Geochemical analysis of Anaseuli obsidians and mobility pattern of ancient humans in western Georgia

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Abstract

Archaeological excavations conducted at various times in south-western Georgia have revealed stone age sites, with a notable collection of flint and obsidian. However, the precise origins of obsidian remain ambiguous. In recent years, Georgian and USA researchers have published noteworthy works connected to origins of obsidian artefacts (*Chkhatarashvili, Glascock 2022; Chkhatarashvili et al., 2024a,b; Chkhatarashvili et al., 2025a,b*). This work present the results of geochemical analyses conducted on obsidian artefacts discovered at the Neolithic sites of Anaseuli I-II. The research was carried out using the XRF method at the Archaeometry Laboratory at the University of Missouri Reactor Research (MURR). The analysis identified two different sources of obsidian supply, which once again indicates that the Caucasus region has been an active zone of human mobility and contact since ancient times.

Keywords: Guria, Anaseuli, obsidian, XRF, mobolity.

Introduction

During the prehistoric period, various types of stone were used to make tools. When selecting raw materials, priority was given to high quality and ease of processing. Obsidian is a prime example of such a material, with a long history of use dating back to ancients time. The earliest known use of obsidian dates back to the Oldowan period (Piperno et al., 2009). Over time, however, there was a gradual increase in demand for these materials (Ono, 2014; Kuzmin, 2017).

The Caucasus is considered one of the most active regions in terms of obsidian utilization. This is particularly evident given the numerous identified obsidian sources within its northern and southern parts (Doronicheva, Shackley, 2014; Badalyan et al.,2004; Frahm et al., 2016; Adler, 2002; Biagi et al., 2017; Chataigner, Gratuze, 2014) of Caucasus.

The territory of Guria has been part of the obsidian distribution and supply zone since prehistoric times. Research conducted at Neolithic sites in the region has demonstrated that a substantial portion of the lithic assemblage is composed of obsidian artifacts. Unfortunately, the majority of these materials remain unexamined, and their provenance has yet to be determined. An exception is Anaseuli I, where a group of prominent scholars analyzed several obsidian artifacts (Badalyan et al., 2004).

The present study, supported in 2023 by the Shota Rustaveli National Science Foundation of Georgia (project: ,,Transporting of obsidian and Homo Sapiens Mobility in Western Transcaucasia in the Early Holocene"), aimed to analyze a larger number of samples from the Anaseuli collection, which would naturally allow us to draw more accurate conclusions. In addition, several samples from Anaseuli II were also examined.

Accordingly, this paper presents the results of the geochemical analysis of obsidian artifacts from the Neolithic sites of Anaseuli I and Anaseuli II, which reveal a particularly informative and intriguing picture of raw material procurement and distribution in western Georgia.

Geographical position and archaeological background.

The sites are located approximately 2 km southwest of Ozurgeti, on the hills of Anaseuli (Fig. 1-2). They represent open-type settlements situated on elevated terrain near the rivers Achistskali, Bzhuzha, Lechkhumi, and Choloki.

The Anaseuli sites geographically situated in the Colchis Plain, which occupies the extreme eastern part of the Black Sea. The region's climate is classified as subtropical, fostering the growth of flora typical of this geographical zone. Unfortunately, no palynological data are available concerning the ancient climate and flora of the sites. However, research conducted at sites of the same period in the neighboring Kobuleti Municipality provides valuable information for the reconstruction of the paleoenvironment. These studies indicate that during the Early Holocene, the area was characterized by a temperate and warm climate (Chkhatarashvili et al., 2020; 2024a).

It is noteworthy that the Guria region, particularly its Black Sea coast, is distinguished by its abundant precipitation and high relative humidity, which ranges from 70% to 83% annually. The absence of faunal and/or anthropological material in excavations of open-air sites may be attributed to the constant dampness of the soil. Therefore, the only material evidence that provides insight into the nature of human life during that period is derived from stone tools, cores and produce waste.

The sites were discovered, and surface materials were collected, by the local researcher V. Sharkovski, a senior research fellow at the former Anaseuli Research Institute of Tea and Subtropical Crops.

The first reports concerning the discovery of Neolithic remains at Anaseuli were published between 1950 and 1955 (Japaridze, 1950: 110; Khoshtaria, 1955: 71). Between 1956 and 1962, the archaeologist Lamara Nebieridze conducted systematic excavations at the Neolithic settlements of Anaseuli, after which the sites were comprehensively studied and published in a monograph (Nebieridze, 1972). Later, during 2008–2010, small-scale field investigations were carried out at Anaseuli I by archaeologist Tengiz Meshveliani (Meshveliani, 2013).

Given that detailed information about the Anaseuli settlements has already been published, the archaeological material is discussed here only briefly.

The techno-typological analysis of the lithic assemblage indicates that stone tool production was based on the use of the hand pressure technique, as evidenced by the presence of conical and pencil-like cores in the collection. The abundance of cores and production debris suggests that tool manufacture was carried out on-site.

During the excavations at Anaseuli I, a total of 4,044 artifacts were recovered, among which 3,160 were made of obsidian (Fig. 3; Table 1). The assemblage includes both finished tools and manufacturing by-products.

Among the tools, scrapers and burins are the dominant categories. The burins are notable for their abundance and morphological variability; they were produced mainly on thin, straight blades. Scrapers also display a wide range of forms, most of which are made on flakes. Rounded and micro-scrapers are particularly common.

Another interesting group within the assemblage consists of retouched and notched blades/bladelets. Geometric microliths are relatively few, but trapezes are present and noteworthy.

The pebble-stone tool collection is also of interest and includes axes, choppers, polishers, sling stones, and other tools.

The lithic assemblage from Anaseuli II is among the most numerous Neolithic complexes in western Georgia, comprising a total of 12,310 artifacts (Fig. 4). In contrast to Anaseuli I, obsidian is represented in smaller quantities (1,090 specimens).

Among the tools, burins are again the most common type (147 specimens), most of which were made on blades. Although the Anaseuli II assemblage is three times larger than that of Anaseuli I, the number of scrapers decreases significantly (66 specimens).

Notably, perforators are abundant (79 specimens), and the assemblage also demonstrates considerable diversity of geometric microliths, including trapezes, segments, and backed rectangles, as well as tools made from river pebbles and basalt. Similar morphological diversity is evident in the ceramic assemblage as well.

Materials and methods.

Within the stone collection of the Anaseuli I-II, obsidian is particularly notable for its abundance and diversity. The specimen is primarily distinguished by the presence of black, transparent, and black-brown veins. We think their diversity should be associated with different origins. To this end, a geochemical analysis was conducted. A total of 21 obsidian flakes were selected for the study.

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 prof. M. Glascock (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.

Results.

The geochemical study of obsidian artifacts conducted in Anaseuli I-II in 2023 yielded the following picture (Fig. 5; Tab. 2):

1. **Chikiani** is a mountain of volcanic origin. It is situated in the Javakheti region of southern Georgia, in proximity to Lake Paravani. Chikiani is the sole obsidian source in Georgia, distinguished by its high-quality obsidian. As demonstrated by research findings, Chikiani obsidian was utilized in the construction of not only prehistoric sites but also those from subsequent historical periods (Badalyan et al., 2004; Biagi, Nisbet, 2018; Gratuze, Rova, 2022).

The Chikiani obsidian source is located at a distance of 165-170 kilometers from the Anaseuli sites. Chikiani is arguably among the youngest volcanic mountains in the Caucasus, with an estimated age ranging from 2.6 to 2.3 million years (Badalyan et al., 2004).

2. The source of the **Sarıkamış** obsidian is located in the eastern Turkish province of Kars. Preliminary studies have indicated that the Sarikamish Obsidian were used since stone ages. This can be attributed to the superior quality of the stone. Sarıkamıs obsidian is classified by specialists into two distinct groups: "northern" and "southern." The southern group is situated in proximity to the contemporary cities of Mescitli and Sehitemin. Its distinguished by a high concentration of barium and a relatively low concentration for zirconium (Chataigner et al., 2014). The estimated age of the source is between 4.9 and 4.4 million years (Bigazzi et al., 1998). The "Northern group," situated in proximity to contemporary cities such as Kizil Kilisa, Handere, and Hamamli, is comparatively younger, with an estimated 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. In Anaseuli, the Hamamli obsidian has been discovered, situated at a distance of 180-190 km from a direct line.

Discussion and Conclusion.

The lithic collection from Anaseuli is represented by high-quality flint, comparable to that recovered from Mesolithic–Neolithic settlements located along the Black Sea coast of western Georgia. The local flint is diverse and excellent quality, meaning it is easily for making tools. It's a one of the key advantages in selecting raw materials for tool production by prehistoric communities. Unfortunately, the sources and distribution of flint within the Guria region have not yet been the subject of a specialized study. It is hoped that future research will address this issue and contribute to a better understanding of the mobility of prehistoric populations.

As for obsidian, its study has become increasingly active in recent years. A substantial part of the obsidian assemblages from the Stone Age sites of western Georgia has already been examined (Badalyan et al., 2004; Chkatarashvili, Glascock, 2022; Chkhatarashvili et al., 2024a,b; Chkhatarashvili et al., 2025a,b). In the present paper, particular attention is given to the obsidian inventory from Anaseuli. The interest in obsidian is twofold: first, the Caucasus is rich in obsidian sources; and second, obsidian occupies a dominant position within the Anaseuli lithic collection. This is especially true for Anaseuli I, where obsidian accounts for more than 78% of the raw material. Geochemical analysis shows that the inhabitants of Anaseuli I likely only used Chikiani obsidian sources to replenish their reserves. The situation is somewhat different at Anaseuli II, where the use of obsidian is less intensive. Although the contact zone (South Caucasus and Eastern Turkiye) expands. We assume that this difference may reflect a shift in raw material procurement strategies - from an earlier phase of active contact with obsidian-rich regions, where obsidian served as the principal material for tool manufacture, to a later phase when other types of stone were increasingly used, and obsidian was mainly employed for microlith production.

It is particularly noteworthy that the inhabitants of Anaseuli were well acquainted with obsidian as a raw material and clearly valued its properties. As studies have shown, in order to replenish their obsidian supplies, they were capable of covering distances of several hundred kilometers. The Chikiani and Sarikamish obsidian sources are located approximately 165-190 km in a straight line from the Anaseuli sites; however, considering the relief of western Caucasia and the available communication routes, the actual distance may have reached 300-350 km. Traversing such a distance, in our estimation, would have required roughly 10–14 days. Nevertheless, the possibility of obsidian trade should not be excluded.

The absolute dates for Anaseuli I fall within the 10th-9th millennia BC, with close parallels at the Darkveti rock shelter (Layer IV) (Nebieridze, 1972; Chkhatarashvili et al., 2025a), Kobuleti (Chkhatarashvili et al., 2020; Chkhatarashvili, Manko 2020), Khutsubani (Chkhatarashvili et al., 2024a), and Kvirike (Manko, Chkhatarashvili, 2022), among others. Unfortunately, Anaseuli II has not yet yielded absolute dates; however, based on the typological study of its lithic and ceramic assemblages, it shows close affinities with Makhvilauri (7th-6th millennia BC) (Chkhatarashvili et al., 2024b), Odishi, Gurianta, Mamati (Nebieridze, 1972), and related sites.

Thus, the geochemical analysis of the obsidian assemblages from Anaseuli I and II provides valuable insights. It appears that obsidian held a privileged position for the inhabitants of these sites, who undertook long-distance movements to secure it. The study of obsidian offers a unique opportunity to trace patterns of mobility and migration across western Transcaucasia during the 10th-6th millennia BC.

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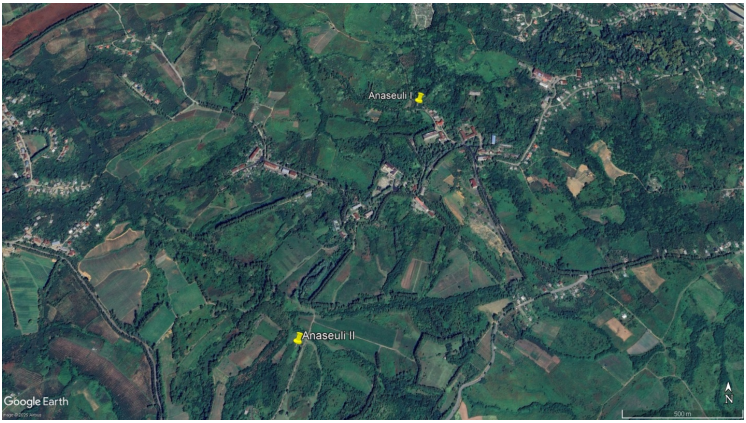

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Fig. 1-2. Map showing the location of the archaeological sites and identified obsidian sources.

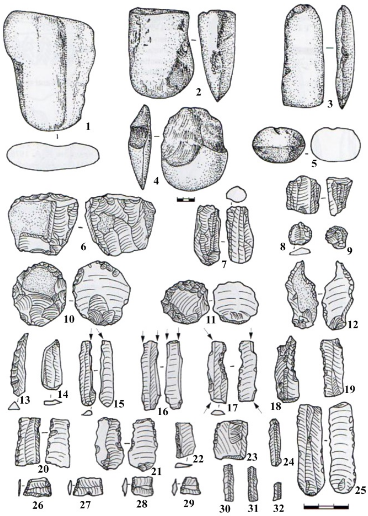

Fig. 3. Stone complex of Anaseuli I.

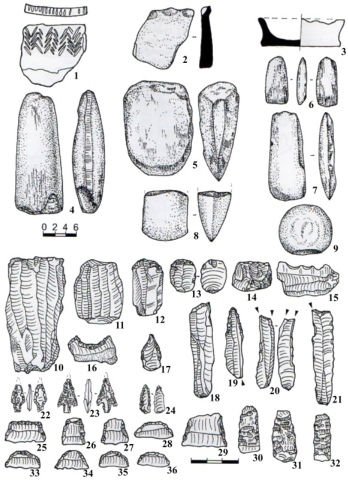

Fig. 4. Stone and ceramic complex of Anaseuli II.

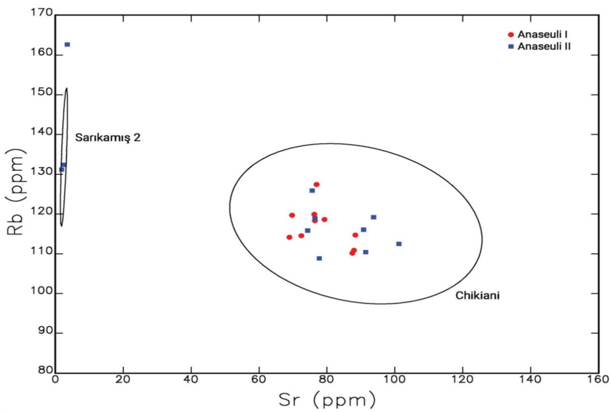

Fig. 5. Scatterplot of strontium versus rubidium showing samples from Anaseuli I-II with Ellipses representing compositional groups. Ellipses are drawn at 90% confidence.

Table 1. Flint and Obsidian complexs of Anaseuli I.

Artifatcs		Flint	Obsidian	Total
1	Cores	14	14	28
2	Flakes	480	720	1 200
3	Chunks	250	1 450	1 700
4	Blades, microblades	245	465	710
5	Burins	29	131	160
7	Scrapers	35	85	120
8	Drills	2	2	4
9	Combined tools	1	12	13
10	Trapezes	5	5	10
11	Others	10	2	8
		1 071	**2 886**	**3 957**

Tab. 2. Results of geochemical analysis of obsidian.

	Site	**Sample**	**Source**	K	Ca	Ti	Mn	Fe	Zn	As	Rb
GUG101	Anas. I	1	Chikiani	26293.22	3664.20	561.11	432.59	4799.25	41.21	0.00	114.54
GUG102	Anas. I	2	Chikiani	30335.39	3814.19	615.00	453.21	5551.27	46.87	0.00	118.61
GUG103	Anas. I	3	Chikiani	29275.74	3946.32	668.95	437.94	5300.13	44.04	0.00	118.33
GUG104	Anas. I	4	Chikiani	28336.18	3907.90	810.47	390.14	6095.45	47.03	0.00	114.69
GUG105	Anas. I	5	Chikiani	29340.28	3515.82	566.72	424.98	4908.84	43.44	0.00	119.68
GUG106	Anas. I	6	Chikiani	26461.22	4228.23	744.54	383.36	5664.23	164.44	4.51	110.17
GUG107	Anas. I	7	Chikiani	26054.37	2960.50	573.43	402.70	4691.57	47.61	0.00	114.15
GUG108	Anas. I	8	Chikiani	32443.83	4523.04	712.56	496.39	5866.85	52.99	0.42	127.42
GUG109	Anas. I	9	Chikiani	27251.36	3769.31	791.26	389.47	5839.18	62.15	0.00	110.88
GUG110	Anas. I	10	Chikiani	28542.81	3579.21	616.86	407.19	5327.03	45.39	0.00	119.90
GUG111	Anas. II	1	Chikiani	30470.72	4694.90	763.76	398.74	6280.36	50.33	0.00	112.50
GUG112	Anas. II	2	Chikiani	28338.00	3869.94	613.23	442.42	5158.12	46.37	0.00	118.90
GUG113	Anas. II	3	Sarik 2	25984.60	2121.88	483.67	501.95	6976.71	80.31	5.70	132.40

GUG114	Anas. II	4	Chikiani	32645.55	5203.65	830.55	446.51	6559.63	53.29	0.00	116.05
GUG115	Anas. II	5	Chikiani	27840.91	3370.83	561.67	358.53	5144.67	43.67	0.00	108.85
GUG116	Anas. II	6	Chikiani	32151.54	4259.61	725.10	474.79	5627.82	51.60	0.00	125.91
GUG117	Anas. II	7	Chikiani	33968.20	4948.52	846.62	474.03	6569.72	49.88	1.99	119.21
GUG118	Anas. II	8	Sarik 2	29261.59	2594.06	546.27	322.07	7605.23	50.18	3.33	162.65
GUG119	Anas. II	9	Chikiani	28780.00	3862.76	565.10	422.63	5189.29	47.63	0.00	115.84
GUG120	Anas. II	10	Chikiani	29495.53	4597.98	801.71	409.75	5773.72	55.36	2.23	110.41
GUG121	Anas. II	11	Sarik 2	23617.53	1911.94	580.42	502.13	7295.36	197.06	2.68	131.20

	Site	Sr	Y	Zr	Nb	Th	**Sr/Rb**	**Rb/Zr**	**Sr/Zr**	**Y/Zr**	**Nb/Zr**	**Fe/Mn**
GUG101	Anas. I	72.44	12.05	74.19	19.16	12.73	0.63	1.54	0.98	0.16	0.26	11.09
GUG102	Anas. I	79.27	11.91	82.98	18.16	15.01	0.67	1.43	0.96	0.14	0.22	12.25
GUG103	Anas. I	76.46	13.04	79.94	18.75	13.44	0.65	1.48	0.96	0.16	0.23	12.10
GUG104	Anas. I	88.37	11.60	99.59	16.28	14.71	0.77	1.15	0.89	0.12	0.16	15.62
GUG105	Anas. I	69.70	12.48	70.55	18.48	15.04	0.58	1.70	0.99	0.18	0.26	11.55
GUG106	Anas. I	87.46	11.54	93.19	16.70	14.18	0.79	1.18	0.94	0.12	0.18	14.78
GUG107	Anas. I	68.92	10.94	70.79	17.47	12.80	0.60	1.61	0.97	0.15	0.25	11.65
GUG108	Anas. I	76.94	11.71	80.02	19.01	15.50	0.60	1.59	0.96	0.15	0.24	11.82
GUG109	Anas. I	87.97	12.22	97.59	16.99	15.08	0.79	1.14	0.90	0.13	0.17	14.99
GUG110	Anas. I	76.26	11.72	80.46	19.52	14.41	0.64	1.49	0.95	0.15	0.24	13.08
GUG111	Anas. II	101.20	11.66	110.26	17.90	14.67	0.90	1.02	0.92	0.11	0.16	15.75
GUG112	Anas. II	76.43	11.75	81.81	19.58	14.18	0.64	1.45	0.93	0.14	0.24	11.66
GUG113	Anas. II	2.33	37.20	174.76	23.46	17.05	0.02	0.76	0.01	0.21	0.13	13.90
GUG114	Anas. II	90.78	11.74	97.21	18.13	13.97	0.78	1.19	0.93	0.12	0.19	14.69
GUG115	Anas. II	77.76	10.60	83.29	18.34	14.68	0.71	1.31	0.93	0.13	0.22	14.35
GUG116	Anas. II	75.66	12.34	73.70	19.12	14.94	0.60	1.71	1.03	0.17	0.26	11.85
GUG117	Anas. II	93.78	12.16	97.92	18.42	15.23	0.79	1.22	0.96	0.12	0.19	13.86
GUG118	Anas. II	3.49	27.52	184.74	21.72	24.31	0.02	0.88	0.02	0.15	0.12	23.61
GUG119	Anas. II	74.35	11.20	77.34	18.62	13.54	0.64	1.50	0.96	0.14	0.24	12.28

GUG120	Anas. II	91.42	10.11	99.09	16.80	13.95	0.83	1.11	0.92	0.10	0.17	14.09
GUG121	Anas. II	1.81	36.77	153.97	24.26	16.53	0.01	0.85	0.01	0.24	0.16	14.53