

Obsidian at Kobuleti (Western Georgia): Evidence for early human contact in Western Transcaucasia during the Early Holocene

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A B S T R A C T. We describe a study of obsidian artifacts from an early Holocene period site located at Kobuleti, Georgia, in the southeastern Black Sea region. A collection of obsidian artifacts discovered there were analyzed by X-ray fluorescence to determine their provenance. Two of the three types of obsidian identified correspond to the Chikiani and Sarikamis sources indicating early human mobility and cultural contact within Caucasia. One unprovenanced artifact did not match any of the currently known sources.

Keywords: Kobuleti, Chikiani, Caucasus Mountains, obsidian, , X-ray fluorescence

1. Introduction

Obsidian (volcanic glass) was one of the most popular varieties of stone used by prehistoric humans to produce sharp-edged tools. The sources of obsidian are generally restricted to geologically-recent volcanic regions, such as eastern Africa, western North America, the trans-Mexican volcanic belt, western South America, Russian Far East, Japan, islands of the South Pacific, Mediterranean, and the Caucasus Mountains. In recent years, archaeologists have made extensive use of geochemical analysis to investigate questions about obsidian artifact provenance (Glascock, 2020).

One of the most active regions for obsidian usage during the early Holocene was the Caucasus Mountains. The Caucasus Mountains are located in the region separating the Black and Caspian seas and where Europe and Asia join. The country of Georgia lies between two separate ranges—the Greater Caucasus in the north and the Lesser Caucasus in the south. Although sources of obsidian are abundant in the region, a majority of the sources are located south and southwest of

Georgia in the countries of Armenia, Azerbaijan, and Turkey (Adler, 2002; Badalyan et al., 2004; Biagi et al., 2017, 2018; Chataigner and Gratuze, 2014a,b; Frahm et al., 2016; Pleurdeau et al., 2007). The two sources most accessible to archaeological sites in Georgia are the Chikiani source in south-central Georgia and the Baksan River source in southern Russia. See the map in **Fig. 1**.

The Chikiani source, located near Lake Paravani, is the most northern of the Lesser Caucasus obsidian sources. The Middle-Late Pliocene volcano whose age is estimated to be between 2.4Ma and 2.8Ma (Lebedev et al., 2008; Nomade et al., 2016) is composed of a mixture of trachyrhyolites, obsidian, and perlites (Nasedkin et al., 1983). The obsidian is very homogeneous, without inclusions, and comes in a variety of colors. According to Gogadze (1980) and Kikodze (1983), exploitation of obsidian from Chikiani began in the Palaeolithic and extended until the Historic Period.

The Baksan source was discovered by Borchevskiy (1900) and is located on the flanks of Mt. Elbrus. The presence of obsidian artifacts from Baksan in the Atzhukino region was confirmed by Dubanskiy (1911, 1912) and at the Neolithic settlement of Nalchik by Ermelenko (1929). According to Chirvinskiy (1934), the exploitation of obsidian from Baksan began during the Palaeolithic. Uranium fission-track dating has estimated the age of Baksan obsidian to be about 2.2Ma (Komarov et al., 1972).

Archaeological excavations in the territory of Georgia have revealed several hundred sites (caves, grottos, rock shelters, open-air sites, etc.) from the Stone Age (Paleolithic, Mesolithic, Neolithic) both near the Black Sea coastline (Gogitidze, 1978; Kalandadze, 1978; Nebieridze, 1972) and in the mountainous area (Adler et al., 2006, 2008; Bar-Yosef et al., 2011; Gabunia, 1976; Grigolia, 1977; Meshveliani et al., 1999; Nioradze, 1933, 1953; Pinhasi et al., 2014; Tsereteli, 1973; Tushabramishvili, 1960; Tushabramishvili et al., 1999, 2012). Many of the sites show evidence of both temporary and long-term habitation. Some of the sites were used as lithic workshops.

Excavations carried out at various times have uncovered extensive archaeological materials, including obsidian. Unfortunately, obsidian artifacts from only a limited number of early Holocene sites in central Georgia have been studied to determine their provenance (Badalyan et al., 2004; Blackman et al., 1998; Le Bourdonnec et al., 2012) which have mainly originated from Chikiani. Due to its convenient location in central Georgia, obsidian from the Chikiani source, is likely to have spread to other sites in western and eastern Georgia.

The available evidence for early Holocene occupation of the western Georgia will be presented here based on the archaeological data obtained from the site of Kobuleti. The main objective of this work is to present evidence of human contact at the site in the early Holocene (10,000 to 7,000 years ago)

2. Geographic and archaeological context

Kobuleti is an open-air site situated on the Colchian Plain, which occupies almost the whole of western Georgia and lies to the east of the Black Sea. The Colchian Plain is characterized by a humid subtropical climate. The site of Kobuleti is located on a hill overlooking the north bank of the river Kintrishi in Ajara (western Georgia) (GPS: 41.8030° N, 41.8844° E). The hill with a height of 50m a.s.l. is formed from basaltic rock. The upper portion is associated with the archaeological site.

The first archaeological investigations at Kobuleti were performed by Berdzenishvili and Nebieridze (1964). The first excavations were conducted by archaeologist Gogitidze (1978, 2008), who organized multiple field seasons at Kobuleti from 1971-1986. Gogitidze (2008) dated the site to the Late Mesolithic - Early Neolithic period. More than one hundred pits used for different purposes were found during archaeological excavations. A total of about 30,000 artifacts made of flint and obsidian were recovered. About 2,000 of the artifacts were tools and the remainder were debitage (flakes, chips, chunks, etc.). Because of the moist soil, wood and bone materials were not found during the excavations at Kobuleti. Unfortunately, no radiocarbon and palynological studies were conducted.

In 2019, for the first time in 33 years, funding from Batumi Shota Rustaveli State University supported an opportunity to investigate the site of Kobuleti using interdisciplinary research (palynology, use-wear analyses, and geochemistry). The techno-typological and use-wear analysis of the stone artifacts found that the tools were not made locally, but instead were brought to the site as ready-made products. Microscopic analysis of the artifacts reveals that the main activities conducted at the site were the processing of game meat and working with leather (Esakiya and Chkhatarashvili, 2020). No evidence for long-term usage was determined on any of the tools. According to the palynological analysis, the climate was warm at the time when the site was

functioning. This was confirmed by examining the spores of thermophilic plants in the samples (Chkhatarashvili et al., 2020).

The new excavations were carried out in the central part of the hill to the north of a previously studied trench. In order to locate an undisturbed cultural layer, several survey trenches were made. The most interesting among these was trench number 3 where we investigated 32 m² and found the stratigraphic details listed in Table 1.

All cultural evidence was fixed in three soil layers. Despite different colors, all three layers belong to the same period – the Mesolithic – both typologically and structurally. In addition, we discovered 12 pits with numerous flint and obsidian artifacts. Pit 5 was found in layer 1, pit 6 in layer 2 and pits 1-4 and 7-12 were associated with layer 3.

During the course of the archaeological work, a total of 1533 artifacts were discovered (see Tables 2-3). Of these, a total of 262 were formal tools (i.e., burins, chisels, endscrapers, etc.). Also found were 179 bladelets, 165 microblades, and the remainder consisted of debitage (i.e., chips, flakes, and chunks). Three spent cores and four tablets (i.e., rejuvenated platforms) were also recovered.

Typological analysis of the flint and obsidian artifacts indicates they were not knapped on the spot. By comparing the quantity of blades versus flakes/chunks, it appears the artifacts were probably brought to Kobuleti in the form of ready-made products and mainly used for hunting.

A majority of the bladelets and microblades have semi-flat shapes. Apparently, they used a pressure technique to produce bladelets and microblades from cores (Hildebrand, 1996). Many of these show evidence of retouching on their edges (**Fig. 2: 1-3**). Some of the bladelets were notched (**Fig. 2: 4-6**).

Second most numerous among the tools were burins. They were rather diverse with side and angle burins, double-faceted and dihedral burins, etc. (**Fig. 2: 7-9**). A majority of the burins were produced from blades, but some of them were made from flakes. There is one combined tool - burin-endscraper (**Fig. 2: 10**).

Also, among the finds were 15 endscrapers (**Fig. 2: 11**) and several chisels (**Fig. 2: 12**). It appears the endscrapers and chisels were produced by retouching some of the flakes. There were also several truncated blades (**Fig. 2: 13**) -- some of them were truncated faceted blades still showing the negative of a microburins spall.

An important group of tools are microblades with abrupt retouching on their edges. These were used specifically for hunting. There are both thick (up to 3 mm) and thin (about 1 mm) microblades (Fig. 2: 14-18).

At present, we only have one absolute date for the site of Kobuleti (Table 4). According to other archaeological sites of the Stone Age in Georgia, the date fits exactly in the chronological framework of the Mesolithic period (Gabunia and Tsereteli, 1991: 196). It is still debatable whether the Mesolithic Period should be distinguished separately and independently from the Upper Paleolithic Period (Rogachev, 1966). Other archaeologists see it as a separate epoch (Formozov, 1970). Some researchers consider the main criteria for isolating the Mesolithic Period to be only the typological features of the tools and the nature of economy; others consider only the ecological-climatic, paleontological and social elements (Kozłowski, 1973). With all this in mind, we suggest that the Kobuleti is a Mesolithic site that early hunters visited seasonally.

3. Materials and Methods

Following the 2019 field work, it was decided to submit obsidian artifacts for geochemical analysis to determine the chemical composition and provenance of the obsidian. It should be noted that four samples of Kobuleti obsidian had been analyzed previously (Badalyan et al., 2004). The earlier study established that all four artifacts came from Chikiani Mountain in southern Georgia. However, our goal was to study a much larger number of samples, which would naturally allow us to draw more accurate conclusions. The study was conducted by submitting 50 artifacts from Kobuleti and ten geological samples from the Chikiani source to the Archaeometry Laboratory at the University of Missouri Reactor Research (MURR).

The geological and artefact samples were analyzed for their compositions by using a ThermoQuantx ARL spectrometer operating at 35kV. The spectrometer was calibrated earlier for obsidian studies by analyzing a suite of 40 geological obsidians analyzed by NAA, XRF and inductively coupled plasma mass spectrometry (Glascok, 2020). The elements measured were K, Ca, Ti, Mn, Fe, Zn, Rb, Sr, Y, Zr, Nb, and Th. A measurement time of 60 seconds was used on each sample.

4. Results

The results for the ten geological samples from Chikiani are listed in Table 5. The results for the 50 artifacts from Kobuleti are listed in Table 6. A comparison of the Kobuleti artifacts to the geological samples from Chikiani determined that 48 of the artifacts did indeed come from the Chikiani source (see **Fig. 3**). However, artifacts GUG001 and GUG024 were found to be different from the rest. Artifact GUG001 came from the Sarikamis source (northern subgroup) located in northeastern Turkey. After comparing artifact GUG024 to all known sources in Armenia, Azerbaijan, North Caucasus and Turkey, we concluded that it came from an unknown source.

5. Discussion

The main materials used for the stone tools on Kobuleti site were flint and obsidian. The Lesser Cascasus region is rich in flint outcrops due to the presence of limestone in which large amounts of Turon-type flint are frequently encountered. Flint is absent in the immediate (Kintrishi River valley) and further surroundings (valleys of Supsa, Natanebi and Rioni) near the Kobuleti site. The flint used at Kobuleti and on the eastern Black sea littoral is of very high quality (red, white, grey, yellowish and other colours). Whereas a low-quality chert formed on the basis of petrified wood was exclusively used in the highlands and is not encountered on the littoral. Unfortunately, no attempts have been made to provenance the type of flint used at Kobuleti site by means of archaeometric methods.

Concerning the obsidian, it represents the most often used material after flint for making tools at Kobuleti. The obsidian is of high quality and is mainly characterized by transparent and black colours. However, examples with red-veins points to the fact that different sources were sometimes used. The closest obsidian source is located ca. 170 km from Kobuleti, at Chikiani mountain, which remains as the only known obsidian source on the territory of Georgia. It should be noted that geologists have documented obsidian veins have been in a few gorges in western Georgia, however they are too limited in thickness and volume to be suitable for tool production. Based on the technotypological analysis of stone industry, we conclude that obsidian, being a high quality and easily workable material, was favored by the settlers of Kobuleti site for the tool production.

The second obsidian source used for the tools at Kobuleti site was Sarikamis (Turkey), located at the distance of ca. 200-220 km. The Sarıkamış obsidian source is named after a small town in the Kars province in eastern Turkey. The area is very mountainous. According to chemical

analyses obsidian has been discovered in several deposits that separate into two groups: Sarikamis “South” and “North”. The Sarikamis South source area is located near the towns of Mescitli and Sehitemin. It is characterized by high barium concentrations and relatively low amounts of the zirconium (Chataigner et al., 2014). This group is the oldest (4.9–4.4 Ma, Bigazzi et al., 1998) and comes from an undifferentiated magma (Gallet, 2001). The Sarikamis North source area is located near the towns of Kizil Kilisa, Handere and Hamamlı. It is characterized by low barium concentrations and higher concentrations zirconium. This group is the more recent (3.8–3.5 Ma; Bigazzi et al., 1998) and comes from a more evolved magma in which zircon is present as microcrystals (Chataigner et al., 2014; Gallet, 2001).

According to geochemical analyses of obsidian artifacts discovered at the sites of Aratashen, Karkrakar, and Ketı in western Armenia (Chataigner et al., 2014: 20-22) and at Ortvala-klde in western Georgia (Le Bourdonnec et al., 2012) the obsidian came from the Sarikamis North source. The sample of Sarikamis obsidian in this study also came from the Sarikamis North source.

6. Conclusion

According to our research, the early humans at Kobuleti obtained obsidian from multiple sources. By far, the most important source was Chikiani Mountain which lies southeast of Kobuleti. In addition to being closest to Kobuleti, obsidian from the Chikiani source was favored for tool production because it was a high quality and easily workable material. The Sarikamis source located south of Kobuleti served as a minor secondary source for the inhabitants of Kobuleti. Our analysis also revealed the existence of one unknown source. Although the latter could not be identified, it may be evidence of more extensive contacts as research has shown that early humans were often mobile and had active contacts with other regions. In summary, it can be said that obsidian found in the Ajara region along the southeastern Black Sea coast is the earliest evidence of the use of obsidians from Chikiani and Sarikamis in the early Holocene (approximately 10,000 to 7,000 years ago).

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Table 1. Stratigraphy of trench number 3 at the site of Kobuleti.

| Depth (m) | Description of layers |
|----------------|--|
| 0 to 0.2 | Humus layer |
| 0.2 to 0.3 | Layer 1. Blackish-brown soil |
| 0.3 to 0.45 | Layer 2. Brown soil |
| 0.45 to 0.65 | Layer 3. Light brown soil with small pebbles |
| 0.65 and below | Yellow (sterile) layer |

Table 2. List of flint and obsidian artifacts in soil layers 1-2 at Kobuleti.

| Type | Layer 1 | | Layer 1, Pit 5 | | Layer 2 | | Layer 2, Pit 6 | | Total | | |
|---|-----------|-----------|----------------|----------|-----------|-----------|----------------|-----------|-----------|------------|------------|
| | Flint | Obsidian | Flint | Obsidian | Flint | Obsidian | Flint | Obsidian | Flint | Obsidian | |
| Core | 1 | | | | | 1 | | | 1 | 1 | 2 |
| Tablettes | | | | | 2 | 1 | 1 | | 3 | 1 | 4 |
| Blades | 3 | | | | 7 | 2 | 18 | 9 | 28 | 11 | 39 |
| Bladelets | 8 | 13 | 3 | 8 | 45 | 27 | 7 | 14 | 63 | 62 | 125 |
| Microblades | 2 | 10 | 1 | 6 | 16 | 23 | 34 | 24 | 53 | 63 | 116 |
| Flakes | 8 | 9 | 19 | 16 | 54 | 23 | 99 | 31 | 180 | 79 | 259 |
| Chips | 12 | 18 | | | 16 | 6 | 65 | 21 | 92 | 45 | 138 |
| Chunks | 5 | 12 | | | 35 | 63 | 13 | 20 | 53 | 95 | 148 |
| Burin spalls | | 1 | | | 3 | 2 | | | 3 | 3 | 6 |
| Tools | 15 | 25 | 6 | 8 | 26 | 44 | 15 | 48 | 62 | 122 | 184 |
| Burins | 5 | 5 | 5 | | 12 | 5 | 3 | 9 | 25 | 19 | 44 |
| Endscrapers | | 3 | | 1 | 2 | 2 | | 2 | 2 | 8 | 10 |
| Chisels | | | | | 5 | 4 | 1 | 2 | 6 | 6 | 12 |
| Retouched Flakes | | | | | 1 | | | 2 | 1 | 2 | 3 |
| Retouched blades, bladelets, microblades | 7 | 13 | | 2 | 4 | 15 | 2 | 13 | 13 | 43 | 59 |
| Notched blades, bladelets | 1 | | | 5 | 1 | 8 | 2 | | 4 | 13 | 17 |
| Truncated Blades, bladelets, microblades | 2 | 3 | | | 1 | 3 | 4 | 5 | 7 | 11 | 18 |
| Microblades with abrupt retouch | | 1 | | | | 7 | 3 | 12 | 3 | 20 | 23 |

| | | | | | | | | | | | |
|------------------|-----------|-----------|-----------|-----------|------------|------------|------------|------------|------------|------------|-------------|
| Endscraper-Burin | | | 1 | | | | | | 1 | | 1 |
| Total | 54 | 88 | 29 | 38 | 204 | 192 | 252 | 164 | 539 | 482 | 1021 |

Table 3. List of flint and obsidian artifacts in soil layer 3 at Kobuleti.

| Type | Layer 3 | | Pit 1 | | Pit 2 | | Pit 3 | | Pit 4 | | Pit 7 | | Pit 8 | | Pit 9 | | Pit 10 | | Pit 11 | | Total | | |
|--|------------|-----------|----------|----------|-----------|-----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|--------|--|-----------|-----------|------------|------------|------------|
| Cores and debitage | Flint | Obsidian | Flint | Obsidian | Flint | Obsidian | Flint | Obsidian | Flint | Obsidian | Flint | Obsidian | Flint | Obsidian | Flint | Obsidian | | | Flint | Obsidian | Flint | Obsidian | Total |
| Cores | | | | | 1 | | | | | | | | | | | | | | | | 1 | | 1 |
| Blades | | 3 | 2 | 3 | | | | | | | | | 1 | 2 | | | | | | | 3 | 8 | 11 |
| Bladelets | 14 | 3 | | | 8 | 1 | | | | | 2 | 2 | 3 | 3 | 3 | 2 | | | 12 | 1 | 42 | 12 | 54 |
| Microblades | 12 | 5 | 1 | 4 | 7 | 3 | | | | | 1 | 3 | | | 2 | | | | 8 | 3 | 31 | 18 | 49 |
| Flakes | 22 | 11 | 2 | 1 | 17 | 5 | | | | 1 | 2 | | 7 | 3 | 26 | 9 | | | 14 | 6 | 90 | 36 | 126 |
| Chips | 23 | 2 | | | 10 | 2 | | | | | 3 | 3 | 12 | 3 | | | | | 11 | 2 | 59 | 12 | 71 |
| Chunks | 47 | 12 | | | 41 | 4 | | | | | | | | | | | | | 15 | 3 | 104 | 19 | 122 |
| Tools | 19 | 7 | 0 | 0 | 4 | 1 | 1 | 0 | 0 | 0 | 4 | 7 | 7 | 4 | 6 | 2 | | | 2 | 14 | 43 | 35 | 78 |
| Burins | 3 | 2 | | | 2 | 1 | | | | | 1 | 1 | 1 | 3 | | | | | | 4 | 7 | 11 | 18 |
| Endscrapers | | 1 | | | | | | | | | 1 | | 1 | | 2 | | | | | | 4 | 1 | 5 |
| Chisels | 2 | | | | | | | | | | | | | | | | | | 1 | | 3 | | 3 |
| Retouched Flakes | 2 | | | | | | | | | | | | 1 | | 2 | 1 | | | | | 5 | 1 | 6 |
| Retouched Blades, bladelets, microblades | 12 | 3 | | | 2 | | 1 | | | | 2 | 6 | 4 | 1 | 1 | 1 | | | | 10 | 22 | 21 | 40 |
| Truncated Blades, bladelets | | 1 | | | | | | | | | | | | | | | | | | | | 1 | 1 |
| Microblades with abrupt retouch | | | | | | | | | | | | | | | 1 | | | | 1 | | 2 | | 2 |
| Total | 137 | 43 | 5 | 8 | 88 | 16 | 1 | | | 1 | 12 | 15 | 30 | 15 | 37 | 13 | | | 62 | 29 | 372 | 140 | 512 |

Table 4. Radiocarbon date of Kobuleti site.

| Location | Sample | Lab. Cod | Dates ^{14}C BP | Dates cal. BC (68.2 %) | Dates cal. BC (95.4 %) | Reference |
|-------------------|----------|--------------|--------------------------|------------------------|------------------------|-----------|
| Pit 7, Level 2 | Charcoal | Spb- 3084 | 8670 \pm 100 | 7831-7584 | 7995-7534 | This work |

Table 5. Concentrations of elements in parts per million for obsidian from the Chikiani source.

| ANID | K | Ca | Ti | Mn | Fe | Zn | Rb | Sr | Y | Zr | Nb | Th |
|--------|-------|------|-----|-----|------|------|-------|------|------|------|------|------|
| CHIK01 | 31822 | 4172 | 797 | 536 | 5520 | 44.0 | 122.5 | 81.2 | 14.2 | 83.4 | 20.9 | 14.0 |
| CHIK02 | 25947 | 3064 | 588 | 368 | 4824 | 40.4 | 118.0 | 74.9 | 13.4 | 78.4 | 20.6 | 14.9 |
| CHIK03 | 41274 | 5645 | 909 | 576 | 6143 | 44.8 | 129.2 | 87.8 | 14.9 | 93.3 | 20.2 | 14.8 |
| CHIK04 | 40402 | 4929 | 816 | 473 | 5684 | 43.5 | 126.6 | 82.4 | 14.2 | 86.6 | 19.4 | 16.7 |
| CHIK05 | 43258 | 6251 | 963 | 580 | 6327 | 49.4 | 129.8 | 93.3 | 14.5 | 98.0 | 21.6 | 15.7 |
| CHIK06 | 41727 | 5431 | 924 | 519 | 5866 | 43.0 | 125.5 | 87.5 | 15.2 | 92.6 | 19.9 | 15.3 |
| CHIK07 | 41199 | 4968 | 829 | 508 | 5635 | 45.8 | 122.6 | 81.5 | 14.5 | 84.9 | 20.8 | 13.2 |
| CHIK08 | 35756 | 4500 | 749 | 428 | 5681 | 43.6 | 119.5 | 86.5 | 14.5 | 95.2 | 19.9 | 13.7 |
| CHIK09 | 41265 | 5623 | 853 | 466 | 5822 | 45.0 | 124.8 | 83.5 | 14.3 | 91.2 | 20.3 | 15.3 |
| CHIK10 | 38654 | 4989 | 778 | 474 | 5864 | 48.8 | 124.5 | 87.4 | 13.8 | 93.3 | 19.5 | 16.4 |

Table 6. Concentrations of elements in parts per million for obsidian artifacts from Kobuleti.

| ANID | Source | K | Ca | Ti | Mn | Fe | Zn | Rb | Sr | Y | Zr | Nb | Th |
|--------|-----------|-------|------|------|-----|------|------|-------|-------|------|-------|------|------|
| GUG001 | SARIKAMIS | 37093 | 2234 | 538 | 623 | 7899 | 69.2 | 136.2 | 3.3 | 42.7 | 222.9 | 27.1 | 17.3 |
| GUG002 | CHIKIANI | 35480 | 4309 | 746 | 431 | 5613 | 45.1 | 117.6 | 85.4 | 13.4 | 97.1 | 18.6 | 14.7 |
| GUG003 | CHIKIANI | 26886 | 3302 | 653 | 274 | 5606 | 38.0 | 97.2 | 105.3 | 10.4 | 117.7 | 16.9 | 12.7 |
| GUG004 | CHIKIANI | 37396 | 4904 | 871 | 441 | 6224 | 42.4 | 118.6 | 98.6 | 14.5 | 109.5 | 18.6 | 15.0 |
| GUG005 | CHIKIANI | 42435 | 6770 | 1152 | 478 | 7000 | 45.0 | 122.7 | 115.3 | 14.3 | 121.2 | 18.5 | 16.6 |
| GUG006 | CHIKIANI | 35441 | 4200 | 720 | 423 | 5360 | 41.7 | 118.0 | 80.9 | 13.6 | 90.0 | 21.2 | 14.5 |
| GUG007 | CHIKIANI | 31828 | 3547 | 563 | 369 | 4902 | 45.0 | 112.9 | 69.0 | 13.2 | 75.7 | 19.8 | 12.2 |
| GUG008 | CHIKIANI | 43092 | 6236 | 879 | 608 | 6002 | 47.4 | 128.7 | 77.1 | 16.0 | 79.0 | 21.0 | 15.2 |
| GUG009 | CHIKIANI | 37242 | 4406 | 741 | 433 | 5875 | 42.9 | 118.7 | 83.2 | 13.8 | 91.4 | 20.4 | 12.1 |
| GUG010 | CHIKIANI | 38044 | 4767 | 815 | 471 | 5521 | 42.4 | 119.4 | 83.4 | 14.8 | 90.1 | 20.0 | 14.3 |
| GUG011 | CHIKIANI | 36764 | 4322 | 839 | 410 | 5898 | 42.9 | 116.6 | 91.5 | 13.6 | 100.8 | 19.5 | 15.6 |
| GUG012 | CHIKIANI | 38249 | 4785 | 834 | 485 | 6325 | 46.0 | 122.9 | 87.7 | 13.5 | 97.3 | 20.7 | 14.0 |
| GUG013 | CHIKIANI | 38363 | 4107 | 882 | 510 | 6019 | 47.2 | 124.5 | 76.2 | 14.7 | 78.8 | 21.1 | 14.9 |
| GUG014 | CHIKIANI | 38430 | 4705 | 791 | 483 | 5831 | 42.4 | 116.5 | 88.0 | 14.6 | 94.2 | 19.4 | 13.6 |
| GUG015 | CHIKIANI | 33274 | 4631 | 882 | 374 | 6370 | 38.6 | 103.8 | 112.5 | 12.3 | 121.5 | 17.7 | 14.1 |
| GUG016 | CHIKIANI | 35608 | 4227 | 778 | 396 | 5451 | 36.6 | 113.6 | 86.1 | 13.7 | 95.4 | 17.9 | 13.9 |
| GUG017 | CHIKIANI | 41694 | 5359 | 843 | 581 | 5789 | 45.3 | 129.5 | 76.3 | 16.0 | 80.3 | 21.3 | 15.2 |
| GUG018 | CHIKIANI | 38094 | 4818 | 781 | 499 | 5920 | 45.0 | 122.9 | 83.4 | 14.9 | 92.8 | 22.0 | 14.8 |
| GUG019 | CHIKIANI | 37510 | 4326 | 715 | 411 | 5517 | 43.5 | 119.8 | 82.6 | 14.1 | 89.4 | 19.3 | 15.5 |
| GUG020 | CHIKIANI | 42580 | 6348 | 1036 | 527 | 6804 | 44.0 | 124.4 | 99.4 | 15.0 | 108.0 | 17.2 | 15.0 |
| GUG021 | CHIKIANI | 40122 | 4657 | 767 | 510 | 5636 | 45.2 | 128.4 | 76.8 | 15.7 | 81.4 | 21.0 | 13.1 |
| GUG022 | CHIKIANI | 37057 | 5286 | 1154 | 450 | 7258 | 41.3 | 112.5 | 110.1 | 13.1 | 117.3 | 17.8 | 15.4 |
| GUG023 | CHIKIANI | 37685 | 5037 | 837 | 445 | 5833 | 43.5 | 121.1 | 86.3 | 15.0 | 94.2 | 19.4 | 15.6 |
| GUG024 | unknown | 39940 | 6075 | 647 | 437 | 5221 | 39.9 | 177.1 | 51.9 | 16.1 | 69.4 | 27.2 | 14.2 |
| GUG025 | CHIKIANI | 33744 | 3916 | 823 | 375 | 5734 | 43.4 | 113.8 | 87.9 | 13.2 | 91.5 | 19.8 | 14.8 |
| GUG026 | CHIKIANI | 35858 | 4606 | 992 | 435 | 6759 | 48.6 | 114.3 | 89.6 | 14.2 | 98.9 | 17.3 | 14.5 |
| GUG027 | CHIKIANI | 39018 | 5341 | 847 | 476 | 6271 | 44.9 | 121.2 | 95.7 | 14.1 | 102.6 | 17.8 | 15.8 |

| | | | | | | | | | | | | | |
|--------|----------|-------|------|------|-----|------|------|-------|-------|------|-------|------|------|
| GUG028 | CHIKIANI | 34082 | 3746 | 684 | 406 | 5775 | 42.7 | 119.3 | 73.0 | 13.1 | 76.0 | 20.2 | 14.8 |
| GUG029 | CHIKIANI | 42618 | 6154 | 1003 | 567 | 6400 | 47.6 | 127.5 | 87.4 | 15.3 | 91.0 | 20.1 | 13.7 |
| GUG030 | CHIKIANI | 35675 | 4009 | 674 | 430 | 5086 | 42.7 | 120.1 | 75.6 | 14.6 | 78.1 | 21.0 | 14.6 |
| GUG031 | CHIKIANI | 30135 | 4182 | 709 | 342 | 5300 | 40.1 | 110.3 | 86.9 | 11.9 | 93.6 | 18.0 | 14.2 |
| GUG032 | CHIKIANI | 37628 | 5083 | 1030 | 479 | 6844 | 45.7 | 120.1 | 84.6 | 13.5 | 92.4 | 18.3 | 14.9 |
| GUG033 | CHIKIANI | 41173 | 5061 | 871 | 511 | 5945 | 44.6 | 124.0 | 83.8 | 15.2 | 88.5 | 19.3 | 15.3 |
| GUG034 | CHIKIANI | 39145 | 4985 | 976 | 493 | 6577 | 47.0 | 121.5 | 96.4 | 13.5 | 104.3 | 19.1 | 16.5 |
| GUG035 | CHIKIANI | 39369 | 5432 | 1098 | 421 | 6957 | 45.3 | 116.1 | 108.4 | 13.9 | 114.6 | 19.4 | 13.7 |
| GUG036 | CHIKIANI | 37005 | 4131 | 696 | 432 | 5604 | 40.4 | 122.1 | 80.4 | 13.0 | 85.6 | 21.6 | 14.7 |
| GUG037 | CHIKIANI | 42609 | 5539 | 879 | 554 | 6019 | 50.9 | 130.2 | 83.2 | 15.2 | 89.0 | 20.5 | 14.8 |
| GUG038 | CHIKIANI | 35549 | 3750 | 717 | 386 | 5817 | 45.9 | 113.7 | 85.7 | 12.5 | 95.1 | 18.7 | 14.4 |
| GUG039 | CHIKIANI | 28742 | 3215 | 701 | 334 | 4651 | 42.4 | 107.4 | 73.5 | 12.6 | 77.7 | 19.1 | 13.0 |
| GUG040 | CHIKIANI | 38281 | 5146 | 807 | 469 | 5942 | 48.6 | 123.5 | 79.5 | 14.7 | 85.5 | 20.2 | 13.4 |
| GUG041 | CHIKIANI | 37166 | 4772 | 814 | 452 | 5710 | 42.3 | 120.6 | 79.0 | 13.6 | 83.8 | 19.2 | 14.8 |
| GUG042 | CHIKIANI | 38041 | 4537 | 792 | 434 | 5700 | 44.3 | 118.3 | 92.2 | 13.9 | 99.1 | 18.4 | 14.3 |
| GUG043 | CHIKIANI | 43325 | 6708 | 1046 | 539 | 6882 | 47.3 | 126.3 | 105.7 | 14.7 | 112.2 | 19.4 | 15.5 |
| GUG044 | CHIKIANI | 30789 | 3510 | 756 | 381 | 5275 | 40.1 | 118.2 | 79.5 | 13.7 | 87.5 | 18.8 | 13.9 |
| GUG045 | CHIKIANI | 40397 | 5392 | 985 | 469 | 6179 | 53.8 | 121.7 | 97.9 | 13.6 | 109.0 | 18.3 | 15.3 |
| GUG046 | CHIKIANI | 43177 | 6055 | 984 | 515 | 6552 | 48.2 | 125.6 | 98.1 | 14.7 | 106.1 | 18.6 | 15.3 |
| GUG047 | CHIKIANI | 32940 | 4172 | 827 | 415 | 6014 | 46.5 | 111.9 | 92.3 | 13.4 | 99.0 | 19.3 | 14.6 |
| GUG048 | CHIKIANI | 35501 | 4073 | 651 | 398 | 5655 | 41.3 | 114.5 | 82.3 | 13.8 | 90.3 | 17.1 | 13.3 |
| GUG049 | CHIKIANI | 36795 | 4291 | 689 | 423 | 5676 | 43.4 | 117.0 | 84.9 | 13.2 | 88.4 | 20.2 | 14.9 |
| GUG050 | CHIKIANI | 41545 | 5197 | 845 | 557 | 5748 | 50.0 | 132.5 | 77.3 | 16.4 | 76.1 | 21.2 | 15.1 |

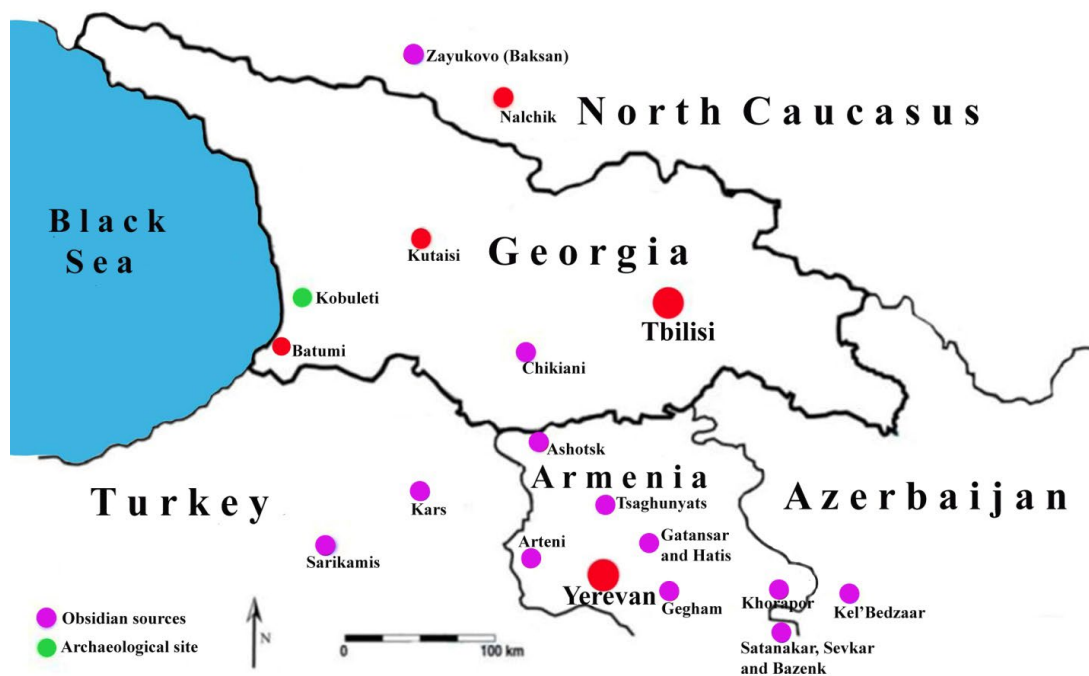


Fig. 1. Map showing the location of the Kobuleti archaeological site and the main obsidian sources in Caucasus.

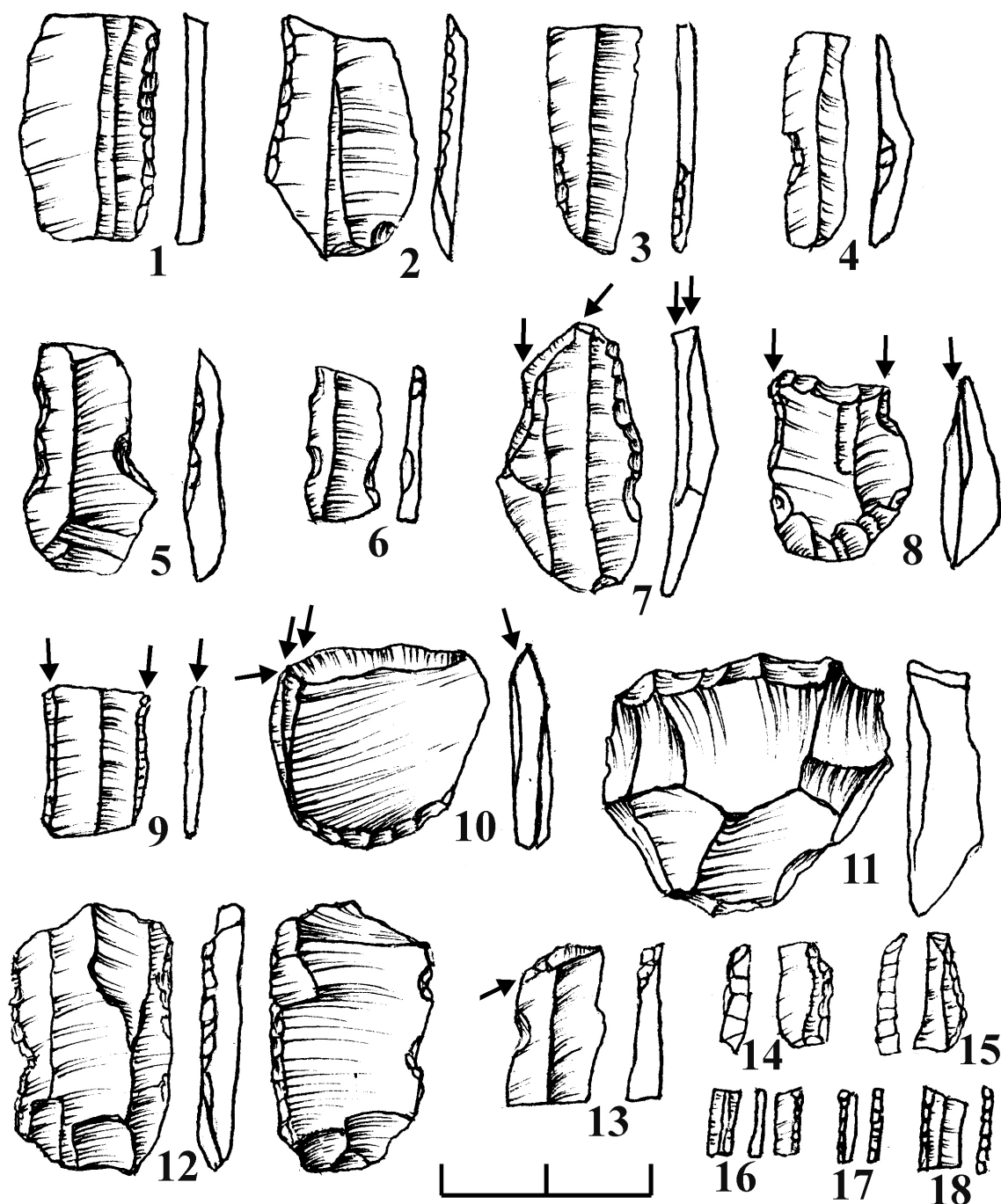


Fig. 2. Obsidian tools at Kobuleti.

1-3 retouch blades; 4-6 notch blades and bladelets; 7-9 burins; 10 combined tool: endscraper-burin; 11 endscraper; 12 chisel; 13 truncated blade; 14-18 microblades with abrupt retouch

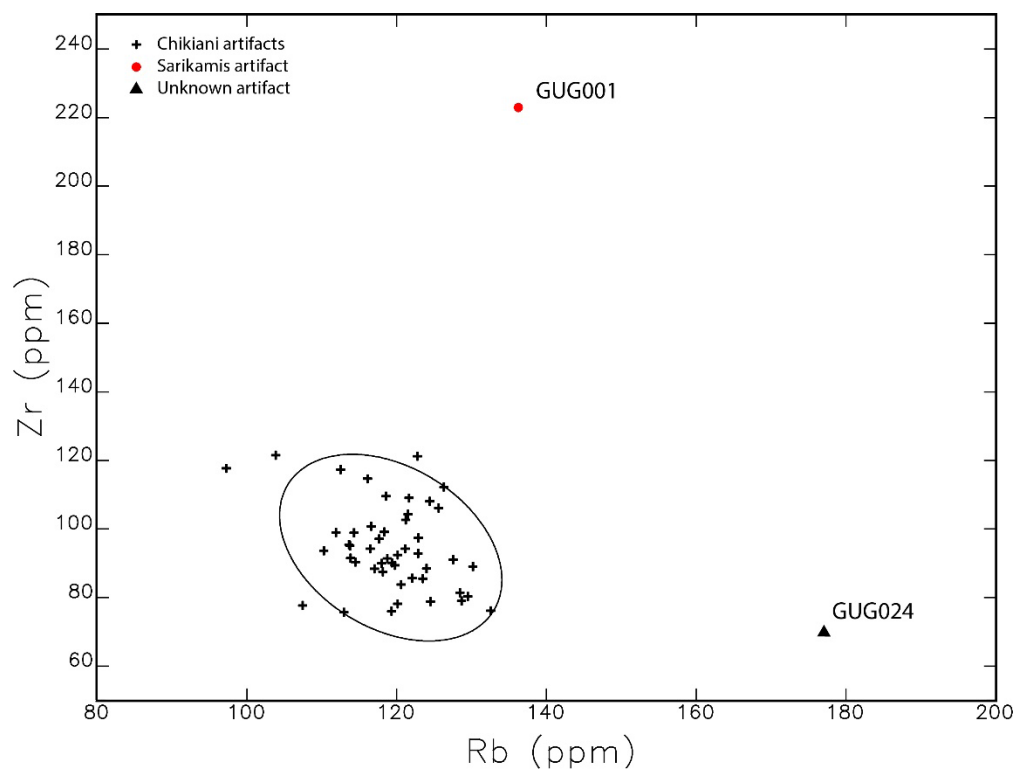


Fig. 3. Scatterplot of Rb versus Zr for obsidian artifacts from the site of Kobuleti. All ellipses indicate 90% confidence intervals for group.