SOURCING OBSIDIAN ARTIFACTS FROM ARCHAEOLOGICAL SITES IN BANAT (SOUTHWEST ROMANIA) BY X-RAY FLUORESCENCE

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Cuvinte cheie: artefacte din obsidian, sursele de obsidian, neolitic și eneolitic în Banat, sursele de la Čejkov și Vinicky

(Abstract)
This article concerns the chemical analysis by X-ray fluorescence and source determination for five obsidian artifacts from archaeological sites in Banat (Southwest Romania). The results show that all of the artifacts could be assigned to an obsidian source located in the Kosice region of Slovakia. The specific source is known as Čejkov and it is a sub-source of the Vinicky source.

A Brief History of Obsidian Source Characterization at MURR

The Archaeometry Lab at MURR has been involved in obsidian research for more than thirty years. Work on obsidian was started in 1979 by Robert Cobean and James Vogt who collected geologic samples of obsidian from sources located in east-central Mexico (Cobean *et al.* 1991).

More than 710 kg of rocks were collected and submitted to the Archaeometry Lab for chemical characterization by neutron activation analysis (NAA). The advantages of NAA for studying obsidian are: (1) ability to measure about 30 elements with high accuracy and precision data; (2) minimal contamination issues caused by sample preparation; (3) NAA provides a true bulk analysis; (4) samples weighing only a few milligrams can be analyzed; and (5) data collected in different NAA laboratories can be compared (Glascock *et al.* 1998). Its main drawback is that NAA is destructive, and artifacts analyzed using this method are no longer available for further study.

The Archaeometry Lab's investigation of Mesoamerican obsidian successfully identified distinct compositional fingerprints for 25 sources in east-central Mexico (Cobean *et al.* 1991). With a success rate exceeding 99%, obsidian artifact sourcing at the Archaeometry Lab became routine. The research soon attracted the attention of archaeologists in other world regions who began submitting obsidian geologic specimens and artifacts to the Archaeometry Lab for characterization. At the present time, our NAA database includes sources located in South America, the western USA, Alaska-Canada, the eastern Mediterranean, Turkey, Armenia, central Europe, East Africa, the Russian Far East, Japan, and the South Pacific. As of 2012, more than 8,000 samples from about 700 sources around the world have been analyzed and more than 15,000 artifacts have been characterized and sourced by NAA.

More recently, the Archaeometry Lab purchased a hand-held portable X-ray fluorescence (XRF) spectrometer in order to satisfy archaeologists who were interested in non-destructive analyses of obsidian and the possibility of analysis in situ. Although XRF measures fewer elements, has less precision and accuracy than NAA, and small or thin obsidian artifacts present a particular challenge, the success rate for obsidian sourcing is still acceptable for many obsidian studies.

The difficulty in analyzing small or thin artifacts is primarily due to the effects of absorption

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for low-energy secondary X-rays emitted from within the sample. XRF instruments are typically calibrated using source samples that one assumes tobe "infinitely thick". Many obsidian artifacts are too thin (< 3 mm) to be considered "infinitely thick". To overcome this limitation, ratios of the mid-Z elements (i.e., Rb, Sr, Y, Zr, Nb) have been used with some success (Hughes 2010). Depending upon the number of possible sources with similar composition and the sample thickness, the success rates for sourcing obsidian by XRF can be quite high. Whenever the analysis of obsidian artifacts by XRF fails to achieve satisfactory results, the option of performing NAA is recommended (Glascock 2010). The Archaeometry Lab has previously characterized a range of obsidian sources from the Carpathians (e.g., Rosania *et al.* 2008), and has previously determined sources for later obsidian from the Banat (Rosania-Barker 2010).

Stratigraphy and Cultural Context of the Artifacts

Research undertaken in Banat in recent decades has contributed significantly to our knowledge of Neolithic and Eneolithic occupations in this area. Research conducted in the Foeni, Parţa (Tell 1 and 2), Timişoara (Freidorf and Fratelia), Chişoda Veche, Hodoni, Sânandrei and Uivar sites (Draşovean 1994; 1996; 2004; Lazarovici, C.M.-G. Lazarovici 2006; 2007; Draşovean-Schier, 2010; Schier 2008; Schier-Draşovean 2004), north of the province, has provided rich and varied archaeological material in addition to the data on the geographical environment, the types of site and the internal organization. A special place in these studies is occupied by the lithic inventory, including both chipped and groundstone tools. Unfortunately, this important source of information was not given its due attention.

Recently however, through the contribution of foreign specialists, the lithic material was the subject of specialized studies in which they treated the issue of the raw material from which they were made and its point of origin, alongside the function and technical typology (Biagi *et alii* 2007a; 2007b). This study further contributes to these inquiries by investigating the sources of five obsidian artefacts discovered at the Foeni-Orthodox Cemetery (PMS–6) site, the Timisoara-Freidorf IV (PMS–7) site, the Sanandrei-Ocsăplaţ (PMS–8) site, the Uivar-Gomila (PMS–9) site and the Parţa-Tell 1 (PMS–10) site (Map 1).

The Foeni-Orthodox cemetery artifact was discovered in the second level of the settlement and dated, based on Bayesian modelling of C14 data, between 4626–4518/4556–4474 calBC (Draşovean 2014a, 139, 142–143). From a cultural point of view, at this stage of research, this level belongs to the earliest presence in the Danubian area of the newly named Foeni group (Draşovean 1994; 2004), which was included in the Foeni-Petreşti Cultural Complex, Phase I (Draşovean 2013, 23–24; 2014b, 137–138).

The Timisoara-Freidorf IV (PMS–7) sample comes from hut no. 1/1984 which, culturally, belongs to the transition to the Middle Neolithic of the Banat Culture phase IB, contemporary with phase A3 of the Vinča culture (Draşovean 2006). In terms of absolute chronology, this phase dates between 5383–5217/5287–5124 calBC (Draşovean 2014a, 137–139).

The artifact from Sanandrei-Ocsăplaţ (PMS–8) was discovered in level 3, which from a cultural point of view, belongs to the Banat culture, phase IIB–IIC (Draşovean 2014a: 137). The Bayesian modeled C14 data places the level 5 between 5483–4857/5253–4899 calBC (Draşovean 2014a: 162).

The Uivar-Gomilă (PMS–9) sample was discovered during the Romanian-German research conducted between 1998 and 2009 (Schier-Draşovean 2004; Schier 2008; Draşovean-Schier 2010). In terms of stratigraphy, it belongs to level 2.2 (in Trench I) and it is dated between 4999–4897/4981–4896 calBC (Draşovean 2013, 15).

The sample from Parta-Tell 1 (PMS–10) comes from level six, belonging to the Banat Culture IIC, located between 5285–5055/5211–4857 calBC, according to the Bayesian modelled C14 data (Draşovean 2014a, 135–136, 139).

Materials and Methods

Information on the five obsidian artifacts in this investigation is listed in Table 1. All samples were analyzed using a hand-held Bruker III–V spectrometer which operates at a voltage of 40 kV and current of 17 microamps. The incident X-ray beam was filtered by copper, titanium, and aluminum to reduce the low-energy background. All obsidian samples were counted for three minutes of real-time. After the data were collected, the concentrations for K, Ti, Mn, Fe, Zn, Ga, Rb, Sr, Y, Zr, Nb, and Th were calculated using an obsidian calibration established by Glascock and Ferguson (2012). In most cases, the elements useful by XRF are limited to Rb, Sr, Y, Zr, and Nb.

Results

The results obtained from conducting XRF on the obsidian artifacts are presented in Table 2.

Obsidian sources in Hungary, Slovakia and the Ukraine were studied earlier by XRF and for comparison purposes the elemental data are listed in Table 3.

In order to identify the sources for each artifact, scatterplots comparing the geologic sources and artifacts were used. Figures 1 and 2, respectively, show scatterplots of the geologic sources and the obsidian artifacts compared to 90% confidence ellipses for the geologic sources. The artifacts plot near the two Čejkov and Vinicky sources in Slovakia and far away from the other sources. Because the confidence ellipses are based on geologic samples that are "infinitely thick", it is not a surprise that several of the smaller and thinner artifacts do not plot inside the ellipses for reasons explained earlier. In order to make source assignments, ratios of Sr/Rb and Zr/Rb were calculated for the geologic and artifact data and these are shown in Figure 3. A source assignment of Čejkov for all five of the artifacts in this study is reasonable.

While the number of samples analyzed is not large, and additional work needs to be completed, analyses to date suggests that from ca. 5383–5217/5287–5124 calBC to 4626–4518/4556–4474 calBC the communities of the Neolithic and Early Eneolithic in northern Banat consistently relied on obsidian extracted from the Čejkov source.

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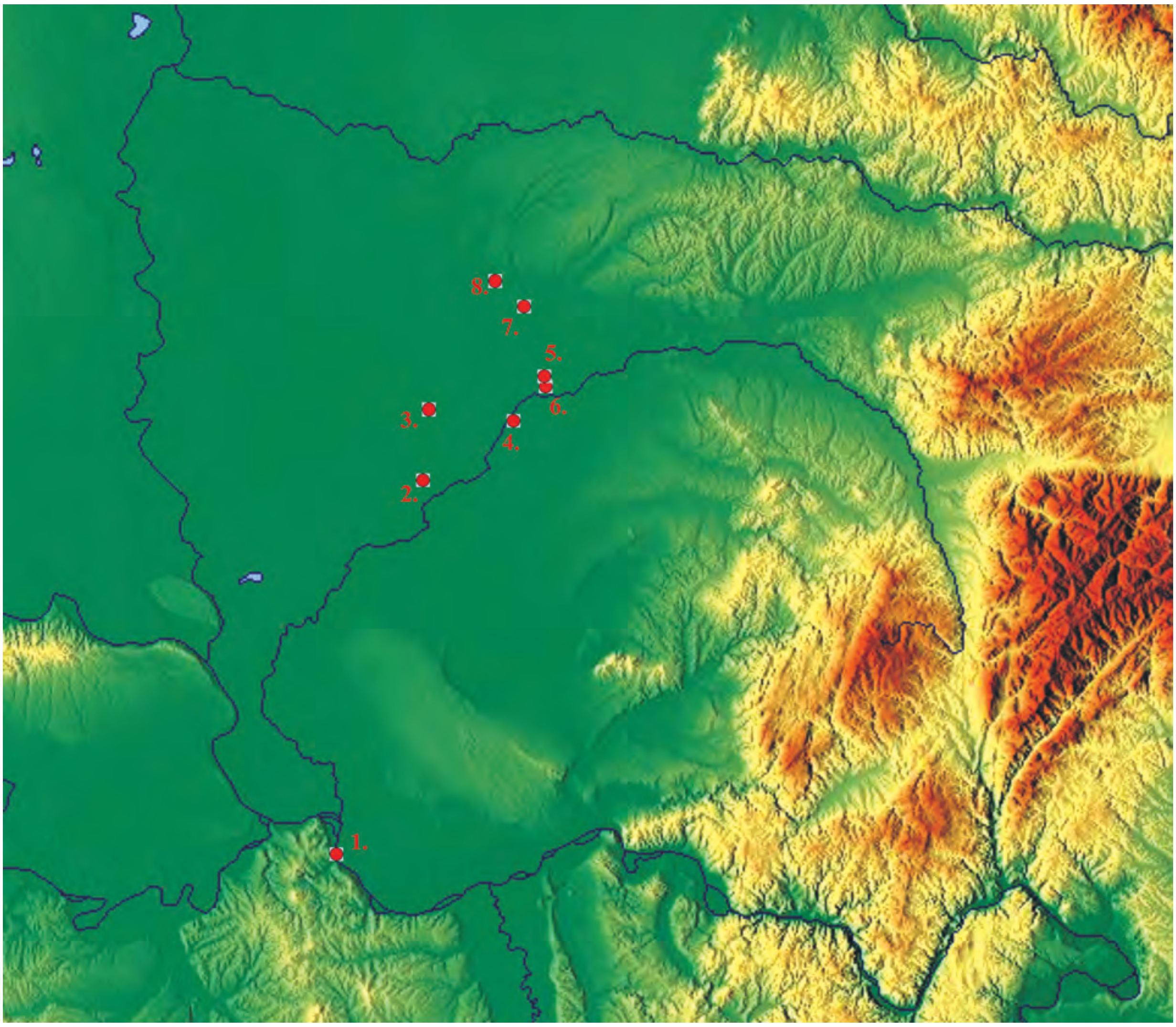

Map. 1. Map of Banat with the sites mentioned in the text: 1. Vinca; 2. Foeni; 3. Uivar; 4. Parța; 5. Timișoara-Freidorf; 6. Sânandrei.

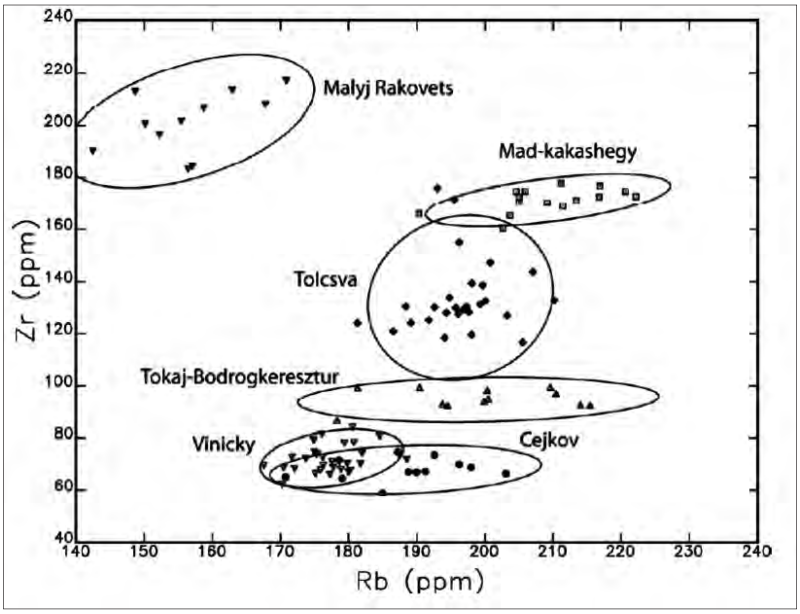

Fig. 1. Scatterplot of the compositional data for Rb and Zr from X-ray fluorescence on "infinitely thick" samples from geologic sources located in Hungary, Slovakia, and Ukraine. Ellipses at the 90% confidence level surround each source group.

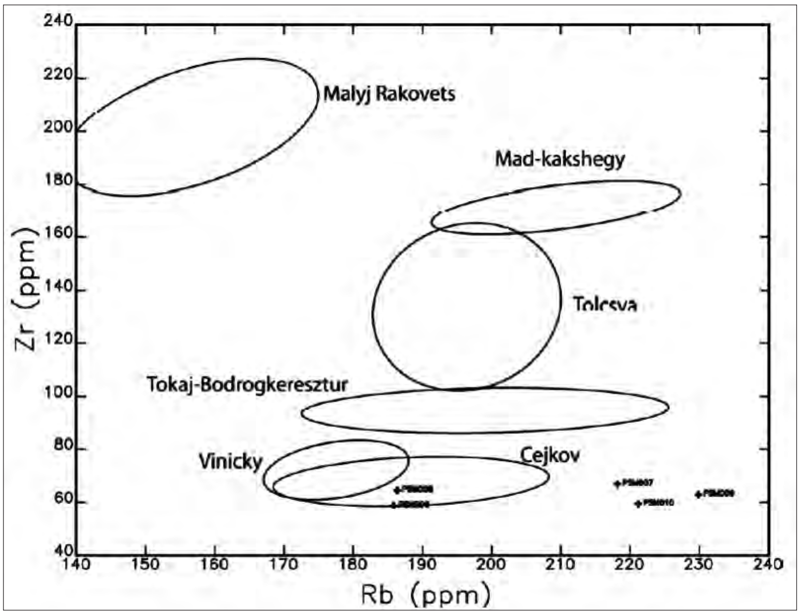

Fig. 2. Scatterplot of the compositional data for Rb and Zr from X-ray fluorescence for the obsidian artifacts from archaeological site in Romania projected against 90% confidence ellipses calculated from "infinitely thick" geologic samples from Hungary, Slovakia, and Ukraine. Artifacts plotting outside the ellipses are small or thin.

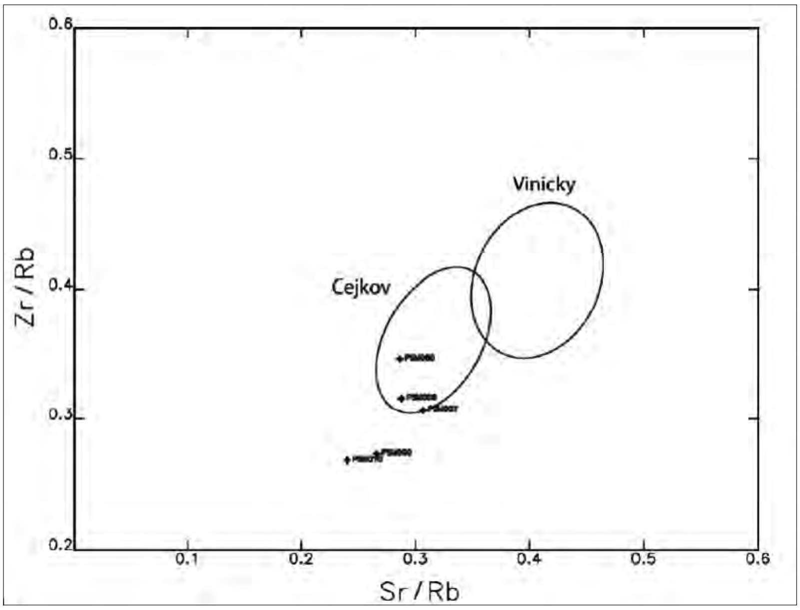

Fig. 3. Scatterplot of Sr/Rb and Zr/Rb data fromX-ray fluorescence for the artifacts compared to "infinitely thick" samples from the geologic sources in Slovakia. Ellipses are drawn at the 90% confidence level around each source group.

ANID	Alternate_ID	Site_Name
PSM006	2012-MBT-1	Foeni
PSM007	2012-MBT-2	Freidorf '84
PSM008	2012-MBT-3	Sanandrei
PSM009	2012-MBT-4	Uivar
PSM010	2012-MBT-5	Parta

Table 1. Sample IDs and site names for the obsidian artifacts in this study.

anid	PSM006	PSM007	PSM008	PSM009	PSM010
K (%)	3.54	3.63	3.53	3.59	3.59
Ti (ppm)	486	403	641	558	443
Mn (ppm)	297	394	313	474	343
Fe (%)	0.73	0.96	0.73	1.02	0.81
Zn (ppm)	32	53	38	79	46
Ga (ppm)	11	17	16	21	13
Rb (ppm)	186	218	186	230	221
Sr (ppm)	53	67	53	61	53
Y (ppm)	22	28	29	28	31
Zr (ppm)	59	67	64	63	59
Nb (ppm)	7	11	8	7	10
Th (ppm)	17	20	18	20	16

Table 2. Element concentrations measured in obsidian artifacts from Banat (Romania) by XRF.

	Mad-Kakashegy (n = 15)			Tokaj-Bodrogkeresztur (n = 12)			Tolcsva (n = 27)			Vinicky (n = 30)			Cejkov (n = 12)			Malyj Rakovets (n = 11)		
Element	mean		stdev	mean		stdev	mean		stdev	mean		stdev	mean		stdev	mean		stdev
K (%)	3.66	±	0.07	3.58	±	0.08	3.67	±	0.06	3.70	±	0.05	3.63	±	0.13	3.49	±	0.08
Ti (ppm)	853	±	97	517	±	179	747	±	105	656	±	63	615	±	195	1064	±	119
Mn (ppm)	410	±	82	190	±	137	445	±	55	426	±	48	447	±	123	670	±	88
Fe (%)	1.38	±	0.03	0.87	±	0.10	1.13	±	0.09	0.86	±	0.05	0.95	±	0.44	2.11	±	0.09
Zn (ppm)	72	±	15	73	±	52	66	±	17	48	±	11	48	±	9	89	±	13
Ga (ppm)	18	±	3	15	±	4	18	±	3	17	±	3	17	±	4	19	±	2
Rb (ppm)	209	±	8	199	±	12	196	±	6	178	±	5	188	±	9	157	±	8
Sr (ppm)	77	±	4	10	±	2	68	±	4	72	±	5	59	±	3	188	±	4
Y (ppm)	29	±	3	25	±	3	30	±	3	26	±	2	27	±	3	24	±	3
Zr (ppm)	171	±	5	95	±	4	134	±	14	72	±	5	68	±	4	202	±	12
Nb (ppm)	12	±	2	9	±	2	12	±	2	9	±	1	8	±	2	13	±	2
Th (ppm)	22	±	2	22	±	3	22	±	2	18	±	2	17	±	2	18	±	2

Table 3. Element concentrations and means for obsidian sources in Hungary, Slovakia, and Ukraine by XRF.

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