Preliminary investigations on the chipped stone industry of the Copper Age settlement of Malnaş Băi (Málnásfürdő)-Füvenyestető (Covasna County, Romania)

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Abstract:

The chipped stone collection unearthed during the 2014-2016 archaeological excavations from the Copper Age settlement at Malnaş Băi was analysed from a multidisciplinary perspective. The aims were to differentiate between the processing technologies of the local rocks and of the long-distance raw materials and to assess the technological traditions that characterise their production. The elemental composition of a selected sample set of the artefacts determined using Prompt Gamma Activation analysis (PGAA) verified the presence of both local and long-distance raw materials. In addition, the PGAA results corroborated that differentiation in both categories requires further field work and comparison. Attribute analysis, typology and use-wear investigations were employed for identifying the main features of the lithic industry in each class of raw materials. These results showed that it might be possible to differentiate between two technological traditions. One of them is represented by the on-site production of small blades made of obsidian, in the Tiszapolgár and Bodrogkeresztúr specific technology. As the PGAA proved, this raw material is a long-distance commodity, but the technological structure of the assemblage suggests its local processing. The other tradition, visible in the flint (also a long-distance material, though not knapped on-site) and local raw materials, is more characteristic for the Copper Age from the east of Carpathian Mountains, meaning the production of medium-long blades through the punch technique. As for the retouching technology and the use of implements, no differentiation based on raw materials could be observed. These preliminary investigations on the chipped stone artefacts from Malnaş Băi allowed the identification of long-distance transfer of lithic materials and technologies and to address their role in the large networks that existed during the Copper Age.

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1. Introduction and background

The archaeological excavations carried out during the 20th century (1976-1989) at the prehistoric site of Malnaş Băi (hun. *Málnásfürdő*)-*Füvenyestető* have proven the existence of a tell-like, multi-layered and fortified settlement of the Copper Age Ariuşd (*Erősd*) group from the second half of the 4th Millennium BC. The new phase of the archaeological research of the site, which started in 2014, has enriched our knowledge with new data and placed it in a broader cultural and archaeological context. The excavations and simultaneous geophysical research project the image of a rather complex settlement from a spatial and probably functional point of view, which, based on our current knowledge, so far has only rare parallels in the distribution area of the Ariuşd-Cucuteni-Trypillia cultural complex. An examination of the wider environment of the site also revealed that this settlement, which consists of several separate spatial units, may have formed the central core of a larger settlement network in the surrounding area (see László & Sztáncsuj 2020).

The outstanding role of the site seems to be confirmed by the ongoing analysis of the rich finds brought to light during the excavations. One particularly interesting part of the archaeological material is the chipped stone assemblage discovered between 2014-2016 (Vornicu & Sztáncsuj 2019). Although not represented in significant numbers, the composition of the lithic material, its circumstances of discovery, and distribution by raw material types provide valuable data for the cultural and economic relations of the former community. Considering the variety of the raw materials, one of our aims was to determine the technological processes behind the manufacture of the tools from local and from long-distance raw materials, through analysis of the debitage and retouching techniques. Earlier works on the Late Neolithic or Early Copper Age from the sub-Carpathian area showed distinct reduction sequences for flint (long-distance material) and siliceous sandstone (local raw material) (at Traian - Dealul Viei: Ţurcanu 2009: 161-177). (Rock terms, such as “flint” are based on those defined by the British Geological Survey (see Hallsworth & Knox 1999).) Related to that, another aim was to compare the features of this collection with those of the lithic industries from other Ariuşd and Cucuteni sites (Biró & Sztáncsuj 2006; Bodi 2010; Boghian 1995; 1996; Dumitrescu 1954; Florescu 1999; Lazarovici & Babeş 2015; Mantu *et al*. 1995; Marinescu-Bîlcu 1981; 2000; Păunescu 1970; Ţurcanu 2012; Ursulescu & Ignătescu 2003; Vornicu 2014; 2015; 2020) in order to understand if the technology of the Malnaş Băi community fits its chrono-cultural context, or if different technological traditions can be ascertained. This in the context of the fact that, at the time, large networks were circulating commodities between various cultural areas in Central and South-Eastern Europe, the Cucuteni-Trypillia communities being an integrating part of such networks (for comprehensive studies on the subject see Boghian & Enea 2013; Cotoi 2019; Mantu 1998; Popovici 2001).

2. The site and the archaeological research

The prehistoric settlement of Malnaş Băi-*Füvenyestető* (rou. *Platoul nisipos;* eng. Sandy heights) is located in Southeastern Transylvania, in the valley of the Olt River (Figure 1). The narrow north-south valley connects the intra-Carpathian basins of Ciuc- and Braşov Depressions, which in the Copper Age formed the two centres of the settlement area of the Ariuşd group (Sztáncsuj 2015: 108-109). This region, located at the intersection of two mountainous regions of different origin, the volcanic chain of the Harghita Mountains, and the Bodoc and Baraolt mountains belonging to the Carpathian flysch, is characterised by a wealth of natural resources (timber, volcanic rocks, salty water springs, mineral waters, etc.), some of which were probably exploited in the prehistoric period (Bányai 1957: 19-22; Buzea & Deák 2008: 66-75). The region is still dominated by deciduous forests in the mountain zone and willow and alder groves in the Olt Valley.

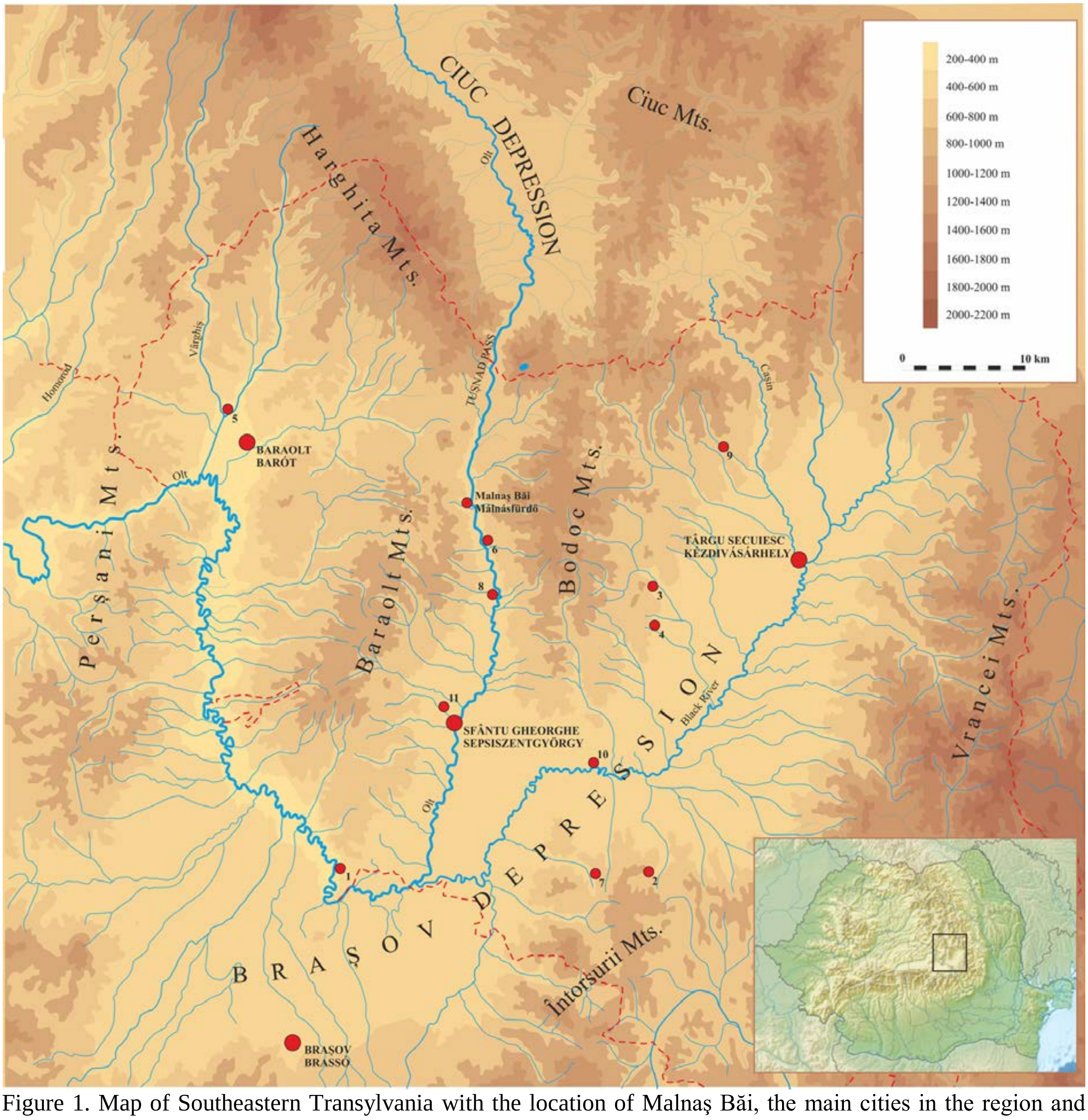

Figure 1. Map of Southeastern Transylvania with the location of Malnaş Băi, the main cities in the region and the other archaeological sites of the Ariuşd group with PGAA investigations. 1: Ariuşd (Erősd)-Tyiszk-hegy; 2: Boroşneu Mic (Kisborosnyó)-Borzvára; 3: Cernatul de Jos (Alsócsernáton)-Aranyos-hegy; 4: Dalnic (Dálnok)-Tanorok; 5: Doboşeni (Székelyszáldobos)-Borvízoldal; 6: Malnaş (Málnás)-Csereoldal; 7: Măgheruş (Sepsimagyarós)-Losonczi; 8: Olteni (Oltszem)-Vármege; 9: Petriceni (Kézdikővár)-Polyvár; 10: Reci (Réty)-Törökrétje; 11: Sfântu Gheorghe (Sepsiszentgyörgy)-Gémvára. Map by: L. L. Méder.

The relatively small site, with an area of only 0.6 ha, lies on the right side of the valley, on a high terrace bordered by the Olt River and the Somos Creek, at an altitude of 586 metres above sea level. The terrace is surrounded on three sides by natural slopes and is protected on its north side by two artificial ditches, which separate the two main areas of the settlement. On the western edge of the site a third area is bounded by a shallower ditch. These areas were marked during the excavations as zones A, B and C (see Figures 2 and 3). While the traces of the outer, northern ditch are visible only in a small area, on the eastern edge of the terrace, the inner defensive ditch, separating zones A and B, has survived to this day in an imposing size.

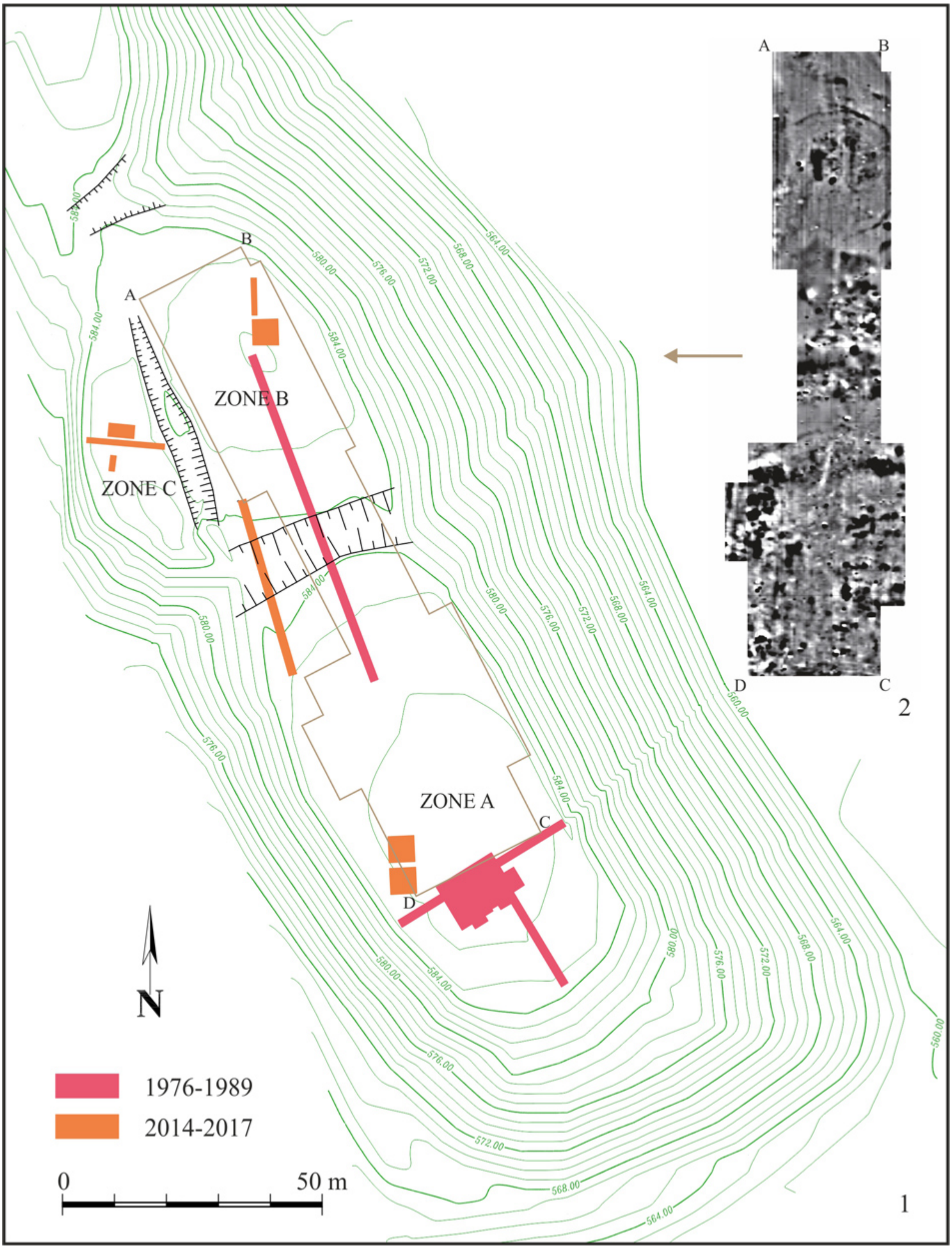

Figure 2. Malnaş Băi-Füvenyestető. Site map with the three main zones (A, B, C) of the Early Copper Age settlement (1) and the results of the geophysical investigations (2). After László & Sztáncsuj 2020.

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Figure 3. Aerial view of the Malnaş Băi site with the indication of the three main habitation zones (photo by Felix-Adrian Tencariu and Andrei Asăndulesei).

The site was discovered by Ferenc László, the custodian of the Szekler National Museum in Sfântu Gheorghe. László carried out several field surveys and small-scale test excavations in 1909-1910 (László 1911: 177). The exact location of these can unfortunately no longer be determined. Larger scale, systematic excavations took place between 1976 and 1989, led by prof. Attila László (Alexandru Ioan Cuza University, Iaşi). During these investigations a portion of approx. 120 square metres was excavated in the southern part of the site, where traces of houses and fireplaces from four habitation levels of the Copper Age settlement were discovered. The area of the inner defensive ditch was also investigated in 1976. The results of the research were published in several articles, dedicated to the fortification system (László 1993), the unearthed houses and rituals related to their construction (László 1988; 2000; 2010; 2013), as well as to some parts of the discovered material (László 2014; 2015). Radiocarbon dating of some of the habitation levels was also performed (László 2009).

New research from 2014 to 2017, conducted by Sándor-József Sztáncsuj and Sándor Berecki, focused on all three areas, and was preceded by magnetometer survey of most parts of the site (Popa *et al.* 2015). In 2014, the interior defensive ditch was sectioned (Berecki & Sztáncsuj 2015). In the following years, in the southern part of the settlement (zone A), the traces of a burnt house, belonging to the third habitation level were investigated (Figure 4.1). The most interesting results were obtained in zone B, in 2015. In this area, magnetometer surveys and excavations revealed the existence of a circular enclosure, consisting of two shallow concentric ditches and the remains of a burnt house inside (Figure 4.2-3) (Berecki *et al.* 2016). At the same time, research from 2015-2016 also showed that the small plateau in area C was in turn used by Copper Age communities. Both the 1976-1989 excavations and newer research have revealed scattered traces of habitation from the Late Copper Age (Coţofeni culture), Early (Schneckenberg culture) and Middle Bronze Age (Wietenberg culture).

Figure 4. Malnaş Băi-Füvenyestető. 1: Aerial view of the remains of House 2015/2 during the excavation (photo by Felix-Adrian Tencariu and Andrei Asăndulesei); 2: The excavation trenches in zone B with the remains of the circular enclosure and the internal building; 3: Unearthed section of the inner circular ditch in zone B; 4: Excavation trench with the remains of the internal fortification between zones A and B.

Summarising the main results of the archaeological investigations, the Copper Age settlement sequence of the site, belonging to the Ariuşd group, includes four successive habitation levels (from bottom to top: I, II, IIIa and IIIb) in zone A, which formed the central core of the inhabited area. While in the first (I) and third (IIIa) levels only traces of outdoor stoves were found, levels II and IIIb revealed the remains of several surface dwellings: L1 and L2, uncovered between 1976 and 1989, and House 2015/2, investigated during the 2015-2017 excavations. The houses were built with different construction techniques. Houses L2 and 2015/2 were built on wooden posts, their plastered clay floor being adhered directly to the former, levelled ground surface, a construction technique also found in the case of other settlements of the Ariuşd group in Transylvania (see László 1914: 323-378, 402-414, figs. 78-79). In contrast, dwelling L1 from the uppermost habitation level (IIIb) was built on a clayed beam floor (*platform*), laid on the ground, typical of the Cucuteni and Trypillia cultures of Eastern Europe (László 2000: 246-249). Observations made during the investigation indicate that construction was associated with building rituals and foundation sacrifices, and the houses were probably destroyed by deliberate fires, as part of some other ritual acts (László 2000: 249; 2013).

According to the data provided by the geophysical prospecting, this interior area was densely inhabited, the dwellings being arranged in several rows, with a larger open area in its centre, interpreted as a community space. The interior area was delimited on its northern edge by a 6-8 m wide, approximately 2 m deep defensive ditch with a rampart (vallum) on both sides (László 1993: 43-47). On the northern side of the ditch, in zone B, a circular enclosure system delimited an area with a diameter of 25-28 m. The two narrow (60 and 120 cm), shallow (60-75 cm, respectively) ditches were located 4.5 m apart in the excavated area and were probably separated by a palisade. Unlike zone A, a single habitation level was found in this area, with traces of a larger, surface building built on wooden posts. Contrary to the interior ditch, this circular enclosure probably did not have a defensive character. In terms of its form and the cognitive meaning behind it, the entire structure relates to the circular enclosure systems of Neolithic and Copper Age cultures in Central Europe (László & Sztáncsuj 2020). However, we do not have exact knowledge on the dating of the fortification and the circular enclosure. During the excavations, it became evident that the Copper Age settlement also had a third area, artificially separated from the other parts of the settlement (area C). No traces of buildings were found in the small, secluded terrace segment, but based on the density of the findings, this area was also in use sometime in the life of the settlement. The whole site was protected by a second, external ditch on its northern periphery, where no research had been carried out so far.

Excavations in both 1976-1989 and recent years have provided significant amounts of archaeological finds, made up mostly of pottery but also of cult and ornamental objects (anthropomorphic and zoomorphic figurines, clay ornamental discs), copper objects (axe-adze, awls, wire, spiral ring), chipped and polished lithic artefacts and faunal remains (see László 2014; 2015).

Although the excavated material is still being processed, in general we can state that the Copper Age habitation levels of the site represent almost the entire period of the Ariuşd group. Pottery bears the marks of the early and the advanced phases of the cultural group, characterised by the presence of both basic categories of decorated ceramics (bichrome and trichrome painting). These phases are generally contemporaneous with the early stage of the Cucuteni culture (A1-4) in Moldavia. Radiocarbon data also seem to confirm this assumption. ^{14}C age determinations, made on charcoal and bone samples collected from the lowest habitation levels (I and II), indicate a time-span between 4576-4244 cal. BCE for the first and second period of the settlement (see László 2009: 208-215 and Tab. 1). Data on the upper habitation levels (IIIa and IIIb) extends the whole period of the settlement probably to the end of the 5th and the beginning of the 4th millennium BC. These data are partially contemporaneous with the Moldavian Cucuteni A-B phases. This hypothesis seems to be supported by the presence of some vessels and potsherds with shape and decoration specific to phases Cucuteni A-B (László & Sztáncsuj 2020: fig. 8.5, fig. 9.10).

3. Methodology

To understand the technology behind the production of lithic artefacts at Malnaş Băi, the chipped stone assemblage was approached from a multi-disciplinary perspective, applying macroscopic morpho-technological analysis of artefacts and geochemical investigations of raw materials. We intended to gain information on the *chaîne opératoire* (Leroi-Gourhan 1965; Lemonnier 1980: 8) specific for each raw material, incorporating information on the raw materials and their place of origin, debitage techniques, modification of the blanks and use of tools.

While the techno-typological and use-wear analysis were applied to 134 artefacts discovered during the 2014-2015 and only partially those from the 2016 excavation campaigns, the PGAA was applied to 37 artefacts coming from the 2014-2016 investigations. Several artefacts that were submitted to PGAA were not included in the analysis of the techno-typology of the chipped stone items from the Chalcolithic settlement at Malnaş Băi (those indicated in Table 1 as Málnásfürdő 5, 19, 26, 32).

The first step of the raw material classification was constituted by the macroscopic characterisation of the raw materials, in terms of grain, texture, impurities, lustre, translucence (see Crandell 2006). After that, 37 lithic implements, from different groups of raw materials, were selected for further analysis of the elemental composition.

In order to determine the raw materials of the 37 selected lithic implements through elemental composition (with emphasis on non-local originated raw materials), Prompt Gamma Activation Analysis (PGAA) have been applied on a $9.6\times10^{7}cm^{-2}s^{-1}$ intensity horizontal cold neutron beam of the Budapest Neutron Centre, Hungary. The Budapest PGAA facility is described by Szentmiklósi *et al*. (2010). During PGAA, a beam of cold neutrons irradiates a few cm^3 volume of the objects, and the characteristic gamma radiation is detected (Molnár *et al.* 1998). The intact objects of various sizes are typically irradiated for a period of 1 to 17 hours to obtain statistically reliable prompt-gamma spectra. The elements in the samples are identified according to their characteristic prompt-gamma lines. The quantitative elemental compositions are determined on the basis of our data library (Révay *et al*. 2001), using the k_0-method (Molnár *et al*. 1998; Révay 2009).

In principle, every chemical element can be detected with PGAA, but the detection limits vary within a wide range, primarily determined by the neutron absorption cross-sections of the atomic nuclei (Révay 2009). In case of various lithic materials, concentrations of the major, minor (Si, Ti, Al, Fe, Mn, Mg, Ca, Na, K and H, sometimes S and C), and some trace (B, Cl, Nd, Sm and Gd) elements can be determined and the results are used in archaeometric studies of chipped and polished stone tools, too (Kasztovszky *et al*. 2008; 2022; Szakmány & Kasztovszky 2004). Major and minor components are usually expressed as oxides, trace components in elemental forms. In this study, bivariate plots of the measured data have been applied, to reveal similarities and differences between the objects. Thanks to the relatively low intensity of the applied neutron beam, no macroscopic or microscopic alteration or remaining radioactivity can be observed on the studied objects.

Since no field survey for local raw materials was carried out in the region, the chipped tools from Malnaş Băi were compared to products of lithic industry from the surrounding 11 sites of the Ariuşd-Cucuteni-Trypillia culture. It was our aim to see whether the site fits into the wider archaeological context by finding similarities or differences in the geochemical composition of stone tool raw materials. The comparative data set contains more than 100 geochemical compositions (measured by the same PGAA facility) of objects coming from the South-Eastern Transylvanian sites (partly published in Sztáncsuj *et al*. 2015). These comparative data are presented in the Appendix. Most of them derived from multi-layered fortified settlements, located in the valley of the Olt and its principal tributary, Râul Negru, which have been investigated through systematic excavations (Ariuşd-Tyiszk-hegy (László 1914; Zaharia & Székely 1988), Boroşneu Mic-Borzvára). The other occurrences of the investigated samples (Cernat-Aranyos-hegy, Dalnic-Tanorok, Doboşeni-Borvízoldal, Malnaş-Csereoldal, Măgheruş-Losonczi, Petriceni-Polyvár, Reci-Törökrétje, Olteni-Vármege and Sfântu Gheorghe-Gémvára) were studied with smaller rescue-excavations or field surveys. The lithic industry of these settlements contained objects of similar raw materials (*e.g*. Prut and Volhynian flint, local rock types (silicified rhyolite, radiolarite, other unspecified flint, sandstone) and obsidian) to that of Malnaş Băi.

To understand the specificity of the lithic technology of the Copper Age community in Malnaş Băi, 134 artefacts were submitted to an attribute analysis (as described by Tostevin 2003). They were assigned in three main groups, sub-divided in several classes (see Table 2): cores (fragments and boulders with minimum modification included), debitage products (flakes and blades according to their place in the reduction chain) and 'debris & shatters'. The specimens that were intentionally retouched for creating tools of a certain morphology were considered for elaborating a typological list specific for this site (Table 3). To understand the way in which the prehistoric community from the site used the products resulted through stone debitage, use-wear analysis was performed. It was done by comparing the microscopic traces (edge removals, rounding, polish and striations: Keeley 1980; Vaughan 1985; van Gijn 1989) from the archaeological samples with those from the experimental database from the Institute of Archaeology in Iași. The microscope used for this approach is a ZEISS AxioScope A1 at magnifications of 5x, 10x and 20x; the microphotographs were taken with an Axiocam 105 color camera.

4. Macroscopic identification of raw materials

According to the methodology of macroscopic identification of raw materials, several types were distinguished that were classified in three main groups: obsidian, flints and other raw materials (most probably of local origins). This classification into groups is supported by observations on the small collection of raw material samples existing at the Institute of Archaeology in Iași.

4.1. Obsidian

Obsidian was categorised as a black rock, very fine-grained, medium shiny, highly translucent; and when seen in light, black spots and black bands are visible (Figure 5.1-2).

4.2. Flints

To the category of flints there were assigned the rocks of fine and very fine grains, medium shiny, medium translucent, with impurities. Four types of flint were recorded in the assemblage. The first type is black coloured, medium shiny, medium translucent, fine-grained, with impurities. This material is specific for the Cenomanian deposits of the Moldavian Platform that cropped out, during the Pleistocene, on the shores of the Prut and Dniester Rivers (Albu *et al*. 1959; Băcăuanu 1968; Bâgu & Mocanu 1984: 44-76; Crandell 2012; Ionesi 1988: 9-37; Macovei & Atanasiu 1934: 181; Muraru 1990; Văleanu 2015) (one *plein debitage* blade and a cortical flake). Another type is the brown coloured flint, translucent when seen in light, very fine-grained, semi-shiny and more problematic in the attribution of its origin, since this type of flint was recorded for both the Prut flint and Volhynian flint (Figure 6.4,6). The third category of flints is that of fine-grained, smoky black with white-greyish opaque stripes (represented by one specimen: Figure 6.5) specific for the deposits in the Podilia highlands (NW Ukraine) (Petruni 2004: 204). This type of flint is called in the archaeological literature as Volhynian flint. We have to mention that a fourth category of flint was recorded, but its characteristics are not related to its specific appearance but to the heat alteration to which was submitted, heat alteration unrelated to technological improvement. The Ariuşd-Cucuteni dwellings ended in huge fires that also affected the artefacts inside them. The flint artifacts that were subjected to such firing, with temperatures between 600-1000°C, become white in colour, opaque, lose weight, have cracks and exfoliations of their surfaces (for experimental work with heating the Prut flint at temperatures over 600°C see Cucoş & Muraru 1985: 607; Vornicu 2014: 39 - note 115; for the changes that flint undergoes when exposed to temperatures lower than 600°C see Gurova *et al.* 2020). These characteristics were recorded for 20 specimens (17 pieces of shatter, one blade and two flakes).

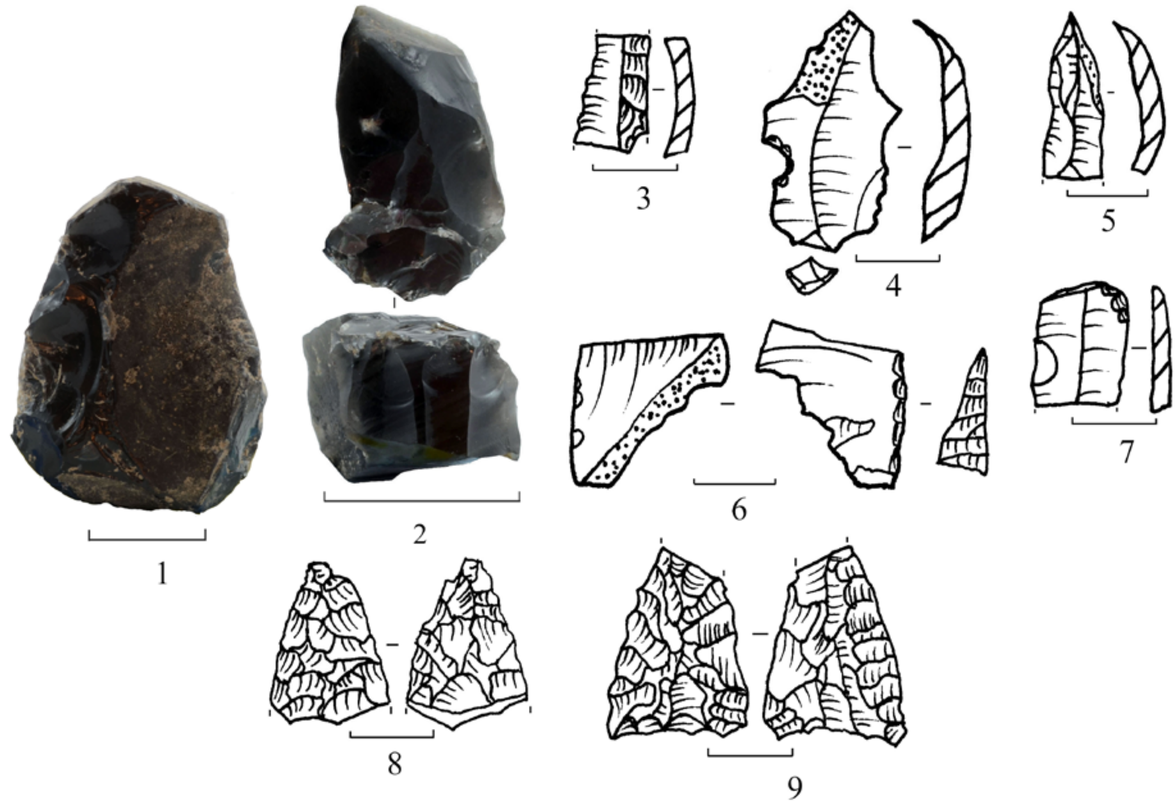

Figure 5. Malnaş Băi-obsidian assemblage. 1: Core fragment (inv. 19915); 2: Tablet (inv. 19914); 3: Crested blade fragment (inv. 19911); 4: Notch on a cortical flake (inv. 997-5); 5: Fragment of cortical blade (inv. 19911); 6: Retouched cortical flake (inv. 997-4); 7: Fragment of endscraper; 8-9: Fragments coming from bifacial arrowheads (inv. 19992, 19912). Scale from each artefact: 1 cm.

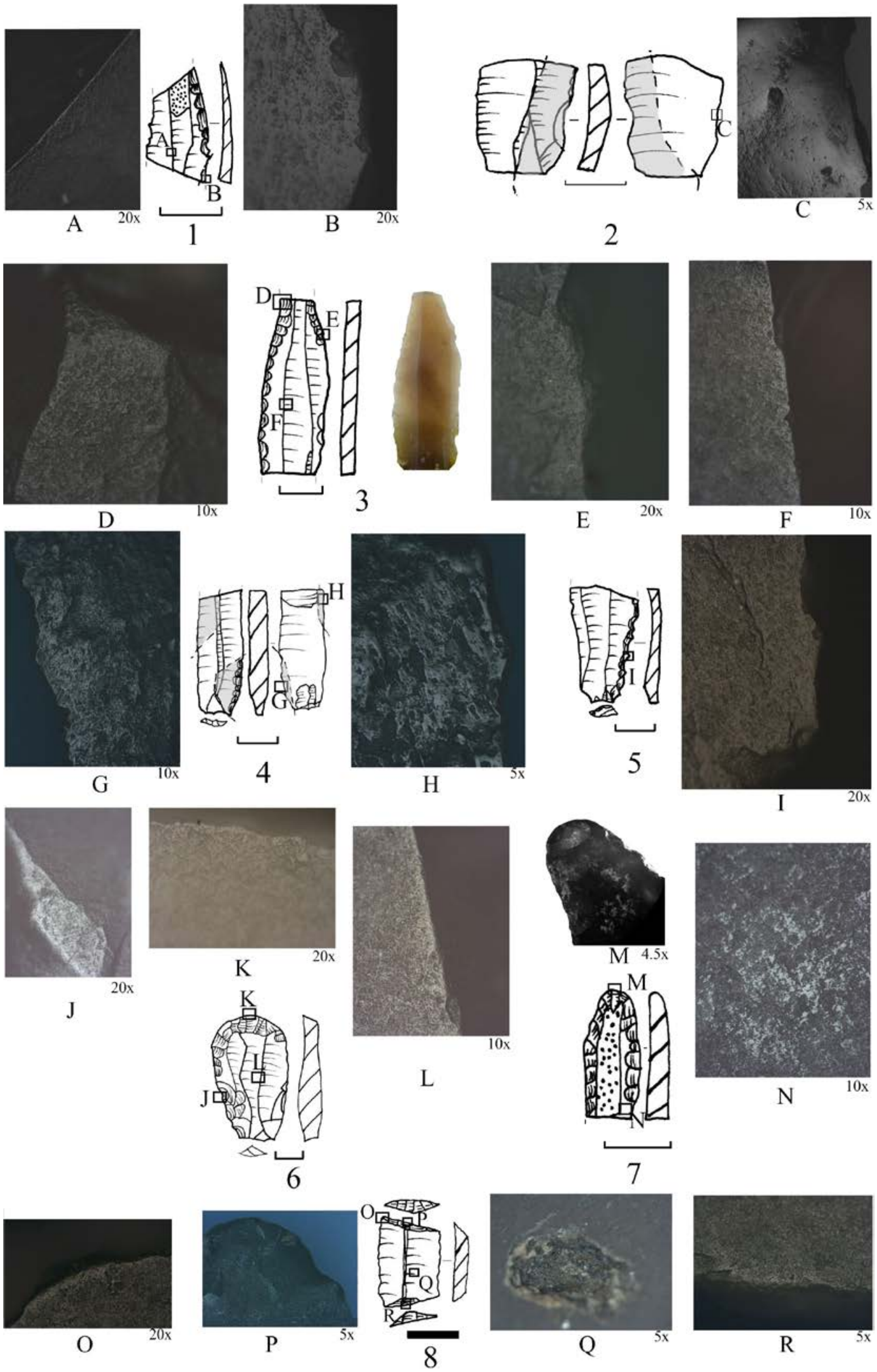

Figure 6. Malnaş Băi - flint assemblage. 1: Retouched cortical blade (inv. 19921); 2: Blank blade; 3-4: Retouched non-cortical blades; 5: Denticulated blade (inv. 19919); 6: Endscraper on flake; 7: Borer on blade 8: Trapeze. The bar represents 1 cm for each drawing. The micro-photographs depict the wear found on the artefacts. A, F, L, N, O, R: Hafting traces; B-C, G-H: Cereal reaping polish; D-E: Cutting & scrapping various materials; I: Hard animal material cutting; J: Hard animal material cutting; K: Hide scraping; M, P: Edge removals from a shooting event; Q: Residues.

4.3. Other rocks

The group of other rocks, most probable of local origins is very heterogeneous, and denominating all the types proved to be a difficult task. A coarse-grained, black to grey coloured, dull, opaque rock was determined as sandstone (Figure 7.4). As jasper or opal were considered the rocks of colours varying from grey to red, medium shiny, opaque, medium to fine-grained, with bands of diverse colours (Figure 7.7). Lydite was the denomination given to a black coloured, medium shiny, opaque, fine-grained material, with no inclusions (Figure 7.9), while a grey rock, medium-shiny, opaque, fine grained, with black inclusions was identified as radiolarite (Fig. 9.5). In addition, marl (white, calcareous, matte, opaque, medium to coarse-grained) was also differentiated.

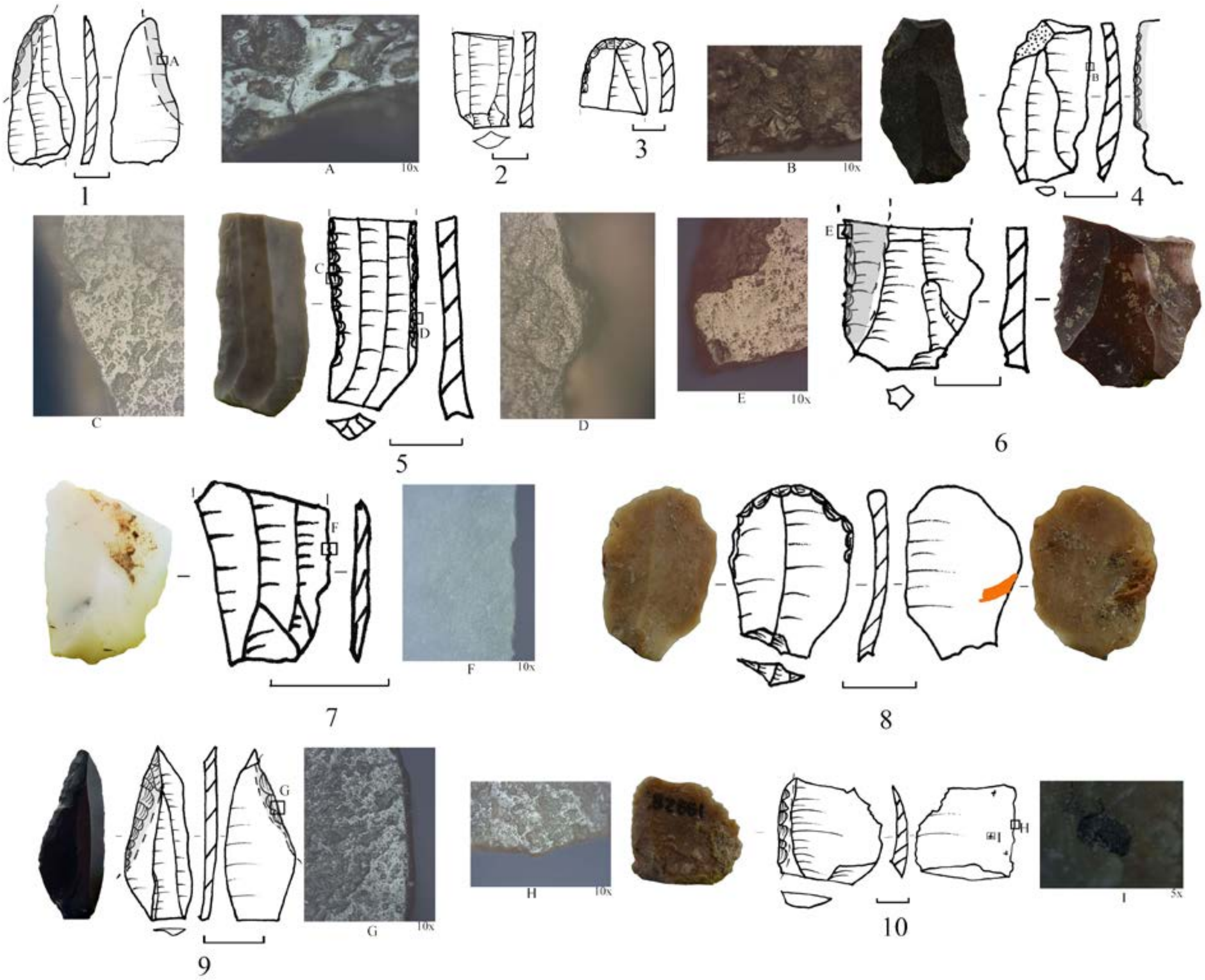

Figure 7. Malnaş Băi - the assemblage made of local rocks. 1,5,9: Retouched blades; 2: Blank blade; 3,8: Endscrapers (in orange indicated the place of the residues); 4: Retouched cortical flake (inv. 19922); 6: Denticulate on blade fragment (inv. 19926); 7: Blank flake; 10: Retouched non-cortical flake (inv. 19928). The bar from each artefact is 1 cm. The micro-photographs depict the wear found on the artefacts. A-C, G-H: Cereal reaping; D: cutting a hide-like material; E: Sod cutting; F: Edge without wear.

5. Nuclear analytical (PGAA) investigations

To chemically characterize the raw material types of the chipped stone implements, 37 finds were selected for PGAA. The selected chipped stone tools represent all the main categories (obsidian, flint, other rocks) of raw materials identified by macroscopic methods, but with emphasis on the non-local originated types. Thus, the selected sample set contained all obsidian finds of the assemblage (18 pieces), while approx. half of the non-debris flint artefacts (9 pieces) and of the non-debris local sandstone tools (7 pieces), and just a few (3 pieces) of other local raw materials. Subfigures of Figure 8 contain chemical data points (either numbers or black triangles) of all the 37 Malnaş Băi tools while comparative archaeological data are outlined with irregular shaped fields covering maximum distribution areas of them.

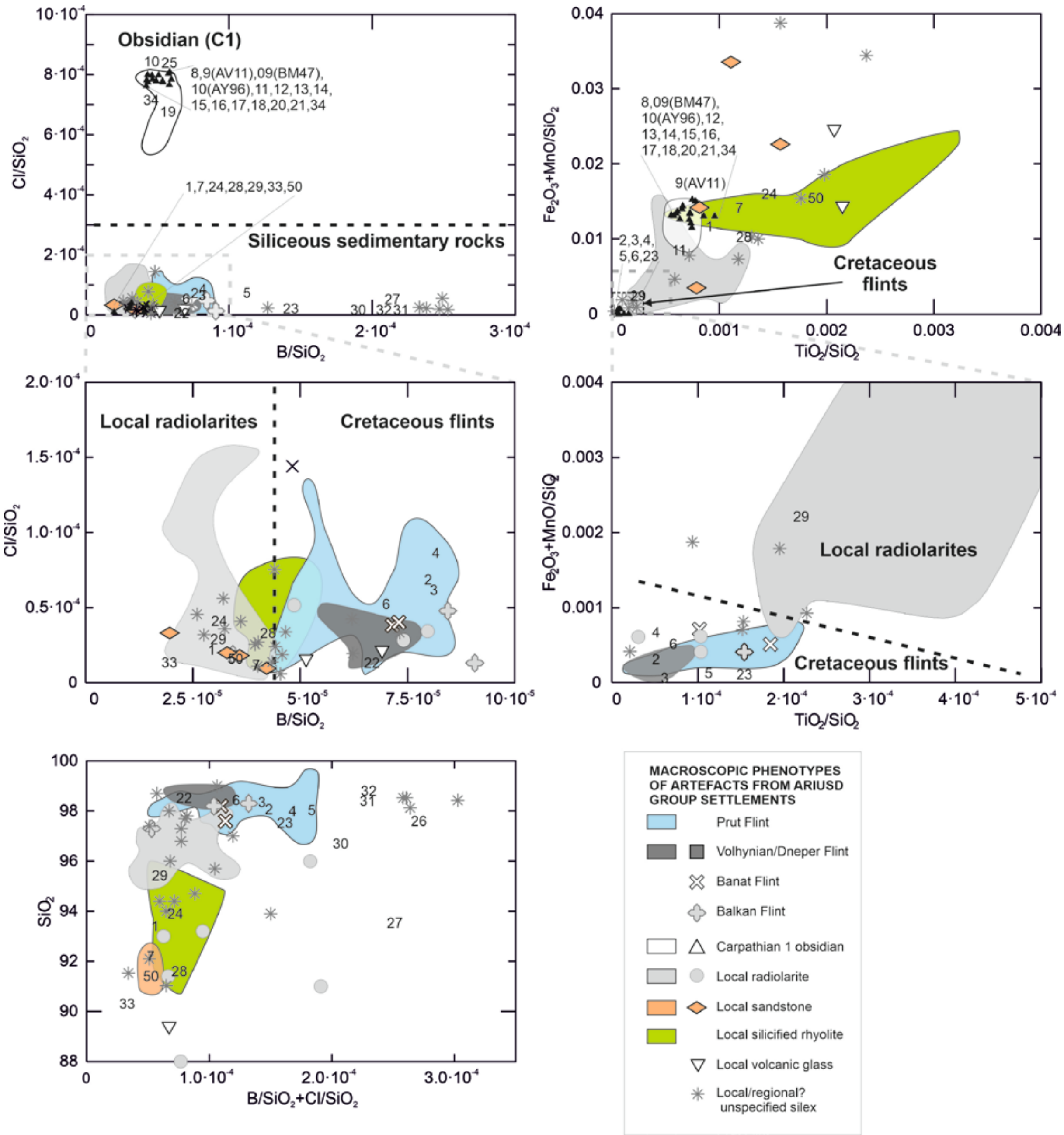

Figure 8. Bivariate discrimination diagrams (ratios of bulk element concentrations) of chipped stone tools from Malnaş Băi (indicated with numbers or, in case of close distribution on lower resolution diagrams, small black triangles) and comparative lithics from Ariuşd group settlements (indicated with fields or symbols, see in the legend), based on their geochemical composition. The three levels of discrimination (see discussion in section 5) are demonstrated: first (diagrams 1 and 3); second (diagrams 2, 3 and 4); third (diagrams 2, 4 and 5).

As a result, major raw material groups could be differentiated on three levels. On the first level, obsidians can be clearly separated from the siliceous sedimentary (flint, radiolarite, other cherts, sandstone) or other silicified rocks (Figure 8.1). Obsidians are the least siliceous group (75-77 wt%) in this assemblage with a significantly large Cl, large Fe-Mn and moderate Ti content compared to the siliceous raw materials (Figure 8.1; samples No. 8, 9 (AV11), 09 (BM47), 10, 10 (AY96), 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 25, 34). The overall composition of the obsidians verifies Carpathian 1 type origin compared to geological and archaeological data, as it is demonstrated in Kasztovszky *et al*. (2019), and probably comes from South-Eastern Slovakia (Viničky, Cejkov or Kašov subtypes) (Figure 9). This provenance is determined by the moderate B (32-45 ppm), small Cl (513-634 ppm) and small Ti (TiO_2 0.042-0.072 wt%) content.

On the second level, flints can be convincingly differentiated from radiolarites and other siliceous rock types (e.g. sandstone, siliceous rhyolite) based on their 'higher purity' (Figure 8.2). It means that not only the SiO_2 content is higher in the flints but also the importance of the minor and trace elements (e.g. Al, Ti, Fe, Mn, rare earth elements like Sm and Gd) related to non-marine but terrigenous input during the formation of the silica is smaller compared to radiolarites. In addition, marine-originated B content of flints is clearly higher than that of radiolarites. To sum up, flints are rocks the richest in silica (SiO_2>97 wt%), and B. Local radiolarite is the rock group with medium silica content (88-98 wt%, with the average >95 wt%, depending on the carbonate contamination from the embedding limestone) and varied but still large Cl content. Local raw material types of moderate silica content are the silicified rhyolite (formerly nominated as 'basaltoid' (see in Sztáncsuj *et al*. 2015); 88-95 wt%, however the average is 93-95 wt%) and the sandstone varieties (90-94 wt%, with the average of 91-93 wt%), both with similarly large Fe, Mn and Ti content. These two rock types can be slightly differentiated by larger B and Cl content of rhyolites and smaller B and Cl content of sandstones. Among Malnaş Băi samples, macroscopically similar dark coloured and grainy samples chemically proved to be silicified rhyolite (samples No. 1, 7), sandstone (samples No. 24, 28, 33, 50) or possibly volcanic glass (sample No. 22). Other, unspecified chert or opal or jasper versions (samples No. 26, 27, 29, 30, 31, 32) can show silica content in a range from 90 to 99 wt% with very varied major and minor-trace element composition (Figure 8.1-5). Thus, it has to be noted that a clear agreement between the macroscopic and geochemical categorisation was not found (see also in Table 1) in the case of the dark coloured and more or less grainy raw material types (sandstone, silicified rhyolite, volcanic glass, lydite, radiolarite). In addition, flints and other chert types could be further differentiated from each other based on their elemental composition.

On the third level, some flint types could be differentiated from each other (Figure 8.2-5). Long-distance flint types were compared to macroscopically identified lithics of neighbouring Ariuşd group settlements. Since the comparison is not complete, some flint types could be investigated in detail (Prut and Volhynian Flints) while others could not (Balkan and Banat Flints). Artefacts No. 2, 3, 4, 6 from Malnaş Băi could be related to the Cenomanian dark flints of Prut or Volhynian origin. Although having different macroscopic appearance, the few comparative samples from Balkan and Banat flint types have similar geochemical constituents. These Cretaceous age flint varieties have small Ti (TiO_2 0.005-0.007 wt%), Al (Al_2O_3<0.14 wt%), Fe (Fe_2O_3<0.06 wt%), Mn (MnO 0.001-0.006 wt%), Ca (CaO 0.02-0.08 wt%) and alkali oxide (<0.1 wt%) content, accompanied with moderate B concentrations (68-80 ppm). Other flint types, samples No. 5 and 23, have moderately different chemical composition with large B content (140-250 ppm).

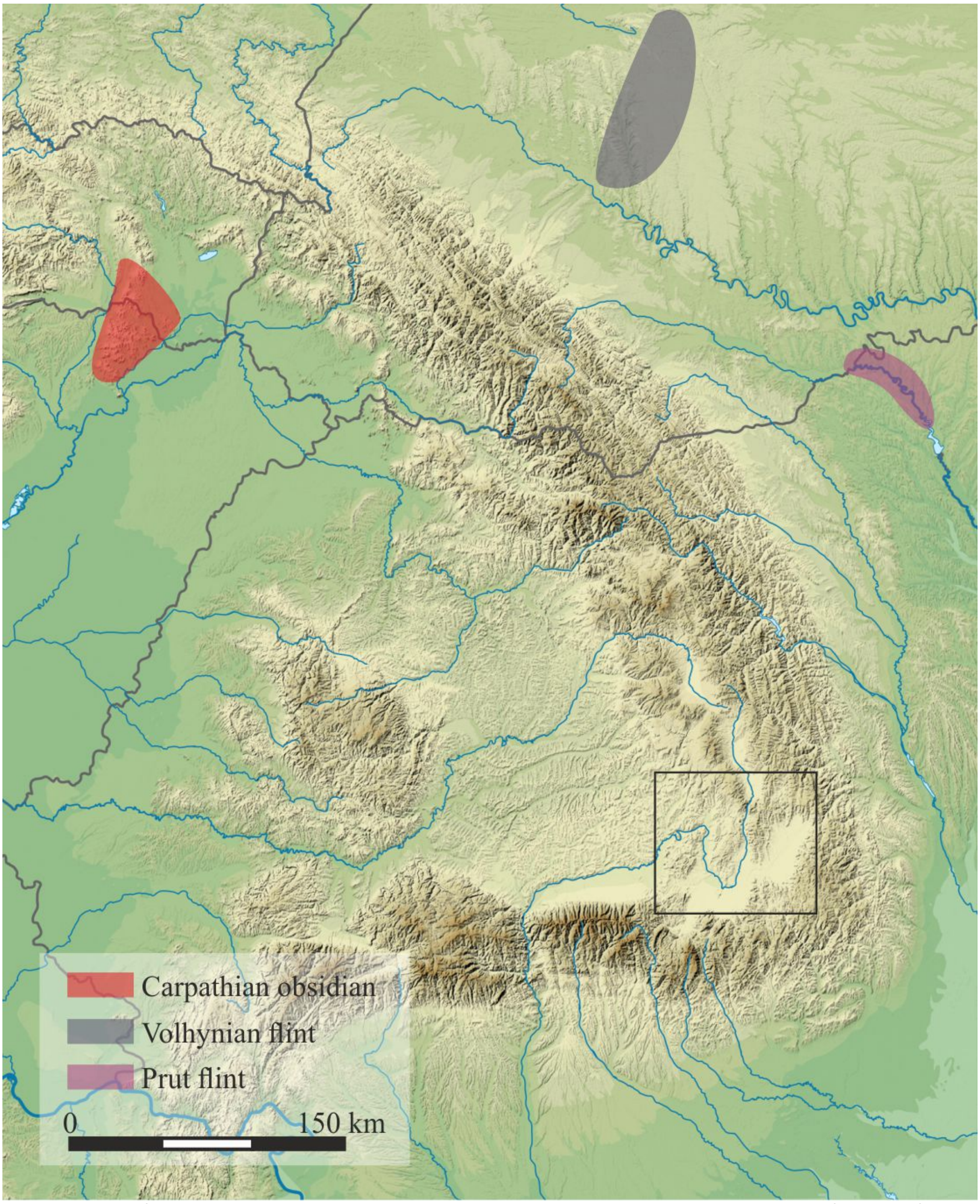

Figure 9. Map of raw materials distribution. 1. Carpathian 1 obsidian, 2. Cenomanian deposits of the Prut flint, 3. Volhynian flint (after Petruni 2004).

Table 1. Chemical composition (wt%) of 37 selected chipped stone tools from Malnaş Băi measured by PGAA. The displayed digits refer to the precision of the measured value. “<DL” stands for “less than the detection limit”.

Sample	Inventory No.	Macroscopic raw material type	Geochemical raw material type	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	H_2O	SO_3	CO_2	B	Cl	Nd	Sm	Gd
Málnásfürdő 1		local sandstone	silicified rhyolite	93.4	0.085	1.58	0.99	0.095	<DL	1.86	0.18	0.28	0.978	0.090	<DL	2.79E-03	2.34E-03	7.53E-04	7.64E-05	9.79E-05
Málnásfürdő 2		Prut flint	Prut/Volhynian flint	98.1	0.005	0.14	0.03	0.001	<DL	0.05	0.04	0.04	1.530	<DL	<DL	7.91E-03	6.43E-03	<DL	<DL	1.60E-05
Málnásfürdő 3		Prut flint	Prut/Volhynian flint	98.3	0.006	<DL	<DL	0.005	<DL	0.05	0.07	0.03	1.505	<DL	<DL	7.97E-03	6.13E-03	<DL	1.02E-05	1.69E-05
Málnásfürdő 4		Prut/Volhynian flint	Prut/Volhynian flint	98.0	0.005	0.12	0.06	0.006	<DL	0.08	0.05	0.03	1.620	0.040	<DL	7.99E-03	8.46E-03	<DL	7.11E-06	1.41E-05
Málnásfürdő 5		Prut flint	unspecified flint	98.0	0.011	<DL	<DL	0.013	<DL	0.04	<DL	0.04	1.780	<DL	<DL	1.10E-02	7.00E-03	<DL	<DL	<DL
Málnásfürdő 6		Prut flint	Prut/Volhynian flint	98.4	0.007	0.12	0.05	0.001	<DL	0.02	0.03	0.04	1.275	<DL	<DL	6.89E-03	5.10E-03	<DL	5.91E-06	8.31E-06
Málnásfürdő 7		local sandstone	silicified rhyolite	92.2	0.109	2.04	1.28	0.021	<DL	0.35	0.21	0.31	1.561	0.554	<DL	3.72E-03	1.10E-03	<DL	6.56E-05	8.40E-05
Málnásfürdő 8		obsidian	C1 obsidian	76.3	0.057	13.09	1.09	0.056	<DL	0.82	3.53	4.73	0.230	<DL	<DL	4.10E-03	5.88E-02	<DL	3.10E-04	3.65E-04
Málnásfürdő 9 (AV11)		obsidian	C1 obsidian	76.0	0.059	13.19	1.26	0.058	<DL	0.79	3.64	4.70	0.233	<DL	<DL	4.07E-03	5.88E-02	3.53E-03	3.26E-04	4.10E-04
Málnásfürdő 09 (BM47)	19911-1	obsidian	C1 obsidian	76.1	0.048	12.90	0.89	0.057	<DL	1.13	3.80	4.87	0.166	<DL	<DL	4.53E-03	5.93E-02	2.97E-03	3.23E-04	4.35E-04
Málnásfürdő 10 (AY96)		obsidian	C1 obsidian	75.4	0.072	13.99	0.91	0.060	<DL	0.82	3.59	4.75	0.367	<DL	<DL	4.40E-03	6.07E-02	2.23E-03	3.14E-04	4.06E-04
Málnásfürdő 10 (BM48)	19911-2	obsidian	C1 obsidian	76.3	0.056	12.91	0.85	0.057	<DL	0.84	3.80	4.90	0.213	<DL	<DL	3.48E-03	6.34E-02	3.48E-03	3.38E-04	3.99E-04
Málnásfürdő 11	19911-3	obsidian	C1 obsidian	76.8	0.047	12.78	0.57	0.060	<DL	0.78	3.77	4.95	0.193	<DL	<DL	3.76E-03	5.94E-02	3.67E-03	3.10E-04	3.92E-04
Málnásfürdő 12	19912	obsidian	C1 obsidian	76.0	0.059	12.86	1.07	0.060	<DL	1.13	3.71	4.86	0.165	<DL	<DL	3.50E-03	6.03E-02	2.59E-03	3.19E-04	4.01E-04
Málnásfürdő 13	19913	obsidian	C1 obsidian	75.9	0.055	13.04	0.94	0.057	<DL	1.23	3.61	4.81	0.329	<DL	<DL	3.28E-03	5.85E-02	2.25E-03	3.29E-04	3.96E-04
Málnásfürdő 14	19915	obsidian	C1 obsidian	75.6	0.046	13.06	0.96	0.057	<DL	1.22	3.57	4.77	0.628	<DL	<DL	4.40E-03	5.76E-02	2.94E-03	3.01E-04	3.85E-04
Málnásfürdő 15	19916	obsidian	C1 obsidian	76.8	0.050	12.84	1.01	0.052	<DL	0.88	3.36	4.65	0.247	<DL	<DL	3.23E-03	5.82E-02	2.71E-03	3.13E-04	3.87E-04
Málnásfürdő 16	19992	obsidian	C1 obsidian	76.5	0.055	13.12	0.89	0.060	<DL	0.79	3.35	4.97	0.208	<DL	<DL	4.41E-03	6.11E-02	3.05E-03	3.23E-04	4.34E-04
Málnásfürdő 17	5103-1	obsidian	C1 obsidian	76.2	0.042	12.75	0.93	0.060	<DL	0.80	3.75	4.84	0.563	<DL	<DL	3.86E-03	6.05E-02	2.94E-03	3.18E-04	4.01E-04
Málnásfürdő 18	5103-1	obsidian	C1 obsidian	76.7	0.057	12.80	0.82	0.054	<DL	0.87	3.61	4.75	0.276	<DL	<DL	3.25E-03	5.96E-02	2.66E-03	3.31E-04	4.21E-04
Málnásfürdő 19	8928	obsidian	C1 obsidian	76.0	0.050	12.89	1.02	0.059	<DL	1.13	3.54	4.94	0.329	<DL	<DL	4.38E-03	5.13E-02	3.16E-03	3.17E-04	4.19E-04
Málnásfürdő 20		obsidian	C1 obsidian	76.1	0.065	13.06	0.92	0.060	<DL	1.14	3.60	4.73	0.198	<DL	<DL	3.27E-03	6.05E-02	2.98E-03	3.37E-04	4.17E-04
Málnásfürdő 21		obsidian	C1 obsidian	75.6	0.045	13.17	0.94	0.062	<DL	1.26	3.71	4.87	0.286	<DL	<DL	3.51E-03	5.89E-02	2.40E-03	3.23E-04	4.37E-04
Málnásfürdő 25		obsidian	C1 obsidian	75.8	0.055	12.93	0.95	0.062	<DL	0.80	2.94	6.09	0.247	<DL	<DL	4.21E-03	6.35E-02	2.34E-03	2.26E-04	2.62E-04
Málnásfürdő 22		lydite	volcanic glass?	98.6	<DL	<DL	<DL	0.010	<DL	0.12	0.06	<DL	1.166	<DL	<DL	6.57E-03	1.27E-03	<DL	<DL	9.99E-06
Málnásfürdő 23		Prut flint	unspecified flint	97.5	0.015	0.31	<DL	0.007	<DL	1.07	0.05	0.10	0.901	<DL	<DL	1.40E-02	1.82E-03	<DL	2.66E-05	3.73E-05
Málnásfürdő 24		local sandstone	local sandstone	93.9	0.134	1.75	1.47	0.031	<DL	1.01	0.24	0.29	1.125	<DL	<DL	2.92E-03	3.86E-03	9.89E-04	8.81E-05	1.18E-04
Málnásfürdő 26		Prut/Volhynian flint	unspecified flint	97.6	<DL	<DL	0.24	0.069	<DL	0.08	0.07	<DL	1.397	0.474	<DL	2.47E-02	1.75E-03	<DL	<DL	<DL
Málnásfürdő 27		Prut flint	unspecified flint	93.5	0.014	<DL	<DL	<DL	<DL	<DL	<DL	0.06	1.286	<DL	5.2	2.00E-02	3.49E-03	<DL	1.90E-05	1.83E-05
Málnásfürdő 28		local sandstone	local sandstone	91.6	0.111	2.65	0.75	0.189	0.6	0.15	0.17	0.51	2.341	0.482	<DL	3.89E-03	3.02E-03	<DL	6.27E-05	6.64E-05
Málnásfürdő 29		Prut flint	unspecified flint	95.4	0.021	0.52	0.20	0.012	<DL	2.22	<DL	0.12	1.115	0.363	<DL	2.91E-03	2.77E-03	<DL	3.61E-05	5.03E-05
Málnásfürdő 30		local sandstone	local chert	96.8	<DL	<DL	<DL	<DL	<DL	1.95	0.11	<DL	1.122	<DL	<DL	1.83E-02	1.49E-03	<DL	<DL	2.71E-05
Málnásfürdő 31		local radiolarite	local chert	98.4	<DL	<DL	<DL	<DL	<DL	0.22	<DL	<DL	1.370	<DL	<DL	2.12E-02	1.30E-03	<DL	<DL	1.10E-05
Málnásfürdő 32		local radiolarite	local chert	98.8	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	1.188	<DL	<DL	2.10E-02	1.67E-03	<DL	<DL	1.10E-05
Málnásfürdő 33		local sandstone	local sandstone	90.3	<DL	<DL	<DL	<DL	0.6	4.09	0.22	0.17	0.850	0.493	<DL	1.76E-03	1.21E-03	1.18E-03	7.94E-05	1.07E-04
Málnásfürdő 34		obsidian	C1 obsidian	76.6	0.044	12.88	0.93	0.059	<DL	0.79	3.66	4.79	0.196	<DL	<DL	3.52E-03	5.45E-02	2.67E-03	3.09E-04	4.03E-04
Málnásfürdő 50		local sandstone	local sandstone	91.4	0.172	2.14	1.21	0.200	0.5	2.09	0.36	0.35	0.957	0.527	<DL	3.22E-03	1.56E-03	1.42E-03	1.20E-04	1.50E-04

Thus, the results indicate that the two main long-distance procured materials were obsidian and flint since these raw materials are not known to be present in the geologic background of the studied region (Săndescu *et al.* 1968; Burchfiel & Bleahu 1976). The category of the local raw materials is diverse, with a multitude of taxa. In the lack of field survey, local geology was studied in the literature (Săndescu *et al.* 1968; Burchfiel & Bleahu 1976; Rădulescu & Samson 1985; Fielitz & Seghedi 2005; László 2005; Macaleţ *et al.* 2005; Lexa *et al.* 2010) and was based on the lithic assemblages of surrounding Ariuşd group archaeological sites (see the sites and references in the previous section).

6. Technology, typology and use of the chipped stone artefacts

As mentioned before, 134 chipped stone items discovered at Malnaş Băi were submitted to techno-typological analysis. 56 pieces (41%) are 'debris & shatters'. Thus, the other 78 artefacts (59%) were subjected to the techno-typological and use-wear analysis.

As is the case with all Cucuteni lithic assemblages, the artefacts from the site are characterised by high rates of fragmentation, intact items being rare. Various rocks, of local and remote origins, were used to produce the chipped stone tools (Table 2).

Table 2. Malnaş Băi. The morpho-technological structure of the lithic assemblage.

Morpho-technological classes	Obsidian n	Flint n	Sandstone n	Other local raw materials n	TOTAL n	TOTAL %
1. Core fragments & boulders	2	-	-	1	3	4
Tablets & *flancs*	1	-	-	1	2	3
2. Crested & sub-crested elongated items	1	-	-	-	1	1
Entame flakes	-	-	-	1	1	1
Secondary cortical flakes	4	1	1	11	17	22
Secondary cortical elongated items	1	2	-	-	3	4
Non-cortical flakes	-	4	12	7	23	29
Non-cortical elongated items	3	7	5	13	28	36
TOTAL	**12**	**14**	**18**	**34**	**78**	**100**
(3. Debris & shatters)	(5)	(21)	(4)	(26)	(56)	
(TOTAL with debris & shatters)	(17)	(35)	(22)	(60)	(134)	

6.1. The obsidian assemblage

The obsidian assemblage consists of 18 artefacts, all discovered in the circular enclosure of the Copper Age settlement. Only 17 were analysed from a techno-typological perspective. The specimens come from all stages of lithic production sequence and from all three main morpho-technological groups: cores (represented by core fragments & boulders: Figure 5.1, rejuvenation tablets: Figure 5.2), debitage products (crested blades: Figure 5.3, secondary cortical flakes & blades: Figure5.4-6, non-cortical blades: Figure 5.7) and debris (see Table 2). This indicates a worked-on site assemblage. The rejuvenation tablet (inv. 19914) was removed from a core with a small striking platform (19 mm ×10 mm) created through three large flakes. The knapping was initiated only on one face of this core, while the rest of the faces remained covered in cortex (Figure5.2). As the knapping progressed, several small removals were performed to create a proper striking surface. When the knapping angle became straight (90^0) the platform was rejuvenated through separating this tablet; faceting and abrasion are visible on some edges of the platform. The core was unidirectionally exploited; negatives of five bladelets with regular edges and big bulbs (their *contre-bulb* is visible) are individualised. The artefacts of obsidian are, in general, of small dimensions (Figure 10); the elongated products can be categorised as bladelets, being 1.5-4 mm thick and 7-10 mm wide.

Only one blade is intact: its proximal end has a large bulb and a punctiform butt. The elongated pieces have curved profiles, triangular cross-sections and regular edges and arrises. All come from unipolar cores.

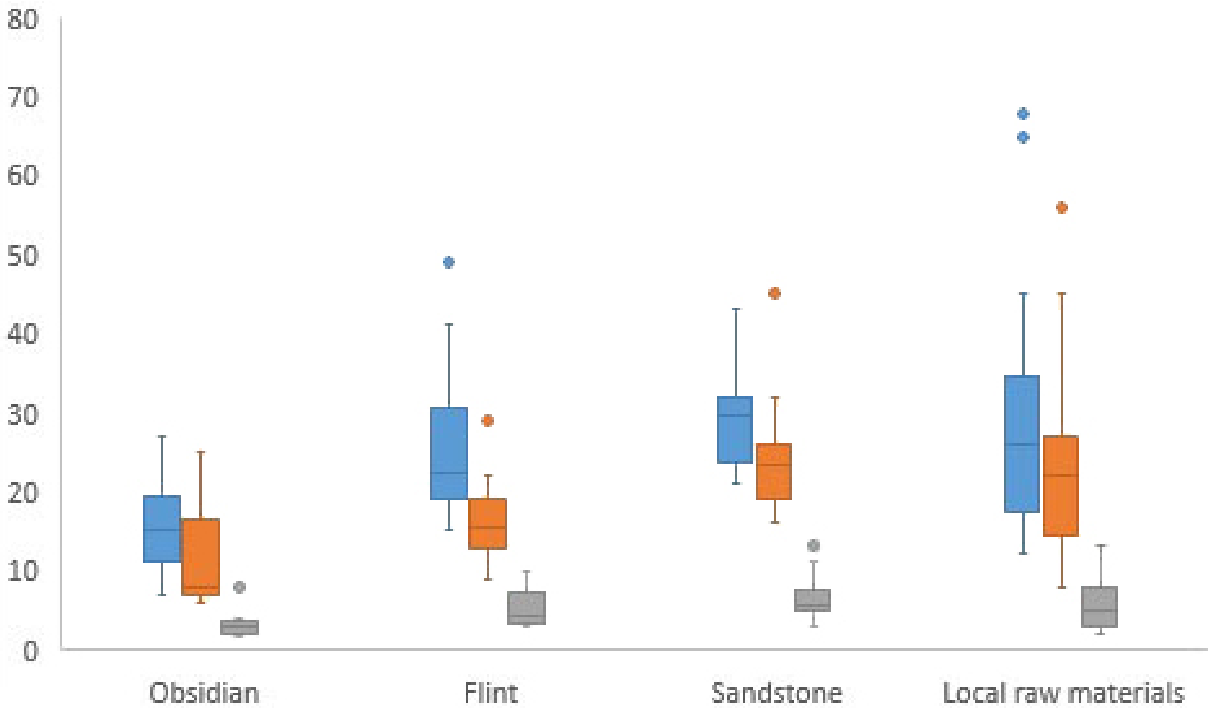

Figure 10. Malnaş Băi. Metric characteristics (in mm, blue for length, red for width and grey for thickness) of the chipped stone assemblage depending on the raw materials.

Of the obsidian items, six were retouched (see Table 3). They were transformed into a retouched blade (direct, invasive retouches on a section of the right edge), an endscraper which broke probably during use (Figure5.7), a steep retouched flake (Figure 5.6), a notched piece (Figure 5.4) and two bifacial retouched triangular arrowheads (Figure 5.8-9). Both arrowheads are lenticular in their cross-section, have slightly convex edges and are fragmented: one is missing its base (Figure 5.8), while the other one has a slightly concave base but its tip was broken (Figure 5.9). The retouches cover their entire surface. Only two obsidian specimens were used by the prehistoric community in Malnaş Băi: one core fragment as a hammer, while the retouched flake was employed in cutting a medium hard material.

Table 3. Malnaş Băi. The typological structure of the chipped stone collection.

	Obsidian	Flint	Sandstone	Local raw materials	TOTAL	
Types	**n**	**n**	**n**	**n**	**n**	**%**
Retouched blades	1	4	1	4	10	32
Retouched flakes	1	1	1	4	7	23
Endscrapers	1	1	1	2	5	16
Notched items	1	-	-	-	1	3
Denticulates	-	1	-	2	3	10
Bifacial triangular arrowheads	2	1	-	1	4	13
Trapezes	-	1	-	-	1	3
TOTAL	**6**	**9**	**3**	**13**	**31**	**100**

6.2. Flint

Flint is another raw material that can be distinguished through its macroscopic features (see Table 2 for numeric data). The 35 flint items can be divided only in two main technological groups: debitage products and shatters. The debitage products were categorised as: secondary cortical flakes, non-cortical flakes, secondary cortical blades (Figure 6.1, 7), non-cortical blades (Figure 6.2-5, 8) (Table 2). Only one blade and three flakes are intact. The measurements of the flint specimens show larger dimensions and greater variety than those of obsidian (Figure 10). The elongated products are 3-7 mm thick and 10-19 mm wide. The negatives from the dorsal faces of the blades indicate that they were produced from unipolar cores. Five proximal pieces from flint blades were found, with no obvious connection between the bulb morphology and that of the butts, their aspects being variable. For example, for the two blades with facetted butts, it was noticed in one instance a big bulb, while in the other instance the detached bulb. Two types of blades were found: those with a curved profile and somewhat irregular edges (Figure 6.1-3, 5) and others that have trapezoidal cross-sections, straight profile and regular edges and arises (Figure 9.4, 7, 8). This variety of morphological traits of the blades is a consequence of using the punch technique for producing them (Crabtree 1972; Pelegrin 2006), technique that was widely used in the Cucuteni-Trypillia area at that time (Kiosak 2016; Radomsky 2018; Vornicu 2020). Crested blades are missing from the assemblage; cortical elongated specimens are present.

Only one blank blade has usewear: a medial fragment from a blade that was employed in cereal harvesting (Figure 6.2/C).

As for the deliberate modified specimens, they were transformed, through retouching, into four retouched blades (Figure 6.1, 3, 4), two borers (Figure 6.7), a retouched flake, a denticulate (Figure 6.5), a symmetrical trapeze (Figure 6.8), an endscraper (Figure 6.6) and an arrowhead. The retouched blades have marginal (sometimes slightly invasive), semi-abrupt retouches on their dorsal face (arranged in two cases on the extremities and in the other two cases along the whole length of one edge). Among these products, one has a low angle slightly invasive retouches on its other edge. The use of these items is connected in two cases with agricultural practices, being employed as sickle inserts (Figure 6.1/B, 2/C, 4/G-H). A retouched blade (Figure 6.3/D-E) was used both for cutting and scraping materials of unknown origins, while another fragment for grass cutting. The borers were made on the distal extremities of blade fragments by creating a tip through direct, abrupt, invasive retouches. Both were employed in piercing activities; one of them has a rounded tip due to excessive use (Figure 6.7/M). The denticulate was made on a proximal blade fragment and was used in hard animal material cutting (Figure 6.5/I). The trapeze was created on a small rectilinear blade. Both truncations are oblique, but not parallel to each other. The artefact was involved in a shooting event (Figure 6.8); wear coming from hafting are visible on both truncations. A residue, probably from the hafting adhesive, adheres on the dorsal surface of the artefact (Figure 6.8/Q). The endscraper, made on a thick flake, was used in hide scraping (Figure 6.6/K). Most of these implements also have hafting traces (Figure 6.A, F, L, N, O, R). The only arrowhead made of flint from the site (burnt flint) has a triangular shape with a slightly concave base, is of small dimensions (length = 14 mm, width = 12 mm, thickness = 4 mm) has a triangular cross-section and was retouched through invading retouches that do not cover its entire surface, which is common for the Cucuteni arrowheads, being in this manner different from those worked in obsidian from the site.

6.3. The group of chipped stone artefacts made of local materials

The group of chipped stone artefacts made of local materials is the widest (n=82), being very heterogeneous in terms of raw materials. Almost half of the artefacts from local rocks have weathered (water-rolled) surfaces, suggesting that their provenance is not from primary geological deposits but rather from riverbeds (probably from the Olt River that flows close to the settlement).

6.3.1. Sandstone

In this group, sandstone (Figure 7.4) has the highest number of specimens (n =22) (Figure 7.1-4), technologically divided into secondary cortical flakes (Figure 7.4), non-cortical flakes, non-cortical blades (Figure 7.1-3) and debris (Table 2). They have medium metric characteristics, showing less variability than in the case of flint (Figure 10) (for blades the thickness is 4-8 mm, the width: 20-30 mm). The proximal ends from both flakes and blades have plain butts and usually no bulbs; all the blades show dorsal reduction. The angle of their platforms ranges from 60º to 90º. Only three specimens were intentionally modified into a retouched blade (Figure 7.1), a retouched flake (Figure 7.4) and an endscraper (Figure 7.3) (Table 3). The blade was retouched in the same manner as the ones made of flint (Figure 7.1) and was used as a sickle insert (Figure 7.1/A). The modified flake has marginal, semi-abrupt, ventral retouches (Figure 7.4) and was used in the same manner as the retouched blade (Figure 7.4/B). The endscraper has no wear coming from use.

6.3.2. The other local raw materials

The other local raw materials are represented, in many instances, only by very few specimens (see their possible denomination in Chapter 4 and their actual type in Chapter 5). The metric and morpho-technological characteristics of these items are diverse (see Table 2 and Figure 10). The blade technology produced elongated products of various dimensions (thickness of 2-7 mm; width of 8-22 mm), depending on the mechanical properties of each rock. For example, the four radiolarite bladelets are standardised in dimensions (thickness of 2-3 mm and width of 10-14 mm). As was the case of flint, two types of blades can be discriminated: those with somewhat irregular edges and others that have trapezoidal cross-sections, straight profile and regular edges and arises. Five proximal ends have plain butts and no bulb associated. The blanks have no use-wear (see Figure 7.7/E). The intentionally modified artefacts are of various morphologies: retouched blades, retouched flakes, endscrapers, a denticulate and one bifacial triangular arrowhead (Table 3). The method of retouching and knapping is identical to that of flint specimens, and were used in the same manner. One retouched flake (Figure 7.10/I) and two retouched blades (Figure 7.5/C, 9/G) were employed in cereal reaping. One of these blades has the left edge used in cereal reaping, while the other edge in cutting a hide-like material (Figure 7.5/D). The denticulate was made on the proximal end of a blade and was employed in sod cutting (Figure 7.6/E). The endscraper (Figure 7.8) was used in hide scraping and has residues from the wood of the haft on its ventral face. A retouched flake has use-wear on its modified edge coming from antler cutting. The only fragment coming from an arrowhead made from local materials is fragmented, only its tip being intact. Judging by its dimensions (length = 26 mm, width = 14 mm, thickness = 4 mm) it can be presumed that this is, in fact, a spearhead fragment.

7. Discussion

The lithic collection discovered in the Copper Age settlement at Malnaş Băi, although not very numerous in specimens, is diverse, both in terms of raw materials and techno-typological aspects.

Based on the geochemical composition of the analysed samples, we were able to determine the main long-distance lithic materials used at Malnaş Băi and in the Copper Age of Eastern Transylvania. These long-distance raw materials are: obsidian and flint.

We documented the presence of artefacts made of Carpathian **obsidian**, exclusively the C1 type (see Kasztovszky *et al*. 2019). This specific industry, concentrated in the circular enclosure area, is characterised by small-sized specimens, a blade technology from unidirectional cores that produced bladelets with curved profiles and regular edges and arrises. The morpho-technological structure of the obsidian assemblage from Malnaş Băi suggests that this raw material was knapped on-site, being brought inside the settlement as nodules. The geologic deposits of obsidian are situated in nowadays South-Eastern Slovakia, 500 km away from the site, as the crow flies (Figure 9) In the Copper Age, at the time that the Malnaș Băi settlement functioned (meaning the second half of the 5th millennium BCE), the area where the obsidian resources were available was populated by the Tiszapolgár and Bodrogkeresztúr communities (Bognár-Kutzián 1972; Brummack 2015; Pavúk & Šiška 1981; Siklósi & Szilágyi 2021; Šiška 1968). (Due to the fact that recent researches showed an overlapping in time and space of the Tiszapolgár and Bodrogkeresztúr material cultures (Raczky & Siklósi 2013; Siklósi & Szilágyi 2021) we will refer these Copper Age communities as Tiszapolgár - Bodrogkeresztúr.) Thus, it is logical to assume that the obsidian artefacts from Malnaș Băi entered inside the settlement through interactions with the Tiszapolgár - Bodrogkeresztúr communities that lived at the time in the Carpathian Basin. The obsidian finds in Tiszapolgár -Bodrogkeresztúr sites are in form of small nodules suitable for knapping small blades, small unretouched artefacts and retouched tools (Balogh 2000; Bognár-Kutzián 1972: 136-137; Iercoșan 2002: 150; Mihail & Sava 2019; Pădurean 1982), technologically identical to those at Malnaş.

Although obsidian artefacts were found in Ariuşd settlements from the intra-Carpathian area (see Biró & Sztáncsuj 2016; Cârciumaru *et al*. 2001; Kasztovszky *et al*. 2019), they are scarce in the sites of Cucuteni-Trypillia culture in Moldavian Plain, in the second half of the 5^{th} millennium BCE (see the data from Vornicu 2020). The morpho-techno-typologic characteristics of the obsidian artefacts in Malnaș Băi are alien to the lithic technology from the eastern Carpathian Chalcolithic. The most striking difference is in terms of metric characteristics (the obsidian artefacts are smaller than the flint artefacts from the Cucuteni area). Also, the arrowheads from obsidian discovered in Malnaș Băi have a striking resemblance through the way of retouching and morphology with the materials from the Tiszapolgár-Bodrogkeresztúr area (see Balogh 2000; Bognár-Kutzián 1972: 136-137; Mihail & Sava 2019).

The second category of long-distance raw materials in Malnaş Băi is **flint**. The geological deposits where these flints are originating are situated at distances of over 300 km in the case of the Prut flint and over 500 km (Figure 9), as the crow flies, in the case of Volhynian flint (Figure 9). Unlike the obsidian, these flint crops were located in the area of the Cucuteni-Trypillia culture. The morpho-technological and typological characteristics of the flint blades from Malnaş Băi are typical to the lithic industries found in the sites from the Cucuteni-Trypillia area (Biró & Sztáncsuj 2006; Bodi 2010; Boghian 1995; 1996; Dumitrescu 1954; Florescu 1999; Lazarovici & Babeş 2015; Mantu *et al*. 1995; Marinescu-Bîlcu 1981; 2000; Păunescu 1970; Țurcanu 2012; Ursulescu & Ignătescu 2003; Vornicu 2014; 2015; 2020). This industry is characterized by medium-sized items obtained from unidirectional cores, by the punch technique. Unlike the obsidian assemblage, in this case there is no evidence that flint was knapped on-site. In most of the Cucuteni settlements, the knapping of flint was practiced at different intensities; however, in some settlements closer to the Carpathian area (as Fulgeriş: Vornicu 2015) there is no evidence of knapping as an on-site craft, although flint products were used. This can be regarded as a consequence of the fact that a large network of craftsmen, or maybe merchants, was supplying the Copper Age Cucuteni-Trypillia settlements situated at high distances from the flint crops.

It was much more problematic to identify the quite diverse varieties of lithics with local origin: opals, sandstones, silicified rhyolite, marl, radiolarite etc., which also occur in large quantities in the lithic industry of different sites in the region. Most of these raw materials are probably found in the sedimentary or volcanic deposits and secondary alluvial outcrops of the Eastern Carpathians. In order to identify and locate these deposits more precisely in the future, it is necessary to collect and analyse more samples from this region (for further details see Sztáncsuj *et al*. 2014; Biró & Sztáncsuj 2016).

Though the use of local rocks was common for the Copper Age communities that were residing in the Carpathian area (Biró & Sztáncsuj 2006; Crandell 2012; Cucoş & Muraru 1985; Marinescu-Bîlcu *et al*. 1981; Sztáncsuj *et al*. 2015; Ţurcanu 2009; Ursulescu & Ignătescu 2003: 123-126), the settlement at Malnaş Băi stands out through the large quantity and variety of these materials. Some of them can be considered as having an opportunistic use (especially in the case of those represented only by few specimens), but for others (as the case of sandstone, and possibly also of radiolarite and opal) organised production seems to have been taking place on or near the site.

As for the retouched specimens, they are typical for the cultural context to which they belong, meaning the Ariuşd-Cucuteni-Trypillia area. Retouched blades and retouched flakes, endscrapers, triangular arrowheads, borers, denticulates, notches, arrowheads, spearheads and trapezes are implements that are common for the Cucuteni-Trypillia area. For obtaining retouched blades were employed small, semi-abrupt, sometimes marginal, sometimes invasive retouches on one or both edges of the blanks. Borers were also produced in Cucuteni tradition, meaning creating a tip through retouching the distal extremities of regular blade fragments with direct, abrupt, invasive retouches.

But peculiarities are also visible in the flint and local materials processing. The main type of tool at Malnaş Băi is the retouched blade, while in Cucuteni sites endscrapers are predominant. In the site the endscrapers were made on flakes, while in Cucuteni sites blades were also employed as blanks. The high number of retouched flakes is unusual for a Copper Age industry but for the one in Malnaş Băi it can be explained through the raised presence of flakes at the site, especially of those made of local raw materials. Thus, the question if these dissimilarities are a consequence of the settlement's economic profile or if this is influence of a different cultural and technologic tradition can be asked. Another peculiarity observed for the settlement is the very high number of items used in cereal working (almost 65%, exceeding all the other settlements from the same cultural area). This suggests that the Copper Age inhabitants were practicing intensive agriculture, but future investigations on other categories of artefacts along with with the analysis of macro and micro-botanical remains will bring light on the subject. A corroboration of the use-wear data with the analysis of the archaeo-zoological remains is also needed, in future studies, in order to appreciate the importance of each economic activity that was revealed by use-wear analysis for the settlement and its hinterland, as hunting, hide scraping, hard animal materials processing, etc. At the moment, we can state, that all the activities that the use-wear analysis proved to have been taken place inside the settlement are those expected to have taken place in a Copper Age site as economic subsistence practices. If any of these is prevailing in one part of the site or on the whole area will be answered when further archaeological features will be excavated.

8. Conclusions

Putting together, the results of the PGAA, the techno-morphological and the use-wear analysis of the artefacts it can be stated that lithic assemblage from Malnaş Băi is characterised through various traditions. On the one hand there is the Ariuşd-Cucuteni tradition in processing flints and local raw materials seen in the medium-sized blades, knapped from unipolar cores, in the high percentage of fragmented blanks and tools in retouching the blades through marginal, semi-abrupt, continuous retouch, and in the use of bifacially worked arrowheads and, in a small degree, of geometric microliths.

The other component is rather related to a Tiszapolgár-Bodrogkeresztúr tradition and regards the on-site production of small sized obsidian bladelets. Thus, the legitimate question is who were the people that produced the obsidian tools since the evidence points to a Tiszapolgár- Bodrogkeresztúr specific craft made on place in an Ariuşd settlement.

Summarizing the main results of this research, it can be stated that the investigations on the lithic assemblage from Malnaş Băi provided new and valuable data regarding the distribution networks during the Copper Age. These networks that were connecting various cultural and geographical areas allowed not only the movement of artefacts and raw materials but also the spread of the knowledge and skills related to their production. The obsidian industry from Malnaş Băi stands as a good example. If this process implied the movement of certain individuals between the given communities for merchandize oriented purposes or within other type of social structures, it is a task for future research.

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List of supplementary files

Supplementary file 1
"Vornicu et al. - supplementary file 1 - Chemical composition of comparative lithics.xlsx"
Appendix: Table with chemical composition (wt%) of comparative lithics from Ariuşd group settlements measured by PGAA.

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Cercetări preliminare cu privire la industria litică cioplită din așezarea Epocii Cuprului de la Malnaş Băi (Málnásfürdő)-Füvenyestető (județul Covasna, România)

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Rezumat:

Articolul prezintă cercetările preliminare asupra utilajului litic cioplit descoperit în timpul săpăturilor arheologice din anii 2014-2016, în așezarea eneolitică de la Malnaş Băi (Málnásfürdő)–Füvenyestető (județul Covasna, sud-estul Transilvaniei, România). Din punct de vedere geografic, situl se află în valea râului Olt, vale îngustă ce conectează depresiunile Ciuc și Brașov din bazinul intra-Carpatic. Este amplasat pe o terasă înaltă, delimitată de râul Olt și pârâul Somoș. Cercetările arheologice efectuate, în diverse rânduri în secolul al XX-lea (de către arheologul F. László și prof. dr. A. László) și secolul XXI (coordonate de S.-J. Sztáncsuj și S. Berecki), au arătat că locuirea eneolitică din acest loc se întinde pe o suprafață relativ redusă (0.6 ha), iar ceramica descoperită este tipică pentru aspectul Ariușd al complexului cultural Cucuteni-Trypillia. Datele radiocarbon obținute pentru acest sit indică faptul că a fost locuit, în etape succesive, în a doua jumătate a mileniului 5 î.e.n.

Utilajul litic cioplit a fost abordat dintr-o perspectivă multidisciplinară cu scopul de a caracteriza industria de cioplire a pietrei în funcție de materiile prime prelucrate. O primă etapă a cercetărilor a constituit-o caracterizarea compoziției elementale a materiei prime pentru un set de artefacte prin analiza Prompt Gamma Activation (PGAA). Astfel, prin utilizarea tehnicii PGAA au fost identificate trei mari categorii de materii prime:

1) obsidian ce provine din depozitele geologice denumite în literatura de specialitate drept sursa Carpathian 1, localizată în zona de sud-est a Slovaciei de astăzi (sub-tipuri Viničky, Cejkov sau Kašov);
2) silexuri tipice pentru depozitele geologice ce au aflorat pe malul râului Prut (denumite în articol silex de Prut) și din zona Volhyno-Podoliană (denumite în articol silex Volhynian);
3) roci locale: gresii, riolit silicifiat, *chert*-uri.

Pentru caracterizarea industriei litice, în funcție de materia primă prelucrată, au fost investigate artefactele descoperite în timpul săpăturilor din 2014-2016 din punct de vedere al tehnologiei de producere (prin analiza atributelor morfo-tehnologice), a tipologiei pieselor retușate și investigațiilor urmelor de uzură (analiza traseologică). Rezultatele obținute indică faptul că ar putea fi posibilă diferențierea între două tradiții tehnologice. Prima dintre aceste tradiții vizibilă în artefactele de silex și

cele din roci locale este caracteristică epocii cuprului din estul Munților Carpați, adică culturii Cucuteni-Trypillia. Aceasta se definește prin producția de lame de lungime medie, prin tehnica percuției indirecte. O a doua tradiție o constituie producția de lame mici din obsidian, în tehnologia specifică culturilor Tiszapolgár și Bodrogkeresztúr. Deși această materie primă a fost adusă de la mare distanță, structura tehnologică a colecției de obsidian sugerează prelucrarea sa locală, fiind descoperiți galeți, fragmente de nuclee și tablete de împrospătarea a platformei de lovire și piese corticale. În ceea ce privește tehnologia de retușare și utilizarea uneltelor, nu s-a putut observa nicio diferențiere pe baza materiilor prime în activitățile în care au fost implicate aceste artefacte.

Investigațiile preliminare asupra artefactelor din piatră cioplită din așezarea de la Malnaș Băi au permis identificarea transferului pe distanțe lungi de materiale și tehnologii litice și încadrarea acestei așezări în marile rețelele de schimb ce au existat în perioada epocii cuprului.

Cuvinte cheie: Eneolitic; PGAA; tradiții tehnologice; tipologie; materii prime aduse de la o distanță mare; materii prime locale; traseologie