ARCHAEOMETRIC ANALYSIS OF THE OBSIDIAN ASSEMBLAGE FROM HODONI/HODONY (BANAT, ROMANIA)

HODONI/HODONY (BÁNÁT, ROMÁNIA) LELŐHELYRŐL SZÁRMAZÓ OBSZIDIÁNOK ARCHEOMETRIAI VIZSGÁLATA•

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Abstract

Hodoni "Pocioroane" is one of the archaeological sites discovered near the village of Hodoni/Hodony, ca. 25 km north of Timişoara, in the Romanian Banat. The excavations carried out at "Pocioroane" have yielded traces of superimposed Neolithic settlements and a medieval cemetery. This paper considers 113 obsidian artefacts recovered during the excavations carried out between 1985 and 1991 in the Vinča C2 and Tisza culture layers and features. The obsidian artefacts are represented by waste flakes, bladelets, exhausted cores and a few retouched tools two of which show utilisation marks. The artefacts have been characterised by LA-ICP-MS and XRF methods at the CNRS laboratory of Orléans University (France) indicating a Carpathian 1 provenance.

Kivonat

Hodoni "Pocioroane" lelőhely egyike a Hodoni/Hodony község határában feltárt régészeti lelőhelyeknek, kb. 25 km-re északra Temesvártól a romániai Bánát területén. A"Pocioroane" lelőhelyen végzett ásatások újkőkori település és középkori temető nyomait hozták felszínre. Ebben a tanulmányban 113 obszidián eszközt mutatunk be, amelyek az 1985 és 1991 között végzett ásatásokból kerültek elő, a Vinča kultúra C2 fázisából és a Tisza kultúra rétegeiből és objektumaiból. Az obszidián leletegyüttest megmunkálási hulladéknak értelmezhető szilánkok, mikropengék, elhasznált magkövek és néhány retusált eszköz képviseli, amelyek közt két darabon használati kopásnyomok voltak felfedezhetők. Az eszközökön LA-ICP-MS és XRF vizsgálatokat végeztünk az Orléans-i Egyetem (Franciaország) CNRS Laboratóriumában. Eredményeink szerint a vizsgált obszidiánok a Kárpáti 1 (szlovákiai) típusba sorolhatók.

KEYWORDS: CARPATHIAN OBSIDIAN SOURCES, CHARACTERIZATION ANALYSES, ROMANIAN BANAT, VINČA AND TISZA CULTURES

KULCSSZAVAK: KÁRPÁTI OBSZIDIÁN FORRÁSOK, GEOLÓGIAI LELŐHELY AZONOSÍTÁSI VIZSGÁLAT, BÁNÁT (ROMÁNIA), VINČA ÉS TISZA KULTÚRÁK

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Introduction

The archaeological site of Hodoni "Pocioroane" is located ca. 500 m west-northwest of the confluence of the Lercici and Caran Rivers, 25 km north of Timişoara in the Romanian Banat. Its geographical coordinates are 45°53'48"N-21°05'32"E. The Lercici River flows just north of Hodoni/Hodony. "Pocioroane" is located on a fluvial terrace some 100 m a.s.l. at the south-eastern edge of the village (**Fig. 1.**). At least eight archaeological sites were known around Hodoni in the 1990s (Draşovean et al. 1996, 7); more sites were discovered in 2014 a few hundred metres south of the previous ones (Rogozea 2015, Muscalu 2016).

The first excavations were carried out at "Pocioroane" in 1959, 1960 and 1976 (Moga & Radu 1977). More trenches, among which is one (Trench 7) crossing the entire site from northeast to southwest, were opened between 1985 and 1991 (**Fig. 2.**). The excavations yielded Neolithic Vinča and Tisza culture traces of occupation and a medieval cemetery that the excavators attributed to the 10^{th}–11^{th} centuries AD (Draşovean et al. 1996).

This paper is concerned with the sourcing of the obsidian assemblages recovered during the "Pocioroane" excavations carried out in 1985, 1987, 1988 and 1991, with the objective of framing the results into the wider picture of the exploitation and circulation of obsidian in this part of the Balkan Peninsula and the Carpathian Basin during the Neolithic.

Archaeological context

The results of the excavations carried out at Hodoni "Pocioroane" in 1985-1991 are contained in a volume published in 1996 (Draşovean et al. 1996). The first chapters provide a description of the location, excavation trenches (S) into which the site has been subdivided, pits (G) and habitation structures (L). The excavations covered an area of ca 700 m^2 (Draşovean 1996, 4 and Fig. 3).

According to the authors, the Neolithic Vinča layer was found just below the Tisza culture occupation ca. 25–45 cm beneath the topsoil (Draşovean 2009, 262). The Vinča horizon has yielded 13 circular or oval pits of different sizes and depths, some of which contained chert and obsidian artefacts, a few polished stone and bone tools.

The Vinča horizon has been attributed to the C2 aspect of the culture due to the typological characteristics of the pottery assemblage.

According to the most recent chronological time-scale (Whittle et al. 2016), the Vinča C period is dated to ca. 4850–4550 cal BC. Two radiocarbon dates have been obtained from Hodoni Pit 4, attributed to the Vinča aspect, from which come also 5 obsidian artefacts. The dates are 5880±60 BP (Deb-1963: 4904–4553 cal BC 2σ) and 5870±60 BP (Deb-2018: 4897–4551 cal BC 2σ) (Draşovean 2013: Table 1).

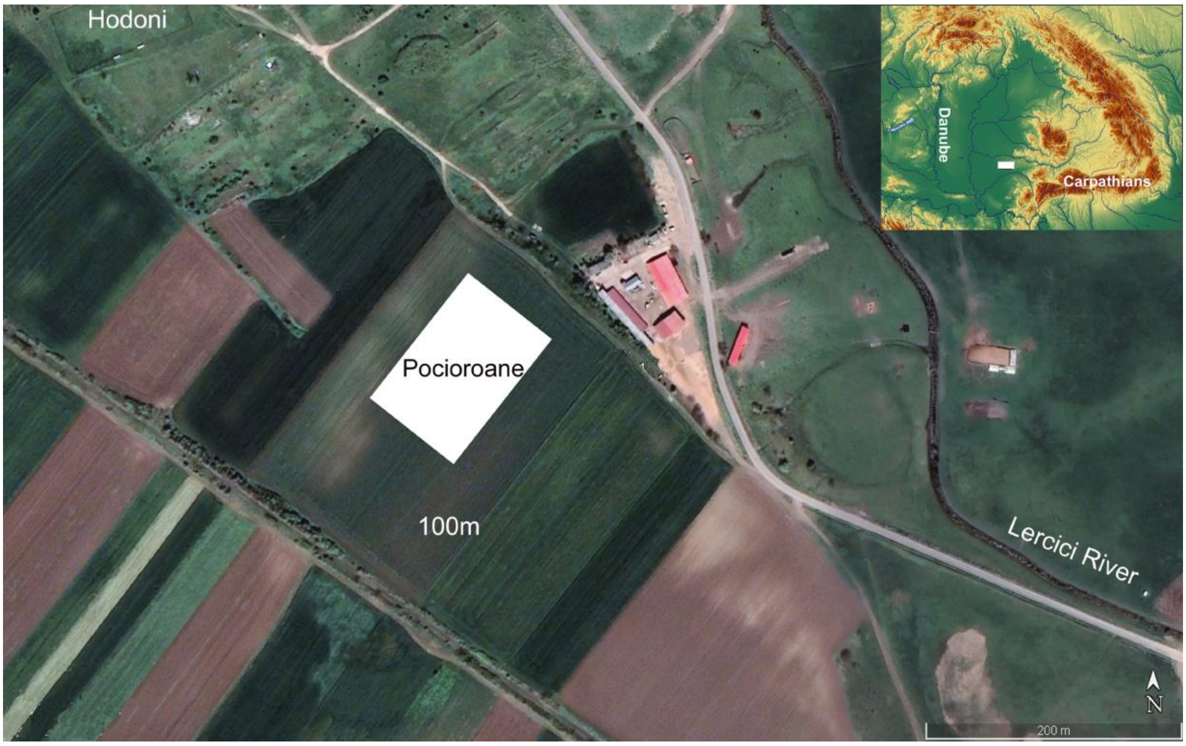

Fig. 1.: Hodoni "Pocioroane": Location of the archaeological site (drawing by P. Biagi).

1. ábra: Hodoni (Hodony) "Pocioroane": A régészeti lelőhely elhelyezkedése (grafika: P. Biagi).

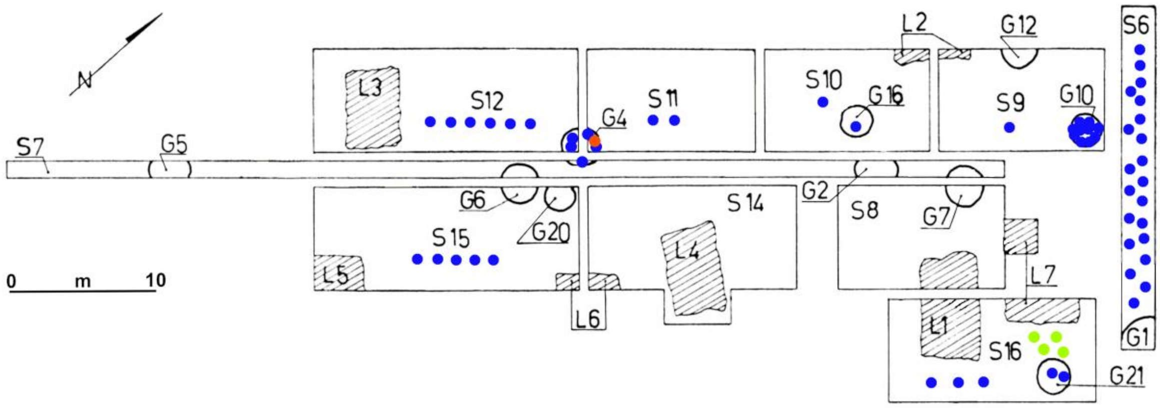

Fig. 2.: Hodoni "Pocioroane": Distribution of the excavation trenches and archaeological features (S-trenches, G-pits, L-houses) and of the Vinča (blue dots) and Tisza obsidian artefacts (green dots), with known location, uncovered during excavation. The red dot in Pit 4 shows the location of the radiocarbon dated samples (drawing by P. Biagi, after Draşovean 1996, Fig. 3).

2. ábra: Hodoni (Hodony) "Pocioroane": Az ásatási szelvények és a megfigyelt régészeti objektumok elhelyezkedése, az ismert kontextusú obszidián leletekkel (kék: Vinča, zöld: Tisza kultúra). A 4 sz. gödörben a C-14 vizsgálattal datált minták vörös ponttal jelölve (grafika: P. Biagi, Draşovean 1996, Fig. 3 nyomán).

The Tisza culture horizon consists of one layer with pit features and remains of rectangular habitation structures, three of which were in a good state of preservation (Draşovean 1996: Fig. 4). The Tisza complex yielded a very rich ceramic assemblage, a few chert and obsidian artefacts, a few polished stone tools, mainly axes and adzes, bone and antler implements. This horizon is undated. Unfortunately, the authors have not provided any information regarding the excavation methods, the way the archaeological material was recovered, or the presence/absence of archaeozoological and archaeobotanical remains.

Materials and methods

The obsidian assemblage

From the excavations carried out at Hodoni "Pocioroane" between 1985 and 1991 we have been given for study113 obsidian artefacts, 109 of which come from the Vinča and 4 from the overlying Tisza settlement. Of those attributed to the Vinča horizon 21 come from Trench 6, 1 from Trench 9, 9 from Pit 10 in Trench 9, 1 from Trench 10, 2 from Trench 11, 6 from Trench 12, 5 from Trench 15, 3 from Trench 16, 2 from Pit 21 in Trench 16. Moreover, 5 artefacts from Pit 4 in Trenches 11 and 12 and 1 piece from Pit 16 in Trench 10 have been published (Draşovean 1996: Plate I, n. 18–20, 22, 23; Plate III, n. 12) but not given for analysis. The location of 53 artefacts was not marked on the bags or the pieces. The obsidian artefacts presented in this paper come from the archaeological layers and a few pit fills. Twenty were recovered from 80–90 cm of depth (**Appendix – Table 1.**).

The obsidian assemblage from the Vinča site consists of 6 microcores made from small volcanic obsidian "bombs" (**Fig. 3/11, 12**; **Fig. 4/3, 10, 11, 14**), 1 bladelet core (**Fig. 4/13**), 10 decortication pieces (**Fig. 3/7**; **Fig. 4/1, 2**), 3 plunging bladelets (**Fig. 4/6, 9**) and 6 retouched tools among which are 2 end scrapers (**Fig. 3/2; Fig. 4/4**), 1 truncation (**Fig. 4/7**), 1 transverse scraper (**Fig. 4/12**), and 1 retouched bladelet (**Fig. 4/5**). The presence of cores, decortications and technical pieces indicate that the raw material was imported as corticated nodules and the artefacts were knapped within the site or somewhere close to it. The blanks were detached by indirect percussion. The number and percentage of bladelets with trapezoidal cross-section (37: 36.63%) is higher than those with triangular cross-section (19: 18.81%). The presence of tools with traces of wear shows that some artefacts have been utilised for woodworking (**Fig. 3/2, 8**). The diagrams of **Fig. 5.** have been developed by measuring 56 complete, unretouched artefacts. They show the microlithic character of the assemblage (microliths 40: 71.42%, normoliths 15: 26.89%, macroliths 1: 1.79%). The absence of hypermicroliths is most probably due to the excavation and recovery techniques which did not involve water sieving with a 2 mm mesh.

The Tisza site yielded only 4 artefacts, among which there are 1 decortication bladelet (**Fig. 3/7**) and 1 crested microflakelet (**Fig. 3/10**).

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Fig. 3.: Hodoni "Pocioroane": Obsidian artefacts from the Neolithic Vinča (n. 1–6, 11–13) and Tisza horizons (n. 7–10): HD-1 (n. 1), HD-2 (n. 2), HD-3 (n. 3), HD-4 (n. 4), HD-10 (n. 5), HD-6 (n. 6), HD-7 (n. 7), HD-5 (n. 8), HD-9 (n. 9), HD-8 (n. 10), HD-12 (n. 11), HD-11 (n. 12), HD-9 (n. 13). CW=cut wood, SW=scrape wood, H=hafting (photographs by E. Starnini).

3. ábra: Hodoni (Hodony) "Pocioroane": obszidián leletek az újkőkori Vinča és Tisza kultúra horizontjából. Használati nyomok: CW= vágás, fa anyagon, SW=kaparás, fa anyagon, H=nyelezés (fotó: E. Starnini).

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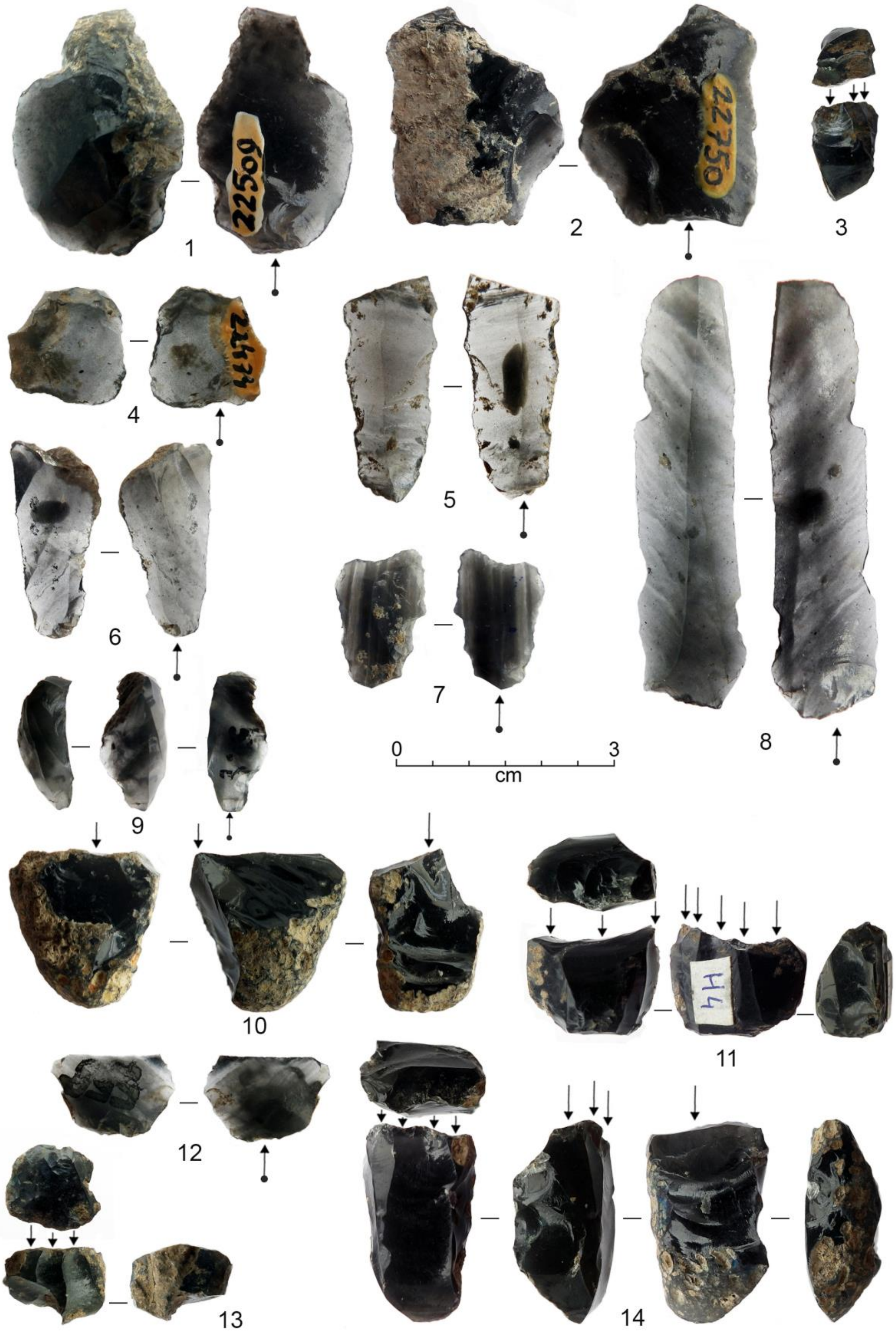

Fig. 4.: Hodoni “Pocioroane”: Obsidian artefacts from the Neolithic Vinča horizon: HD-17 (n. 1), HD-18 (n. 2), HD-14 (n. 3), HD-22 (n. 4), HD-96 (n. 5), HD-104 (n. 6), HD-111 (n. 7), HD-85 (n. 8), HD-84 (n. 9), HD-72 (n. 10), HD-71 (n. 11), HD-81 (n. 12), HD-15 (n. 13), HD-27 (n. 14) (photographs by E. Starnini).

4. ábra: Hodoni (Hodony) “Pocioroane”: obszidián leletek az újkőkori Vinča horizontból (fotó: E. Starnini).

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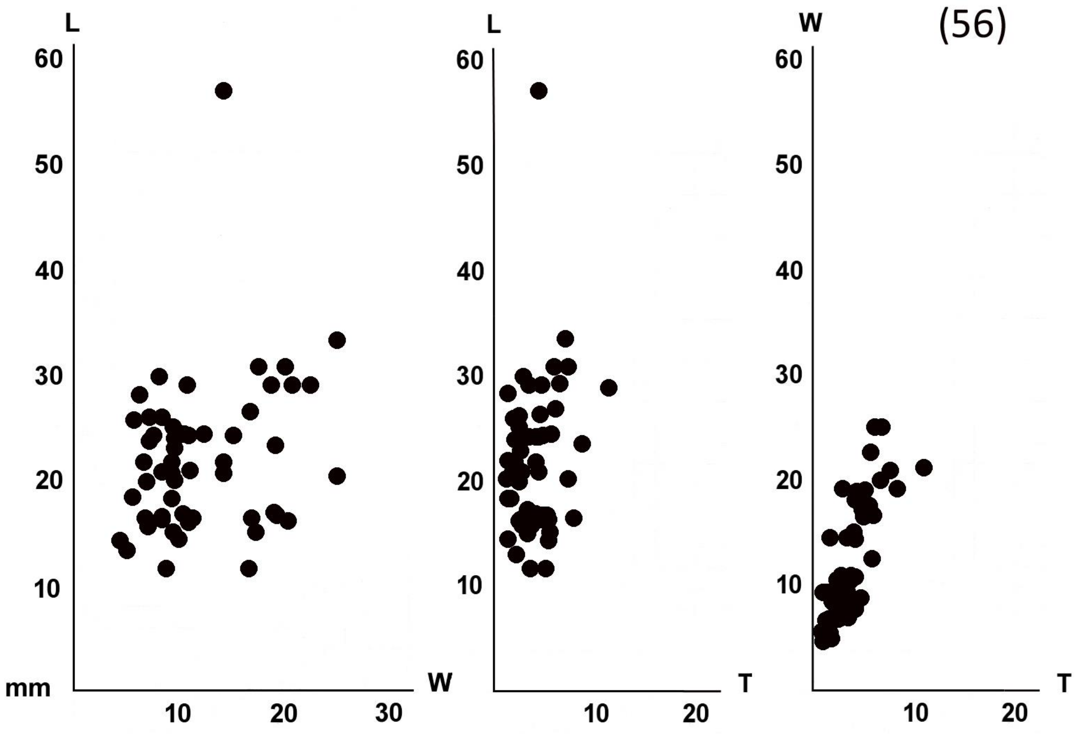

Fig. 5.: Hodoni "Pocioroane": Dimensional diagrams of the complete, unretouched artefacts from the Neolithic Vinča horizon (drawing by P. Biagi).

5. ábra: Hodoni (Hodony) "Pocioroane": az újkőkori Vinča horizontból származó teljes, retusálatlan eszközök méret diagramja (grafika: P. Biagi).

The characterisation methods

Two analytical methods were used at the IRAMAT/Centre Ernest-Babelon (CNRS, Orléans) for sourcing the obsidian artefacts (Astruc et al. 2021a, 2021b). The first is based on Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) and the second on a non-destructive X-ray fluorescence (XRF) approach. Out of the 113 obsidians from Hodoni, 79 artefacts were analysed: 66 by LA-ICP-MS in 2020 and 13 by XRF in 2010 (**Appendix – Tables 1–2.**).

Laser Ablation Inductively Coupled Plasma Mass Spectrometry analysis (LA-ICP-MS)

Laser ablation was carried out with a Resonetics RESOlution M50e ablation device. This is an excimer laser produced by argon fluoride at 193 nm wavelength and operated at 5 mJ and 10 Hz. A dual gas system with helium (0.65 l/min) released at the base of the chamber, and argon at the head of the chamber (1 l/min) carried the ablated material to the plasma torch of an Element XR mass spectrometer from Thermo Fisher Instruments (Gratuze 1999, Chataigner & Gratuze 2014, Palumbi et al. 2014). This mass spectrometer offers the advantage of being equipped with a three-stage detector: a dual mode (counting and analogue modes) secondary electron multiplier (SEM) with a linear dynamic range of over nine orders of magnitude, associated with a single Faraday collector which allows an increase of the linear dynamic range by an additional three orders of magnitude. This feature is particularly important for laser ablation analysis of lithic samples, as it is possible to analyse major, minor, and trace elements in a single run regardless of their concentrations and their isotopic abundance. The measurements are carried out in peak jumping acquisition mode, taking four points per peak for counting and analogue detection modes, and ten points per peak for Faraday detection. Automatic detection mode is used for most of the elements; only sodium, silicon, aluminium, and potassium are systematically detected with the Faraday detector. Silicon is measured on the 28 isotope and is used as an internal standard. A total of 38 elements were recorded. As most of the encountered isobaric interferences could be resolved by working on non-interfered isotopes all the measurements are carried out in low-resolution mode.

Ablation time was set to 45 seconds: 20 s pre-ablation, so that potential surface contamination could be removed, and 25 s collection time. Spot sizes were set to 100 µm. Blanks were run every 15 to 20 samples. From one to two different areas were randomly analysed per sample to check for heterogeneity but, as the relative standard deviation between ablation spots in obsidian are usually below 5% for most of the elements, only one area was sampled for the majority of the artefacts. However, if during analysis element spikes due to the presence of inclusions were observed, a second ablation was carried out. With our analytical parameters the scanning time necessary to measure the 38 selected isotopes is about 2.5 seconds that is approximately 25 seconds per sample if we take into account the delay between each scan.

Calibration was done by using three reference standards glass materials: NIST610, Corning glass B and D, which were run periodically every 15 to 20 samples to correct for instrumental drift. ^{28}Si is used as an internal standard to normalise the measured signal for each element and the final percentage composition is calculated from the response coefficient (k) defined from the reference material (Gratuze 1999).

X-Ray Fluorescence analysis (XRF)

A qualitative X-ray fluorescence (XRF) approach was used for the 13 artefacts analysed in 2010. The instrument used was the Bruker ARTAX portable µ-XRF spectrometer. X-rays were generated with a tungsten tube operating at 45 kV and 0.8 mA. Analytical parameters were as follows: acquisition time of 1200 s, no beam filter, beam collimator diameter 1.5 mm, and energy domain for elemental analysis 0–50 keV. The net signals measured for eleven minor and trace elements present in obsidian: K, Ca, Ti, Mn, Fe, Rb, Sr, Y, Zr, Nb and Ba were systematically recorded.

Geological samples, from sources located in Italy, Hungary, Slovakia and Greece, and archaeological samples were analysed conjointly. The net signals measured for each element were plotted using simple binary diagrams after normalization by the Lα tungsten X-ray. Source attribution was made by comparing directly the net normalised X-ray fluorescence signals of the artefacts with those of geological obsidian samples without needing to determine the real composition of the artefacts. It is however possible to obtain absolute concentration by using classical linear regression. For each element the linear regression coefficients are calculated using the net measured signal on different obsidian reference samples analysed with both methods and their known concentration values.

However, it should be remembered that the results obtained with the XRF technique are very sensitive to surface conditions (alteration, encrustations, roughness, irregularities) as well as the thickness of the artefact (the minimum thickness to have reliable measurements is about 3 mm).

The XRF data (normalized raw counts) allow the separation of the objects into different groups. According to the results obtained on geological samples with our analytical protocol, it was observed that some sources can be directly identified, without any doubt, by using XRF measurements while others show systematic overlap, which may prevent their secure identification. This method allows however a good discrimination of all the Mediterranean (Lipari, Sardinia, Palmarola, Pantelleria, Melos and Giali) and Carpathian (1, 2E and 2T) sources.

Only the results obtained using LA-ICP-MS are presented in **Appendix – Table 2.**

Results

The obsidian outcrops nearest to Hodoni, located less than 300 km as the crow flies, are those of the different Carpathian obsidian deposits (Biró 2006, Kohút et al. 2021) referenced as C1 (environs of Viničky, Mala Bara, Cejkov and/or Kašov in south-eastern Slovakia), C2E an C2T (near Mád and Tolcsva in the southern and central ranges of the Tokaj Mountains in north-eastern Hungary) and C3 (near Rokosovo in western Ukraine). The other Mediterranean obsidian sources (Palmarola, Lipari, Sardinia, Melos, Antiparos, Giali or Sakaeli-Orta) are located between 850 and 1150 km from Hodoni.

For the 13 artefacts analysed using XRF, direct comparison between the signal measured for the artefacts and that measured on the obsidian geological samples shows that all the artefacts match the composition of the C1 Carpathian obsidian source (**Fig. 6.**).

For the LA-ICP-MS data (**Appendix – Table 2.**), we use the discrimination factors log(Sr/Nb) and log(Zr/Nb) vs log(Cs/Nb) proposed by Orange (Orange et al. 2016) for Mediterranean and Carpathian obsidian sources, applied to the Carpathian 3 source by M. Kohút (Kohút et al. 2021). According to these factors (**Fig. 7.**), the remaining 66 obsidian artefacts from Hodoni are also from the Slovakian sources referenced as Carpathian 1.

According to the literature Carpathian obsidian C1, from the Zemplin Hills sources in eastern Slovakia, was a better-quality material, both in terms of block size and knapping properties. It usually predominated among the lithic obsidian assemblages and was more widely distributed than the Carpathian obsidian C2 from the Tokaj Mountain sources in north-eastern Hungary (Milić 2016).

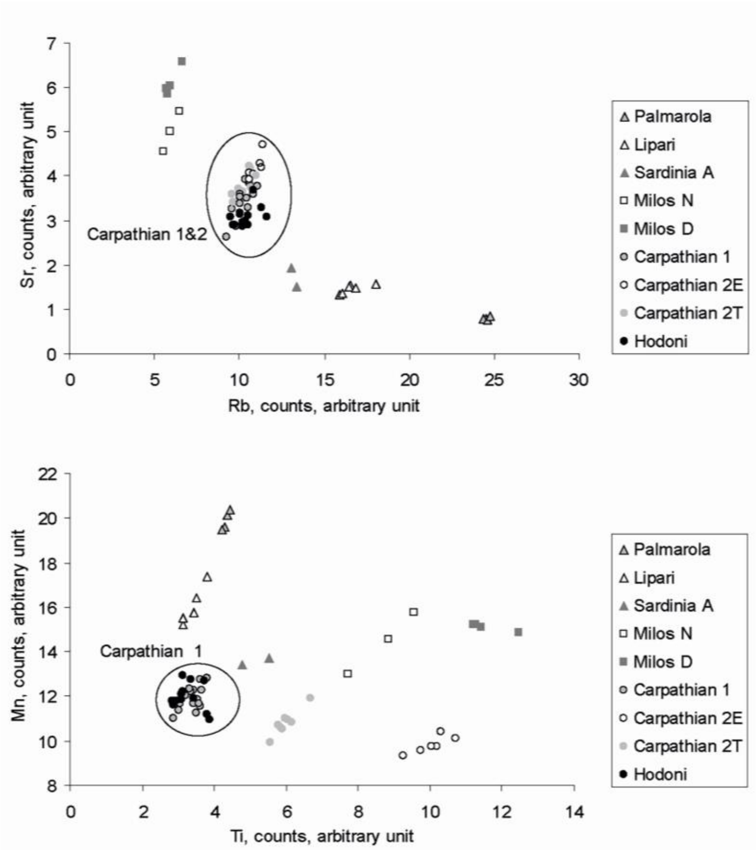

Fig. 6.: Hodoni "Pocioroane": Distribution of the obsidian artefacts analysed using XRF according to their rubidium (Rb) and strontium (Sr) (top) and titanium (Ti) and manganese (Mn) XRF signal intensity (counts number, arbitrary unit). Comparison with the XRF signal measured on geological obsidian originating from Lipari, Palmarola, Sardinia (A), Melos (N & D), and Carpathian 1, 2E & 2T outcrops (drawing by B. Gratuze).

6. ábra: Hodoni (Hodony) "Pocioroane" lelőhelyről vizsgált obszidián eszközök XRF vizsgálattal mért elemeloszlása (Rb, Sr, Ti és Mn) összehasonlítva a következő geológiai lelőhelyről származó mintákkal: Lipari, Palmarola, Szardínia (A), Mílosz (N & D) és Kárpáti 1, 2E & 2T (grafika: B. Gratuze).

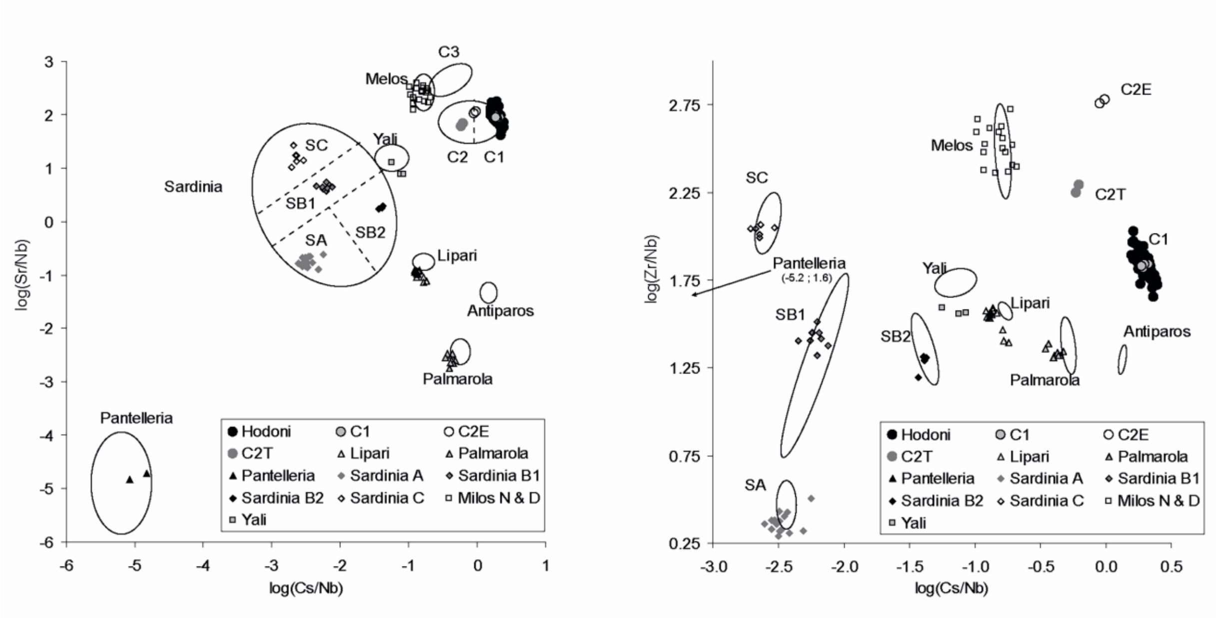

Fig. 7.: Hodoni "Pocioroane": Distribution of the obsidian artefacts analysed using LA-ICP-MS according to their log(Sr/Nb) vs. log(Cs/Nb) (on the left) and log(Zr/Nb) vs. log(Cs/Nb) (on the right). Adapted from Orange et al. (2016) and Kohút et al. (2021). Comparison with the same ratios measured by LA-ICP-MS at the Orléans facilities, on geological obsidian originating from Lipari, Palmarola, Pantelleria, Sardinia (A, B1, B2 & C), Melos (N & D), Yali and Carpathian 1 & 2 outcrops (drawing by B. Gratuze).

7. ábra: Hodoni (Hodony) "Pocioroane" lelőhelyről vizsgált obszidián eszközök LA-ICP-MS vizsgálattal mért elemeloszlása, bal oldalon log(Sr/Nb) vs. log(Cs/Nb) érték, jobb oldalon log(Zr/Nb) vs. log(Cs/Nb) érték szerint. Orange et al. (2016) és Kohút et al. (2021) adatainak figyelembevételével. Az Orleans-i műszerközpont mérései a következő geológiai lelőhelyekre terjedtek ki: Lipari, Palmarola, Pantelleria, Szardínia (A, B1, B2 & C), Mílosz (N & D), Yali és Kárpáti 1 és 2 nyersanyagforrások (grafika: B. Gratuze).

Discussion and conclusions

The study of the obsidians from the Neolithic Vinča site of Hodoni "Pocioroane" has shown that the raw material employed for making artefacts was carried to the site as nodules, more precisely small corticated volcanic "bombs", and that the manufacture processes took place within or very close to the settlement. Most cores are exhausted, which means that they were exploited even to detach very small blanks. This fact emphasises the importance of obsidian, which was imported from a long distance. Although the assemblage examined is rather small, all stages of the operational chain are represented. This is shown, apart from the exhausted microcores, by the occurrence of technical pieces, among which are decortications, core maintenance products among which are plunging blades and finished artefacts, mainly bladelets, which were later retouched into tools. The characteristics of the platforms and percussion bulbs of the artefacts show that they were obtained by indirect percussion. Though the finished implements are few, two were used for woodworking. This indicates that obsidian was employed for everyday activities.

At another Romanian site, the cave of Cheile Turzii in Transylvania, where all the sediments of the 2003 and 2004 seasons were water-sieved at 1 mm, dozens of shatters were recovered. They helped to interpret the activities carried out at the site, and the role played by obsidian, and to estimate the degree of post-depositional disturbance (Biagi & Voytek 2006). The soil screening techniques employed at Hodoni are not described in the excavation report (Draşovean 1996). Tiny pieces (shatters and debitage microlithic debris) are missing from the Hodoni analysed sample and their occurrence is never mentioned from all of the Romanian Neolithic sites so far analysed (Biagi et al. 2007a, 2007b).

Despite the number of Romanian Neolithic sites from which obsidian has been characterised and analysed (Boroneanţ et al. 2018, 2019), the data at present available from Vinča culture and other Middle Neolithic contexts are few (Glasswork et al. 2015; Boroneanţ et al. 2018). In particular, the detailed study of the Miercurea Sibiului/Szerdahely (Transylvania) lithic assemblages has shown that changes took place in raw material procurement and tool manufacture between the Early (Criş) and Middle (Vinča) Neolithic and Chalcolithic periods, especially as regards the non-obsidian material (Biagi 2015, 257). However, Carpathian 1 obsidian, in the form of volcanic "bombs" (Nandris 1975) has been always preferred throughout all these periods, most probably because of its availability and better knapping qualities, though its circulation peak seems to have been reached during the Middle Neolithic (Sherratt 1982).

Hodoni "Pocioroane" is one of the very few Balkan sites from which a reliable number of obsidian artefacts have been retrieved and systematically analysed and archaeometrically sourced. Though only a few comparisons are available, we can extend our observations to Gorzsa, a Hungarian site located in the floodplain of the Tisza River, where excavations have been carried out between 1978 and 1996 and 846 obsidian artefacts have been recovered (Starnini et al. 2007, Bonsall et al. in press). Gorzsa is a very important and well-excavated Late Neolithic Tisza culture tell which is more or less contemporaneous with Hodoni (Horvát 2005). Also, at Gorzsa most obsidian artefacts have been characterised as coming from the C1 source. Moreover, the artefacts from this site show all the technological reduction sequences starting from the raw material blocks, and the employment of the indirect percussion technique for the production of blanks (Bonsall et al. in press).

The new data presented here, confirm once more how important is the study of obsidian in the general context of the archaeology of the Balkans and how it can contribute to the interpretation of the economy of the Neolithic sites in the region.

Contribution of authors

Elisabetta Starnini Writing – Review & Editing, Supervision. **Paolo Biagi** Resources, Conceptualization, Writing – Original draft. **Bernard Gratuze** Writing – Original draft, Formal analysis, Investigation.

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References

ASTRUC, L., GRATUZE, B., GUILBEAU, D., BARGE, O. & CHATAIGNER, C. (2021a): Procurement, least-cost path analysis and technological studies on the obsidian assemblages from the Neolithic to the Early Bronze Age at Mentesh Tepe (Middle Kura Valley, Azerbaijan). *Ancient Near Eastern Studies* **58** 227–286. https://doi.org/10.2143/ANES.58.0.3290207

ASTRUC, L., GRATUZE, B., GUILBEAU, D., BARGE, O. & CHATAIGNER, C. (2021b): Technical report. Procurement, least-cost path analysis and technological studies on the obsidian assemblages from the Neolithic to the Early Bronze Age at Mentesh Tepe (Middle Kura Valley, Azerbaijan). *Ancient Near Eastern Studies*. [Technical Report] IRAMAT - Centre Ernest Babelon; CNRS. 2021. ⟨hal-03319307⟩

BIAGI, P. (2015): The Middle Neolithic and Chalcolithic Chipped Stone Assemblages of Transylvania: Their Exploitation, Manufacture and Trans-Carpathian Trade. In: HANSEN, S., RACZKY, P., ANDERS, A. & REINGRUBER, A., eds., *Neolithic and Copper Age between the Carpathians and the Aegean Sea*. Bonn: R. Habelt, 243–262.

BIAGI, P., DE FRANCESCO, A.M. & BOCCI, M. (2007a): New data on the archaeological obsidian from the Middle-Late Neolithic and Chalcolithic sites of the Banat and Transylvania (Romania). In: KOZŁOWSKI, J.K. & RACZKY, P., eds., *The Lengyel, Polgár and related cultures in the Middle/Late Neolithic in Central Europe*. Kraków, 310–326.

BIAGI, P., GRATUZE, B. & BOUCETTA, S. (2007b): New data on the archaeological obsidians from the Banat and Transylvania (Romania). In: SPATARO, M. & BIAGI, P. eds., A Short Walk through the Balkans: The first Farmers of the Carpathian Basin and Adjacent Regions. *Società per la Preistoria e Protostoria della Regione Friuli-Venezia Giulia*, Quaderno **12** 129–148. Trieste.

BIAGI, P. & VOYTEK, B.A. (2006): Excavations at Peştera Ungurească (Caprelor) (CheileTurzii, Petreşti de Jos, Transylvania) 2003-2004: A preliminary report on the chipped stone assemblages from the Chalcolithic Toarte Pastilate (Bodrogkeresztúr) layers. *Analele Banatului* **XIV/1** 177–202.

BIRÓ, K.T. (2006): Carpathian obsidians: myth and reality. *Proceedings of the 34th International Symposium on Archaeometry*, 3-7 May 2004, C.S.I.C., Zaragoza, 267–277.

BONSALL, C., STARNINI, E., VOYTEK, B. & HORVATH, F. (in press): Obsidian artifacts from tell Hódmezővásárheli-Gorzsa (SE Hungary): results of a provenance study using pXRF. In: JOHNSON, L.M.R., FREUND, K.P. & TRIPCEVICH, N., eds., *Selected Research Papers from the 20-21 International Obsidian Conference: Global Archaeological and Geological Studies of Volcanic Glass.* Archaeological Research Facility Monographs. University of California, Berkeley.

BORONEANŢ, A., MIREA, P., ILIE, A. & BONSALL, C. (2019): Sourcing obsidian artefacts from Early Neolithic sites in south-central Romania. *Materiale şi cercetări arheologice* **15** 27–40.

BORONEANŢ, A., VIRAG, C., ASTALOS, C. & BONSALL, C. (2018): Sourcing obsidian from prehistoric sites in northwest Romania. *Materiale şi cercetări arheologice* **14** 13–23.

CHATAIGNER, C. & GRATUZE, B. (2014): New data on the exploitation of obsidian in the southern Caucasus (Armenia, Georgia) and eastern Turkey, Part 1: Source Characterization. *Archaeometry* **56/1** 25–47.
https://doi.org/10.1016/j.ara.2022.100397

DRAŞOVEAN, F. (1996): Locurile Neolitice de la Hodoni. In: DRAŞOVEAN, F., ŢEICU, D. & MUNTEAN, M., eds., *Hodoni locuirile neolitice târzii şi necropola medievală timpurie.* Muzeul de Istorie al Judeţului Caraş-Severin, Reşiţa, 53–138.

DRAŞOVEAN, F. (2009): Cultural relationships in the Late Neolithic of the Banat. In: DRAŞOVEAN, F., CIOBOTARU, D. & MADDISON, M., eds., *Ten years after: The Neolithic of the Balkans, as uncovered by the last decade of research.* Proceedings of the Conference held at the Museum of Banat on November 9th-10th, 2007. *Bibliotheca Historica et Archaeologica Banatica* **XLIX** 259–274.

DRAŞOVEAN, F. (2013): In regards to certain Late Neolithic – Early Eneolithic synchronism from Banat and Transylvania. A Bayesan approach to published absolute dates. *Studii de Preistorie* **10** 13–48.

DRAŞOVEAN, F., ŢEICU, D. & MUNTEAN, M. (eds.) (1996): *Hodoni locuirile neolitice târzii şi necropola medievală timpurie.* Muzeul de Istorie al Judeţului Caraş-Severin, Reşiţa, 139 p.

GLASCOCK, M.D., BARKER, A.W. & DRAŞOVEAN, F. (2015): Sourcing obsidian artifacts from archaeological sites in Banat (Southwest Romania) by X-Ray Fluorescence. *Analele Banatului* **XXIII** 45–50.

GRATUZE, B. (1999): Obsidian characterisation by laser ablation ICP-MS and its application to the prehistoric trade in the Mediterranean and the Near East: The sources and distribution of obsidian within the Aegean and Anatolia. *Journal of Archaeological Science* **26** 869–881.
http://dx.doi.org/10.1006/jasc.1999.0459

HORVÁT, F. (2005): Gorzsa. Előzetes eredmények az újkőkori tell 1978 és 1996 közötti feltárásából. In: BENDE, L. & LŐRINCZY, G., eds., *Hétköznapok Vénuszai.* Móra Ferenc Múzeum, Szeged, 51–83.

KOHÚT, M., WESTGATE, J.A., PEARCE, N.J.G. & BAČO, P. (2021): The Carpathian obsidians: Contribution to their FT dating and provenance (Zemplín, Slovakia). *Journal of Archaeological Science: Reports* **37** 102861. https://doi.org/10.1016/j.jasrep.2021.102861

LAPLACE, G. (1964): Essay de typologie systématique. *Annali dell'Università di Ferrara* **15** 1–85.

MILIĆ, M. (2016): Obsidian exchange and societies in the Balkans and the Aegean from the late 7th to 5th millennia BC. *Thesis presented for PhD dissertation, UCL (unpublished)*, 385 p.

MOGA, M. & RADU, O. (1977): O contribuţie la cunoaşterea culturii Tisa în lumina descoperirilor de la Hodoni (1959-1960). *Studii şi Comunicări Muzeul Judeţean de Etnografie şi Istorie Locala Caransebeş* **II** 231–239.

MUSCALU, B. (2016): Noi puncte arheologice identificate raza localităţii Hodoni (Com. Satchinez, Jud. Timiş). *Patrimonium Banaticum* **VI** 77–89.

NANDRIS, J. (1975): A Re-consideration of the South-East European Sources of Archaeological Obsidian. *Bulletin of the Institute of Archaeology,* London University **12** 71–94.

ORANGE, M., Le BOURDONNEC, F.X., SCHEFFERS, A. & JOANNES-BOYAU, R. (2016): Sourcing obsidian: a new optimized LA-ICP-MS protocol. *STAR: Science & Technology of Archaeological Research* **2/2** 192–202. https://doi.org/10.1080/20548923.2016.1236516

PALUMBI, G., GRATUZE, B., HARUTYUNYAN, A. & CHATAIGNER, C. (2014): Obsidian-tempered pottery in the Southern Caucasus: a new approach to obsidian as a ceramic-temper. *Journal of Archaeological Science* **44** 43–54. http://dx.doi.org/10.1016/j.jas.2014.01.017

ROGOZEA, O.-C. (2015): Noi aşezări neolitice şi eneolitice descoperite în judeţul Timiş. *Sargetia. Acta Musei Devensis* (S.N.) **VI** 123–143.

SHERRATT, A. (1982): Mobile resources: settlement and exchange in early agricultural Europe. In: RENFREW, C. & SHENNAN, S., eds., *Ranking, resource and exchange. Aspects of the archaeology of Early European society*. Cambridge University Press, Cambridge, 13–26.

STARNINI, E., VOYTEK, B. & HORVÁTH, F. (2007): Preliminary Results of the Multidisciplinary Study of the Chipped Stone Assemblage from the Tisza Culture Site of Tell Gorzsa (Hungary). In: KOZŁOWSKI, J. & RACZKY, P., eds., *The Lengyel, Polgár and Related Cultures in the Middle/Late Neolithic in Central Europe.* The Polish Academy of Arts and Sciences, Kraków, 269–287.

WHITTLE, A., BAYLISS, A., BARCLAY, A., GAYDARSKA, B., BÁNFFY, E., BORIĆ, D., DRAŞOVEAN, F., JAKUCS, J., MARIĆ, M., ORTON, D., PANTOVIĆ, I., SCHIER, W., TASIĆ, N., LINDEN, M.V. (2016): A Vinča potscape: formal chronological models for the use and development of Vinča ceramics in south-east Europe. *Documenta Praehistorica* **XLIII** 1–60. https://doi.org/10.4312/dp.43.1

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