SOURCING OBSIDIAN ARTIFACTS FROM ARCHAEOLOGICAL SITES IN CENTRAL AND WESTERN ROMANIA BY X-RAY FLUORESCENCE

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(Abstract)

Compositional analysis conducted using the latest equipment, provided new data and clarifications regarding the exploitation of sources of obsidian and the distribution of material from different sources used by Neolithic and Eneolithic communities in central and western Romania. Our current results suggest a more complicated and evolving set of trade relationships, with obsidian from at least three sources (Mad-Kakaseghy, Tolcsva and Vinicky-Cejkov) represented, which come from the sites at Foeni (*Sălaș* and *the Orthodox Cemetery*), Uivar-*Gomilă*, Caransebeș-*Balta Sărată*, from Banat, Alba Iulia-*Lumea Nouă* from central Transylvania and Zăuan, Suplacu de Bărcău/Porț-*Corău* and Pericei-*Keller Tag* from north-western Romania.

The analysis proved that at the beginning of the early Neolithic in Banat (the Foeni-*Sălaș* site), the raw materials from which the tools were made of came from Mad-Kakaseghy, and at the end of this period, in phase IVA of the Starcevo-Criș culture of Transylvania (in the Zăuan and Porț-*Corău* sites) the obsidian came only from Vinicky-Cejkov sources. During the Middle Neolithic in Banat (Vinca B site of Caransebeș-*Balta Sărată*) and Transylvania (Vinca B site of Alba Iulia-*Lumea Nouă* and Pișcolt II site of Porț-*Corău*) all of the raw material came from Vinicky-Cejkov. This source will be exclusively exploited by all the late Neolithic communities (site Pișcolt II of Porț-*Corău* and Suplac III of Porț-*Corău* and Pericei-*Keller tag*) and early Eneolithic (Foeni II/Foeni-Petrești cultural group II of Alba Iulia-*Lumea Nouă*) from Transylvania. During the late Neolithic in Banat, Vinca C culture, the majority of the raw material came from Vinicky-Cejkov, but at the Vinca C site of Uivar-*Gomilă*, Tolcsva obsidian was found as well. This situation is also maintained during the early Enoeolithic, as two samples analyzed from the Foeni – Cimitirul Ortodox site came from Tolcsva, and another sample, published in the previous year (Glascock *et al* 2015, 47–49), came from Vinicky-Cejkov.

I. Introduction

As part of an ongoing project analyzing the sources of raw lithic materials from the Neolithic, Eneolithic and Bronze Age, developed as a collaboration between the Museum of Art and Archaeology and the Archaeometry Laboratory of the University of Missouri (USA), and the Museum of Banat Timisoara (Romania), artifacts from a series of Neolithic and Eneolithic sites in Banat were analyzed using non-destructive archaeometric techniques. These analyses (Glascock *et al.* 2015) complement previous studies (e.g., Biagi *et al.* 2007a) which addressed the same domain and which, through compositional analysis conducted using the latest equipment, provided new data and clarifications regarding the exploitation of sources of obsidian and the distribution of material from different sources used by Neolithic and Eneolithic communities in central and western Romania. Encouraged by these results, we continued the

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project by analyzing a set of 37 additional samples, which come from the sites at Foeni (*Sălaș* and *the Orthodox Cemetery*), Uivar-*Gomilă*, Caransebeș-*Balta Sărată*, from Banat, Alba Iulia-*Lumea Nouă* from central Transylvania and Zăuan, Suplacu de Bărcău/Porț-*Corău* and Pericei-*Keller Tag* from north-western Romania (Fig. 1). These sites belong to the Early Neolithic (Foeni-*Sălaș*, Zăuan and Porț-*Corău*), Middle Neolithic (Caransebeș-*Balta Sărată* and Alba Iulia-*Lumea Nouă*), Late Neolithic (Uivar-*Gomilă*, Suplacu de Barcău/Porț-*Corău* and Pericei-*Keller Tag*) and Early Eneolithic (Foeni-*Orthodox Cemetery* and Alba Iulia-*Lumea Nouă*) periods.

II. Sample origin, their stratigraphic position and cultural background.

II.1. Early Neolithic. Starčevo-Cris culture.

II.1.1. Foeni-*Sălaș* (Timiș County, Banat), the earliest Neolithic settlement in southwestern Romania, set in Starčevo-Criș phase IC, is located in southern Banat (Greenfield, Drașovean 1994; Drașovean 2007). Research conducted from 1992–1994 led to the discovery of an interesting lithic toolset, including some obsidian tools (Kuijt 1994; Drașovean 2007, 72). The first sample (MBT–6) comes from Locus 23, excavation level 8, and the second (MBT–7) from the same complex, but excavation level 9. Both pieces of obsidian are black and petrographically distinct from all the other pieces in this sample. From a cultural standpoint, Locus 23 belongs to the earliest cultural events of the Starčevo-Criș from Banat, radiocarbon dated to 7080 ± 50 BP (GRN–28454), (Biagi at al. 2007a; Drașovean 2007)).

II.1.2. The Zăuan settlement (Sălaj County, Crișana) is located in northwestern Romania on a hill called *Dâmbul Cimitirului*, flanking the right bank of the Barcăului valley. This Early Neolithic settlement dates to Starčevo-Criș culture phase IIIB and IVA (Lakó 1978, 11–16; Lazarovici, Lakó 1981, 16–26, Lazarovici 1988, 23–70; 1990–1991, 11–35; 1992, 25–59; Băcueț Crișan 2005, p. 225–228.; Băcueț Crișan 2006, 99–123; Băcueț Crișan 2008, 13–17, 31–38).

Research conducted at this site led to the discovery of a total of 120 finished artifacts or processing debris. Obsidian was the most common lithic material, 77.3%, followed by 9.8% chalcedony, 5% Opal 3.2% hydrophane, 2.5% jasper and 0.8% quartzite. Out of these, quartzite and jasper are the only ones represented by finished pieces, as there are no available sources nearby (Maxim *et al.* 1993, p. 49). So far there have been a total of 108 pieces of obsidian submitted to interdisciplinary handling (Maxim *et al.* 1995, 11). The pieces were cataloged and sorted based on function or origin. The presence of cores and a large quantity of processing waste was noticed, suggesting that obsidian processing took place in the settlement.

The types of parts are identified in descending order: blades representing 56.5% of all finished pieces, scrapers 23%, tips and graters 19.6%. The small percentage of this last category was attributed to the obsidian structure which does not lend itself particularly well to retouch. Under the blade category, we can distinguish two groups, one made up of fragments that could act as sickle blade teeth, and another group of actual blades, of lower quantities.

Previous analyses were conducted in order to identify Zăuan obsidian sources: of the 6 types of obsidian sources, only 2 sources could be determined. 7.41% of the pieces are of type Tokaj obsidian and one piece of type Melos obsidian (Maxim *et al.* 1995, 12).

In 2015 two pieces of obsidian were submitted for analysis, both taken from the upper level, located at a depth between 0.20–0.40 m. One of the pieces was discovered in box 3/1976 (MBT–25); Eva Lakó's excavation journal suggests this comes from a depth of -0,30–0,45 m, in a housing area, later renamed as L5 (Băcueț Crișan 2008, 15) and assigned to a very late Starčevo-Criș IVA manifestation, or even IVB (Băcueț Crișan 2008, 37). The second item (MBT–24) comes from 6/1980 (S6), possibly from housing area L1, which was partially investigated in the campaign of 1975 and attributed to Starčevo-Criș culture IVA (Lazarovici, Lako, 1981, 20; Băcueț Crișan 2008, 16–17).

II.1.3. Suplacu de Barcău/Porț-*Corău* (Crișana). Stračevo Criș settlement

About 10 km from the Zăuan settlement, research conducted at Suplacu de Barcău/Porț-Corău between 2002–2003 led to the identification of a new Starčevo Criș settlement, documented by several surface or recessed houses (Băcueț Crișan 2008, 20–26). Known since the 1970s, the site of Suplacu de Barcău/Porț *Corău* is set on a wide terrace at the exit of the Barcău gorge. The first systematic research, coordinated by Doina Ignat, began in 1973 and was continued until 1990 (Ignat 1998, 18–20). The dynamic economic development of the area, especially the construction of the dam reservoir from Suplac which affected almost the entirety of the *Corău* site, necessitated preventive investigations in both

Bihor and Salaj county. The research was resumed in 2002 (Matei *et al.* 2003, 246–248; Lazarovici *et al.* 2003, 305–309), continued in 2003 (Bejinariu *et al.* 2004, 245–246) and later in 2010–2012 (Băcueţ Crişan et ali. 2011, 220–223; Băcueţ Crişan *et al.* 2012,. 245–246; Băcueţ Crişan *et al.* 2013, 173–174). The six research campaigns carried out at Porţ *Corău* revealed habitation assigned to the Starčevo Criş culture, the Pişcolt group, the Suplac group (Zau culture), the Coţofeni culture, Bronze Age, Iron Age, Latene, Roman times and the early Middle Ages . Intense research led to a diverse collection of archaeological material, in which items from the stone industry stood out, with the Neolithic and Eneolithic levels providing plenty of evidence of stone-working, carving or polishing. In this context, six pieces of obsidian from the site were analyzed in 2015; two were discovered in sunken homes assigned to the Starčevo-Criş culture. Among them one piece (MBT–27) comes from the outline level of L14 (Băcueţ Crişan 2008, 26) and the second (MBT–26) from fill level I of house L15, both assigned to stage IVA of the culture (Băcueţ Crişan 2008, 67).

II.2. Middle Neolithic.

II.2.1. Caransebeş-*Balta Sărată* (Caraş-Severin County, Banat). Vinča culture Phase B.

The Vinča culture habitation at Caransebeş, the Balta Sărată district from *Câmpul lui Poşta*, has been known in specialty literature since the 1960s. Here, in several campaigns, the Neolithic habitation areas were investigated and assigned to phases A3 and B (Lazarovici 1979, 78–79, 81, 83–84, 185; C.M. Lazarovici, G. Lazarovici, 2006, 126–127, 150, 161–179).

All samples for this study come from surface S1/2013 as follows: MBT–20 and 23 were discovered in house L2/2013 and the other belonging to the culture level; MBT–18 and 19 were discovered at a depth of 0.7 m., and the last two, MBT–21 and 22 at a depth of 0.65–0.85 and 0.8 m.

II.2.2. Alba Iulia-*Lumea Nouă* (Alba County, Transylvania). Vinča culture Phase B.

Systematic and preventive archaeological research made in this area in the past 15 years have highlighted dwellings from the Middle Neolithic (Vinča B and Lumea Nouă), Early Eneolithic (Foeni group) and Middle Eneolithic (Petreşti culture A-B) (Gligor 2007; 2009; 2012; 2014). The pieces of obsidian were discovered in archeological complexes researched in the past 10 years belonging to the Vinča culture layer, Phase B. Thus, sample MBT–35 comes from hut B1, depth of 1,70–1,80 m, investigated in Sp. I/2011 in square D, sample MBT–36 was discovered in Sp. I / 2014 Cx pit 006, located in square D, at a depth of 1,55 m, sample MBT–37 was discovered at a depth of 1,35 m in pit Cx. 007, in square C of area Sp. I / 2014, sample MBT–38 comes from hut Cx 013, depth of 1.70–1.85 m., investigated in square D, of area Sp.I / 2014 and finally MBT–40 was discovered in pit G1, square A, at a depth of 0.95 m., from area Sp. III / 2005. Note that in hut Cx. 13, which produced both sample MBT–38 and Vincian ceramics of good quality along with anthropomorphic covers and female anthropomorphic statuettes, fragments of Lumea Nouă-type painted pottery were also discovered.

II.2.3. Suplacu de Barcău/Porţ-*Corău* (Crişana). Pişcolt II habitation.

One specimen (MBT–28) from the Pişcolt group, stage IIA from the C 162 complex has been analyzed. In specialty literature, phase II of the Pişcolt group was parallelized with the classic groups of Esztár, Szakálhát and Tiszadob cultures (except the first part of the evolution of the group), Bükk A, A-B, B, Vinca B1-B2 (Lazarovici, Nemeti 1983, 31–33; Virag 2005 (2008), p. 21, Băcueţ Crişan 2008a, p. 20; Suciu 2009, 169.)

II.3. Late Neolithic.

II.3.1. Suplacu de Barcău/Porţ-*Corău* (Crişana). Suplac habitation type.

The most famous habitation type of this site is the Suplac type; one of these complexes, C13, from which a sample was analyzed (MBT–29), belonged to this stage. Ceramic materials taken from early complexes indicate a mix of styles specific for Pişcolt / Esztár or Lumea Nouă-Zau-Cheile Turzii processed in a manner specific to that community. Absolute and relative chronology data indicate an interval parallel to Tisza I–I/II – Herpály I–II–Vinča C1 – Vinča C2 (Băcueţ Crişan 2013, 17). The next samples (MBT–30 MBT–31) come from the level, section 18 (S18 / 2011), assigned to the same early horizon of habitation as that of C13.

II.3.2. Pericei-*Keller tag.* Suplac habitation type.

Another site that has benefited from extensive archaeological research is Pericei-*Keller tag*, located on the terrace on the left side of the Crasna river (Băcueţ Crişan 2008a, 27–38). Note that the two river basins, Crasna (where Pericei is locatedl) and Barcău (where the Zăuan and Suplacu de Barcău/Porţ sites are located) define a unified geographical unit called Depresiunea Şimleului. In these contexts similar Neo-Eneolithic settlements were found. Archaeological research at Pericei-Keller

tag showed slight chronological discrepancies and the early Suplac-type habitation from Porţ remains unidentified to this day. The three samples from Pericei MBT–32 MBT–33 MBT–34, were collected from levels corresponding to the Suplac type II horizon, identified both at Pericei and Suplacu de Barcău/Porţ. In the Neo-Eneolithic Transylvanian ensemble, stage II of Suplacu de Barcău, as defined by Doina Ignat, develops in parallel with stage II of the Iclod group (Ignat 1998, 46, 76). According to recent research, for Iclod II the following Turdaş II–Iclod II synchronisms were established; Turdaş II – the beginning of the Foeni group in Banat, in absolute chronology between 4780–4630 BC (Diaconescu *et al.* 2013, p. 52–53). The only datum of absolute chronology referring to the Suplac-type discoveries comes from Şimleu Silvaniei, a horizon similar to the Suplac III and which dates to the 4528BC (95.4%) 4365BC interval (Băcueţ Crişan, Pop 2014, 47).

II. 3.3. Uivar-*Gomilă* (Timiş County, Banat). Vinča culture phase C.

Systematic research, begun in 1998 under the Romanian-German project (Schier-Draşovean 2004; Draşovean-Schier 2010), led to important clarifications of tell stratigraphy, cultural and chronological evolution, and the relationship between this community and ones in adjacent areas. One fragment of obsidian (PSM09 = MBT–4) was analyzed in a recent study (Glascock *et al.* 2015) and determined to be from Slovak sources in Cejkov.

For the current project eight samples of obsidian were analyzed, originating from the upper levels of the tell. Sample MBT–8 was discovered in surface area T II, under the rubble from the burnt house Feat. 216, which belongs to level 2. Samples MBT–9 and MBT–10 come from surface area T I, level 3.2, the first of which was discovered in Feat. 533, and the second in Feat. 468; sample MBT–11 was discovered in area T IV in pit Feat. 1229. The other four samples, MBT–14–17 were discovered in area T XI: two of these come from level 3.2. MBT–14 in complex Feat. 3219 and MBT–16 in the yellow clay level adjacent to the hearth from Feat 3204, respectively; MBT–15 was discovered in level 2.1.5, in the burnt ruins area Feat. 3172/3173 – Feat. 3148/3149, and MBT–17 in level 4.1 adjacent to feat. 3208. We specify that there is no stratigraphic correlation between level 3.2 from T I and level 3.2 of T XI, as the layer and level numbering of the two surfaces were made based on layering in local sequences of anthropogenic deposits. However, as the available C14 data shows, level 2.1.5, 3.2 and 4.1 of T XI, are between 4770–4600 cal BC (Draşovean *et al.* 2016), and later than level 2 of T I, dated between 4870–4725 cal BC.

II.3. Early Eneolithic

II.3.1. Foeni-*Cimitirul Ortodox* (Timiş County, Banat). Foeni-Petreşti cultural complex, Phase I.

Early Eneolithic habitation in this location has been systematically researched between 1991–2013. Research has revealed three living levels (I–III) belonging to the Foeni-Petreşti cultural complex, Banat phase (I) (Draşovean 2013; 2014). Recently, from the second level of this site, an obsidian sample (PSM–006 = MBT–001) was analyzed whose geological deposit source is Cejkov, Slovakia (Glascock *et al.* 2015, 46–48).

As part of the current project two more samples were analyzed, one of which (MBT–12) derived from the lower level (I) investigated in area S4 and the second (MBT–13), hut Gr. 38 from area S16, which stratigraphically belongs to level II of this site (Draşovean 2014, 145, 170).

II.3.2. Alba Iulia-Lumea Nouă (Alba County, Transylvania). Foeni cultural group.

In this multilayered site, along with stratigraphic units belonging to the Vinča B and C cultures, complexes belonging to the Foeni cultural group, Phase II (Foeni-Petreşti cultural group II) were also investigated, fitting into the Early Eneolithic in Transylvania (Draşovean 1996, 94, 99; 2014; 2015; Gligor 2007; 2009; 2012; 2014). Three samples of obsidian were analyzed from this site. The first of these (MBT–39) was discovered in the filling of a trench (Cx. 004) which was researched in area Sp. I / 2014, square D at a depth of 1,95 m. On the bottom of the trench between two graves (M7 and M8), another was identified (M9) that belongs to a male individual, approx. 16 to 24 years. The obsidian piece was identified after lifting the skeleton and may be connected to the funerary event.

The other two samples, MBT–41 and MBT–42 were found in hut B1 from area Sp. II / 2005 B1 at a depth of 1,35 m and 1,60 m respectively. The pit of the hut has an oval shape with a dimension of 4.00 m (E-W) × 3.40 m (N-S) and a maximum depth of 2.60 m. Two circular holes were found on the northeast outline of the hut. Emptying the hut resulted in a large amount of high-quality ceramics, typical of the Foeni group. 18 vessels were reconstructed, mostly of the black-topped and black pottery category (Gligor 2007, 1–26).

III. Nondestructive analysis of the obsidian pieces found in Neolithic and Eneolithic sites in Banat and Transylvania, through X-ray fluorescence.

Analytical procedure

The obsidian pieces were analyzed at the University of Missouri MURR Archaeometry Laboratory by X-ray fluorescence (XRF) using a ThermoScientific ARL Quantx energy-dispersive XRF spectrometer. The instrument has a rhodium-based X-ray tube and thermoelectrically-cooled silicon-drift detector (SDD). The tube was operated at 35kV and current was automatically adjusted to a fixed 30% deadtime. The samples were counted for two minutes each allowing for measurement of Mn, Fe, Zn, Rb, Sr, Y, Zr, Nb, and Th. Normalization to the Compton scattering peak was used to account for differences in sample size and thickness. However, this method has limitations when the artifacts are very small or thin and sometimes necessitates the use of ratios.

The instrument was calibrated by measuring a set of 40 very well-characterized obsidian source samples previously analyzed by neutron activation analysis (NAA), inductively coupled plasma-mass spectrometry (ICP-MS), and XRF. More information about the calibration method is available in a report by Glascock and Ferguson (2012).

Results

The concentration data for individual artifacts are presented in Table II. Due to the normalization procedure used to estimate the amount of sample exposed to X-rays, many of the absolute concentrations for the smallest/thinnest samples have depressed values. To reduce the effect of this problem, the artifact concentration data were converted to ratios of the elements divided by Zr before comparing to source data.

The process of assigning sources involves eliminating the sources that clearly do not match the artifacts and then selecting the best matching source from the remainder. A scatterplot of Rb/Zr versus Y/Zr is shown in Figure 1 which best explains how the artifacts in this investigation were assigned to sources. The Vinicky and Cejkov sources are combined because they could not be resolved by ED-XRF. All sources groups are surrounded by 90% confidence ellipses and the artifacts are shown projected against the sources.

The results indicate the artifacts MBT006 and MBT007 are from Mad-Kakaseghy, artifacts MBT009, MBT012, and MBT013 are from Tolcsva, and the remaining artifacts are from the Vinicky-Cejkov source. The results are summarized in Table III.

IV. Conclusions

Some previous studies (e.g., Biagi *et al.* 2007b) found that all of the obsidians tested dating from the middle to late Neoltihic and Chalcolithic were from the Slovakian "Carpathian 1" source; our earlier study (Glascock *et al.* 2015) came to similar conclusions. Our current results suggest a more complicated and evolving set of trade relationships, with obsidian from at least three sources (Mad-Kakaseghy, Tolcsva and Vinicky-Cejkov) represented.

The earliest samples in the sequence, from Foeni-*Sălaş*, are made of obsidian from the Mad-Kakashegy source in the Tokaj Mountains. No other sites in the current project produced obsidian from this source. From a cultural point of view, this community belongs to the first wave of the Banat neolithisation, situated at the turn of the 7th and 6th centuries, BC (Draşovean 2007).

Subsequent to this only the Vinicky-Cejkov source is represented in our sample until the Late Neolithic and Eneolithic periods.

At Uivar-*Gomilă* two sources are represented. Seven of the samples are from the Vinicky-Cejkov source, but one (MBT009) is from the Tolcsva source in the Tokaj Mountains, and Level 3.2 produced a mix of five samples, four from Vinicky-Cejkov, and one from the Tolcsva. From a cultural point of view, level 2 of Trench II and 2.1.5, 3.2 of Trench XI belong to the Vinca culture, phase C and are dated between 4870–4800 cal BC and 4790–4725 cal BC (level 2 of T II) and 4770–4600 cal BC (level 4.1 of T XI, Feat 3208).

At Foeni-*Cimitirul ortodox* both sources are also represented; MBT001, from Level 2, is made from Vinicky-Cejkov obsidian, while two additional samples (MBT012 and MBT013) from Level 1 and Level 2, respectively, are from obsidian from Tolcsva. Level I is dated between 4823–4614 cal BC (mean 4720 cal BC) and 4626–4518 cal BC (mean 4566 cal BC), and the second ends between 4556–4474 cal BC (mean 4520 cal BC) (Draşovean 2014, Fig. 7–7d, 139–145, 162; 2015, Fig. 4–4b).

At the beginning of the Eneolithic phase in Transylvania, marked by the presence of the Foeni-Petreşti cultural complex, phase II (Draşovean 2015, 137–138 and Table I), and at the Alba Iulia-Lumea Nouă site, dated between 4632–4499 cal BC (mean 4557 cal BC) and 4543–4441

cal BC (mean 4495 cal BC), (Draşovean 2014, Fig. 12–12b,160, 163), all of the analyzed pieces come from the Vinicky-Cejkov source.

In conclusion, at the beginning of the early Neolithic in Banat (the Foeni-*Sălaş* site), the raw materials from which the tools were made came from Mad-Kakaseghy, and at the end of this period, in phase IVA of the Starcevo-Criş culture of Transylvania (in the Zăuan and Porţ-*Corău* sites) the obsidian came only from Vinicky-Cejkov sources. During the Middle Neolithic in Banat (Vinca B site of Caransebeş-*Balta Sărată*) and Transylvania (Vinca B site of Alba Iulia-*Lumea Nouă* and Pişcolt II site of Porţ-*Corău*) all of the raw material came from Vinicky-Cejkov. This source was exclusively exploited by all the late Neolithic communities (site Pişcolt II of Porţ-*Corău* and Suplac III of Porţ-*Corău* and Pericei-*Keller tag*) and early Eneolithic (Foeni II/Foeni-Petreşti cultural group II of Alba Iulia-*Lumea Nouă*) from Transylvania. During the late Neolithic in Banat, Vinca C culture, the majority of the raw material came from Vinicky-Cejkov, but at the Vinca C site of Uivar-*Gomilă*, Tolcsva obsidian was found as well. This situation is maintained during the early Eneolithic as well, as two samples analyzed from the Foeni-Cimitirul Ortodox site came from Tolcsva, and another sample, published in the previous year (Glascock *et al.* 2015, 47–49), came from Vinicky-Cejkov.

These results contradict and correct earlier indications (Biagi *et al.* 2007a; Glascock *et al.* 2015), based on the predominance of the Vinicky-Cejkov source in smaller samples, that Neolithic and early Eneolithic communities relied exclusively on Slovakian obsidians. These results further underscore the need for continued systematic, archaeometric research on the source and distribution networks for obsidian during these periods of profound social transformation and change.

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Table I. List of obsidian artifacts from Banat and Transylvania submitted for analysis by XRF.

MURR ANID	Site Name	Site State	Comments
MBT006	Foeni-Sălaş	Banat	
MBT007	Foeni-Sălaş	Banat	
MBT008	Uivar-Gomilă	Banat	
MBT009	Uivar-Gomilă	Banat	very small
MBT010	Uivar-Gomilă	Banat	
MBT011	Uivar-Gomilă	Banat	
MBT012	Foeni-Cimitir	Banat	very small
MBT013	Foeni-Cimitir	Banat	very small
MBT014	Uivar-Gomilă	Banat	
MBT015	Uivar-Gomilă	Banat	very small
MBT016	Uivar-Gomilă	Banat	
MBT017	Uivar-Gomilă	Banat	very small
MBT018	Caransebeş-Balta Sărată	Banat	very small
MBT019	Caransebeş-Balta Sărată	Banat	very small
MBT020	Caransebeş-Balta Sărată	Banat	
MBT021	Caransebeş-Balta Sărată	Banat	
MBT022	Caransebeş-Balta Sărată	Banat	
MBT023	Caransebeş-Balta Sărată	Banat	very small
MBT024	Zăuan	Transylvania	
MBT025	Zăuan	Transylvania	
MBT026	Porţ-Corău	Transylvania	
MBT027	Porţ-Corău	Transylvania	
MBT028	Porţ-Corău	Transylvania	
MBT029	Porţ-Corău	Transylvania	
MBT030	Porţ-Corău	Transylvania	
MBT031	Porţ-Corău	Transylvania	
MBT032	Pericei	Transylvania	
MBT033	Pericei	Transylvania	
MBT034	Pericei	Transylvania	
MBT035	Alba Iulia-Lumea Nouă	Transylvania	
MBT036	Alba Iulia-Lumea Nouă	Transylvania	
MBT037	Alba Iulia-Lumea Nouă	Transylvania	
MBT038	Alba Iulia-Lumea Nouă	Transylvania	
MBT039	Alba Iulia-Lumea Nouă	Transylvania	
MBT040	Alba Iulia-Lumea Nouă	Transylvania	
MBT041	Alba Iulia-Lumea Nouă	Transylvania	
MBT042	Alba Iulia-Lumea Nouă	Transylvania	

Table II. Concentrations in parts per million measured in artifacts from Banat and Transylvania.

ANID	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Th
MBT006	324.6	12547.7	29.0	194.1	71.5	29.1	152.5	10.9	24.2
MBT007	305.0	9640.1	25.1	134.5	53.9	20.8	113.0	8.1	13.2
MBT008	459.4	7426.2	22.1	180.2	65.1	27.6	73.6	10.1	15.1
MBT009	333.7	3767.0	11.0	75.8	21.4	9.8	39.3	5.0	6.6
MBT010	444.8	6351.4	19.1	167.9	44.1	25.8	63.2	9.3	13.2
MBT011	509.1	7803.1	21.6	152.9	54.6	23.0	67.1	8.5	13.0
MBT012	351.1	3841.4	7.8	77.5	24.1	11.7	41.7	5.5	7.1
MBT013	310.8	3030.7	11.4	51.3	14.5	6.6	30.8	3.8	5.2
MBT014	472.8	6932.1	23.3	158.4	49.2	22.0	61.8	7.9	11.6

ANID	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Th
MBT015	372.7	4954.2	16.8	100.9	33.4	14.6	45.3	6.7	9.7
MBT016	494.3	8634.0	29.5	194.4	62.7	28.5	73.6	9.0	14.7
MBT017	383.6	5212.5	20.0	100.5	28.6	13.3	42.0	4.1	8.4
MBT018	413.8	7000.8	20.5	141.3	41.2	21.4	58.6	7.6	10.8
MBT019	401.4	5779.8	19.2	133.9	38.3	19.9	56.6	7.9	11.8
MBT020	411.4	7447.9	22.3	154.6	55.4	23.2	66.0	8.1	13.2
MBT021	451.7	7501.6	20.2	168.5	54.3	24.8	67.7	7.5	14.6
MBT022	482.9	7550.9	21.8	193.3	55.8	29.1	70.1	10.2	16.7
MBT023	402.8	7252.3	19.7	144.6	46.3	22.0	61.3	9.1	12.7
MBT024	472.7	7453.1	18.9	161.3	49.1	22.8	63.7	7.5	12.6
MBT025	442.0	6825.5	20.1	172.5	50.7	26.1	65.5	10.2	13.3
MBT026	477.0	9088.0	25.1	174.6	60.6	25.4	73.1	9.9	17.6
MBT027	455.2	7171.4	21.6	184.7	54.8	29.0	70.6	9.8	14.7
MBT028	453.7	7790.2	21.4	181.3	59.4	28.5	73.3	9.4	15.3
MBT029	448.8	7130.1	18.9	178.6	60.6	27.5	70.9	9.3	15.1
MBT030	483.9	7582.5	23.0	198.1	55.8	29.5	70.1	10.5	16.6
MBT031	498.8	7939.9	25.0	209.4	60.5	31.8	77.9	11.5	15.4
MBT032	449.3	7069.4	22.0	173.8	52.4	27.0	69.7	9.2	13.5
MBT033	425.7	6534.5	18.0	169.1	47.6	25.5	65.5	8.7	13.0
MBT034	488.7	7626.7	23.7	201.7	58.0	30.5	72.6	11.5	16.5
MBT035	434.2	6642.3	18.5	158.3	50.4	24.4	67.6	8.4	11.9
MBT036	478.3	7008.9	19.6	203.7	52.1	31.0	73.1	10.2	14.6
MBT037	489.5	7703.7	21.8	203.5	59.4	30.1	72.7	9.9	15.5
MBT038	461.7	6827.5	16.9	192.5	56.1	29.6	72.1	10.0	17.0
MBT039	459.9	7664.1	24.4	193.1	59.0	28.7	72.2	10.3	16.1
MBT040	550.8	8514.8	27.4	204.0	56.0	28.0	66.7	10.2	15.0
MBT041	471.5	7710.0	18.0	190.9	68.8	29.4	75.4	9.6	16.9
MBT042	465.0	8176.4	21.2	192.1	67.6	28.3	74.1	10.4	16.0

Table III. Source assignments for artifacts from Banat and Transylvania.

ANID	Site Name	Site State	Source Name	Source State
MBT006	Foeni-Sălaş	Banat	Mad-Kakashegy	Tokaj Mountains
MBT007	Foeni-Sălaş	Banat	Mad-Kakashegy	Tokaj Mountains
MBT008	Uivar-Gomilă	Banat	Vinicky/Cejkov	Kosice Region
MBT009	Uivar-Gomilă	Banat	Tolcsva	Tokaj Mountains
MBT010	Uivar-Gomilă	Banat	Vinicky/Cejkov	Kosice Region
MBT011	Uivar-Gomilă	Banat	Vinicky/Cejkov	Kosice Region
MBT012	Foeni-Cimitir	Banat	Tolcsva	Tokaj Mountains
MBT013	Foeni-Cimitir	Banat	Tolcsva	Tokaj Mountains
MBT014	Uivar-Gomilă	Banat	Vinicky/Cejkov	Kosice Region
MBT015	Uivar-Gomilă	Banat	Vinicky/Cejkov	Kosice Region
MBT016	Uivar-Gomilă	Banat	Vinicky/Cejkov	Kosice Region
MBT017	Uivar-Gomilă	Banat	Vinicky/Cejkov	Kosice Region
MBT018	Caransebeş-Balta Sărată	Banat	Vinicky/Cejkov	Kosice Region
MBT019	Caransebeş-Balta Sărată	Banat	Vinicky/Cejkov	Kosice Region
MBT020	Caransebeş-Balta Sărată	Banat	Vinicky/Cejkov	Kosice Region
MBT021	Caransebeş-Balta Sarata	Banat	Vinicky/Cejkov	Kosice Region

ANID	Site Name	Site State	Source Name	Source State
MBT022	Caransebeş-Balta Sarata	Banat	Vinicky/Cejkov	Kosice Region
MBT023	Caransebeş-Balta Sărată	Banat	Vinicky/Cejkov	Kosice Region
MBT024	Zăuan	Transylvania	Vinicky/Cejkov	Kosice Region
MBT025	Zăuan	Transylvania	Vinicky/Cejkov	Kosice Region
MBT026	Porţ-Corău	Transylvania	Vinicky/Cejkov	Kosice Region
MBT027	Porţ-Corău	Transylvania	Vinicky/Cejkov	Kosice Region
MBT028	Porţ-Corău	Transylvania	Vinicky/Cejkov	Kosice Region
MBT029	Porţ-Corău	Transylvania	Vinicky/Cejkov	Kosice Region
MBT030	Porţ-Corău	Transylvania	Vinicky/Cejkov	Kosice Region
MBT031	Porţ-Corău	Transylvania	Vinicky/Cejkov	Kosice Region
MBT032	Pericei	Transylvania	Vinicky/Cejkov	Kosice Region
MBT033	Pericei	Transylvania	Vinicky/Cejkov	Kosice Region
MBT034	Pericei	Transylvania	Vinicky/Cejkov	Kosice Region
MBT035	Alba Iulia-Lumea Nouă	Transylvania	Vinicky/Cejkov	Kosice Region
MBT036	Alba Iulia-Lumea Nouă	Transylvania	Vinicky/Cejkov	Kosice Region
MBT037	Alba Iulia-Lumea Nouă	Transylvania	Vinicky/Cejkov	Kosice Region
MBT038	Alba Iulia-Lumea Nouă	Transylvania	Vinicky/Cejkov	Kosice Region
MBT039	Alba Iulia-Lumea Nouă	Transylvania	Vinicky/Cejkov	Kosice Region
MBT040	Alba Iulia-Lumea Nouă	Transylvania	Vinicky/Cejkov	Kosice Region
MBT041	Alba Iulia-Lumea Nouă	Transylvania	Vinicky/Cejkov	Kosice Region
MBT042	Alba Iulia-Lumea Nouă	Transylvania	Vinicky/Cejkov	Kosice Region

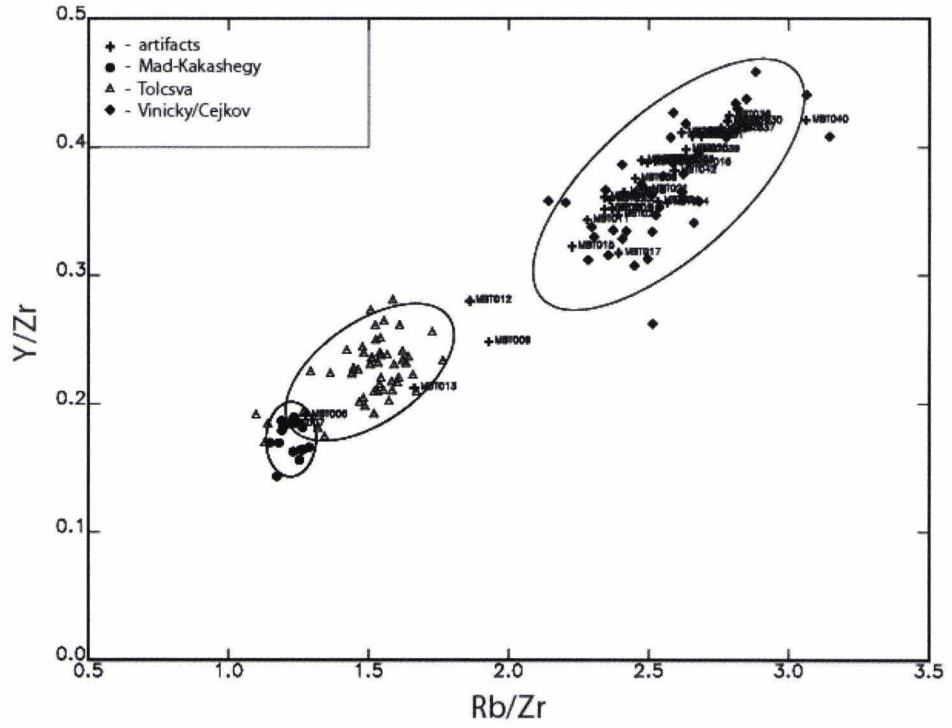

Figure 1. Scatterplot of Rb/Zr versus Y/Zr for obsidian artifacts from Banat and Transylvania. Source ellipses are shown at the 90% confidence interval.