Obsidian Exploitation Strategies in the Middle and Upper Paleolithic of the Northern Caucasus: New Data from Mesmaiskaya Cave

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ABSTRACT

This paper is the first comprehensive study of obsidian exploitation in the Middle, Upper, and Epipaleolithic in the Northern Caucasus. The authors analyzed 528 obsidian artifacts from Mezmaiskaya Cave (Northwestern Caucasus, Russia) and characterized 38 samples by XRF to determine source. This is the first report of all obsidians sampled from Mezmaiskaya Cave, currently representing the largest collection of obsidian artifacts known from a Paleolithic site in the Northern Caucasus. Our study indicates that all sampled obsidian artifacts were produced from obsidians derived from two sources—Zayukovo or Baksan in the North-central Caucasus and Chikiani-Paravani in the Southern Caucasus. Based on these results, we suggest that possible cultural contacts, and social or trade networks existed within the Caucasian Middle and Upper Paleolithic.

INTRODUCTION

Much attention is currently paid to the study of Paleolithic raw materials, including those related to the Paleolithic of the Caucasus (Adler et al. 2006, 2014; Andrefsky 2009; Brantingham 2003; Braun 2005; Dibble et al. 2005; Féblot-Augustins 2009; Frahm et al. 2014; Géneste et al. 2008; Grégoire 2000; Kuhn 2004; Le Bourdonnec et al. 2012). These studies provide significant data for understanding behavioral, social, and cultural adaptations, as well as subsistence, exchange, mobility, and contacts among hunter-gatherer groups in the Paleolithic. Like flint, obsidian is one of the most widely dispersed raw materials used for tool production since the early stages of human evolution (Féblot-Augustins 1997; Negash and Shackley 2006; Negash et al. 2006). Moreover, obsidian geochemical compositions are generally unique for each source, whereas the flint geochemistry can vary significantly within each outcrop.

There are very few studies of obsidian artifacts from the North Caucasian Paleolithic sites. In the first half of the 20th century, most obsidian finds in the Northern Caucasus were associated with Armenian sources. Nasedkin and Formozov (1965) published the initial study of obsidians from several Upper Paleolithic and Neolithic sites in the Northern Caucasus. They analyzed several obsidian artifacts excavated from the Upper Paleolithic levels at Gubs I and VII rockshelters (Figure 1), Double Grotto, and Lubochniy Rockshelter, using the refraction index, and proposed Zayukovo and Chegem sources located in the Baksan River basin (the Elbrus-Kazbek volcanic province [areas surrounding the Elbrus and Kazbek major volcanoes], in the North-central Caucasus). Numerous obsidian sources are known in the Elbrus-Kazbek province (Laverov et al. 2005); and, numerous surface finds of Paleolithic obsidian artifacts are reported from this area (e.g., Panichkina 1950).

Recently it has been reported that obsidian has been used since the Middle Paleolithic (MP), but mainly during the Upper Paleolithic (UP) and Epipaleolithic (EPP) at Mezmaiskaya Cave, in the Northwestern Caucasus (Golovanova et al. 2010a). Our paper is the first comprehensive study of obsidian exploitation through the Middle, Upper, and Epipaleolithic in the Northern Caucasus, based on the data from Mezmaiskaya (see Figure 1).

Today the cave is located in the upper level of mountain forest, at an elevation of 1310m above sea level. It was discovered by L. Golovanova in 1987, and since then about 80m² has been excavated to a maximum depth of 5m (Figure 2). Strata 3 thru 2 contain late Middle Paleolithic (LMP), Strata 1C, 1B, and 1A have Early Upper Paleolithic (EUP), and Strata 1-4 and 1-3 yielded Epipaleolithic (EPP) artifacts (Golovanova et al. 1998; 1999; 2006; 2010a, b; 2012).

We analyzed lithic collections from the 1987–2001, 2004, 2006, 2007, 2009, and 2010 excavations at Mezmaiskaya, containing 51,722 lithic artifacts from nine cultural levels in total (Table 1). These include 528 obsidian artifacts (~1% of the total lithics), of which 38 pieces were analyzed using a Thermo/ARL *Quant'X* energy dispersive x-ray fluorescence (EDXRF) spectrometer. The trace element analyses were performed in the Geoarchaeological XRF Laboratory, De-

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Figure 1. Map showing locations of the main stratified Middle and Upper Paleolithic sites in the Caucasus, and some obsidian sources (based on Chataigner and Gratuze (2014), Golovanova and Doronichev (2003), Le Bourdonnec et al. (2012), and Pinhasi et al. (2008). Paleolithic sites: 1) Mezmaiskaya Cave; 2) Matuzka; 3–4) Ilskaya I and II; 5–6) Dagovskaya Cave and Hadjoh-2; 7–10) Monasheskaya, Barakaevskaya, and Gubs I and VII Rockshelters; 11) Baranakha-4; 12–18) Atsinskaya, Kepshinskaya, Malaya Vorontsovskaya, Navalishenskaya, Khostinskaya I-II, and Ahshtirskaya; 19) Mushtulagti Lagat (Weasel Cave); 20) Machagua; 21) Apiancha; 22–24) Chakhati, Ortvala, and Sakajia; 25–36) Sagvarjile, Mgvimevi, Gvardjilas, Dzudzuana, Bondi, Ortvale Klde, Mgvimevi, Kudaro I and III, Tsona, Djruchula, and Damdjili; 37–38) Damdjili and Dashsalahli; 39) Zar; 40–41) Azikh and Taglar; 42) Hovk-I; 43) Kalavan I; 44–46) Lusakert I and II and Erevan; 47) Gazma. Obsidian sources: I) Zayukovo (Baksan); II) Chikiani (Paravani); III) Ashotsk; IV) Tsaghkunyats; V) Gatansar and Hatis; VI) Gegham; VII) Khorapor; VIII) Satanakar, Sevkar and Bazenk; IX) Kel'Bedzar; X) Arteni; XI) Kars.

partment of Anthropology, University of California, Berkeley, applying analytical methodology available online at http://www.swxrflab.net/analysis.htm and described in Shackley (2005: 193–195; 2011). From this analysis, we identified two obsidian source areas, one (Zayukovo or Baksan) located in the North-central Greater Caucasus and another (Chikiani-Paravani) located in the Lesser Caucasus (in the Southern Caucasus), that were exclusively used by the Mezmaiskaya Cave inhabitants in the LMP, EUP, and EPP, from ca. 70 to 10 kya.

GEOCHEMICAL METHODS

LABORATORY SAMPLING, ANALYSIS, AND INSTRUMENTATION

The entire set of archaeological samples was analyzed whole. The results were derived from 'filtered' intensity values ratioed to the appropriate x-ray continuum regions through a least squares fitting formula and are thus quantitative (McCarthy and Schamber 1981). Importantly these data allow inter-instrument comparison with a predictable degree of certainty (Shackley 2011). The analyses were conducted on a ThermoScientific *Quant'X* EDXRF spectrometer. The spectrometer is currently located in the Geoarchaeological X-Ray Fluorescence Laboratory in Albuquerque, New Mexico, USA. Details concerning the spectrometer and petrological choice of the elements in obsidian are available in Davis (2011), Shackley (2005; 2011), and also in Hughes and Smith (1993) and Mahood and Stimac (1991). Nineteen specific pressed powder standards were used for calibration for elements Ti-Nb, Pb, Th, and Ba, including G-2 (basalt), AGV-2 (andesite), RGM-1 (obsidian), W-2 (diabase), GSP-2 (granodiorite), SY-2 (syenite), BHVO-2 (hawaiite), STM-1 (syenite), QLO-1 (quartz latite), BIR-1 (basalt), SDC-1 (mica schist), TLM-1 (tonalite), SCO-1 (shale), NOD-A-1 and NOD-P-1 (manganese) [all US Geo-

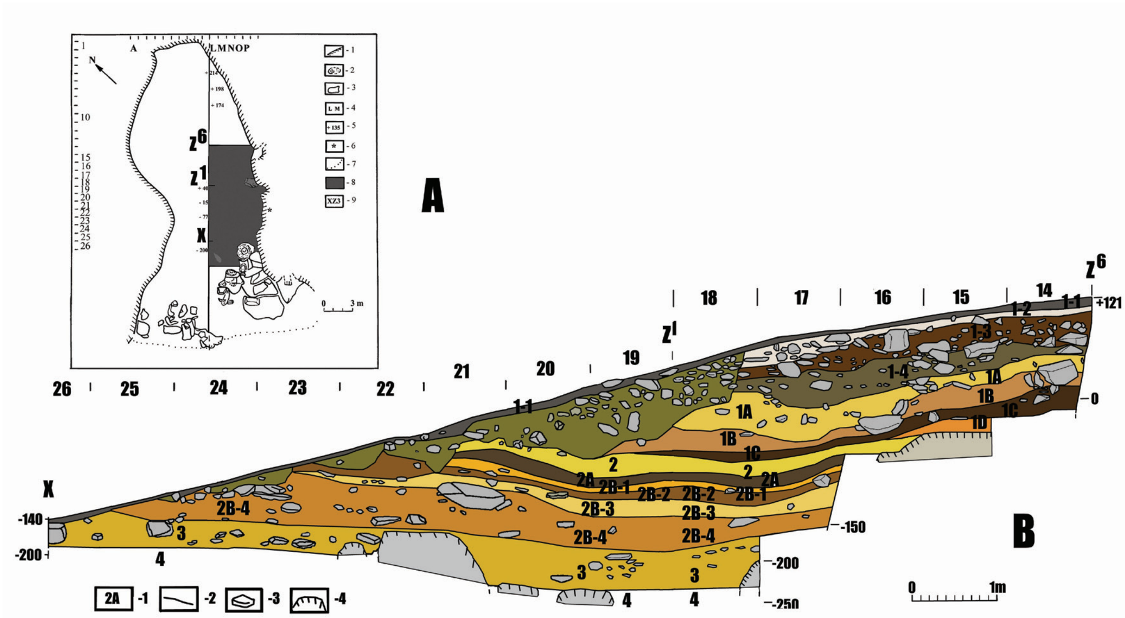

Figure 2. Mezmaiskaya Cave. A: cave plan: 1) cave wall; 2) stalagmites; 3) limestone blocks; 4) sections; 5) elevations of the modern cave floor; 6) datum; 7) 1997 excavation; 8) 1994–1995 excavation area; 9) main axis. B: Longitudal profile XZ6: 1) strata number; 2) borders; 3) stones; 4) cave wall.

logical Survey standards], JR-1 and JR-2 (obsidian) from the Geological Survey of Japan, NIST-278 (obsidian) [U.S. National Institute of Standards and Technology], and BE-N (basalt) from the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994).

The statistical analyses were applied using Excel for Windows software and SPSS for Windows. The machine data were compared to measurements of known standards during each run. Many of the samples analyzed were quite small for EDXRF analyses (Davis et al. 2011). For these samples at or below 10mm in largest dimension, a 3.5mm tube collimator was used to focus the beam into a smaller area. The trend of the data, however, suggests a similarity to the sources as assigned. Source assignments were made by reference to Poidevin (1998) and source data in the laboratory.

LATE MIDDLE PALEOLITHIC

The lithic assemblages produced by the LMP Neanderthal occupants of Mezmaiskaya Cave are attributed to the Eastern Micoquian industry (Figure 3). In the Northwestern Caucasus, this industry is characterized by non-Levallois technology with low indexes of facetted platforms and blades. Among retouched tools, simple side-scrapers absolutely predominate, transversal and diagonal scrapers are individual finds, and convergent tools (scrapers and points) and déjeté scrapers are variable. Denticulates are virtually absent. Bifacial tools, including bifacial laurel-leaf-like points, small triangular bifaces, and various modifications of bifacial side-scrapers or knives, constitute the most characteristic group of retouched tools (Golovanova and Doronichev 2003; Golovanova et al. 1999; 2010a).

The ESR dating estimates the age of the lower MP Layers 3 and 2B-4 between ca. 70 and 60 ka ago, the middle MP Layers 2B-3 thru 2B-1 between ca. 60 and 42 ka, and the uppermost MP Layers 2 and 2A older than 40 ka (Skinner et al. 2005). Recent results of the ultrafiltered AMS dating of the uppermost MP layers suggest the Neanderthal occupation of the cave ended between 43–40 ka BP, with a 95% probability (Pinhasi et al. 2011).

Only 8 obsidian artifacts (<0.2% of the total MP lithics) were recovered in the MP layers (see Table 1). These include 6 fragments and flakes, 2 chips, and no tools. The patina of MP obsidians differs from that in the EUP and EPP layers—all MP lithics have a light speckled patina (Figure 4). The EDXRF analysis of two obsidian flakes from Layers 3 and 2B-2 (see Table 3 below) indicates that both are derived from the Zayukovo (Baksan) source located in the Baksan River basin, near Kazbek Volcano, in the North-central Caucasus (approximately 200–250km eastward from Mezmaiskaya Cave; Figures 5–8).

EARLY UPPER PALEOLITHIC

The EUP assemblages from Mezmaiskaya Cave (Layers 1C–1A), dated by a robust series of radiocarbon estimates between 33–27 ka ^{14}C BP (Pinhasi et al. 2011: Table S2), are characterized by a developed bladelet technology and a variety of tools made on bladelets and micro-bladelets (including numerous backed bladelets, Gravette and micro-Gravette points, etc.; Figures 9–11). These industries are similar to the South Caucasian EUP and Levantine Ahmarian (Bar-Yosef et al. 2011; Golovanova et al. 2006; 2010a; 2010b).

Currently, 25 radiocarbon dates have been obtained from five different laboratories for the EUP layers in Mezmaiskaya. Excluding aberrant estimates, eleven dates available for the lower EUP Layer 1C define the calendric age of the initial EUP occupation in the interval from 32 to 36 ka cal BP. For Layer 1B, there are 3 dates around 32 ka cal BP,

TABLE 1. MEZMAISKAYA CAVE: COMPLOSITION OF OBSIDIAN ARTIFACTS (1987–2001, 2004, 2006, 2007, 2009, AND 2010 excavated assemblages).

Layer (period)	Small fragments/pieces	CTE	Flakes			Laminar blanks			Chips/microchips	Tools	Total	Percent in the total excavated assemblage
			Primary (50–100% cortex)	Cortical (1–50% cortex)	Without cortex	Blades	Bladelets	Microbladelets				
1-3 (EPP)	3	3	-	-	3	2	4	4	11/24	2	**56**	14,409 (0.4%)
1-4 (EPP)	3	-	-	-	4	-	13	14	32/79	2	**147**	7,328 (2%)
1A (EUP)	13/ 1	3	1	1	16	1	22	19	67/98	10	**252**	13,932 (1.8%)
1B (EUP)	1	1	-	-	1	-	2	2	7/13	4	**31**	3,969 (0.8%)
1C (EUP)	2	-	-	-	2	-	3	11	8/4	4	**34**	7,355 (0.5%)
2A (LMP)	-	-	-	-	1	-	-	-	1/-	-	**2**	189 (1.1%)
2B-2 (LMP)	-	-	-	-	1	-	-	-	-	-	**1**	196 (0.5%)
2B-4 (LMP)	-	-	-	-	-	-	-	-	1/-	-	**1**	1,430 (0.1%)
3 (LMP)	2	-	-	-	2	-	-	-	-	-	**4**	2,914 (0.1%)
Total:	25	7	1	1	30	3	44	50	127/218	22	**528**	51,722

and the uppermost EUP Layer 1A has two dates of 28.5 and 21 ka cal BP (Golovanova and Doronichev 2012; Pinhasi et al. 2011: Table S2).

At Mezmaiskaya, 317 obsidian artifacts (1.3% of the total EUP lithics) are found in the EUP layers. In the lowermost EUP Layer 1C, obsidian artifacts are individual finds (34 pieces, 0.5% of the assemblage; see Table 1; Table 2 below). They comprise flakes, bladelets (blades 5–10mm in width), microbladelets (blades <5mm in width), fragments, chips (flakes <10mm), and microchips (flakes <5mm). Tools include backed bladelets (see Figure 11: 3–4) and one Gravette point (see Figure 11: 6). The absence of cores, core trimming elements (CTE), and flakes with cortex, along with an assemblage dominated by bladelets/microbladelets and chips/microchips, and the high percentage of retouched tools (12% of obsidian artifacts) suggest that obsidian was apparently transported to the cave as ready-to-use blanks (bladelets or microbladelets) or retouched tools that were subsequently retouched or rejuvenated by retouching, assuming in this case chips/microchips as the by-products of retouching, although they may also result from core preparation (see below).

In the middle EUP Layer 1B, obsidian artifacts are also individual finds (31 pieces, 0.8% of the assemblage; see Table 1). Tools are represented by backed bladelets, retouched bladelets, and one micro-Gravette point (Table 2). The overall composition of obsidian artifacts, and retouched tools (13% of obsidian artifacts) in Layer 1B are all similar to those observed in Layer 1C, suggesting the same mode of transportation and on-site exploitation of obsidians.

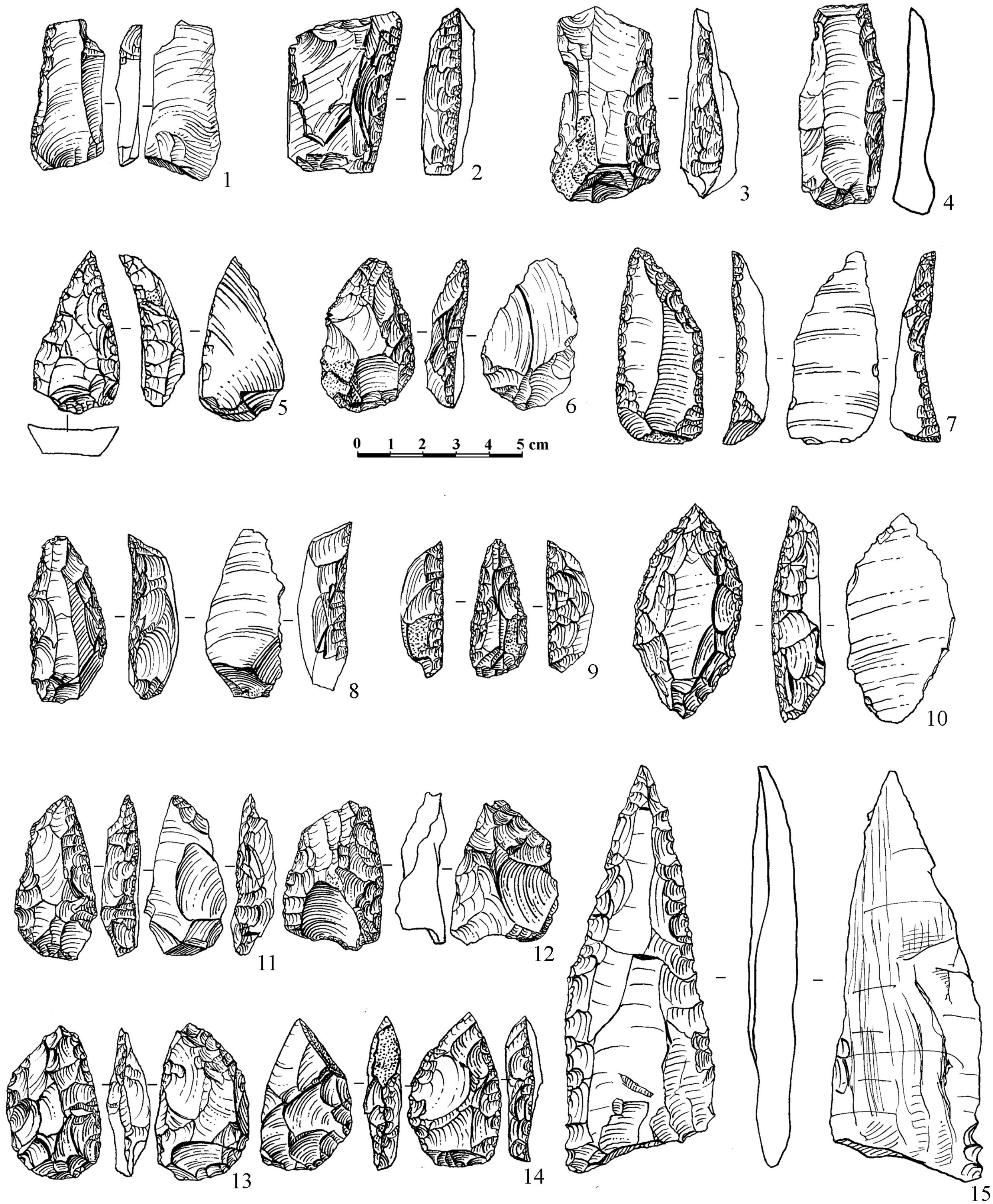

Figure 3. Mezmaiskaya Cave, Layer 3. 1–4: sidescrapers; 5–9: convergent tools; 10: limace; 11–12: partly-bifacial tools; 13–14: bifacial sidescrapers; 15: convergent tool.

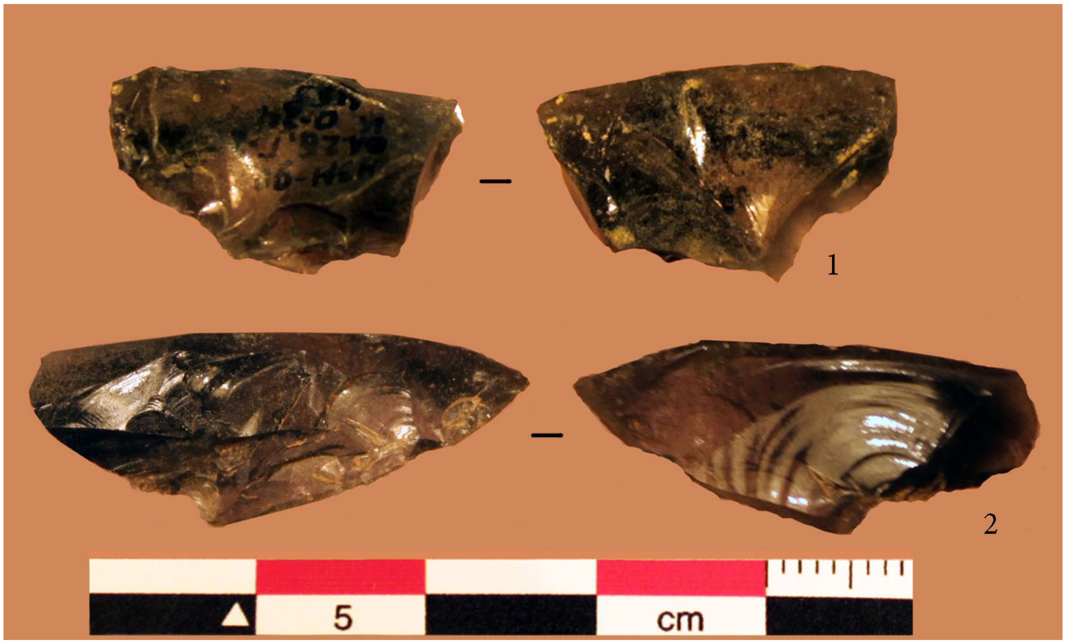

Figure 4. Mezmaiskaya Cave, obsidian finds. Flakes: 1) Layer 2B-2; 2) Layer 3.

Figure 5. Simplified map showing the location of Mezmaiskaya Cave and obsidian source in Zayukovo (Baksan) that was exploited in the Middle Paleolithic.

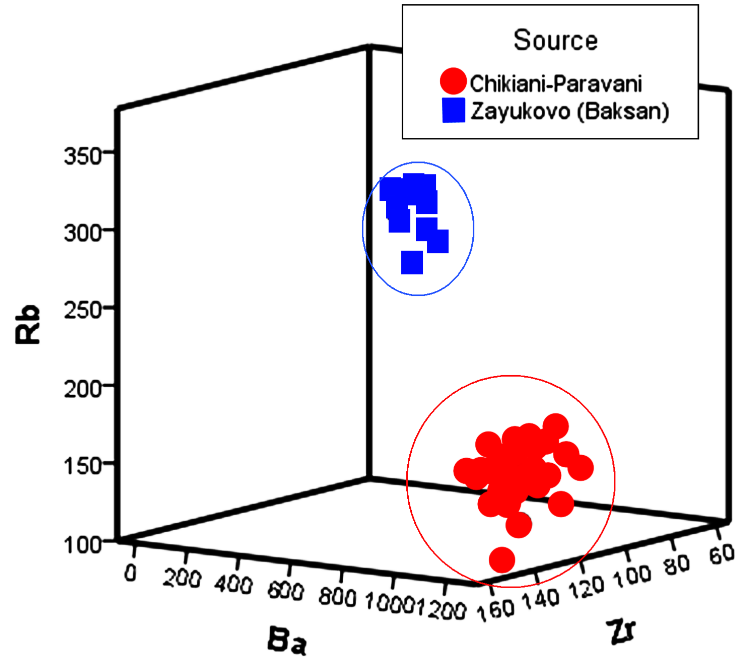

Figure 6. 3D diagram of the Rb, Ba, Zr contents (in ppm) of obsidians from Mezmaiskaya Cave and source data from Chikiani (Paravani) and Zayukovo (Baksan) sources.

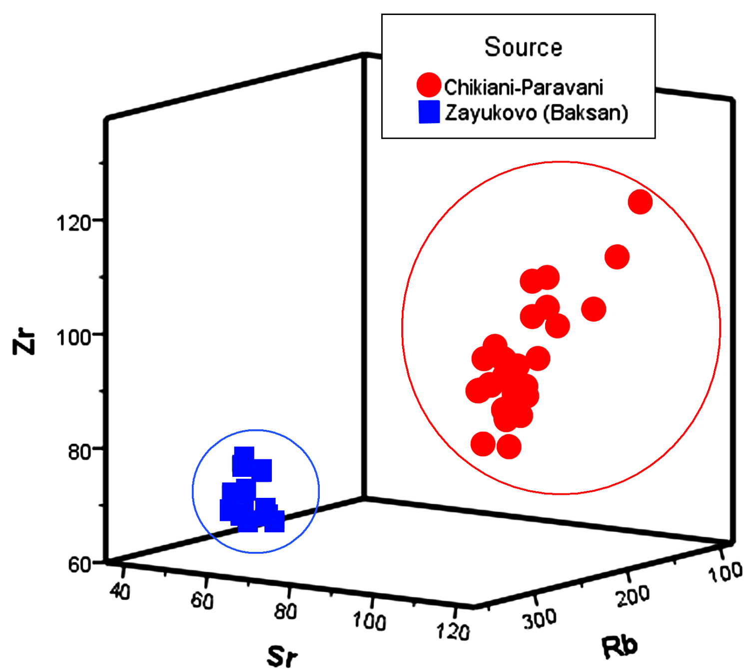

Figure 7. 3D diagram of the Zr, Sr, Rb contents (in ppm) of obsidians from Mezmaiskaya Cave and source data from Chikiani (Paravani) and Zayukovo (Baksan) sources.

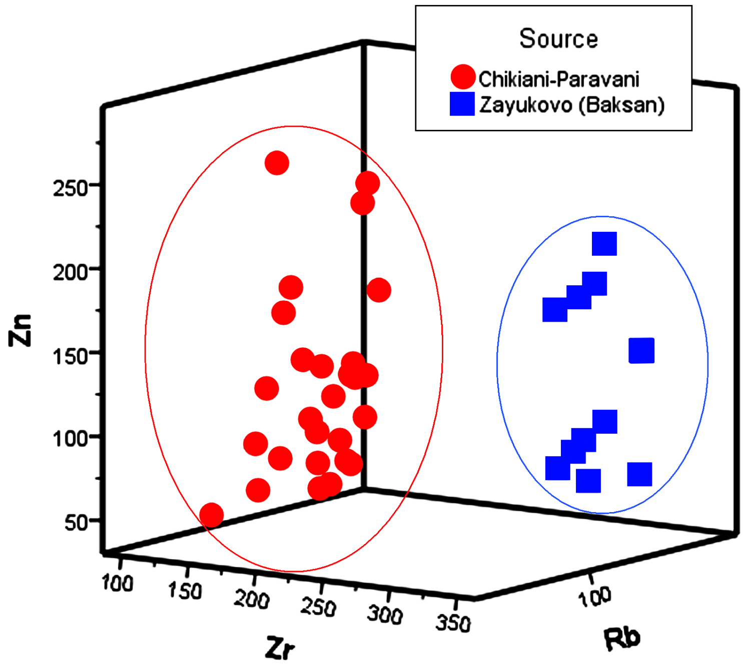

Figure 8. 3D diagram of the Zn, Zr, Rb contents (in ppm) of obsidians from Mezmaiskaya Cave and source data from Chikiani (Paravani) and Zayukovo (Baksan) sources.

Most of the obsidian artifacts analyzed here come from the uppermost EUP Layer 1A (252 pieces, 1.8% of the total lithics in Layer 1A; see Table 1). The overall composition of the obsidian artifact assemblage, including small (<2cm) fragments, CTE, cortical flakes, and a flaked piece of obsidian (found in Layer 1A only), suggests that a limited on-site flaking of obsidian took place in the cave. In Layer 1A, obsidians were apparently transported to the cave not only in the form of ready-to-use blanks (bladelets or microbladelets) or retouched tools that were subsequently retouched on-site or rejuvenated by retouching, as in the lower EUP Layers 1C and 1B, but also as unworked pieces of raw material for subsequent tool production. This might be seen as an indicator of some change in obsidian transportation and use in Layer 1A, although more data are required for more confident comparisons and conclusions.

The on-site obsidian tool production in Layer 1A is additionally confirmed by the presence of obsidian artifact concentrations excavated in 2010 in Square M-11 (Figure 12). It includes 63 obsidian artifacts. Although no cores were found, there are 3 CTE, 5 flakes including cortical ones, 2 flake fragments, 26 microchips, 16 chips, 8 microbladelet fragments, 2 fragments, and one tool (burin), all produced from obsidian. this concentration suggests by-products in the area where an obsidian core was flaked to produce a series of blanks (probably microbladelets) that subsequently were retouched into tools and transported away.

The composition of retouched tools made from obsidian in Layer 1A is similar to that observed in Layers 1C and 1B (see Table 2), and is characterized by a predominance of backed and retouched bladelets. However, the proportion of tools is almost three times lower in Layer 1A (4% of obsidian artifacts) than in Layers 1C and 1B, and this deviation cannot be explained by anything else but that the analyzed assemblage includes materials from the concentration of flaked obsidians excavated in this layer.

While it is always hazardous to assign all obsidian artifacts to specific sources, with a small sample of source standards that we have, our study suggests that at least five obsidian artifacts analyzed from the EUP layers at Mezmaiskaya were derived from the Zayukovo (Baksan) source (Table 3; Figure 13). Zayukovo source standards were analyzed for this study (Shackley 2010; 2012). The other obsidian artifacts analyzed are likely derived from the Chikiani (Chikiani-Paravani), also called in Turkish Kojun Daği (Kojun Dağ), source located on the Javakheti Plateau in Samtskhe-Javakheti province in southern Georgia, in the Lesser Caucasus (approximately 450km southwest from Mezmaiskaya Cave; Poidevin 1998). This area is bordered by Armenia and Turkey to the south. The elemental concentrations of these artifacts are clustered around four source samples from Chikiani (Kojun Dağ), as listed in Poidevin (1998: 200). Although this inference is based on only four source samples, the Ba data is rather unique in the region, and there is good agreement on Rb, Sr, and Zr as well (see Figures. 6 and 13).

Our study suggests that the EUP humans transported obsidians mostly as ready-to-use blanks (bladelets or microbladelets) or retouched tools made on bladelets or microbladelets (in Layers 1C and 1B), or as prepared cores (in

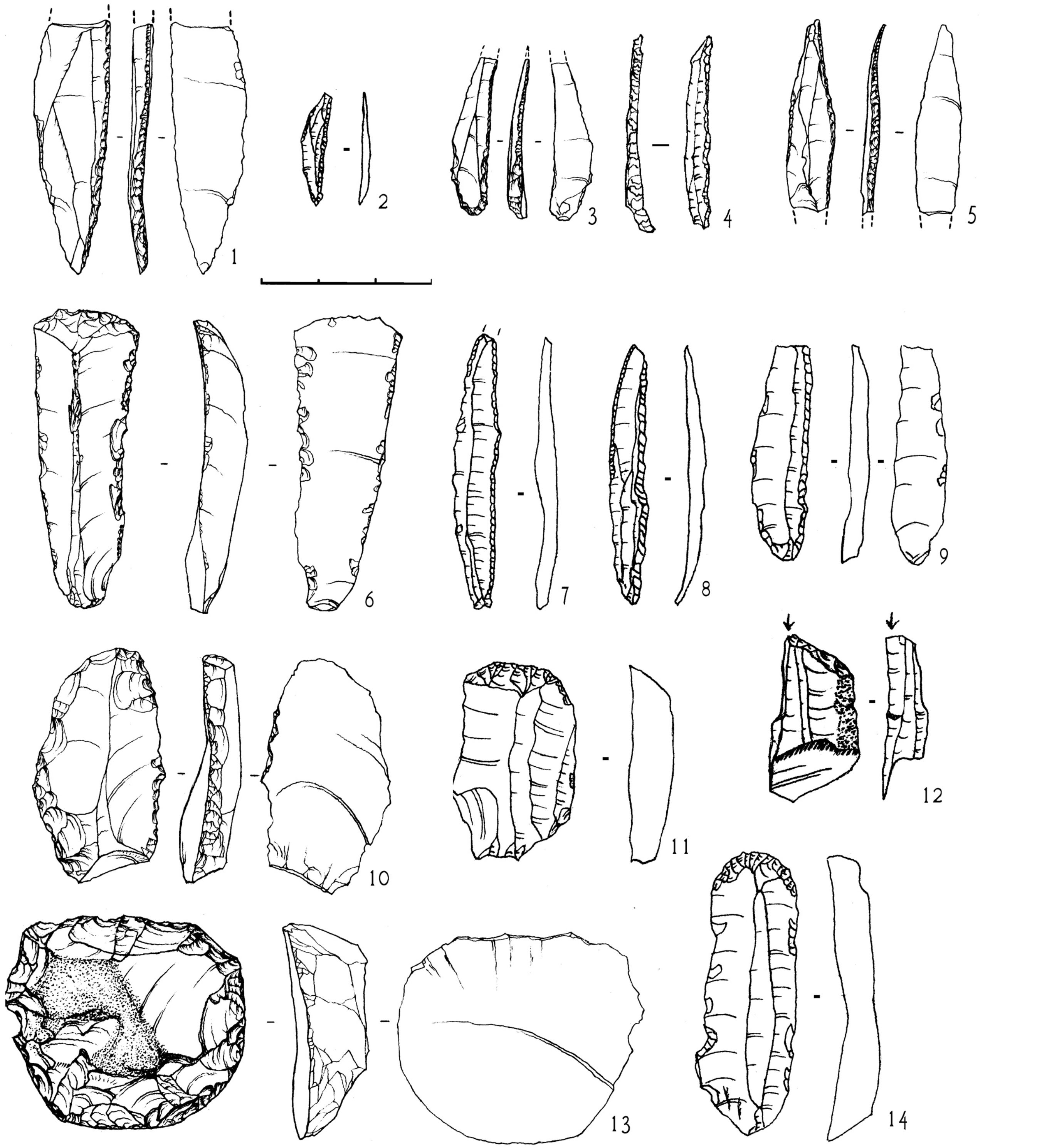

Figure 9. Mezmaiskaya Cave, Layer 1B. 1: retouched blade; 2: retouched microbladelet; 3, 7–8: retouched bladeletes; 4–5: backed bladeletes; 6, 10–11, 14: endscrapers; 9: Gravette point fragment (?); 12: retouched burin; 13: rounded endscraper.

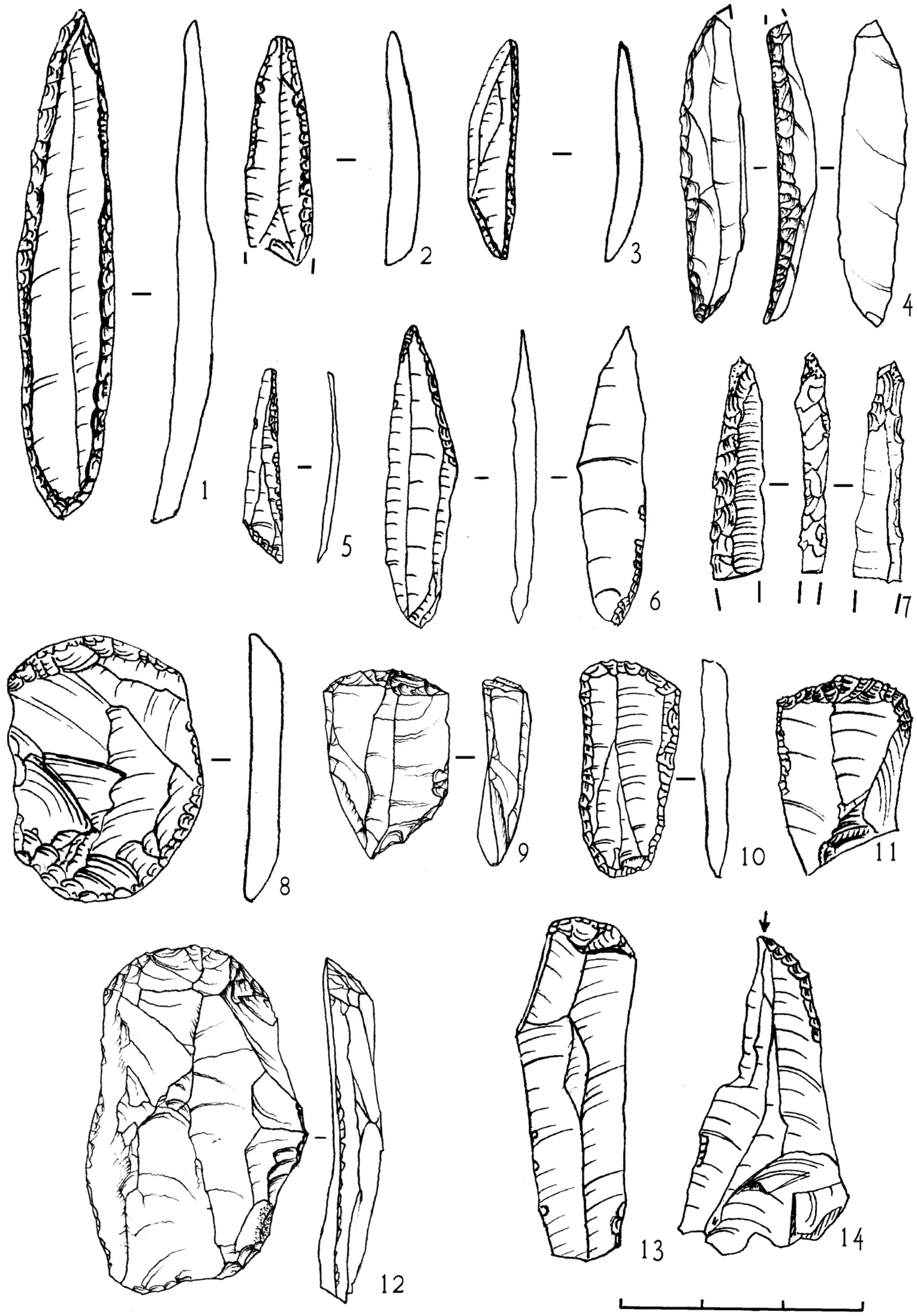

Figure 10. Mezmaiskaya Cave, Layer 1A. 1: Font-Yves point; 2: symmetrical point fragment (?); 3–4) Gravette points: 5: retouched bladelet; 6: miscellaneous; 7: backed bladelet; 8–13: endscrapers; 14: retouched burin.

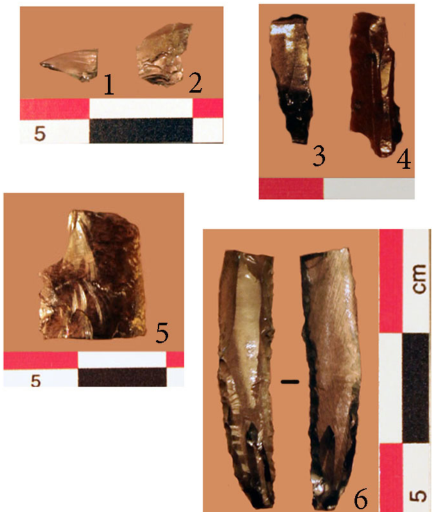

Figure 11. Mezmaiskaya Cave, obsidian finds, Layer 1C. 1, 2: chips; 3, 4: backed bladelets; 5: flake fragment; 6: Gravette point fragment.

Layer 1A). It also indicates that the EUP humans more intensively exploited the Chikiani-Paravani source area in the Southern Caucasus rather than the closer Zayukovo source in the North-central Caucasus, and the exploitation of the South Caucasian source increased toward the end of the EUP as can be seen in the sequence of 1.5:1 (Layer 1C), 4:1 (Layer 1B), and 5:1 (Layer 1A), with artifacts from Chikiani in the numerator and artifacts from Zayukovo in the denominator (see Table 3).

Our studies of obsidian (this paper) and flint (Doronicheva et al. 2012; 2013) artifacts from Mezmaiskaya suggest a deliberate selection of high quality raw materials derived from distant sources by EUP humans. In the cave, local low-quality flints were used mainly for making flakes and only rarely for production of bladelets and microbladelets, bladelet tools, or retouched tools such as end-scrapers and burins—these classes of artifacts were made mainly on high-quality non-local flints and obsidians.

EPIPALEOLITHIC

The EPP assemblages from Layers 1-4 and 1-3 at Mezmaiskaya cave are radiocarbon dated between the Last Glacial Maximum (LGM) (25.5–18.5 ka cal BP) and the Younger Dryas (13–11.5 ka cal BP), from 18.517 ka cal. BP to 14-13 ka cal. BP. They are characterized by a highly developed bladelet technology, numerous backed bladelets and microbladelets, various bladelet points, including shouldered points, the early appearance of geometric microliths, widely known in the Levantine EPP, and a rich bone industry (Figure 14). They have many analogies with the EPP assemblages of Imeretian culture from west Georgia, in the Southern Caucasus, and some similarities to the Kamennobalkovskaya EPP culture in the south Russian Plain (Golovanova et al. 2012; Leonova et al. 2006). The lower Layer 1-4 was formed at the beginning of the post-LGM period. It was almost destroyed by water erosion and contains reworked EPP materials. Contrary to Layer 1-4, the upper Layer 1-3 is a level of active human habitation, containing a large (more than $7m^2$) and thick fireplace with at least eight separate charcoal or ash horizons, and a rich concentration of cultural and faunal remains.

In Layer 1-4, 147 obsidian artifacts were found. They comprise 2% of the overall lithic assemblage (see Table 1) and include mostly chips/microchips, and also less abundant bladelets/microbladelets, and only two tools (retouched bladelets; see Table 2). Because the assemblage is reworked within a highly eroded Layer 1-4 and may in-

TABLE 2. MEZMAISKAYA CAVE: COMPOSITION OF OBSIDIAN TOOLS (1987–2001, 2004, 2006, 2007, 2009, and 2010 excavated assemblages).

Layer	Backed bladelet	Backed microbladelet	Retouched bladelet	Retouched microbladelet	Gravette point	Micro-Gravette point	Flake with denticulate retouch	Burin on flake	Flake with irregular retouch	Total
1-3	-	-	1	-	-	-	1	-	-	**2**
1-4	-	-	2	-	-	-	-	-	-	**2**
1A	2	-	3	3	-	-	-	1	1	**10**
1B	1	-	2	-	-	1	-	-	-	**4**
1C	2	1	-	-	1	-	-	-	-	**4**

Figure 12. Mezmaiskaya Cave, obsidian finds, 2010 excavations, Layer 1A, Square M-11. 1: bladelet fragment; 2: backed bladelet fragment; 3, 4: bladelet fragments; 5, 6: flakes; 7–9: flake fragments; 10–12: Core Trimming Elements (CTE); 13: burin on a flake; 14–26: microchips; 17–42: chips.

clude intrusive artifacts from upper and lower layers, we did not analyze them here.

From the intact EPP Layer 1-3, 56 obsidian artifacts (comprising 0.4% of the lithic assemblage; see Table 1) were analyzed. They include waste products of flaking (CTE, fragments, and flakes; Figure 15: 1–2) and blanks (blades, bladelets, and microbladelets). Although no cores or cortical flakes were found, the presence of waste products of core reduction suggests a limited on-site knapping of obsidian cores that were brought to the cave. The prevalence of chips and microchips (62.5% of all obsidian artifacts) may indicate on-site tool production, although obsidian tools are extremely rare finds in this layer (see Table 2) and chips/microchips might be the by-products of core preparation in this layer (see below).

It is worth noting that obsidian artifacts sometimes comprise small concentrations in the excavated areas of Layer 1-3. In the 2004 excavation, three such concentrations were found (Golovanova et al. 2012)—in Square N-13 (4 microchips, a fragment, and a bladelet fragment); in Square O-14 (1 chip, 3 microchips, and a fragment); and in Square P-14 (4 microchips and a fragment). Similar artifact types suggests that these concentrations appear to reflect working areas, in which obsidians (probably, obsidian cores) were exploited for blank production (probably bladelets/microbladelets), and the by-products of core reduction (chips/microchips and small fragments) were discarded.

Thus far, only three obsidian samples from Layer 1-3 were analyzed using EDXRF (see Table 3). Two of them originate from the Chikiani-Paravani source in the Southern Caucasus, and one comes from the Zayukovo source in the North-central Caucasus; both sources are discussed above (see Figures 6–8 and 13).

Our results suggest that the EPP inhabitants of Mezmaiskaya Cave had contacts with distant areas located on both sides of the Greater Caucasus. However, currently we do not have enough data to suggest the manner in which (mode) or how (in which form) obsidian was transported. We think that this important topic should be the subject of future study, when more materials become available.

TABLE 3. MEZMAISKAYA CAVE: ELELMENTAL CONCENTRATIONS FOR THE ARCHAEOLOGICAL SPECIMENS AND TWO SOURCE STANDARDS (all measurements in parts per million [ppm]).

Layer	Ti	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Ba	Th	Source	Artifact type
1-3	1,095	412	8,798	57	127	85	16	104	21	884	17	Chikiani-Paravani	Flake
1-3	1,260	470	9,010	104	133	74	16	84	20	680	12	Chikiani-Paravani*	Bladelet fragment
1-3	840	512	9,306	89	297	58	30	75	12	233	29	Zayukovo (Baksan)	Flake
1-4	1,551	452	9,063	123	132	80	15	87	19	691	16	Chikiani-Paravani*	Bladelet fragment
1-4	1,223	474	9,350	129	131	77	18	92	18	702	21	Chikiani-Paravani*	Bladelet fragment
1-4	1,031	426	8214	63	133	81	16	80	20	818	17	Chikiani-Paravani	Flake
1-4	887	598	10,531	71	334	59	30	73	18	254	34	Zayukovo (Baksan)	Flake
1-4	813	494	9,358	97	298	59	24	69	17	230	29	Zayukovo (Baksan)	Flake
1-4	1,390	475	8,954	165	147	84	13	76	23	678	16	Chikiani-Paravani	Chip
1-4	1,015	470	9,344	201	290	53	26	66	14	181	26	Zayukovo (Baksan)	Chip
1-4	1,365	556	9,719	231	151	84	16	81	23	778	19	Chikiani-Paravani	Chip
1-4	1,093	468	8,601	215	133	75	11	75	19	693	16	Chikiani-Paravani	Chip
1-4	1,236	559	9821	120	163	92	19	86	26	908	22	Chikiani-Paravani [1]*	Chip
1-4	1,063	423	8314	67	134	83	18	89	23	923	18	Chikiani-Paravani	Chip
1A	1,236	413	9,191	73	129	86	16	98	19	963	21	Chikiani-Paravani	Flake fragment
1A	1,432	480	9,208	92	132	79	17	90	20	767	18	Chikiani-Paravani	Chip
1A	1,189	473	9,057	79	143	79	19	86	20	784	15	Chikiani-Paravani	Flake fragment
1A	1,441	435	9,296	160	251	43	24	65	13	202	24	Zayukovo (Baksan)	Chip
1A	1,340	455	9,773	52	135	113	19	121	18	1247	16	Chikiani-Paravani	Flake
1A	1,024	381	8,116	48	126	83	20	85	21	855	25	Chikiani-Paravani	Flake
1A	1,059	426	8,267	51	131	82	17	84	25	833	18	Chikiani-Paravani	Flake
1A	1,241	433	8,576	63	139	81	14	81	23	967	11	Chikiani-Paravani	Bladelet
1A	1,085	475	8,844	115	144	82	15	82	21	641	18	Chikiani-Paravani	Bladelet
1A	1,156	493	9,132	119	148	87	17	85	20	816	21	Chikiani-Paravani	Bladelet
1A	1,019	487	9,320	177	285	57	28	67	16	256	26	Zayukovo (Baksan)	Chip

TABLE 3. MEZMAISKAYA CAVE: ELELMENTAL CONCENTRATIONS (continued).

Layer	Ti	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Ba	Th	Source	Artifact type
1A	1,116	491	8841	123	147	84	16	83	22	925	13	Chikiani-Paravani *	Chip
1B	1,474	434	9,575	160	129	92	19	97	16	729	13	Chikiani-Paravani *	Chip
1B	1,184	462	8,993	86	137	76	17	90	23	724	17	Chikiani-Paravani	Bladelet fragment
1B	1,370	479	9,449	168	274	47	23	67	13	169	24	Zayukovo (Baksan)*	Bladelet fragment
1B	1,465	409	9,198	170	116	84	15	90	13	731	15	Chikiani-Paravani *	Bladelet fragment
1B	1,152	468	8,960	92	152	87	18	82	21	833	22	Chikiani-Paravani [1]	Shatter
1C	1,633	493	10,438	251	131	90	15	100	17	724	19	Chikiani-Paravani	Chip
1C	1,343	407	9,314	85	127	89	16	105	19	938	18	Chikiani-Paravani	Flake fragment
1C	1,220	402	8,237	74	264	54	25	65	14	292	27	Zayukovo (Baksan)	Gravettian point fragment
1C	0,901	563	10,167	145	333	62	27	72	14	303	26	Zayukovo (Baksan)*	Chip
1C	1,324	540	10,229	124	154	112	21	112	21	951	27	Chikiani-Paravani *	Chip
3	0,873	477	9351	62	291	53	23	71	17	229	26	Zayukovo (Baksan)	Small flake
2B-2	1,029	466	9884	70	278	49	26	75	15	243	25	Zayukovo (Baksan)	Flake
	880	436	9,310	54	284	51	26	76	16	229	22	Zayukovo (Baksan) source	-
		719	7,210		119	98	15	100	16	858		Chikiani-Paravani source[1]	-
RGM1	1685	296	13676	36	143	104	26	220	10	799	13	USGS standard	-

*These samples are under the minimum size required for confident source assignment by EDXRF, but appear similar to the source standard data (Davis et al. 2011).
[1]Data from Poidevin (1998).

DISCUSSION

The Middle Paleolithic in the Caucasus is now viewed by most researchers as a multi-zonal and multi-industrial complex. In the Southern Caucasus, several MP industries are currently recognized (Golovanova and Doronichev 2003). In the MP of west Georgia, obsidian artifacts are completely absent, as in the LMP *Tsutskhvati-type Mousterian* assemblages from the Bronze Age cave in the Tsutskhvati cave system, or extremely rare (0.4% of all lithics) as in LMP layers at Ortvale Klde rockshelter, in which obsidian occurs as small fragments or highly reduced retouched tools (Adler et al. 2006). All these assemblages are based almost exclusively on local flints. Recent studies indicate that the Ortvale Klde Neanderthals used obsidians derived, in particular, from the Chikiani source (about 180km southeast of the site), and probably from other potential sources (Sarikamis and Ikisdere in eastern Anatolia) located more than 350km from the site (Le Bourdonnec et al. 2012). These recent results, indicating obsidian transport from sources located in southern Georgia, near the border with Turkey and Armenia, and especially in eastern Anatolia, confirm the similarity to the Ortvale Klde Mousterian industry and to the Karain-type Mousterian assemblages from Karain cave in the Taurus Mountains, in Anatolia, as noted earlier, based on techno-typological similarities between these LMP industries (Adler et al. 2006; Golovanova and Do-

Figure 13. Simplified map showing the location of Mezmaiskaya Cave and two obsidian sources that were exploited in the Upper Paleolithic and Epipaleolithic: Zayukovo (Baksan) in the North-central Caucasus and Chikiani (Paravani) in the Southern Caucasus.

ronichev 2003).

The LMP *Tskhalsitela-type Mousterian* includes assemblages from the cave sites of Chakhati, Ortvala, and Sakajia (Nioradze 1992). As in the case of the Tsutskhvati-type Mousterian, local raw materials (mostly flints) were mainly used, while obsidian artifacts are extremely rare. One can infer that the obsidian lithics originate from the Javakheti region (where the Chikiani source is located) in southern Georgia; however, no compositional analyses have been done on obsidian from these sites.

The early Middle Paleolithic (EMP) *Djruchulian (or Kudaro-Djruchulian) Mousterian* (similar to the Early Levantine Mousterian of Tabun-D type from Tabun Cave) includes EMP assemblages from the caves of Djruchula, Kudaro I, Kudaro III, and Tsona (Golovanova and Doronichev 2003; Liubin 1977; Meignen and Tushabramishvili 2006; 2010), in Georgia and South Ossetia, and, probably, from Unit 8 at Hovk 1 Cave, in Armenia (Pinhasi et al. 2008; 2011). The high-elevated cave sites of Tsona (2050masl), Hovk 1 (2040masl), Kudaro I, and Kudaro III (1800–1850masl) were used by Neanderthals as short-term occupation sites (hunting camps). Local raw materials predominate in these assemblages, although a few artifacts of non-local obsidian are found at Tsona and Hovk 1 only. Meignen and Tushabramishvili (2006) suggest that the rare obsidian tools found at Djruchula Cave may be derived from the Javakheti region, some 100km south of the site; however, no compositional analyses of obsidian artifacts from Kudaro-Djruchulian Mousterian has yet been done.

Nine stratified cave sites (Yerevan, Lusakert, Zar, Damdjili, Dashsalakhli, Gazma, Azykh, Taglar, and Buseir), most of which were assigned to a local Caucasian variant of the *Zagros Mousterian* (Golovanova and Doronichev 2003), are known in the Lesser Caucasus and adjoining regions of the southern Caucasus. A majority of these LMP sites are located in immediate proximity to obsidian sources that are quite numerous and easy available in the Armenian volcanic highland and adjacent areas of the Lesser Caucasus. Local Neanderthals exploited rich sources of volcanic lavas and preferred obsidians when they were available. Obsidian prevails in all sites located close to obsidian sources within the Armenian volcanic highland. In Zar Cave, all lithics are made from obsidian. In Lusakert Cave, 99% of the lithics are made from obsidian, outcrops of which are known in the cave vicinity. In Yerevan Cave, obsidian artifacts prevail (96% of lithics) over andesite and basalt (2.7%), and flint (1.3%); the nearest known sources of obsidian are 30km from the cave (Adler et al. 2012; Eritsyan 1970). In Gazma Cave, obsidian artifacts compose 92.6% of the total lithics. In the caves of Damdjili, Dashsalakhli, and Buseir located outside the Armenian volcanic highland and far from obsidian sources, obsidian was rarely used, and local

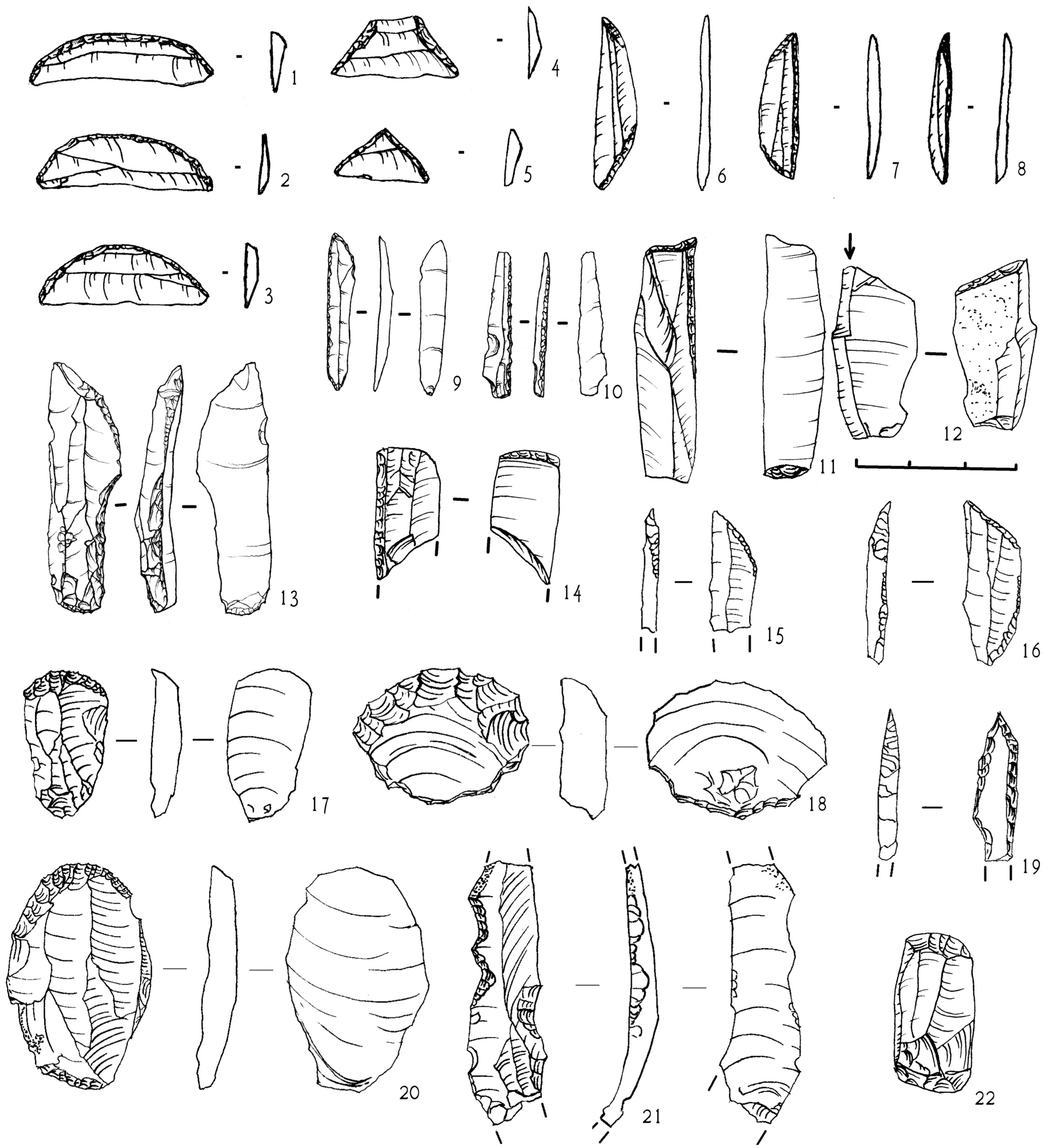

Figure 14. Mezmaiskaya Cave, Layer 1-3. 1–3: segments; 4: trapezoid; 5: triangle; 6–7: Gravette points; 8: micro-Gravette point; 9–10: backed bladelets; 11: truncated bladelet; 12: retouched burin; 13: shouldered point; 14: tool fragment; 15–16: oblique retouch bladelets; 17–18, 20, 22: endscrapers; 19: point fragment; 21: blade with denticulate retouch.

Figure 15. Mezmaiskaya Cave, obsidian finds, Layer 1-3. 1–2: Core Trimming Elements (CTE).

raw materials predominate.

Obsidian sources are also absent near Taglar Cave. In the cave, Neanderthals more actively used non-local obsidians in the earlier occupations and local raw materials in the later occupations (Djafarov 1999). This tendency may indicate that the local Neanderthal population moved eastward from areas located close to obsidian sources in the Armenian volcanic highland and experienced a gradual shift (as the result of raw-material adaptation) to local non-volcanic rocks, such as jasper, chert, diabase, and limestone (Golovanova and Doronichev 2003).

In the Northern Caucasus, a local *Eastern Micoquian* industry, closely related to the Eastern Micoquian industries in Central and Eastern Europe, spans much of the Middle Paleolithic (from ca. 75 to 40 kya). Ten stratified Eastern Micoquian sites are known here—the caves of Mezmaiskaya, Matuzka, Monasheskaya, and Barakaevskaya, Gubs I Rockshelter, the open-air sites of Ilskaya I-II and Baranakha 4, and the two workshops at Besleneevskaya and Hadjokh 2 which are located on raw material sources (Beliaeva 1999; Doronicheva 2010; Golovanova and Doronichev 2003). Almost all sites are located in the immediate proximity to flint sources. High-quality flints were transported to these sites as tools and flakes, at distances of 20–300km (Doronicheva and Kulkova 2011). The long distance raw material transport of up to 100km and more is characteristic for the Eastern Micoquian Neanderthal populations also in Eastern and Central Europe (Rensink et al. 1991).

Our other study (Doronicheva and Kulkova 2011) shows that, in the Caucasian MP, the area of resource exploitation usually did not exceed a radius of about 0–5km from a site, and that Neanderthals mainly used local raw materials (flint or chert) even if their quality was poor. In addition, Neanderthals used high-quality non-local flints from sources located mostly within a radius of 20–100km from a site. These non-local rocks were mostly transported by MP Neanderthals as retouched tools or ready-to-use flakes, contrary to the UP humans who in most cases preferred to transport high-quality non-local flints as mostly cores and rarely pre-cores.

Obsidians were also sporadically transported by Neanderthals from sources located between 200–250km and 350–400km from sites, both in the Northern (Golovanova et al. 2010a) and Southern (Le Bourdonnec et al. 2012) Caucasus. The authors of both publications assume that the obsidian transport reflects inter-regional migrations or contacts of Neanderthal groups in the Northern Caucasus, and in the Southern Caucasus.

In this study, we applied the direct distance measurements from each archaeological site to raw material sources on a small scale map (scale 1:200 000), ignoring modern landscape. We ignored specifics and elevations of the existing landscape because it is not correct, in our view, to apply them directly to the Upper Pleistocene landscape inhabited by MP or UP hominids. This is because the Caucasus is a mountain province with active recent volcanic and tectonic history, characterized by very different speed and direction of movement (uplifting or down lifting) of various tectonic blocks even within small geographical areas (see details in Nesmeyanov 1999). This means that it is practically impossible to calculate an accurate distance, assuming significant changes of the Upper Pleistocene paleo-relief, especially when discussing distances of several hundred kilometers, as from Mezmaiskaya Cave, located in the Northwestern Caucasus, to the Zayukovo source in the North-central Caucasus, or between Mezmaiskaya and the Chikiani-Paravani source in the Southern Caucasus.

In both the Northern and Southern Caucasus, scholars report a cultural discontinuity and break between the final MP and EUP industries (e.g., Adler et al. 2006, 2008; Golovanova et al. 2010). This break is correlated and apparently related to dramatic climatic changes of the so-called "volcanic winter" after the Campanian Ignimbrite (CI) super-eruption that caused the total disappearance of Neanderthals soon after ~40–39 ka cal. BP (Golovanova et al. 2010; Pinhasi et al. 2011; 2012). A new occupation of these territories apparently occurred some 2,000–3,000 years after the Neanderthal disappearance, or ~38–36 ka cal. BP, with the arrival of EUP modern humans in the Caucasus from more southern areas of West Asia.

The Upper Paleolithic in the Caucasus is now subdivided into two major stages, EUP (~38–25 ka cal. BP) and EPP (~18–10 ka cal. BP). The Last Glacial Maximum (MIS 2, 25–18 ka cal. BP) separates EUP and EPP occupations (Golovanova et al. 2006; 2012). The EUP modern humans began to exploit new raw material (high-quality flint) sources either unknown or unavailable to LMP Neanderthals. Flints from distant sources were mainly transported as cores and pre-cores. The preference for high-quality flints was apparently closely related to the introduction of blade/bladelet technology, which allowed production of a larger number of standardized blanks from a single core. This technological innovation made populations of EUP *H. sapiens* less dependent on local sources of raw materials, a reflection of the increased mobility of EUP humans compared to LMP Neanderthals who were dependent on local raw material sources (Doronicheva and Kulkova 2011).

After the LGM—a cold event, which interrupted the EUP development in the Caucasus—new EPP industries appear in the Southern and Northern Caucasus, and exist until the end of the Pleistocene at ~10 ka cal. BP. During the EPP period, scholars note a more intense occupation of the Caucasus compared to the EUP that is attested to by more numerous sites (Golovanova et al. 2012). As in the EUP, the EPP humans preferred high-quality raw materials (especially flints), even if these had to be transported long distances (Doronicheva, 2011; Doronicheva and Kulkova 2011).

At the Kalavan-I site in Armenia, dated to the Upper Paleolithic (Montoya et al. 2013; 15 cal ka BP) Chataigner and Gratuze (2014) report that 66% of tools are made from non-local obsidian, while the use of local siliceous rocks is limited. Eighteen artifacts were studied by LA-ICP-MS. Most obsidians originate from outcrops located to the west of Lake Sevan (Hatis, Gutanasar, and Geghasar), with only one sample from a source located south-east of the lake (Sevkar). Researchers suggest that most obsidian sources are located within 3–4 days walking from a site and that the obsidian procurement was embedded in the hunting of caprines (mouflons), the bones of which are numerous at the site.

Additionally, obsidian artifacts are reported from many Palaeolithic sites in the Imeretian region of western Georgia, in the Southern Caucasus—the cave sites of Chakhati, Sakajia, Apiancha, Mgvimevi, and others. In Layer V at Sagvarjile Cave, researchers mention that only 1.5% of the total assemblage numbering 2,000 artifacts is made from obsidian. Unfortunately, almost no obsidian studies are published. Also, because most of the sites were excavated in the 1960–1980s, materials from MP and UP layers often were mixed during excavations (Liubin 1989). Among the recently excavated sites, it is reported that the UP artifacts from Bondi cave and Ortvale klde were brought to the sites from the same obsidian source (Chikiani-Paravani), and transported as unretouched blanks or retouched tools (Le Bourdonnec et al. 2012).

Both EUP and EPP industries of the Northern Caucasus exhibit significant similarities to contemporaneous assemblages in the Southern Caucasus; this similarity suggests cultural contacts. The transportation of obsidian from sources in southern Georgia to Mezmaiskaya Cave in the Northwestern Caucasus additionally confirms contacts between these regions during entire Upper Paleolithic. The import of obsidian from Zayukovo (Baksan) in the North-central Caucasus indicates a wider distribution eastward of this cultural networking area. In this regard, the recently discovered Bodynoko rockshelter, in which the EPP Level 5 is radiocarbon dated between 13–14 ka ^{14}C BP (Zenin and Orlova 2006), may represent an important site for the study of cultural contacts between the western and eastern halves of the Northern Caucasus.

CONCLUSIONS

The recently published data on obsidian exploitation at Bondi and Ortvale-klde, in Georgia (Le Bourdonnec et al. 2012), suggests that obsidian was brought to the caves mostly from the Chikiani source in the Lesser Caucasus (170km away from the sites), as well as from other sources located as far away as 350km, in eastern Anatolia (Ikisdere and Sarikamis) and Armenia (Hatis and Gutansar). Le Bourdonnec and colleagues (2012: 12) report that Neanderthals and early modern humans transported obsidians as unfinished products and hypothesize that "*Neanderthals and later Modern Humans apparently employed the same behavior with regard to how they worked their obsidian, which raises the question of an eventual transmission of this tradition*".

Our data on obsidian transportation at Mezmaiskaya does not support this hypothesis of transmission of behaviors from LMP Neanderthals to EUP modern humans and are strongly supported by other archaeological data (see above), indicating no cultural transition from LMP to EUP in the Caucasus. Contra to Le Bourdonnec and colleagues (2012), our studies of flint (Doronicheva and Kulkova 2011) and obsidian (this paper) artifacts from Mezmaiskaya indicate significant differences between Neanderthals and early modern humans in behavior related to the transportation and exploitation of distant rocks in the Caucasus. Our conclusions may be summarized as the following:

1. In the EUP and EPP, the area of resource exploitation and mobility usually did not exceed a distance of ~100km from a site, and both EUP and EPP humans preferred to exploit more intensively high-quality raw material sources located within 20–100km from their occupation sites. This raw-material behavior is different from those typical of the MP Neanderthals, who exploited mostly local (0–5km from a site) raw materials even if these rocks were poor quality.
2. At Mezmaiskaya, the EUP humans brought obsidians mostly as ready-to-use blanks (bladelets or microbladelets) or retouched tools made on bladelets or microbladelets in EUP Layers 1C and 1B, although transportation of some obsidians as prepared cores is not excluded. The transportation of obsidians as prepared cores is clearly documented in EUP Layer 1A and EPP Layer 1-3. A similar mode of raw material transportation by UP humans as mostly cores and rarely pre-cores also was defined for high-quality non-local flints; and, it differs from the mode typical for the Neanderthals who transported non-local rocks mostly as retouched flake tools or flakes, but almost never as cores (see Doronicheva and Kulkova 2011).
3. At Mezmaiskaya, the EUP humans exploited more intensively the Chikiani-Paravani obsidian source area in the Lesser Caucasus rather than the closer Zayukovo source in the North-central Caucasus, and the exploitation of the Chikiani-Paravani source increased toward the end of EUP (see Table 3), in contrast to the LMP Neanderthal occupations, for which our study identifies exploitation only of the Zayukovo (Baksan) source.
4. Our studies of obsidian (this paper) and flint (Doronicheva and Kulkova 2011) artifacts from Mezmaiskaya suggest a deliberate selection by UP humans of high quality raw materials de-

rived from distant sources mostly for the production of bladelets and micro-bladelets, and tools on bladelets and micro-bladelets; such strong selection of high quality rocks for making special classes of artifacts is not documented in the LMP Neanderthal occupations in the Caucasus.

Le Bourdonnec and colleagues (2012) argue for an "intermediary exchange" for obsidian artifacts derived from sources located more than 350km from a site. Our study of obsidian artifacts from Mezmaiskaya suggests that the UP inhabitants of the cave had contacts with distant areas located on both sides of the Greater Caucasus. However, the results do not allow us to infer whether these contacts were the result of intermediary exchange among a number of intermediate human groups or the result of direct obsidian procurement from distant sources. We think this important topic should be the subject of future research when more comparative and statistically significant materials become available.

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