. Context-19.
Artefact N. 519	Archaeological sample	Samshvilde	Trench-N8. Context-1.
Artefact N. 302	Archaeological sample	Samshvilde	Trench-N8 Context-1.
Artefact N. 479	Archaeological sample	Samshvilde	Trench-N8. Context-1.
Artefact N. 206	Archaeological sample	Samshvilde	Trench-N8. Context-1.
Artefact N. 571	Archaeological sample	Samshvilde	Trench-N8. Context-1.
Artefact N. 485	Archaeological sample	Samshvilde	Trench-N8. Context-1.
Artefact N. 17	Archaeological sample	Samshvilde	Trench-N8. Context-1
Artefact N. 484	Archaeological sample	Samshvilde	Trench-N8. Context-1
Artefact N. 395	Archaeological sample	Samshvilde	Trench-N8. Context-1.
Artefact N. 278	Archaeological sample	Samshvilde	Trench-N8. Context-1.
Artefact N. 237	Archaeological sample	Samshvilde	Trench-O17. Context-1.
Artefact N. 269	Archaeological sample	Samshvilde	Trench-N8. Context-1.
Artefact N. 434	Archaeological sample	Samshvilde	Trench-N8. Context-1.
Artefact N. 436	Archaeological sample	Samshvilde	Trench-N8. Context-1.
Artefact N. 493	Archaeological sample	Samshvilde	Trench-N8. Context-1.
Artefact N. 494	Archaeological sample	Samshvilde	Trench-N8. Context-1.
Artefact N. 573	Archaeological sample	Samshvilde	Trench-N8. Context-19.
Artefact N. 195	Archaeological sample	Samshvilde	Trench-N8. Context-1.
Artefact N. 135	Archaeological sample	Samshvilde	Trench-N8. Context-19.
Artefact N. 580	Archaeological sample	Samshvilde	Trench-N8. Context-19.
Artefact N. 162	Archaeological sample	Samshvilde	Trench-N8. Context-13.
Artefact N. 483	Archaeological sample	Samshvilde	Trench-N8. Context-1.
Artefact N. 429	Archaeological sample	Samshvilde	Trench-N8. Context-1.
Artefact N. 160	Archaeological sample	Samshvilde	Trench-N8. Context-13.
Artefact N. 575	Archaeological sample	Samshvilde	Trench-N8. Context-19.
CK-1	Geological sample	Chikiani Mount	41°29'50.28"N 43°52'21.81"E
CK-2	Geological sample		
CK-3	Geological sample		
CK-4	Geological sample		
CK-5	Geological sample		
CK-6	Geological sample		

Table 2. Average chemical compositions (n= 3) for the different obsidian shards and geological samples (concentrations are in ppm).

Sample code	Ti	Mn	Rb	Sr	Y	Zr	Nb	Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Ta	Pb	Th
CK-1	691	396	115	64.0	11.5	79.2	17.5	3.8	683	24.0	44.4	4.15	13.37	2.66	0.38	1.20	0.32	1.81	0.38	0.86	0.21	1.15	0.16	1.43	15.2	13.7
CK-2	676	391	115	67.1	11.6	78.8	17.4	3.8	666	22.6	41.8	3.96	13.21	1.82	0.57	1.96	0.36	1.65	0.29	1.44	0.19	0.47	0.23	1.25	18.2	12.8
CK-3	684	413	123	68.7	12.0	80.6	17.8	4.0	705	24.3	45.5	4.72	15.22	1.61	0.48	2.12	0.29	1.75	0.30	0.44	0.14	2.28	0.17	1.32	21.4	13.5
CK-4	653	318	112	73.4	10.7	75.1	16.2	3.9	652	22.3	43.3	3.83	13.68	2.60	0.48	2.00	0.33	2.27	0.36	1.24	0.11	1.31	0.17	1.31	18.0	11.7
CK-5	765	351	123	78.4	11.0	82.8	16.6	4.1	689	24.8	46.4	4.62	13.61	2.54	0.52	1.32	0.29	2.21	0.31	0.32	0.14	2.06	0.29	1.62	19.7	13.4
CK-6	740	360	123	76.5	12.5	83.3	18.9	3.9	682	24.4	46.9	4.52	13.68	3.26	0.49	1.89	0.42	2.54	0.28	2.27	0.10	1.45	-	1.30	31.2	14.1
Artefact N. 576	894	279	99	113	10.4	113	14.8	3.7	1007	33.2	59.1	5.91	17.19	3.25	0.74	1.99	0.32	1.81	0.42	1.23	0.19	1.34	0.24	1.07	19.4	14.2
Artefact N. 401	739	363	125	80.4	13.0	87.0	18.9	4.3	699	25.9	48.1	4.91	15.69	2.70	-	1.27	0.05	3.39	0.17	1.56	0.32	-	-	1.60	19.8	15.2
Artefact N. 496	677	348	116	74.9	11.8	75.1	17.0	4.4	633	22.8	43.6	3.80	13.54	3.03	0.50	1.87	0.37	1.54	0.41	0.56	0.15	0.49	0.20	1.21	18.5	12.2
Artefact N. 481	766	360	117	80.6	12.0	76.2	18.0	4.2	635	22.9	43.0	4.36	14.34	2.65	0.57	2.04	0.35	1.88	0.40	1.33	0.11	0.36	0.20	1.47	21.9	13.6
Artefact N. 592	720	363	121	68.6	10.9	69.0	19.7	5.0	605	23.1	44.6	3.85	13.91	3.83	0.91	1.92	0.27	1.72	0.30	0.93	0.36	0.61	0.19	1.08	18.7	11.3
Artefact N. 519	406	596	192	8.7	20.5	53.8	47.7	6.7	10	14.6	29.3	2.78	11.90	1.94	0.10	2.68	0.46	2.87	0.66	2.10	0.25	1.91	0.42	4.34	22.8	23.7
Artefact N. 302	870	398	110	97.3	11.9	100	15.9	3.3	893	30.1	52.4	5.26	17.25	2.47	0.81	2.38	0.24	1.43	0.43	0.88	0.29	1.90	0.25	1.21	17.9	15.6
Artefact N. 479	960	357	104	117	11.4	115	17.2	3.3	1048	34.0	58.7	6.03	17.85	2.36	0.55	1.76	0.24	2.26	0.30	1.53	0.13	1.88	0.25	1.14	17.4	15.5
Artefact N. 206	819	387	105	79.3	10.9	76.6	16.2	3.0	724	23.6	44.3	4.02	13.70	3.45	0.47	2.12	0.31	1.50	0.45	0.97	0.16	0.60	0.18	0.93	16.1	12.9
Artefact N. 571	704	377	106	78.9	11.4	81.5	17.2	3.9	767	25.5	47.2	4.48	13.55	2.55	0.58	2.49	0.20	1.65	0.39	1.43	0.22	1.07	0.21	1.34	15.9	14.3
Artefact N. 485	1090	361	97	119	10.5	111	14.5	2.9	972	30.6	51.0	5.12	16.11	2.52	0.66	1.84	0.25	1.44	0.32	1.18	0.14	1.38	0.14	0.82	14.3	14.3
Artefact N. 17	675	400	111	71.4	12.2	70.9	16.6	3.7	623	21.0	38.8	3.61	12.58	2.62	0.54	2.32	0.25	1.25	0.32	0.91	0.18	0.72	0.17	1.61	17.0	13.6
Artefact N. 484	639	334	95	60.9	10.5	66.9	16.6	4.1	688	23.7	43.2	4.33	15.42	3.13	0.13	2.00	0.33	1.84	0.36	0.96	0.45	1.68	0.23	1.33	13.8	11.1
Artefact N. 395	363	403	104	74.7	10.2	76.7	15.4	3.1	615	21.8	40.9	3.88	14.63	1.87	0.52	1.67	0.24	2.05	0.38	0.88	0.18	-	0.18	1.43	14.8	11.4
Artefact N. 278	411	445	117	68.5	12.0	73.9	17.3	4.9	598	20.3	42.3	3.91	15.34	3.29	1.03	4.08	-	1.84	0.43	-	0.40	1.91	-	2.00	20.7	14.1
Artefact N. 237	574	425	113	83.5	12.2	95.1	18.4	3.8	741	27.9	53.3	4.92	14.81	2.11	1.02	2.13	0.21	2.37	0.37	1.66	0.20	2.35	0.57	1.50	18.6	14.1
Artefact N. 269	843	446	124	78.8	11.6	79.6	18.2	4.0	678	22.6	45.7	4.42	14.69	3.70	0.54	3.19	0.16	1.72	0.27	1.18	0.17	1.66	0.14	1.18	15.4	13.5
Artefact N. 434	871	442	122	78.5	12.3	80.8	17.9	3.5	685	23.0	45.4	4.74	13.79	2.71	0.87	2.72	0.43	2.35	0.57	0.94	0.25	1.33	0.33	1.08	20.9	14.8
Artefact N. 436	722	459	119	85.6	11.7	76.8	17.3	4.3	660	25.4	44.5	4.17	15.50	2.72	0.64	2.30	0.34	2.54	0.33	1.05	0.17	1.56	0.22	1.31	18.2	13.0
Artefact N. 493	1201	410	102	137	11.4	129	15.6	2.9	1130	34.8	65.7	6.60	20.36	3.61	0.64	2.78	0.35	2.07	0.48	1.89	0.21	1.58	0.16	1.51	18.1	15.6
Artefact N. 494	750	417	133	73.3	9.6	72.1	19.6	4.4	740	22.4	49.1	4.71	12.88	2.61	0.65	1.96	0.22	1.33	0.46	0.97	0.23	0.79	0.19	1.24	24.4	10.8
Artefact N. 573	1271	373	105	137	11.5	135	14.9	3.0	1175	38.6	64.5	6.36	19.35	3.46	1.35	2.07	0.30	2.81	0.47	2.06	0.32	2.32	0.44	0.98	19.7	15.4
Artefact N. 195	727	429	115	74.1	11.1	77.7	18.7	4.4	698	24.9	45.5	4.78	15.86	3.62	0.51	2.19	0.33	2.02	0.31	0.80	0.20	1.25	0.25	1.40	21.3	13.1
Artefact N. 135	731	448	119	72.4	11.3	70.3	17.3	4.0	573	21.1	41.1	3.98	13.32	2.75	0.29	2.14	0.18	2.35	0.40	1.50	-	1.15	0.41	1.46	19.8	13.2
Artefact N. 580	764	439	119	72.8	11.5	72.9	16.8	4.2	627	21.8	43.2	4.38	14.67	3.51	0.62	1.99	0.32	2.39	0.48	0.86	0.17	1.52	0.35	1.22	19.6	12.9
Artefact N. 162	839	426	112	80.4	11.7	85.2	17.9	3.5	696	25.4	46.3	3.79	13.21	2.75	0.76	1.26	0.27	1.17	0.59	1.14	0.17	1.11	-	0.94	21.2	12.6
Artefact N. 483	724	437	124	74.7	12.6	73.3	19.8	4.3	638	23.6	44.0	4.17	12.75	3.08	0.45	2.07	0.32	2.17	0.49	1.18	0.19	1.11	0.21	1.64	20.5	13.6

Artefact N. 429	904	448	120	80.6	13.1	86.7	18.1	4.1	744	26.6	48.2	4.66	12.65	5.26	0.57	1.96	0.34	1.67	0.52	2.46	0.15	2.33	-	1.45	20.5	15.4
Artefact N. 160	928	426	124	104	11.4	95.1	18.2	4.0	852	29.1	54.2	4.69	15.19	1.99	0.54	1.72	0.32	2.39	0.34	0.72	0.13	1.08	0.24	1.37	20.1	14.2
Artefact N. 575	553	602	136	2.1	41.9	155	27.5	4.9	32	27.7	59.9	6.53	24.58	4.97	0.34	6.62	1.33	7.19	1.38	2.80	0.94	4.51	0.67	1.28	28.1	17.0