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Exploring a novelty in the Middle Palaeolithic of Croatia: Preliminary data on the open-air site of Campanož

Erste Daten zu der neu entdeckenten mittelpaläolithsichen Freilandfundstelle Campanož in Kroatien

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Abstract - In recent decades, the body of evidence from Croatian sites contributing to the understanding of Middle Palaeolithic behaviours has been significant. However, the data has been biased towards cave sites. Until recently open-air sites have exclusively been identified on the basis of surface finds, which often raise questions regarding assemblage integrity. Rescue excavations in the Istrian peninsula have recently brought to light the open-air site of Campanož and a substantial amount of new data. The site is a large and densely packed lithic scatter found stratified between two horizons of typical Mediterranean *terra rossa* soil. Among the lithic finds there is a large presence of nodular chert fragments and a smaller proportion of classifiable chert artefacts, which have been recognized as Middle Palaeolithic based on both typological and technological characteristics. A preliminary analysis shows that the blank production methods are coherent at the site. There are few flaking methods in the sample, with most being related to different modes of discoid reduction. Middle Palaeolithic toolmakers repeatedly procured raw materials and produced blanks on-site. Evidence points to the production of small tools, and also indicates recycling of previously discarded artefacts. Although these data are preliminary, the evidence seems to suggest an expedient and flexible technology may have been present in the Middle Palaeolithic of the Northeastern Adriatic. Despite the limited data on age and site formation processes, the site represents a valuable source of information in our understanding of Middle Palaeolithic technological behaviour and land use in the region.

***Zusammenfassung -** In den letzten Jahrzehnten haben die kroatischen Fundstellen viel zum Verständnis der Verhaltensweisen im Mittelpaläolithikum beigetragen. Allerdings sind die Daten vor allem auf Höhlenfunde ausgerichtet. Bis vor Kurzem wurden Freilandfundstellen ausschließlich anhand von Oberflächenfunden identifiziert, die oft Fragen zur Integrität der Funde aufwerfen. Rettungsgrabungen auf der Halbinsel Istrien haben vor kurzem die Freilandfundstelle Campanož und eine beträchtliche Menge neuer Daten ans Licht gebracht. Es handelt sich um eine mächtige, dichte Steinpackung, die zwischen zwei Horizonten aus typisch mediterranem Terra Rossa-Boden eingebettet ist. Unter den lithischen Funden befinden sich viele knotenförmige Hornsteinfragmente und ein kleinerer Anteil an klassifizierbaren Hornsteinartefakten, die aufgrund ihrer typologischen und technologischen Merkmale dem Mittelpaläolithikum zugeordnet werden können. Eine erste Analyse zeigt, dass die Methoden der Grundformproduktion an der Fundstelle kohärent sind. In dem Inventar gibt es nur wenige Methoden der Abschlaggewinnung, wobei die meisten verschiedenen Arten des diskoiden Abbaus in Verbindung stehen. Die mittelpaläolithischen Steinschlägerinnen und Steinschläger beschafften wiederholt Rohmaterial und stellten Grundformen vor Ort her. Es gibt Hinweise auf die Herstellung von kleinen Werkzeugen und auf die Wiederverwertung von zuvor verworfenen Artefakten. Obwohl diese Daten nur vorläufig sind, deuten sie darauf hin, dass es im Mittelpaläolithikum der nordöstlichen Adria eine zweckmäßige und flexible Technologie gegeben haben könnte. Trotz der begrenzten Daten über das Alter und die Entstehungsprozesse stellt die Fundstelle eine wertvolle Informationsquelle für unser Verständnis des technologischen Verhaltens im Mittelpaläolithikum und der Landnutzung in der Region dar.*

Keywords - Middle Palaeolithic, open-air site, discoid technology, *terra rossa*, Istria (Croatia)
Mittelpaläolithikum, Freilandfundstelle, diskoide Technologie, terra rossa, Istrien (Kroatien)

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Introduction

Middle Palaeolithic sites in Croatia have until now provided important data regarding human behaviour. Much of this data comes from sites located in the Peri-Pannonian Northwestern part of Croatia (Karavanić et al. 2018), but in the past twenty years increased focus has been devoted to the research of sites located on the Eastern Adriatic coast. In this region, cave sites have provided relatively well-preserved evidence of Middle Palaeolithic occupation, often in multi-layered stratigraphic sequences (Karavanić et al. 2018), such as in Mujina pećina (Karavanić et al. 2008; Karavanić & Kamenjarin 2020) and Velika pećina in Kličevica (Karavanić et al. 2018), as well as Crvena stijena (Basler 1975; Dogandžić & Đuričić 2017; Whallon 2017) and Bioče (Derevianko et al. 2017; Dogandžić & Đuričić 2017) in Montenegro. Middle Palaeolithic finds are also known from Romualdova pećina in Istria but are still largely unstudied (Komšo 2011; Janković et al. 2017). A multitude of Middle Palaeolithic open-air sites have been found in Dalmatia, but in each case they represent exposed surface finds (Vujević 2009, 2011; Krile & Vujević 2017; Vujević et al. 2017; Karavanić et al. 2018). In addition to the above, one underwater Middle Palaeolithic site was found at Kaštel Štafilić-Resnik in Central Dalmatia (Karavanić & Barbir 2020). In all open-air sites, the admixture with more recent archaeological chrono-cultural units and the representativeness of the assemblages to ones originally deposited are commonly raised questions (Karavanić et al. 2018). Furthermore, the lack of dating limits the assemblages' potential to contribute to a synchronic and diachronic understanding of technological behaviours in this region (Dogandžić & Đuričić 2017). Hence, the relative significance of open-air sites from the Eastern Adriatic in understanding Neanderthal behaviour in the wider area of the Central Mediterranean and Southeastern Europe has thus far been limited.

The archaeological record from Northeastern Italy provides a more complex picture of Middle Palaeolithic settlement in the context of the Northern Adriatic region (Peresani 2003, 2011). The Northeastern Italian Middle Palaeolithic record started in the Late Middle Pleistocene (Picin et al. 2013) and lasted until some 42 ka BP (Higham et al. 2009; Peresani et al. 2008, 2011; Peresani 2011). Sites with evidence of Middle Palaeolithic occupation are located in the Italian Prealps, bordering the alluvial plain of the Po and other rivers in the Veneto-Friuli area, as well as in the karstic plateau of the Berici Hills and the volcanic Euganean Hills (Peresani 2011). Most of the sites in the region are caves/rockshelters, but some open-air sites are also known (Peresani 2011). These are commonly represented by surface collections (Bertola & Peresani 2000), but in some instances distinct stratified horizons have been documented (Peresani 2000-2001). Among cave sites, some preserve relatively long stratigraphic sequences of human occupation (Peresani 2012). Levallois technology is dominant in the region throughout the duration of the Middle Palaeolithic, although industries with Quina and discoid technology also appear (Peresani 2003, 2012; Peresani et al. 2014; Jéquier et al. 2015).

The sites in the region occupy a variety of landscapes, with those in the Prealps having access to different ecological zones within relatively short distances (Peresani 2011). Certain biases also seem to be present in the pattern of known site contexts and their geographical distribution, most likely related to local geomorphological and lithological conditions (Margaritora et al. 2020). Taken as a whole, the region presents different land use and mobility patterns. In one example, the assemblage of Unit A9 at Grotta di Fumane (Peresani 1998, 2012) in the Venetian Prealps shows evidence of logistical mobility from the differential use of local and semi-local raw materials (Delpiano et al. 2018). On the other hand, some sites such as Grotta Broion in the Berici Hills (Peresani & Porraz 2004); Rio Secco in the Carnic Prealps (Peresani et al. 2014), Caverna Generosa in the Lombard Prealps (Bona et al. 2007) and Caverna degli Orsi in the Trieste Karst (Boschian 1999-2000) display evidence of ephemeral occupation and/or specialized function with scarce evidence of toolmaking and use, in which raw material availability was a contributing factor in provisioning strategies (Peresani 2011). Finally, some sites are probably representative of repeated provisioning at raw material outcrops (Peresani 2000-2001).

In the Eastern Adriatic, the understanding of Middle Palaeolithic settlement patterns and behaviour is also limited by the nascency of geoarchaeological research in Croatia (with notable exceptions in Gerometta 2017 and Boschian et al. 2017). Wide-ranging Quaternary geomorphological trends are understudied or practically unknown, which is also the case for periods older than the Middle Palaeolithic (cf. Tourloukis 2010), significantly restricting the understanding of Middle Palaeolithic site burial, preservation and exposure. This, in turn, limits the degree to which the lack of sites can be discussed in terms of different factors, i.e. demographics (Premo & Kuhn 2010) or ecology (Karavanić et al. 2022), while also constraining reconstructions of the variability of land use in a regional setting. An exception is represented by the more intensively researched topic of marine transgression during the Late Glacial-Holocene, which has been recognized as a significant factor in altering the archaeological record of the Adriatic region (Benjamin et al. 2017; Karavanić & Barbir 2020). Therefore, the discovery of new Middle Palaeolithic sites in the Eastern Adriatic has mostly been fortuitous. One such discovery is the open-air site of Campanož in the southern Istrian Peninsula, which has the potential to improve our understanding of the Middle Palaeolithic in this part of Europe for several reasons. The site fills in a crucial geographic gap in the circum-Adriatic region, between the Northeastern Italian record and the sites in Dalmatia. More importantly, the site is located in a lowland context, which is very different from the contexts of the majority of the sites in Northeastern Italy (Margaritora et al. 2020), and which could have occupied a more central position within the palaeogeographical region of the Great Adriatic Plain (Maselli et al. 2014 ; Benjamin et al. 2017).

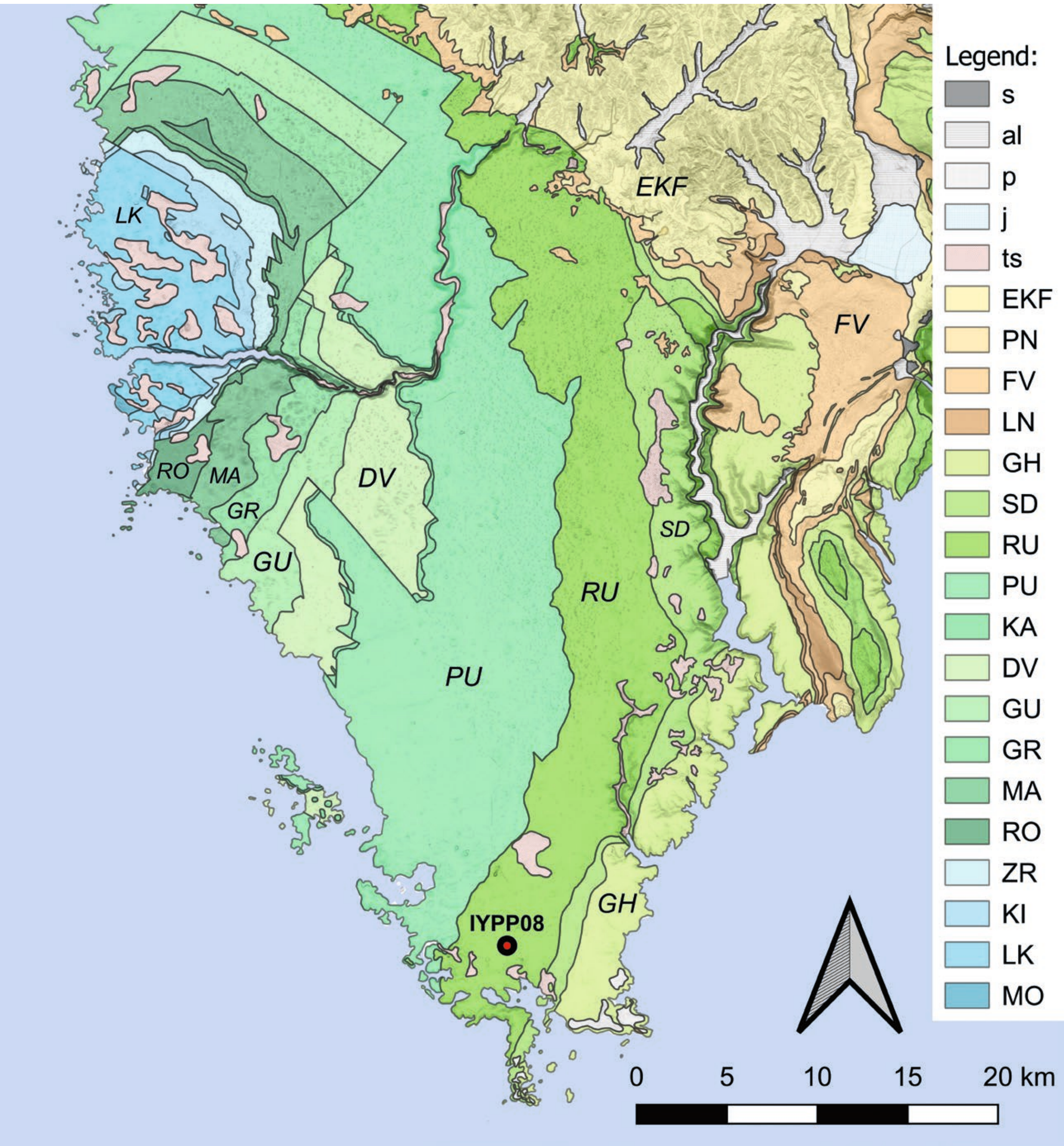

Fig. 1. The location of Campanož (IYPP08) in the Istrian peninsula. Geological map modified after Miko et al. (2013) , 25 m digital elevation model (DEM) from https://geoportal.dgu.hr/. Geological formations in the legend: Jurassic – MO(Monsena), LK(Limski kanal), KI(Kirmenjak Member of Poreč Formation), ZR(Zlatni Rt Member of Poreč Formation); Lower Cretaceous – RO(Rovinj), MA(Materada), GR(Gradina-Cisterna Member of Limska Draga Formation), GU(Gustinja Member of Limska Draga Formation), DV(Dvigrad), KA(Kanfanar), PU(Pula); Upper Cretaceous – RU(Rušnjak), SD(Sveti Duh), GH(Gornji Humac); Paleocene – LN(Liburnian deposits); Eocene – FV(Foraminiferal limestones), PN(Transitional deposits), EKF(Eocene clastic deposits and flysch); Quaternary – ts(Terra rossa), j(Lacustrine deposits), p(Sand and loess), s(Scree deposits and scree breccia).

Abb. 1. *Die Lage von Campanož (IYPP08) auf der Halbinsel Istrien. Geologische Karte geändert nach Miko et al. (2013). Geologische Formationen in der Legende: Jura – MO(Monsena), LK(Limski kanal), KI(Kirmenjak Member of Poreč Formation), ZR(Zlatni Rt Member of Poreč Formation); Unterkreide – RO(Rovinj), MA(Materada), GR(Gradina-Cisterna Member of Limska Draga Formation), GU(Gustinja Member of Limska Draga Formation), DV(Dvigrad), KA(Kanfanar), PU(Pula); Oberkreide – RU(Rušnjak), SD(Sveti Duh), GH(Gornji Humac); Paläozän – LN(Liburnische Ablagerungen); Eozän – FV(Foraminiferenkalke), PN(Übergangsablagerungen), EKF(Eozäne klastische Ablagerungen und Flysch); Quartär – ts(Terra rossa), j(Lacustrine Ablagerungen), p(Sand und Löss), s(Scree Ablagerungen und scree Brekzie).*

Geographical and geological contexts

The site of Campanož is located in the southern part of the Istrian peninsula in the Northeastern Adriatic region (Fig. 1). The peninsula is part of the Adriatic Carbonate Platform, with carbonate formations spanning the Jurassic-Cretaceous-Paleogene (Vlahović et al. 2005a). The Western Istrian Anticline, oriented southwest-northeast, is the dominant structural element of the western and southern part of the peninsula, with Jurassic beds and members forming the core area (Polšak & Šikić 1973). In the southern and southeastern parts of the peninsula, Lower and Upper Cretaceous limestone members forming the bedrock become progressively younger towards the southeast (Polšak 1970). These formations have been designated informally as Pula, Rušnjak, Sveti Duh and Gornji Humac by Miko et al. (2013). The western and southern parts of the peninsula form a wide carbonate plain (Miko et al. 2013). Karstic features appear interspersed within this area, formed by the dissolution of the underlying carbonates. Paleogene (Eocene) strata cover most of the central basins of the peninsula (around Pazin) and the mountainous areas in the northeastern part of the peninsula, where the largest uplift and structural folds occur (Vlahović et al. 2005b; Miko et al. 2013). Paleogene deposits were eroded from the southern and western parts after the final emersion during the Late Paleogene and Neogene, during a process that also created the karstic peneplain (Polšak 1970; Miko et al. 2013).

The formation of sediments and soils during the Quaternary was partly influenced by the distribution of the different bedrocks. *Terra rossa*, or Red Mediterranean soils, developed on the carbonate substrate in the western and southern parts of Istria, while rendzinas, brown soils and alluvial sequences formed on the flysch deposits in the interior (Bašić 2013; Miko et al. 2013). In local geological jargon, these areas are referred to as "Red Istria", meaning limestone-*terra rossa*, and "Grey Istria", referring to Eocene flysch (Miko et al. 2013).

The *terra rossa* soil mantle varies in thickness as a function of local relief, reaching significant depths in the various karstic basins and depressions in the area, thus forming pedo-sedimentary units (Durn 2003). It has been suggested that *terra rossa* soils initially formed during the Tertiary and are thus relict soils or even Vetusols (Durn 2003). However, it is certain that some *terra rossa* soils formed and have continued forming during the Quaternary (Durn 2003). While sometimes considered to have largely formed due to the dissolution of the underlying carbonates, recent investigations have shown that *terra rossa* soils are probably polygenetic, with their granulometric and mineralogical content not always corresponding to the underlying limestone (Durn et al. 2007; Durn 2003). Furthermore, granulometric content and heavy minerals of *terra rossa* soils in southern Istria suggest that some of the matrix derived from reworked aeolian loess, most probably of Middle Pleistocene age (Durn 2003; Durn et al. 1999, 2007). The most recent of these pedogenetic phases in the upper parts of *terra rossa* profiles probably incorporated Upper Pleistocene loess (Durn et al. 2007).

In some parts of Istria, distinct loess deposits have formed during the colder phases of the Upper Pleistocene due to aeolian processes and are often intersected with palaeosols indicative of pauses in deposition and more favourable conditions. The most significant loess-palaeosol sequences are found in Savudrija (Zhang et al. 2018) and the Premantura peninsula (Durn et al. 1999), the northwestern and southern edges of the Istrian peninsula respectively. In both areas of loess presence, aeolian sediments cover *terra rossa* palaeosols (Durn et al. 1999; Zhang et al. 2018).

Research history and site stratigraphy

The site of Campanož (IYPP08) is located about 5 km west from the city of Pula and about 4 km northwest from the town of Medulin (Fig. 1). It is located on the southwestern slope of a low hill. The dip of the slope is southwest-northeast and has a very low angle (about 2°). The bedrock of the site and its immediate surroundings are made of Upper Cretaceous (Cenomanian) limestones (Polšak 1970), which are part of the Rušnjak Formation (Miko et al. 2013). In the wider area, the bedrock is unevenly covered by the *terra rossa* soil mantle.

Chert artefacts were discovered on the surface of the site in 2009 during rescue surveys on the route of the Peličeti-Pomer bypass by D. Komšo and M. Čuka of the Archaeological Museum of Istria (Komšo 2010). In 2010, fourteen 1.5 x 1.5 m test trenches were excavated to assess the stratigraphy and determine the horizontal extent of the site (Čuka et al. 2011). In trenches 8 and 10-14 a single layer of chert finds was recorded, among which lithic artefacts were recognized, preliminarily attributed to the Middle Palaeolithic. In 2011, the excavation was extended to an area of 99 m^2 in order to determine the limits of the site and recover as much archaeological materials as possible (Fig. 2: A). The new excavation area was further divided into 0.75 x 0.75 m squares, following the grid pattern established in 2010. Excavation was conducted with small tools and sediments from the chert-bearing horizon were dry sieved, although not systematically. Squares were excavated to the bedrock alternately, and in every square in which they were excavated, the sediments below the stone layer were recorded as sterile.

Several stratigraphic units (SU) were identified at the site (Fig. 2: B):

- SU 1 – the upper horizon of *terra rossa* which includes the surface A horizon of the soil, silty-clay. Thickness varies from 30 to 60 cm. SU 1 colour is

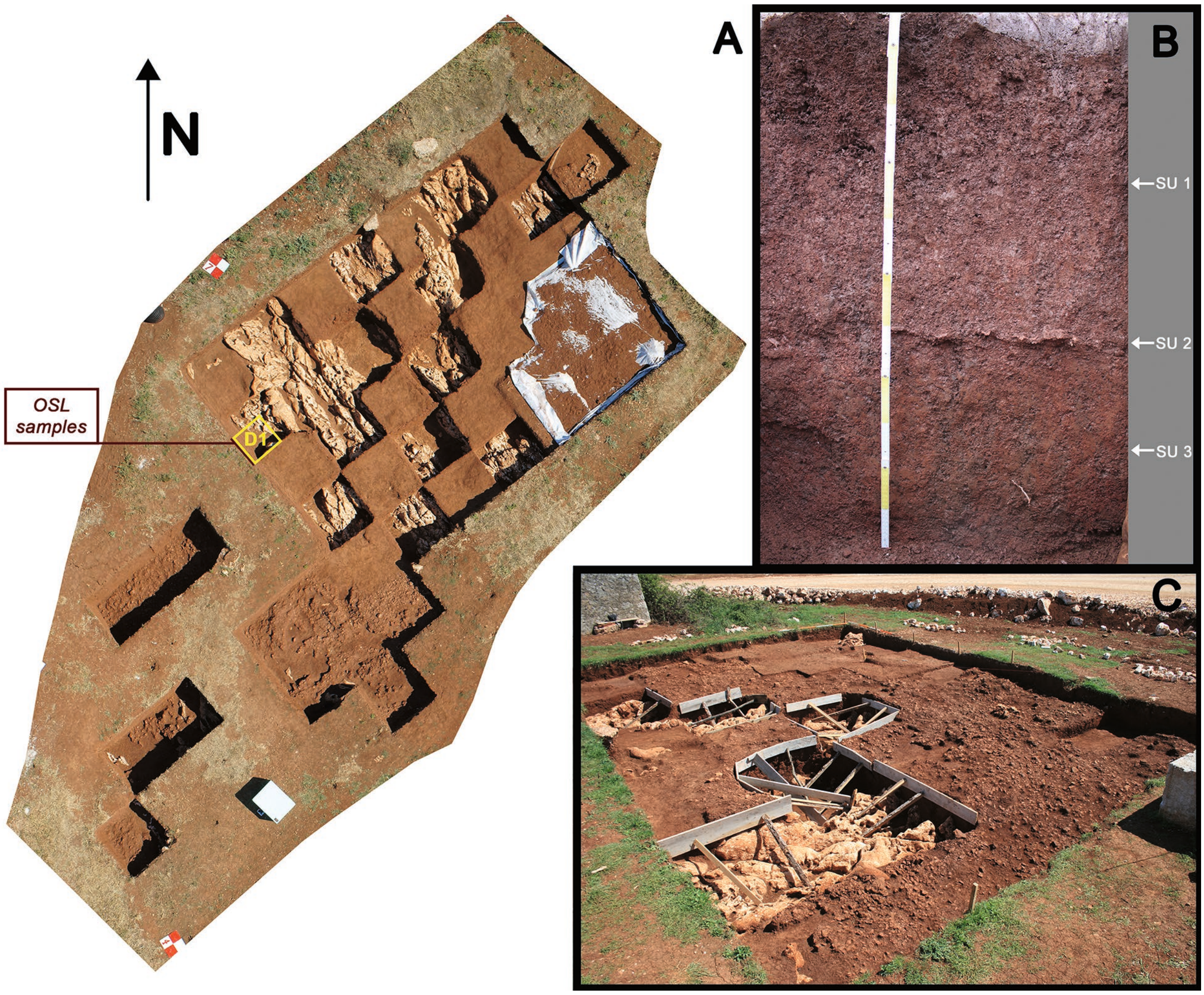

Fig. 2. Field documentation from Campanož: A – Orthoimage of the excavation surface. In the southern squares the stone layer (SU 2) is still present. The positions of square D1 and the section where OSL samples were collected are marked; B – SW profile in square D1 with the major stratigraphic units marked, taken in 2020; C – the surface of the stone layer (SU 2) taken during excavation, viewpoint from the west. Photo credit for A and C: Archaeological Museum of Istria.

Abb. 2. *Felddokumentation aus Campanož: A – Orthofoto der Ausgrabungsfläche. In den südlichen Quadraten ist die Steinschicht (SU 2) noch vorhanden. Die Positionen des Quadrats D1 und des Abschnitts, in dem OSL-Proben entnommen wurden, sind markiert; B – SW-Profil im Quadrat D1 mit Markierung der wichtigsten stratigrafischen Einheiten, aufgenommen im Jahr 2020; C – die Oberfläche der Steinschicht (SU 2), aufgenommen während der Ausgrabung, Blick von Westen. Bildnachweis für A und C: Archäologisches Museum von Istrien.*

MUN 2.5YR 2.5/4 dark reddish brown. Sporadically contains chert fragments and artefacts, as well as more recent waste within the top of this Unit (i.e., ceramic, osseous and construction materials).

- SU 1/2 – arbitrary designation of the transition between SU 1 and the stone layer (SU 2). It contains some small amount of chert finds. The boundary with the underlying stone layer is natural and abrupt.
- SU 2 – stone layer, consisting of numerous chert fragments and artefacts (Fig. 2: C). Most of the unit has a thickness of one stone (ca. 1-10 cm) and contains both large (>100 mm) and very small chert (<10 mm) pieces. While chert finds seem to be quite concentrated in some places, imbrication was not recorded. The unit slopes towards the southwest at about 4°. The inclination differs from that of the modern surface, resulting in its greater depth in the southern and southeastern parts of the site. Therefore, depth varies from 30 to 70 cm below the present surface. Furthermore, in some areas of the site the unit undulates, seemingly following the contours of the underlying bedrock. No organic remains and charcoal fragments were recorded within this unit.
- SU 3 – lower *terra rossa* horizon, clayey, devoid of stones, highly red (MUN 2.5YR 3/4 dark reddish brown). Thickness varies in accordance with the morphology of the underlying bedrock, and can reach up to 70 cm. The unit is archaeologically sterile. Overlies the limestone bedrock.
- SU 8 – Limestone bedrock, does not contain chert nodules in any of the exposed squares. In some of the downslope squares, the bedrock rises higher and intersects with SU 2.

Alongside the above-described horizons, several other stratigraphic units were described, which relate to smaller features at the site:

- SU 4 – grey-brown loose sediment (possibly pit?) in squares A6-10 and B7-10. At the bottom of this unit, a partial Roman amphora was found. The stone layer was visibly disturbed within and around this unit, i.e. the chert finds are highly dispersed. The unit also contains more recent waste (i.e., plastic, glass and concrete).
- SU 5 – a unit that disturbed the stone layer in squares I-J/4. Chert finds are mixed with modern waste. Above the level of SU 2, a concrete block was present within SU 1, the burial of which probably disturbed the stone layer.
- SU 6/7 – a cluster of limestone blocks in square H-5, about five large stones arranged in a semicircle with weathered wood remains in the centre representing a recent construction. The stone layer was visibly disturbed in this area, and it was absent around the limestone cluster.
- SU 9/10 - a cluster of limestone blocks in squares C-D/15-16, about eight mid-sized stones arranged in a circle ca. 30 x 20 cm. Although it resembles the construction of SU 6/7, it does not contain weathered wood. It is probably a recent construction.

Fe-Mn nodules (iron-manganese concretions) are frequently found in the sediments of the site. As horizons overlaying and underlying the stone layer are both clayey and display significant rubification they can be designated as subsoil horizons with clay accumulation (Bt).

Dating

In an effort to radiometrically date the site, in 2020 two sediment samples were collected for OSL dating by hammering metal tubes into the profile of square D1, one 10 cm above the stone layer of SU 2 and one 10 cm below it, in order to obtain minimum and maximum ages of the artefact's deposition. OSL dating was conducted at the Luminescence Dating Laboratory, Institute of Physics – Centre for Science and Education of the Silesian University of Technology. Dose rate radioactivity was measured by gamma spectrometry, and both samples included 45-63 µm quartz grains. The grains were etched in 40 % HF for 45 minutes. The determination of the equivalent dose (D_E) was conducted by the single aliquot regenerative (OSL-SAR) method (Murray & Wintle 2000). The complete dating procedure is available in Moska et al. (2021).

The underlying sediment sample (SU 3) was dated by OSL to 30.1 ± 2.3 ka, and the overlaying sediment to 12.73 ± 0.62 ka (Tab. 1). While both dates are within the range of Late Pleistocene (130-12 ka), the date of underlying sample is at minimum some 7 ka younger than the known calibrated ^{14}C dates for the terminal Middle Palaeolithic (Higham et al. 2014). Thus, while the character of the assemblage points to Middle Palaeolithic, the OSL dates do not support this at first. However, the dates may be underestimated because of the inclusion of bleached quartz grains due to bioturbation (Bateman et al. 2003). In several squares, small eroded fragments of ceramics were found in SU 2. Likewise, during the 2020 sampling both active root canals reaching the lowermost unit (SU 3) and drab halos (MUN Gley 2 8/5B light bluish grey) were recorded. Therefore, the effects of bioturbation as an agent of downward transport of mineral grains cannot be ruled out. Future dating efforts should include single-grain measurements to assess the relative contribution of bleached grains (Bateman et al. 2003). Furthermore, both results are Minimum Age Models (MAM) (Galbraith et al. 1999) of multiple aliquots, and thus may have excluded the larger D_E under the assumption of partial bleaching and/or upward movement of grains. The results may, in fact, date the age of major sediment reworking (Bueno et al. 2013). Based on that, the current state of radiometric dates does not allow for a more precise temporal resolution of the site use within the Pleistocene, and the attribution to the Middle Palaeolithic currently rests solely on the grounds of techno-typology.

Materials and Methodologies

Overall, 97,396 chert finds were recovered from SU 2 and SU 1/2 (Fig. 3), and several thousand more finds were recovered from the modern surface, the upper *terra rossa* horizon (SU 1), and the units that disturbed SU 2. The vast majority of the finds (91,514; 94 %) are unidentifiable chunks and chips (Tab. 2), whereas 5,882 finds are classifiable artefacts, which is only 6 % of the assemblage. Additionally, included with the chunks is a group of 5,539 finds that are questionable pieces, as the attributes they display are reminiscent of, but not unambiguously attributable to human action. The artefacts were defined based on the presence of attributes shown to be diagnostic of human knapping by Peacock (1991). The latter does not imply a natural origin of the entirety of the remaining chunks, i.e., that they should be regarded as geofacts. Simply, they do not bear clear flake scars and surfaces that can be associated with intentional flaking.

The entire assemblage is heavily patinated and most of the chert elements have been altered. This phenomenon has led to a loss in mass in most pieces, and this measure cannot be considered as a reliable proxy of size due to the possibility of differential weathering. Furthermore, the patination has significantly constrained the definition of raw material classes in high resolution, as the vast majority of finds macroscopically presents similar light brown-beige-pink patinas (MUN 7.5YR 8/2 pinkish white; MUN 7.5 8/4 pink; MUN 7.5 YR 8/6 reddish yellow;

ID	Strati-graphic unit	Depth (cm)[1]	H20 (wt %)[2]	K-40 (Bq/kg)	Th-232 (Bq/kg)	U-238 (Bq/kg)	Cosmic dose rate (Gy/ka)[3]	Total Dose Rate (Gy/ka)	No. of ali-quots	D_E (Gy)[4]	OSL age ± 1σ (ka)
GdTL-3829	SU 1	48 (65)	15 ± 5	594 ± 50	91.9 ± 3.5	53.9 ± 2.2	0.225 ± 0.023	4.33 ± 0.17	13	55.4 ± 1.6	12.73 ± 0.62
GdTL-3830	SU 3	69 (88)	15 ± 5	574 ± 48	96.2 ± 3.4	51.4 ± 1.9	0.211 ± 0.021	4.28 ± 0.16	10	129.4 ± 8.4	30.1 ± 2.3

Tab. 1. Results of luminescence dating of sediment samples from Campanož (IYPP08). Dose rate radioactivity measurements by germanium spectrometer. Determination of the equivalent dose by OSL-SAR single aliquot regenerative method. Regenerative doses (in Gy) of 35, 50, 85, 150 for GdTL-3829, and 100, 150, 250, 400 for GdTL-3830. Nonlinear growth of OSL taken into account. Notes: 1 – Depth in brackets corresponds to depth after 2011; 2 – Assumed mean water content; 3 – Calculated from Prescott & Hutton (1994); 4 – Minimum Age Model (MAM) (Galbraith et al. 1999).

Tab. 1. *Ergebnisse der Lumineszenz-Datierung von Sedimentproben aus Campanož (IYPP08). Dosisleistungsmessungen der Radioaktivität mit dem Germanium-Spektrometer. Bestimmung der Äquivalentdosis mit der OSL-SAR-Einzelaliquot-Regenerationsmethode. Regenerative Dosen (in Gy) von 35, 50, 85, 150 für GdTL-3829 und 100, 150, 250, 400 für GdTL-3830. Das nichtlineare Wachstum von OSL wurde berücksichtigt. Anmerkungen: 1 – Die Tiefe in Klammern entspricht der Tiefe nach 2011; 2 – Angenommener mittlerer Wassergehalt; 3 – Berechnet nach Prescott & Hutton (1994); 4 – Minimum Age Model (MAM) (Galbraith et al. 1999).*

MUN 10YR 8/2 very pale brown). The similarities of surface colour are also probably the result of staining by iron oxides in the soil matrix. In light of this issue, it is possible to identify at least three classes of raw materials, which are not necessarily related to different geological formations:

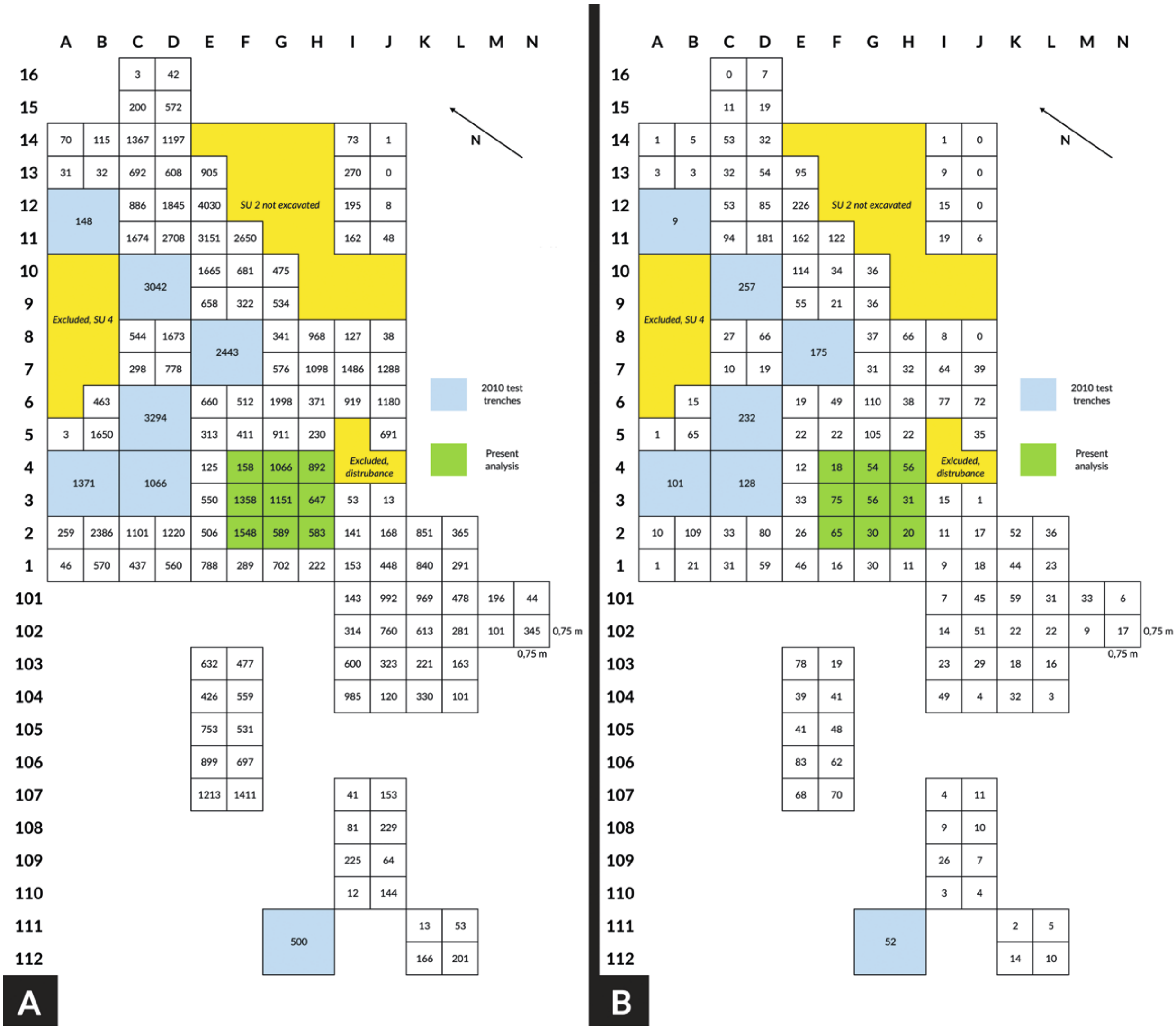

Fig. 3. Plan of the site with the number of all chert finds (A) and selected artefacts (B) in each square.

Abb. 3. *Plan der Fundstelle mit der Anzahl aller Hornsteinfunde (A) und einzelner Artefakte (B) in jedem Quadrat.*

Square	Artefacts (N)	Artefacts (%)	Chunks (N)	Chunks (%)	Total (N)
F-2	65	4.2	1,483	95.8	1,548
F-3	75	5.5	1,283	94.5	1,358
F-4	18	11.4	140	88.6	158
G-2	30	5.1	559	94.9	589
G-3	56	4.9	1,095	95.1	1,151
G-4	54	5.1	1,012	94.9	1,066
H-2	20	3.4	563	96.6	583
H-3	31	4.8	616	95.2	647
H-4	56	6.3	836	93.7	892
Total	405	5.1	7,587	94.9	7,992
SU 2 (entire site)	5,882	6	91,514	94	97,396

Tab. 2. Counts and percentages of classifiable artefacts and non-classifiable chunks in SU 2 and SU 1/2 of the sampled squares and the entire site.
Tab. 2. *Zählungen und Prozentsätze von klassifizierbaren Artefakten und nicht klassifizierbaren Stücken in SU 2 und SU 1/2 der beprobten Quadrate und der gesamten Fundstelle.*

1. Nodular cherts with zones of varying silica content, of ovoid or irregular shapes, varying in size.
2. Small flat elongated nodules of translucent and fossiliferous chert. The patination is of pure white colour.
3. Flat tabular chert, not exceeding 2-3 cm in thickness, presenting an overall uniformity in terms of silica content, when compared to nodular cherts. Despite the tabular appearance of fragments and artefacts made on such fragments, the specimens ascribed to this category may originate from thin lenticular nodules.

Most finds fall within category 1 and 3. The closest known primary sources of chert are located within southwest-northeast stretching Upper Cretaceous limestone members of the Sveti Duh Formation located at minimum about 3-4 km east and southeast from the site (Fig. 1) (Miko et al. 2013; Polšak 1967, 1970). Given the abundance of lithic materials, the contribution of these sources seems likely. A preliminary investigation of the lithic finds from Campanož and an analysis of the selected samples, indicate that the origin of raw material can be traced to the Upper Cretaceous (Lower Turonian) formation of platy limestones with cherts with major outcrops on the Vižula peninsula and Polje inlet on the Premantura peninsula (Z. Perhoč, personal comm.), which coincides with the informal Sveti Duh Formation of Miko et al. (2013) (Fig. 1: SD). Furthermore, some of the raw material likely originated from Upper Turonian rudist-bearing limestones southeast from Medulin, as well as from Coniacian rudist-bearing and platy limestones with cherts, the outcrops of which appear from the Budava inlet to the Marlera peninsula (Z. Perhoč, personal comm.). The latter formation is encompassed by the informal Gornji Humac Formation of Miko et al. (2013) (Fig. 1: GH). In order to resolve the outlined questions on the distribution and relative contribution of different raw material sources to the assemblage, a more detailed raw material study is in progress.

The origin of the chunks and chips on the site is still unresolved. Middle Palaeolithic extraction and reduction sites in the Mediterranean show a similar predominance of chunks in the assemblages (Peresani 2000-2001; Yaroshevich et al. 2018). However, there are several lines of evidence that suggest that the presence of some raw materials at the site is anthropogenic. Namely, there is an absence of evidence for the natural occurrence of chert in the Cenomanian limestones of the Rušnjak Formation in southern Istria (Miko et al. 2013; Polšak 1970), and more specifically in the bedrock of the site (Čuka et al. 2011), unlike at the extraction sites mentioned above (Peresani 2000-2001; Yaroshevich et al. 2018). Furthermore, there is also a presence of different raw material classes at Campanož, and even perhaps cherts of different geological contexts. However, given the relative predominance of chunks in the assemblage, it is conceivable that a source in the immediate vicinity could have contributed to the assemblage or that the site itself could also be a secondary deposit of chert. Unfortunately, prior to raw material provenience studies and geological surveys of the site surroundings, it is not possible to speculate on a definite resolution of this matter.

Given the poor knapping qualities of the raw material, at least a small part of the chunk assemblage probably represents pieces that fractured irregularly during toolmaking. Additionally, many fragmented artefacts display irregular and granular fracture surfaces that are either post-depositional or portions of cracks that were already present in the raw material before knapping. Thermal damage is also attested in the form of pot-lids and pot-lid scars (Patterson 1995). Thus, raw material characteristics and post-depositional processes have also probably contributed to the amount of irregularly, and hence non-diagnostically, fractured chert pieces. For the purpose of the present study, a small subset of the overall classifiable artefact assemblage was selected for lithic analysis. The sample comes from squares F-H/2-4 (Fig. 3). These squares were selected because they represent the deeper end of the site and are thus conceivably less affected by more recent disturbances. The sample consists of 405 elements, and therefore represents 6.9 % of the entire artefact assemblage from SU 2 and SU 1/2. The number of chunks in these squares is 7,587, i.e., 95 % of all lithic finds in these squares (Tab. 2). Thus, the proportion of artefacts among all lithic finds in SU 2 and SU 1/2 of squares F-H/2-4 is 5 %, which corresponds to the percentage of diagnostic artefacts in the entire assemblage of SU 2 and SU 1/2 (Tab. 2).

The artefact sample was analysed technologically, applying both diacritic analysis (i.e., the identification of flaking sequences through the analysis of the knapping directions and the order of each removal visible on each artefact, Dauvois 1976, Inizan et al. 1999) and attribute analysis (Andrefsky 2005). Attributes recorded for the pieces encompass both qualitative and quantitative data. Qualitative attributes relate to technological, typological and morphological data, and quantitative to metric data (length, width, thickness). Tools were classified after Debénath & Dibble (1994).

Measurement procedures for flakes correspond to the Axial method (Dogandžić et al. 2015: Fig. 3c). According to this method, the length of flakes was measured as a straight line from the point of impact to the distal end, following the axis of percussion. Width was measured as a perpendicular line at the midpoint of length, and thickness was measured at the intersection of length and width. This measuring procedure was also applied to incomplete flakes, i.e., flake fragments, but their dimensions were excluded in the analysis. Core length is the maximum linear dimension, width is the largest dimension located at the midpoint of the maximum linear dimension and perpendicular to it. Core thickness is measured at the intersection of length and width. The same measurement method was applied to indeterminate pieces. Measures were recorded in millimetres.

Additionally, some attributes related to taphonomy were recorded. They include patina characteristics, presence of edge damage, presence of rounding and presence of thermal damage (Burroni et al. 2002; Patterson 1995). However, a detailed taphonomic analysis is beyond the scope of this paper.

Results

The general structure of the artefact assemblage is the following (Tab. 3): complete flakes are the most abundant with 189 examples (46.7 %), followed by flake fragments with 138 examples (34.1 %). Cores occur with 37 examples (9.2 %) and cores on flakes with 15 examples (3.7 %). Core fragments are represented by 15 cases (3.7 %). There is a single example of a tested nodule and one retouched natural fragment. Nine elements (2.2 %) are considered indeterminate, as it cannot be established whether they are flake or core fragments.

Cores

Several types of cores are found in the sample (Tab. 4; Figs. 4-7). The largest group is composed of different subtypes attributed to discoid technology *sensu lato* (Mourre 2003; Terradas 2003), followed by unidirectional/bidirectional and multidirectional multifacial cores (SSDA, Forestier 1993). In the following sections each core type is described in more detail.

Discoid cores

The most common subtype in the group of discoid cores are the centripetal ones (Tab. 4, Fig. 4: 1-3 & 5-6), which constitute half of all complete discoid cores. These include both unifacial (3), and more commonly, bifacial cores (11). Bifacial cores are non-hierarchical with asymmetrical surfaces. A common feature is that one flaking face is flatter and more parallel to the intersecting surface between the two core faces, while the other is more tangent. This seems to be a feature of the raw material packages used, rather than a purposeful volumetric organization (Fig. 4: 3). In some cases, however, cores are asymmetrically biconvex (Fig. 4: 1-2 & 5). It is observable that alternate exploitation of the core surfaces was organised according to variable rhythm: on some cores, the knapping sequences were conducted by extracting a flake alternately on each surface (Fig. 4: 2), while in other cores several adjacent removals were performed before reversing the core (Fig. 4: 5). Platform faceting is rare and seems to have been used unsystematically. Most of the discoid cores retain some cortex and indicate that ovoid or flat nodules were mostly selected for exploitation. At least two examples display a difference in patina that points to the use of naturally fractured nodules (Fig. 4: 1). Out of the 14 centripetal cores, four are cores on flakes. In these examples, flaking was conducted on both dorsal and ventral sides of the original flake. Three core fragments are ambiguously attributed to this group (Tab. 4).

Another subtype within the discoid group are the small discoid cores (Fig. 4: 4). In this core group, only one example is a complete core, and the other three are fragmented. The average dimensions of these cores, including the core fragments (L: 33; W: 20; T: 15.1 mm), are smaller than the average dimensions of centripetal cores, including the core fragments (L: 58.7; W: 43.9; T: 24.1 mm). Of the four cores, three are bifacial and biconvex, while one is essentially trifacial. What separates this subtype from the larger subtype of centripetal cores are the pronounced convexity and the lack of flaking faces that take advantage of the largest surfaces of the piece. Despite their small size, there is no unambiguous evidence that these cores were made from flakes. They probably represent fully exhausted cores, but it cannot be argued with certainty if the initial volumes of the exploited raw materials were much larger. Only one of these cores retained cortex (Fig. 4: 4).

Technological category		N	%	R[1] (N)	R[1] (%)
Debitage		**327**	**80.8**	-	-
	Flake	136	33.6	18	13.2
	Debordant flake	22	5.4	5	22.7
	NB knife	17	4.2	5	29.4
	Rejuvenation flake	4	1	1	25
	Double cortical back	2	0.5	-	-
	Kombewa flake	1	0.2	1	100
	Blade	1	0.2	-	-
	Flake (tool)	6	1.5	6	100
	Flake fragment	138	34.1	14	10.1
Cores		**67**	**16.5**	-	-
	Core	37	9.2	-	-
	Core on flake	15	3.7	-	-
	Core fragment	15	3.7	-	-
Tested nodule		**1**	**0.2**	-	-
Retouched natural piece		**1**	**0.2**	1	100
Indeterminate		**9**	**2.2**	-	-
Total		**405**	**100**	**51**	**12.6**

Tab. 3. Count and percentages of technological categories in the sample assemblage, including the amount and percentage of retouched elements within each specific technological category. *Note: 1 – R=retouched.

Tab. 3. *Anzahl und Prozentsätze der technologischen Kategorien in der Stichprobe, einschließlich der Anzahl und des Prozentsatzes der retuschierten Elemente innerhalb jeder spezifischen technologischen Kategorie. *Anmerkung: 1 – R=retuschiert.*

Core type		Core	Core on flake	Total	Core fragment
Discoid *sensu lato*		**20**	**7**	**26**	-
	Centripetal	10	4	14	3
	Small discoid	1	-	1	3
	Bifacial recurrent	2	2	4	2
	Recurrent tabular	6	1	7	3
Prepared cores (Levallois)		**2**	**-**	**2**	-
Unidirectional/Bidirectional		**5**	**2**	**7**	-
	Unidirectional incipient	2	-	2	1
	Unidirectional prismatic	1	2	3	1
	Bidirectional prismatic	2	-	2	-
Unidirectional/Centripetal early-stage		**5**	**-**	**5**	-
Multifacial multidirectional (SSDA)		**4**	**4**	**8**	-
	Multifacial multidirectional incipent	2	-	2	-
	Multifacial multidirectional	2	4	6	-
Others		**2**	**2**	**4**	-
	Short sequence alternate	1	-	1	-
	Single removal	-	1	1	-
	Single removal recycled	1	-	1	-
	Kombewa	-	1	1	-
Indeterminate		-	-	-	2
Total		**37**	**15**	**52**	**15**

Tab. 4. Core types according to core technological categories.

Tab. 4. *Kerntypen nach technologischen Kernkategorien.*

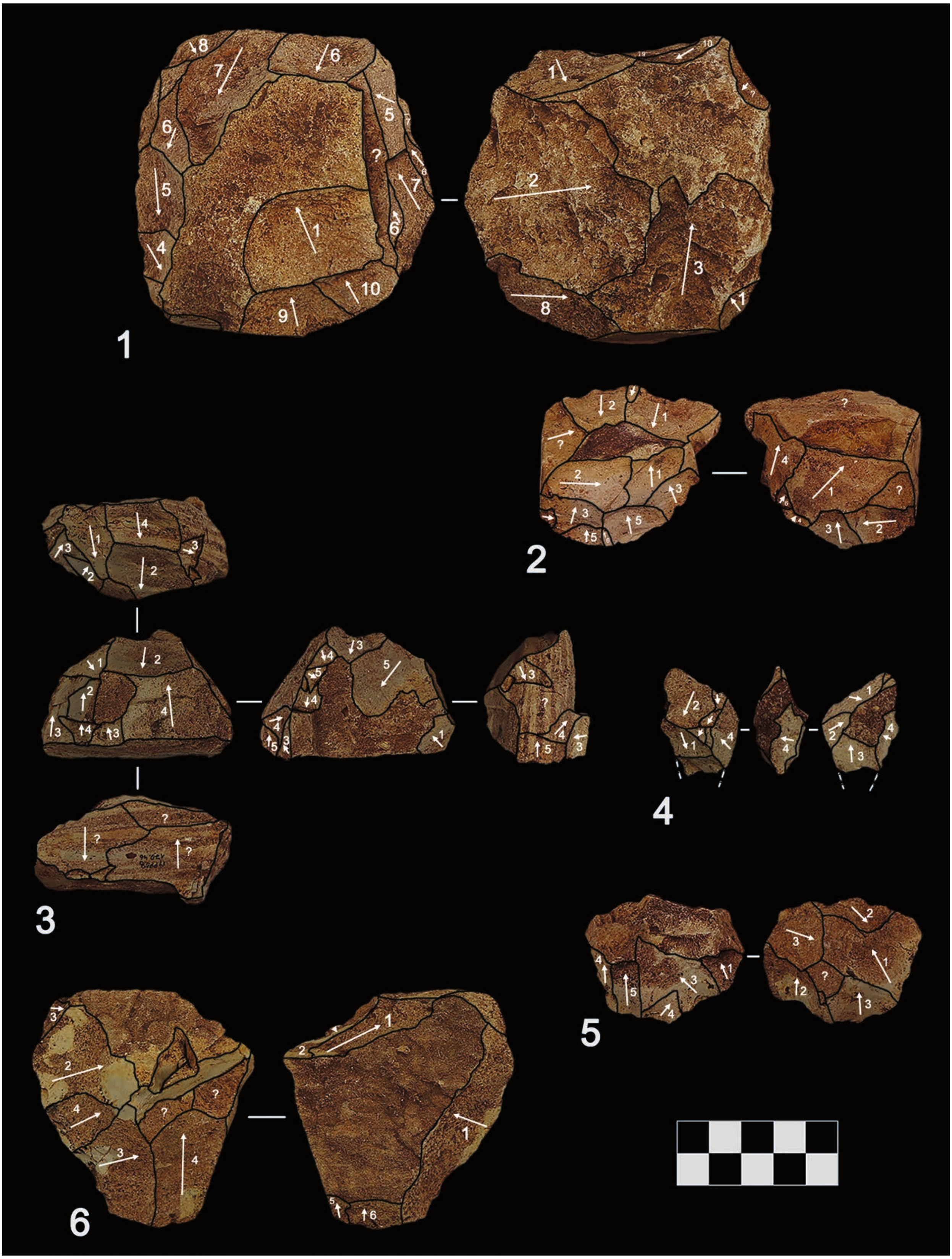

Fig. 4. Cores from Campanož: 1-3, 5-6 – centripetal core; 4 – small discoid core.
Abb. 4. *Kerne aus Campanož: 1-3, 5-6 – zentripetale Kerne; 4 – kleiner diskoider Kern.*

Four other cores belong to the bifacial recurrent core subtype (Fig. 5: 1) with unidirectional, convergent, or orthogonal removals. The common lack of centripetal removals in this subgroup differs from discoid cores in the first subgroup. Despite that, bifacial recurrent cores can be considered as a partial variant of the centripetal cores. In fact, the flaked area is usually concentrated on the most siliceous parts of the core (Fig. 5: 1), which is mirrored on the centripetal cores that have such variation in the raw material (Fig. 4: 2 & 5). Furthermore, one core has a short alternate sequence on a nodule fragment and the other a short sequence on a thick flake, features that might suggest that these represent abandoned early-stage centripetal cores. Interestingly, in both latter examples, hierarchization is not observed. On all cores of this subtype, one flaking face is parallel to the intersecting surface between the two core faces and the other is tangent, in some cases even steep-angled. In two cases, the cores are hierarchical (Fig. 5: 1). Two fragmented cores are tenuously attributed to this core subtype.

Fig. 5. Cores from Campanož: 1 – bifacial recurrent core; 2-3 – recurrent tabular core; 4-5 – possible Levallois core.

Abb. 5. *Kerne aus Campanož: 1 – bifazialer rekurrenter Kern; 2-3 – flache rekurrente Kerne; 4-5 – mögliche Levallois-Kerne.*

The above outlined recurrent knapping was also applied to small and tabular cores (recurrent tabular in Tab. 4), where the knapping sequence is short (usually composed of only two or three flake scars), and the main flaking surface exploited the largest surface of the core. Thin tabular chert was mainly exploited (Fig. 5: 2-3). Among this group, there are six cores, one core on flake and three core fragments. The knapping surfaces appear in hierarchical and non-hierarchical relationships. In hierarchical form (6/10), the main flaking surface exploits the largest surface of the core, while the other surface is tangential or perpendicular to the largest surface of the core and serves as the striking platform. Two cores are unifacial and two are non-hierarchical. Among the latter, one piece is flaked on the narrow side of a small nodule (L: 37.6; W: 27.3; T: 9 mm) and may represent a tool. The scar patterns range from unidirectional to centripetal, a variation that could relate to the morphological properties of the individual raw material pieces and the need to produce flakes of specific size and morphology, rather than a discernible difference in knapping concept. On several pieces, the scars on the flaking face have plunging terminations (Fig. 5: 2-3), probably due to difficulties in controlling the knapping fractures on thin pieces. This is supported by the presence of plunging flakes in the assemblage. Interestingly, platform preparation is present on four cores (Fig. 5: 2-3) and indicates it was utilized primarily for platform isolation.

Prepared cores (Levallois)

There are two cores that suggest the presence of prepared core technology in the assemblage (Fig. 5: 4-5). Both cores show a hierarchization of core surfaces, evidence of control of lateral, and in one case distal (Fig. 5: 4), convexities, preparation of the striking platform, and a flaking surface parallel to the central plane of the core (Fig. 5: 4-5). On one core, the convexity of the flaking surface was achieved by centripetal removals and preferential removals were performed from one side (Fig. 5: 4). On the other core both the preparation removals and the preferential removals have the same orientation (Fig. 5: 5). Both cores were abandoned after a short removal with a hinge termination failed to exploit the better part of the core face. It is possible that the preferential method represents the last stage in an otherwise recurrent centripetal mode of Levallois reduction. This last stage would thus represent an attempt to produce blanks of desired size from a relatively exhausted volume. However, given that there are only two Levallois cores, the range of prepared core technology methods in the whole assemblage is still unknown.

Unidirectional/Bidirectional prismatic cores

Cores from knapping concepts other than discoid in the assemblage are less common, and can be grouped into two main types. One is the unidirectional and bidirectional cores. Unidirectional and bidirectional cores can be subdivided into three subgroups (Tab. 4). The first subgroup is the incipient unidirectional cores (Fig. 6: 1). These cores preserve a short sequence of scars knapped from one platform, and the two cores themselves are not heavily reduced. One example seems to have been recycled into a bidirectional core, as the resulting flake scars differ in patination from the earlier sequence (Fig. 6: 1). One core fragment (1/14) is attributed to this group with a degree of uncertainty.

Another subgroup of cores within the unidirectional/bidirectional scheme are the unidirectional prismatic cores (Tab. 4). Two are cores on flakes (Fig. 6: 4), and one is an ordinary core (Fig. 6: 2). The striking platform of these cores is a flat surface or the ventral face of a flake. The cores are conic or sub-conic, and the knapping was conducted in a rotating and semi-rotating mode, by unidirectional adjacent removals. The knapped surface reaches the bottom of the core, forming a surface at the bottom that is narrower than the striking platform. The flake scars indicate that blades of 24-28 mm in length were produced, albeit most scars relate to wide and quadrangular flakes. One core fragment (1/14) has tenuously been attributed to this group.

The final type of cores with the unidirectional/bidirectional concept are the bidirectional prismatic cores (Tab. 4). There are only two such cores, one made on a natural fragment of a flat nodule and the other on a piece of nodule with remaining cortex (Fig. 6: 3). The flaking was organized parallel to the long axis of the core, with two striking platforms located at the opposite ends. The reduction was conducted by adjacent removals from two opposite platforms in a rotating or semi-rotating mode. (Fig. 6: 3). Elongated blanks were produced, and the final flakes in the sequence had hinge or step terminations.

Unidirectional/Centripetal early-stage cores

Five cores with mostly short (two to three removals) sequences represent either opportunistic or early-stage cores. Because of the short sequences and the inclination of the flake scars in relation to the striking platform, it cannot be identified whether they represent early-stage unifacial centripetal or unidirectional prismatic cores. Besides the few flake scars, these cores preserve the cortex of the raw material packages or naturally fractured surfaces. A single large piece preserved several perpendicular and inclined flake scars (in relation to the striking platform), in which the inclined scars are located on one side of the core and the lateral sides are regularized, which may indicate that this core is in fact a macrotool (Fig. 6: 5).

Multifacial multidirectional cores (SSDA)

The second largest core group is that of multifacial multidirectional cores (SSDA, Forestier 1993). In their reduction, the flaking was conducted on several core surfaces, usually from several distinct striking platforms. These cores appear in the incipient and later stage

Fig. 6. Cores from Campanož: 1 – unidirectional incipient core; 2, 4 – unidirectional prismatic core; 3 – bidirectional prismatic core; 5 – unidirectional early-stage core/macrotool. Note: Yellow coloured arrows in 1 represent removals related to recycling.

Abb. 6. *Kerne aus Campanož: 1 – unidirektionaler Vollkern; 2, 4 – unidirektionale prismatische Kerne; 3 – bidirektionaler prismatischer Kern; 5 – unidirektionaler Vollkern /Makrotool. Hinweis: Die gelb gefärbten Pfeile in 1 stellen Abschläge im Zusammenhang mit dem Recycling dar.*

variant (Tab. 4). There are two cores that could be classified as incipient multifacial multidirectional cores and are characterized by very short sequences of flake scars that only marginally cover the raw material pieces.

Four cores on flakes (Fig. 7: 1-3) are also included in this category. The reduction was guided by the appearance of adequate striking platforms after previous flake removals, especially evident on cores on flakes (Fig. 7: 1 & 3). One of the ordinary cores bears evidence of recycling by the presence of a single newer flake scar. No core fragments are attributed to this group.

Others

A core with a single removal (made from a recycled piece), a narrow core with several alternating removals on secant surfaces, a core on flake with a single removal from the ventral side and a very small Kombewa core which may be related to recurrent tabular cores (L: 19.4; W: 18.1; T: 7.1 mm) also appear in the sample assemblage (Tab. 4).

Core attribute data

The comparison between the distribution of core length and width (Fig. 8: A) indicates that centripetal cores form a continuum from the largest to the smallest cores on the site, with one major outlier. Incipient SSDA and unidirectional cores appear at the upper end of the distribution together with a number of the centripetal cores, which suggests that initial reduction was not strictly structured in terms of specific knapping methods (Baumler 1988). In both the SSDA and unidirectional/bidirectional cores distinct clusters are seen, which correspond to the subtypes within these groups, outlined above. This suggest that both methods were not systematic approaches for reducing the cores until exhaustion, but rather methods applied for extracting flakes from certain raw material morphologies, i.e., from thick flakes for the unidirectional prismatic and SSDA approaches, and from elongated but thick quadrangular fragments of chert nodules for the bidirectional prismatic method. In line with that reasoning, incipient stages of unidirectional and SSDA flaking may be

Fig. 7. Cores from Campanož: 1-3 – multifacial multidirectional (SSDA) cores on flakes.

Abb. 7. *Kerne aus Campanož: 1-3 – multifaziale multidirektionale (SSDA) Kerne an Abschlägen.*

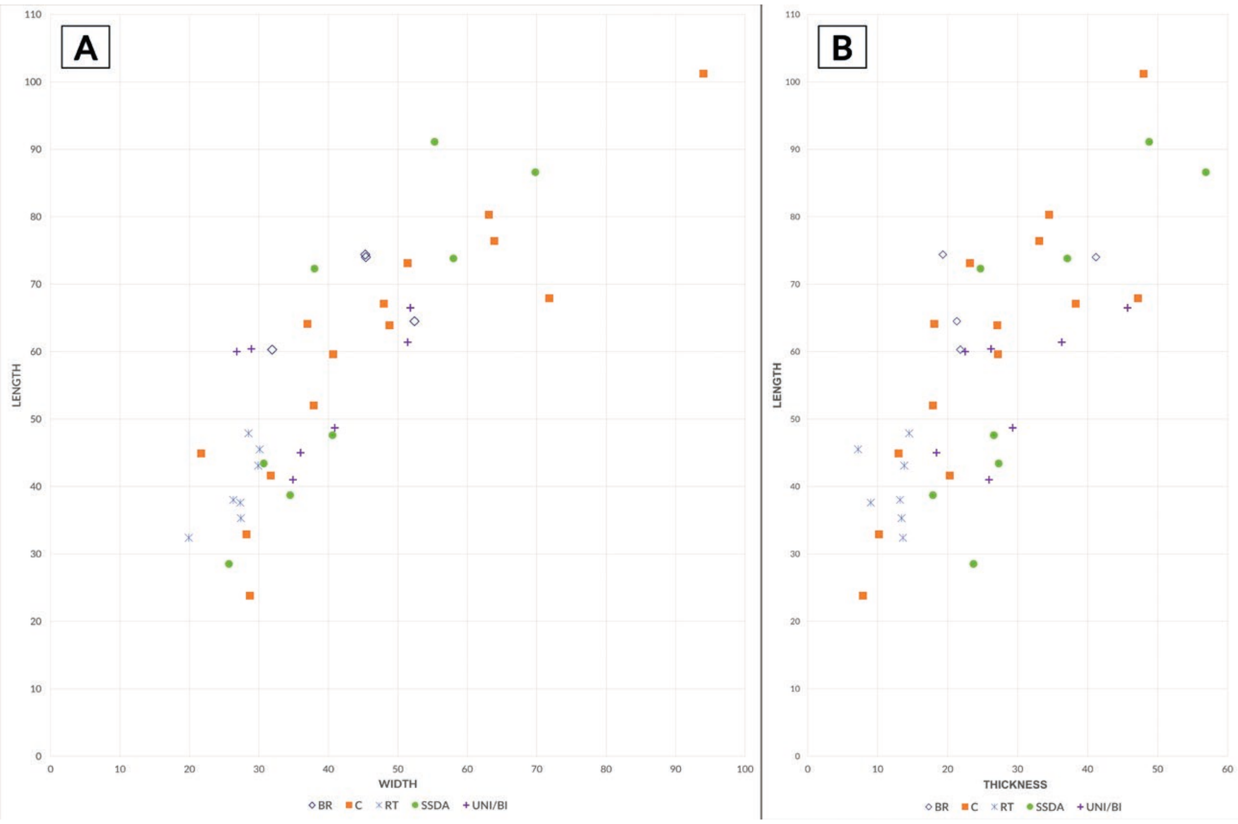

Fig. 8. Plot of core dimensions (core fragments excluded): A – length by width; B – length by thickness. Abbreviations: BR – bifacial recurrent, C – centripetal, RT – recurrent tabular, SSDA – multifacial multidirectional, UNI/BI – unidirectional/bidirectional.

Abb. 8. *Darstellung der Kernmaße (ohne Kernfragmente): A – Länge mal Breite; B – Länge mal Dicke. Abkürzungen: BR – bifazial rekurrent, C – zentripetal, RT – flach rekurrent, SSDA – multifazial multidirektional, UNI/BI – unidirektional/bidirektional.*

related to later centripetal flaking in general, but it may as well reflect opportunistic exploitation. On the other hand, recurrent tabular forms mostly do not overlap with bifacial recurrent and centripetal cores, which does not contradict the notion that these relate to the same knapping concept, applied to raw material packages of different sizes and morphologies. The observed relationships are less clear in the distributions of length and thickness (Fig. 8: B), although some trends such as the clustering of unidirectional/bidirectional and SSDA subtypes and the continuous distribution of centripetal cores is recognizable.

Out of the 67 cores, including cores on flakes and core fragments, 45 (67 %) retain some of the original nodular cortex (Tab. 5). Additionally, about 75 % of all complete cores and cores on flakes (excluding the recycled pieces) are homogenously patinated, while the majority of the remainder presents naturally fractured surfaces with "older" patina (Tab. 6). Thus, in addition to possible complete nodules, naturally occurring chert fragments or chunks have been purposefully procured for blank production. Furthermore, based on the degree of patination, three cores bear evidence of being recycled, as they display flake scars that differ in patina from other flake scars (Tab. 6). In terms of technological categories and morphometrical data, no pattern appears from the recycling, as both very small and very large pieces were recycled.

Debitage

Debitage (various flakes and flake fragments) is present in the sample with 327 pieces. Among the debitage ordinary flakes are the dominant category with 136 cases (41.6 % of all debitage). Core edge flakes are composed of *debordant* flakes (22 or 6.71 %) and naturally backed knives (17 or 5.2 %). There is only a single blade specimen, two flakes with both cortical backs, four rejuvenation flakes, a single Kombewa flake and six flakes that have been significantly altered due to retouch (Tab. 3).

Flake fragments (Tab. 7) are present in 138 cases (42.2 % of all debitage). Almost 45 % are proximal fragments, 4.3% are medial and 9.4 % are distal fragments. Various forms of longitudinal fragments (the fracture does not intersect the bulb of percussion) account for about 31 %, and Siret fragments for 5 %. The remaining fragments are dorsal fragments with irregular coarse fractures opposite the dorsal side, and irregular and indeterminate fractures. About one-third (47/138) of all flake fragments have remnants of cortical surfaces.

On 180 complete debitage elements six dorsal cortex classes were recorded based on 25 % classes

(0-5), excluding the flake platform (Tab. 8). For flake fragments cortex was only recorded as present or absent. About 46 % of complete flakes do not present any cortical surfaces on their dorsal sides. Most of the complete cortical flakes (23.3 % of all flakes) have between 1 and 25 % cortex on their dorsal side, followed by flakes in the 26-50 % class (15.6 %). Flakes with more than 50 % of the cortex cover the remainder, split almost evenly between the 51-75 % and 76-99 % classes, and completely cortical flakes (100 %) occur in only two cases. All cortical flakes have nodular cortex, but some rare cases indicate a formation of neocortex (pebble rind).

A comparison of means of length, width, and thickness between classes 0-4 (0-99 % cortex) indicates a weak trend of size reduction with decreasing cortical surfaces (Fig. 9), with some anomalies in the expected trend (e.g., length and width of class 2), which may be a bias of sample sizes. In terms of patination, 86.2 % of complete flakes (163/189) are homogenously patinated, 7.9 % represent flakes with older patina on natural surfaces (15/189) and 5.3 % (10/167) bear evidence of older patina on some flake scars, indicating that they come from recycled artefacts (Tab. 9).

Platform classification has been conducted on 234 flakes and flake fragments. The dominant type is the plain platform (56.4 %), followed by facetted (22.7 %), dihedral (7.3 %) and cortical platforms (5.6 %). The facetted platform type is composed of both finely prepared types and more irregularly flaked surfaces, of which the latter is more abundant.

A metric comparison of the three most abundant classes of debitage (Fig. 10) shows that naturally backed knives are on average the longest and thickest blanks among the three types, followed by *debordant* flakes. Therefore, ordinary flakes seem to be the smallest on average, although, a closer examination of length and thickness values shows a higher number of outliers compared to the other categories. On the contrary, the width data presents a large degree of overlap between all classes. In terms of scar orientation patterns on the dorsal sides, unidirectional scar patterns predominate among ordinary flakes (21.3 %), followed by orthogonal (11.8 %), centripetal (8.8 %) and convergent (8.1 %) patterns. On the other hand, *debordant* flakes mostly have centripetal and orthogonal (each 18.2 %), as well as unidirectional (13.6 %) and convergent (9.1 %) patterns. Finally, naturally backed knives are dominated by orthogonal (23.5 %), unidirectional (17.6 %), convergent and bidirectional patterns (11.8 % each). Out of the three classes, naturally backed knives and *debordant* flakes appear to have larger proportions of retouched pieces (29.4 % and 22.7 % respectively) than the ordinary flakes (13.2 %) (Tab. 3).

The above outlined data is consistent with the position of naturally backed knives in the earlier phases of the chaîne opératoire, as they probably represent flakes resulting from the expansion of the perimeter of centripetal/recurrent bifacial cores (Peresani 1998). On the other hand, *debordant* flakes resulted from the management of the lateral convexities of the cores, but in some cases may have resulted from the exploitation of the small volumes of recurrent tabular cores, not related to the management of convexity per se. Because of the variation of discoid exploitation in the assemblage, ordinary flakes present an array of different scar orientation patterns. However, a certain number of flakes with unidirectional scar patterns is probably related to unidirectional cores. Several groups of flakes give additional data on the

Cortex (Yes/No)	N	%
Yes	45	67.2
No	21	31.3
Indeterminate	1	1.5
Total	67	100

Tab. 5. Counts and percentages of cores, cores on flakes and core fragments according to the presence or absence of cortical surfaces.

Tab. 5. *Zählungen und Prozentsätze von Kernen, Kernen an Abschlägen und Kernfragmenten je nach Vorhandensein oder Fehlen von Rindenflächen.*

Patination	N	%
Homogenous	39	75.0
Older natural fractures	9	17.3
Older flaking scars	3	5.7
Indeterminate	1	1.9
Total	52	100.0

Tab. 6. Counts and percentages of patination types of complete cores and cores on flakes.

Tab. 6. *Zählungen und Prozentsätze der Patinierungsarten von vollständigen Kernen und Kernen an Abschlägen.*

Flake fragment type	N	%
Proximal (+ medial)	62	44.9
Medial	6	4.3
Distal (+ medial)	13	9.4
Dorsal	3	2.2
Longitudinal	24	17.4
Proximal-longitudinal	12	8.7
Distal-longitudinal	7	5.1
Siret	5	3.6
Proximal-Siret	2	1.4
Irregular	2	1.4
Indeterminate	2	1.4
Total	138	100

Tab. 7. Counts and percentages of flake fragment types.

Tab. 7. *Zählungen und Prozentsätze der Abschlag-Fragmenttypen.*

Dorsal cortex percentage class	N	%
0 %	83	46.1
1-25 %	42	23.3
26-50 %	28	15.6
51-75 %	13	7.2
76-99 %	12	6.7
100 %	2	1.1
Total	180	100

Tab. 8. Counts and percentages of dorsal cortex percentage classes of all complete debitage.

Tab. 8. *Zählung und prozentualer Anteil der dorsalen Kortex-Prozentklassen aller vollständigen Fundstücke.*

variability of production sequences in the assemblage. One complete flake and two flake fragments present features that could point to the use of prepared core technology. Two out of three examples have facetted platforms, unidirectional scar patterns and a straight longitudinal profile (Fig. 11: 9-10). The remaining flake lacks a facetted platform but has a large scar in a central position and with the same orientation, and the overall shape is probably oval/subcircular. However, the overall evidence for prepared core technology in the sample assemblage is scant.

Tools

Retouched pieces comprise less than one-fifth of the assemblage (12.6 % of all artefacts; 15.1 % if cores, cores on flakes and core fragments are excluded; Tab. 3). Interestingly, there is no clear evidence of repurposing cores into retouched tools. Besides debitage, a single natural fragment of a nodule was also retouched.

Among the tool types, scrapers are the predominant category (Fig. 11: 5-8; Fig. 12: 5 & 7; Tab. 10). The second most numerous are pointed abrupt tools, which were identified by a technological reading. These tools are made by abrupt/semi-abrupt retouch of two edges that intersect in a protruding and sharp point (Fig. 11: 3-4; Fig. 12: 6). In a couple of examples, the point is shaped by abruptly retouching the proximal part of the flake and one of the lateral sides (Fig. 11: 3-4). A similar pointed tool component is recorded in the Middle Palaeolithic assemblages of Divje babe I (Turk 2014), but the specimens from Campanož appear to be thicker and more abrupt on average. The remainder of the retouched tool assemblage consists of more lightly retouched tools, and includes denticulates (Fig. 11: 2; Fig. 12: 3), notches and partially retouched flakes (Fig. 11: 9-10; Fig. 12: 1). One tool is a combination of a scraper and notch, which was made by recycling a previously discarded flake, as evident from the difference in patina (Fig. 12: 7). Finally, six tools are fragmented and can only be classified as fragments. Most of the tools are lightly retouched, and only six examples have been significantly morphologically altered by retouch. In spite of that, only one example of a scraper has Quina retouch (Fig. 12: 5). A size distribution between retouched and unretouched debitage (Fig. 13) indicates that flakes larger than approximately 20 mm were selected for retouching, while flakes under this limit are unretouched.

Discussion

Site formation processes and age

Before engaging in a discussion on the character of the lithic assemblage at the site, a short assessment of

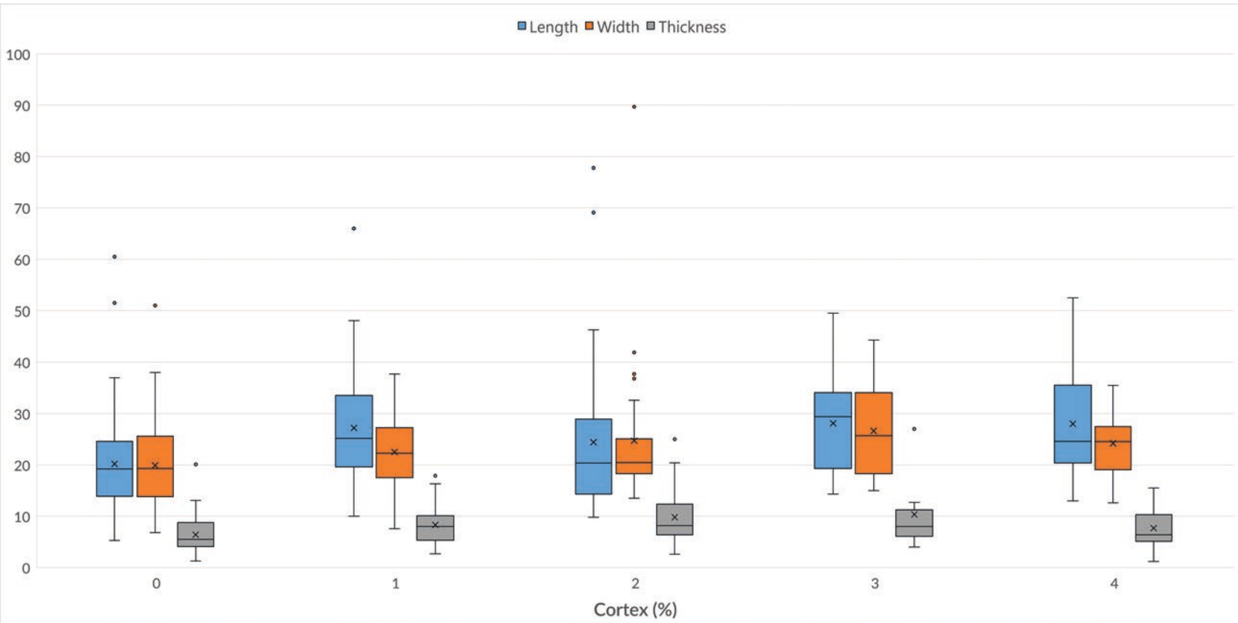

Fig. 9. Boxplots of length, width and thickness for four dorsal cortex classes. Symbols: 0 – 0%, 1 – 1-25%, 2 – 26-50%, 3 – 51-75%, 4 – 76-99%.

Abb. 9. *Boxplots von Länge, Breite und Dicke für vier Klassen des dorsalen Kortex. Symbole: 0 – 0%, 1 – 1-25%, 2 - 26-50%, 3 – 51-75%, 4 – 76-99%.*

Patination	N	%
Homogenous	163	86.2
Older natural fractures	15	7.9
Older flaking scars	10	5.3
Indeterminate	1	0.5
Total	189	100

Tab. 9. Counts and percentages of patination classes of complete debitage.

Tab. 9. *Anzahl und prozentualer Anteil der Patinierungsklassen bei vollständigen Grundformen.*

possible site formation processes is required. Given the context of the site, several alternative hypotheses regarding the formation of SU 2 (stone layer) at Campanož are conceivable:

- SU 2 is an erosional lag deposit, formed by winnowing or sheet erosion, which removed the fine particles and resulted in a single stone layer from vertically distinct assemblages (Karkanas & Goldberg 2019: 76-78).
- SU 2 formed by vertical displacement due to pedoturbation processes (Butzer 1982; Schiffer 1987; Wood & Johnson 1978), which according to the context of the site, most probably include bioturbation and argiliturbation. Bioturbation denotes a process of vertical movement of small particles by burrowing agents, which causes the burial of artefacts to the approximate depth of minimum biological activity, leading to a creation of a subsurface stone line (Johnson 1990; Johnson et al. 2005; Wood & Johnson 1978). Possible agents of bioturbation include earthworms (Canti 2003; Stein 1983), ants (Araujo 2013) and burrowing mammals (Johnson 1989, 1990; Johnson et al. 2005). On the other hand, argilliturbation results from the swelling and contraction of clay minerals, which causes the vertical displacement of artefacts in archaeological context due to upward movement by pushing and downward movement by falling into cracks caused by matrix contraction (Butzer 1982; Wood & Johnson 1978). Therefore, in this scenario the artefacts are vertically (and probably somewhat horizontally) displaced from their original discard position (Cahen & Moeyersons 1977). Other possible processes of pedoturbation on the site include cryoturbation and graviturbation (Butzer 1982; Schiffer 1987; Wood & Johnson 1978).
- SU 2 represents the original level of human occupation, which was subsequently buried.

The currently available data does not allow for the definitive resolution of this question, but several lines of evidence can provide some insights on which to base future research. In any case, given the large number of chunks and artefacts made from chert and the general lack of evidence for significant fluvial geomorphological activity in this area of Istria (Benac et al. 2017; Miko et al. 2013), accumulation by long distance transport is highly unlikely. Furthermore, the chunks mostly display the same degree of patination as the artefacts and suggest that they were exposed to similar

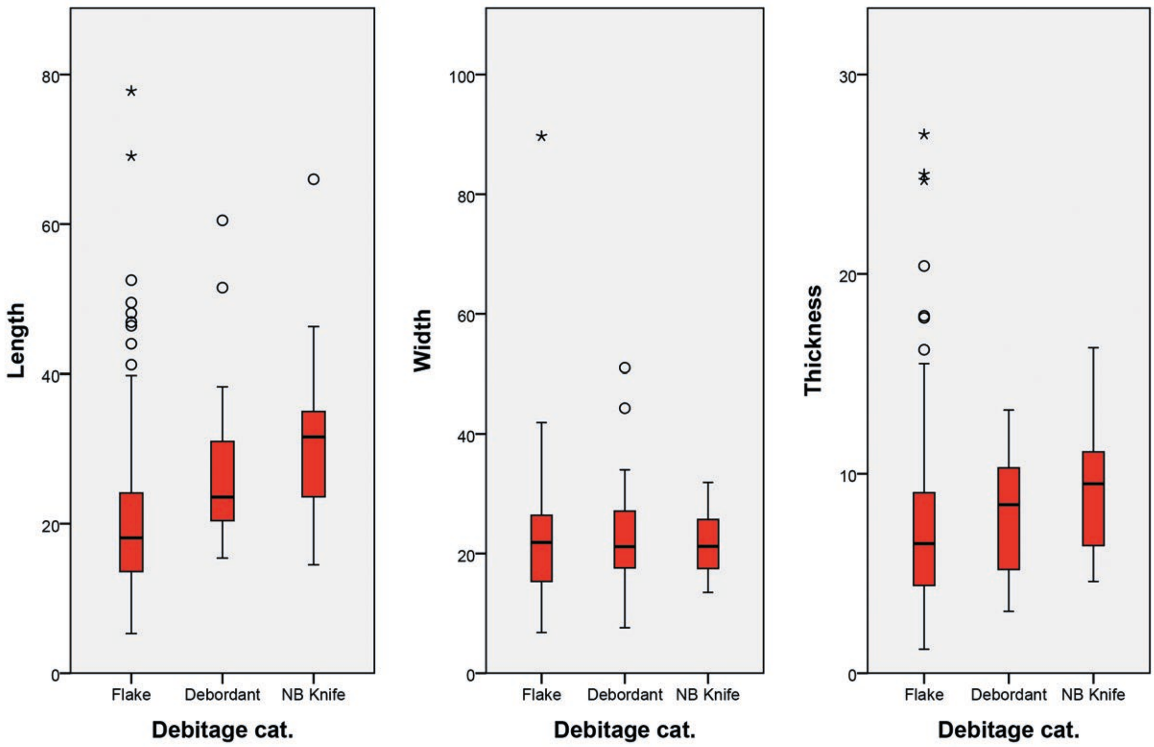

Fig. 10. Boxplots of length, width and thickness for the three major categories of debitage.

Abb. 10. *Boxplots von Länge, Breite und Dicke für die drei Hauptkategorien der Grundformen.*

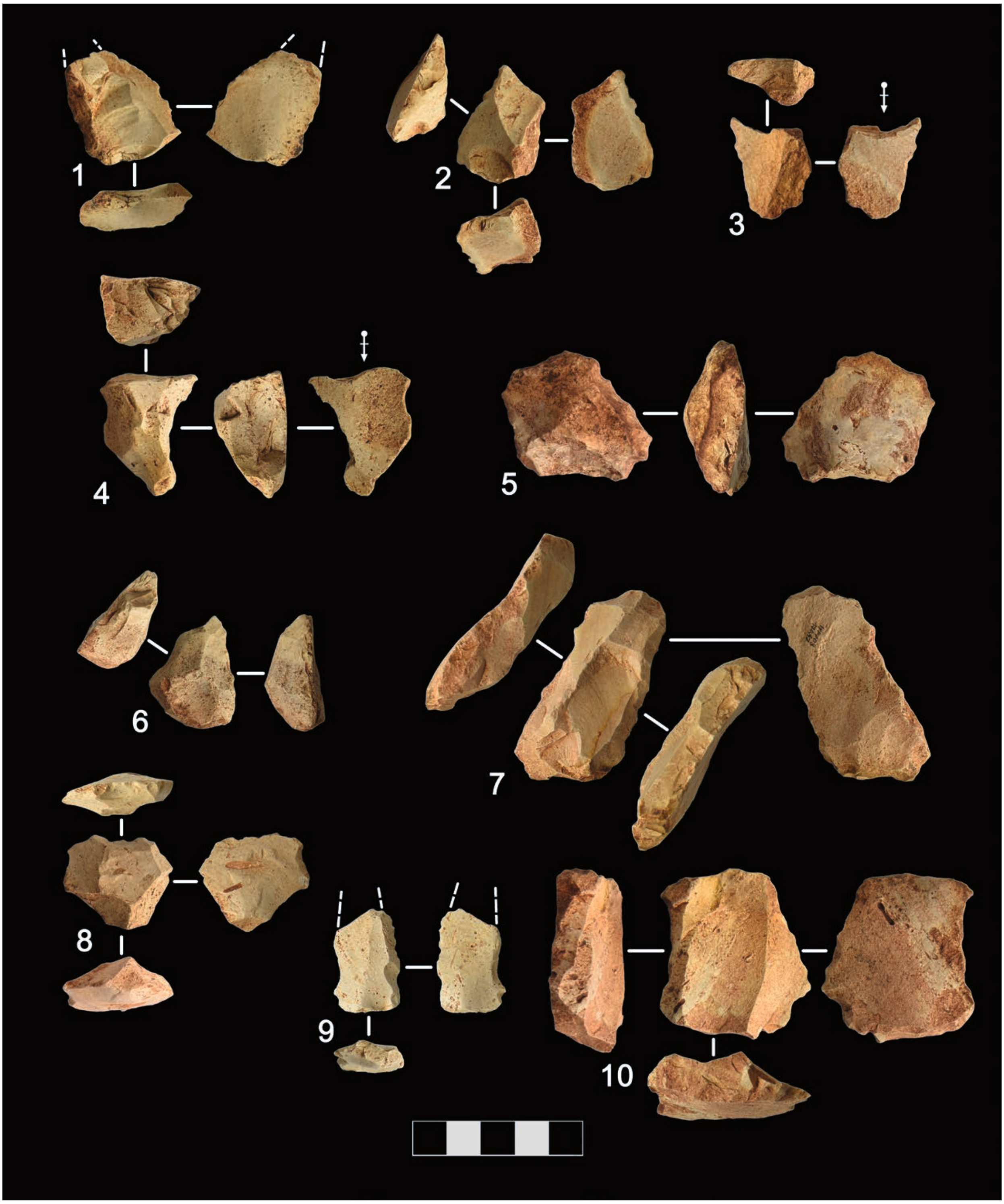

Fig. 11. *Flakes and retouched tools from Campanož: 1 – naturally backed knife; 2 – denticulate on naturally backed knife; 3-4 – pointed abrupt tool; 5 – scraper; 6 – convergent scraper; 7 – double scraper on debordant flake; 8 – transverse scraper; 9-10 – possible retouched Levallois flake.*

Abb. 11. *Abschläge und retuschierte Werkzeuge aus Campanož: 1 – Messer mit natürlichem Rücken; 2 – gezähntes Stück mit natürlichem Rücken; 3-4 – spitzes, abruptes Werkzeug; 5 – Schaber; 6 – konvergenter Schaber; 7 – doppelter Schaber auf debordantem Abschlag; 8 – transversaler Schaber; 9-10 – möglicherweise retuschierter Levallois Abschlag.*

depositional environments. However, the origin of most of the chunks on the site is still unresolved despite some preliminary raw material provenience data, with the possibilities of a unknown nearer raw material source contributing to the assemblage or the site itself being a secondary source of raw material still being open.

The spatial resolution of most artefacts at the site is at the level of 75 x 75 cm squares. There is a positive correlation between the abundance of chunks and debitage (R^2=0.8142) and chunks and cores (R^2=0.8283) in individual squares. This suggests that the pattern of distribution is not

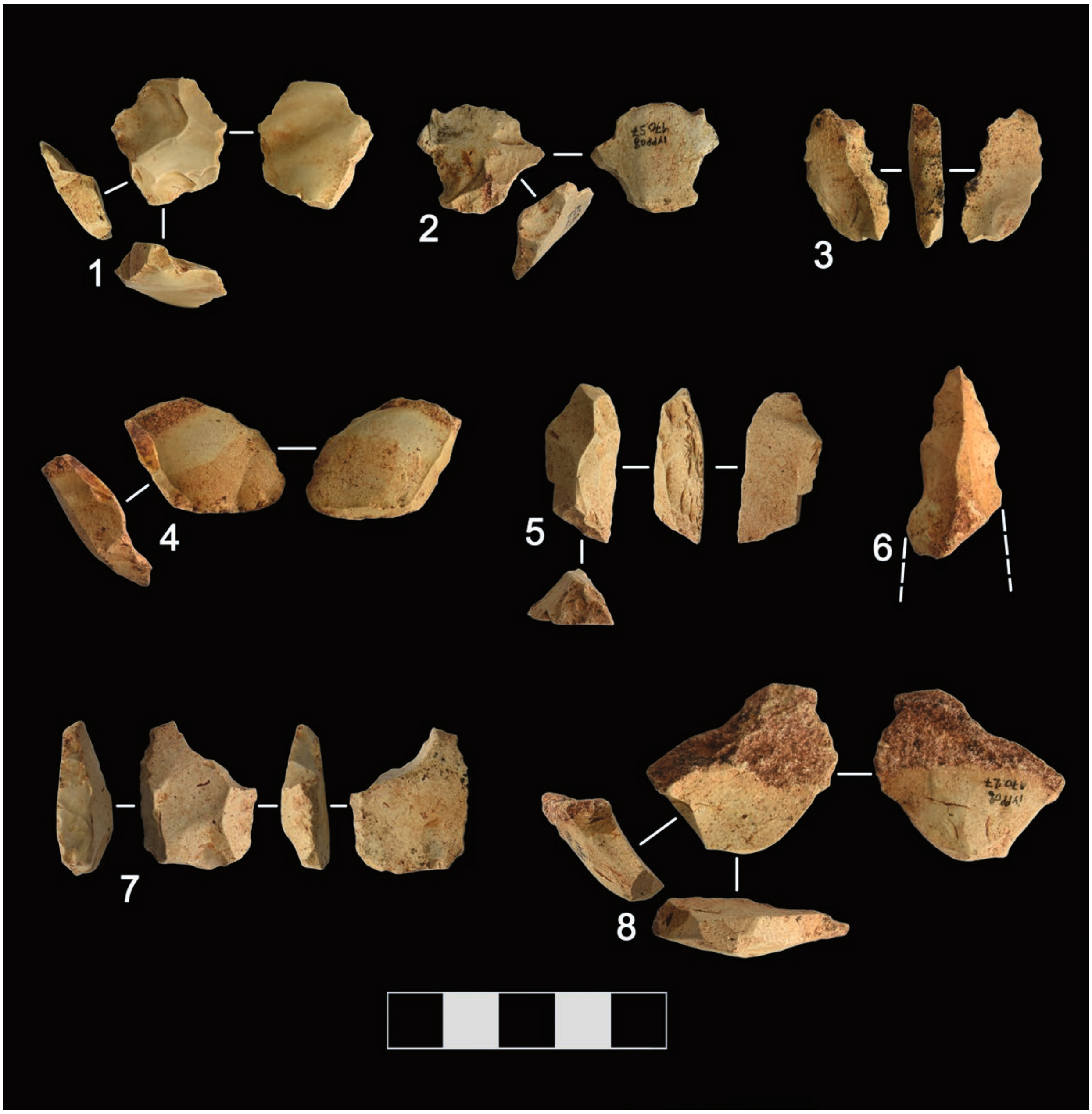

Fig. 12. Flakes and retouched tools from Campanož: 1 – retouched debordant flake; 2, 4, 8 – debordant flake; 3 – denticulate; 5 – scraper; 6 – pointed abrupt tool; 7 – scraper and notch, recycled piece.

Abb. 12. *Abschläge und retuschierte Werkzeuge aus Campanož: 1 – retuschierter Abschlag; 2, 4, 8 – Abschlag; 3 – gezähntes Stück; 5 – Schaber; 6 – spitzes, abruptes Werkzeug; 7 – Schaber und Kerbe, recyceltes Stück.*

Tool type	N	%
Scraper	23	45.1
Denticulate	5	9.8
Notch	3	5.9
Scraper-notch	1	2
Pointed abrupt tool	7	13.7
Partially retouched flake	6	11.8
Tool fragment	6	11.8
Total	51	100

Tab. 10. Counts and percentages of tool types in the sample assemblage.

Tab. 10. *Anzahl und Prozentsatz der Werkzeugtypen in der Stichprobe.*

reflective of different activities on the site and is thus probably affected by post-depositional processes. However, a single refit of two flakes from squares F-2 and F-4 may suggest that at least some artefacts are not horizontally significantly displaced. In any case, the site is a palimpsest (Bailey 2007). The above outlined hypotheses of formation are pertinent for understanding the timeframe of formation and therefore the degree of possible mixing of material from distinct occupation events. The lack of size sorting in relation to the position of the squares on the slope (Fig. 14), lack of evidence of imbrication, as well as the frequent occurrence of micro-artefacts (<20 mm) with larger finds (Malinsky-Buller et al.

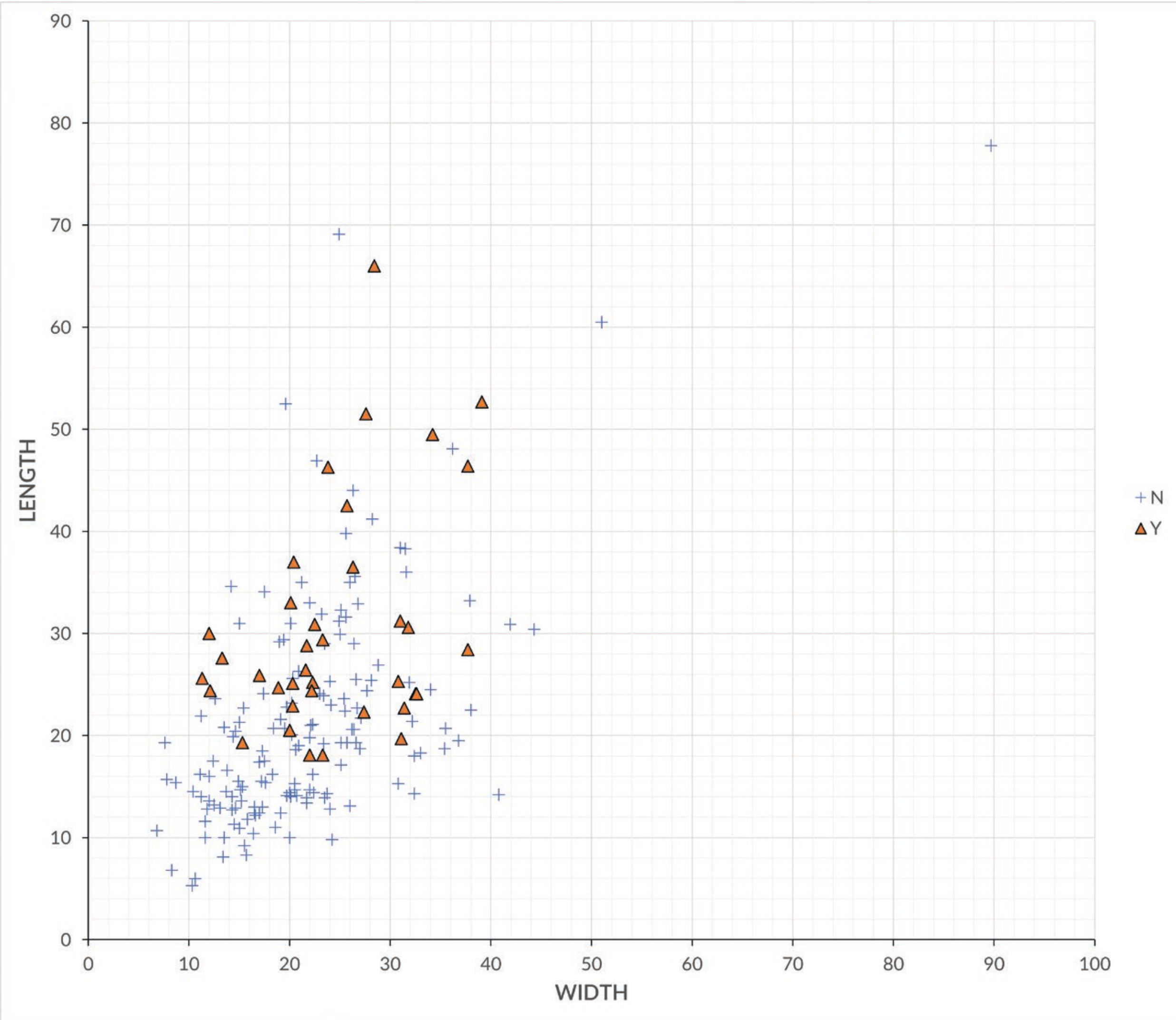

Fig. 13. Plot of dimensions of retouched (Y) and unretouched (N) complete debitage.

Abb. 13. *Darstellung der Abmessungen von retuschierten (Y) und nicht retuschierten (N) vollständigen Grundformen.*

2011), suggest that slope processes did not significantly alter the assemblage composition. Consequently, the lag deposit hypothesis seems to be the most tenuous.

According to the pedoturbation hypothesis, biological activity and clay swelling and contraction in the *terra rossa* soils may have contributed to the burial of the finds from their original discard position. This was further supported by the presence of more recent stone lines (Johnson 1990; Johnson et al. 2005; Wood & Johnson 1978) consisting of both reworked chert finds and recent waste in the modern A horizon of the soil. However, the formation of SU 2 is probably not a recent phenomenon. Namely, if the upper OSL ages indeed reflect the last major reworking of the sediments above SU 2, this would indicate that the stone layer could have formed before 12 ka. The fact that Roman activity disturbed the stone layer and that the inclination of the layer does not correspond to the inclination of the modern surface indicate an older age of formation. In this scenario, artefacts from multiple discrete phases of occupation may have been incorporated in the same layer, and despite being displaced vertically, they may have been only minimally moved horizontally. In any case, the reported OSL ages should be considered unreliable, and future dating efforts should include single-grain dating in order to test the contribution of bleached grains in the sample as a possible factor of age underestimation (Bateman et al. 2003).

Lithic industry

The preliminary analysis of the sample from Campanož F-H/2-4 mainly indicates an industry in which variable discoid systems were adopted in the production of stone tools. The variability in the observed manifestations of this reduction system relates to several factors. One factor refers to the different morphological and qualitative characteristics of the raw material packages exploited. This is most evident in the adoption of similar technological elements and volumetric concepts to small tabular cores and larger centripetal cores. Additionally, exploitation was often concentrated on the most siliceous areas of the raw material, which resulted in only partially exploited discoid cores. This could relate to both greater workability of those volumes and the need for better control of the knapping fracture to achieve the desired characteristics of the resulting flakes. The second level of variability relates to the different stages of abandonment. Namely, discoid cores are represented in a spectrum from large centripetal cores, which retain significant

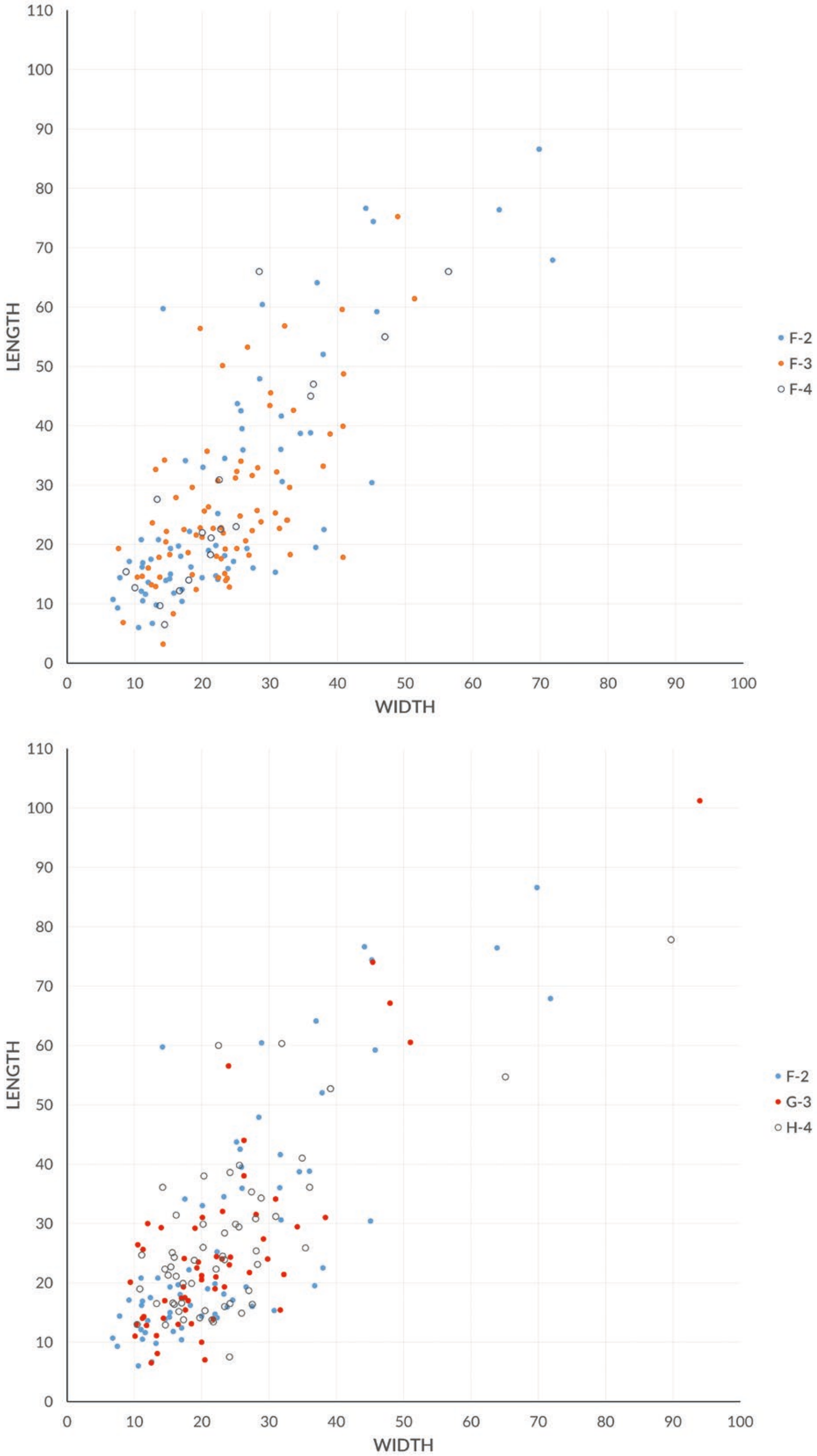

Fig. 14. Plot of dimensions of all artefacts by selected squares.

Abb. 14. *Darstellung der Abmessungen aller Artefakte nach ausgewählten Quadraten.*

cortical surfaces, to small discoid biconvex forms. The stages of abandonment are not necessarily related to raw material quality, but to original raw material size and the specific requirements for tool blanks within a given knapping sequence.

The variances expressed here are not unique within the Northern Adriatic region, as similar variations in flaking were observed for the discoid method in unit A9 at Grotta di Fumane (Peresani 1998, 2012). There, the production sequence is broken into two subsequences, one reducing nodules by centripetal removals and the other exploiting large flakes, usually coming from the initial stages of production (Delpiano et al. 2018; Peresani 1998). A recurrent goal of such production were the *debordant* flakes and pseudo-Levallois points, the backed edges of which were often additionally retouched for specific functions (Delpiano et al. 2019). Techno-economic examination of the various raw materials procured at Grotta di Fumane unit A9 shows a difference of provisioning and production strategies when examining local (<5 km from the site) and semi-local (5-10 km) raw materials, reflecting on the one hand expedient and complete reduction sequences, and planned and fragmented sequences on the other (Delpiano et al. 2018). Besides the discoid industry of unit A9 in Grotta di Fumane (Peresani 2012), in Northeastern Italy assemblages with discoid technology (Peresani 2003) have also been recorded in Rio Secco in the Carnic Alps (Peresani et al. 2014) and in Caverna degli Orsi (Boschian 1999-2000) in the Trieste Karst and the open-air site of Monte del Cason in the Berici Hills (Bertola & Peresani 2000). Both Rio Secco and Caverna degli Orsi present evidence of only ephemeral occupations and marginal on-site tool production, thus pointing to the use of these locations as specialized and/or seasonal camps related to the exploitation of non-lithic resources (Peresani 2011; Peresani et al. 2014). In chronological terms, discoid industries in Northeastern Italy are related to the period after MIS 5 (Boschian 1999-2000; Peresani 2003). Chronometric data suggests unit A9 from Fumane is older than 47.6 ka cal. BP (Peresani et al. 2008) and that the Rio Secco sequence ranges from ca. 46-42 ka cal. BP (Peresani et al. 2014). In the Eastern Adriatic, elements of discoid technology are seen in the various layers of Mujina pećina (Šprem et al. 2020) in Dalmatia, as well as in Crvena stijena and Bioče in Montenegro (Dogandžić & Đuričić 2017; Mihailović & Whallon 2017). The sequence from Mujina pećina is currently dated to MIS 3 (Boschian et al. 2017; Rink et al. 2002), although recent unpublished OSL results suggest that the lowermost layers may date to the end of MIS 5 or to MIS 4. The Late Mousterian sequence from layers XVIII-XII of Crvena stijena also probably dates to MIS 3 (Mercier et al. 2017; Whallon & Morin 2017). Thus, based on the above outlined comparative data from the Northern and Eastern Adriatic, the assemblage from Campanož may date to the Upper Pleistocene, more precisely to a period after MIS 5. However, a final resolution of the chronology requires more accurate chronometric data.

Evidence of other reduction systems appear more sporadically and may be related to chronologically different occupations. However, in light of the current knowledge about the typological and technological variability of the Aurignacian (Karavanić 2003) and Epigravettian (Janković et al. 2012; Karavanić et al. 2013) in southern Istria, no unambiguous Upper Palaeolithic elements were recorded in the analysed sample, especially in terms of typological classes. Alternatively, other reduction systems may represent strategies employed at exploiting specific raw material volumes, such as the unidirectional prismatic and SSDA systems for cores on flakes.

The above presented elements of the lithic industry of Campanož suggest flexible and complex technological behaviours of Neanderthal populations in the Northern Adriatic, with an expedient technology (*sensu* Nelson 1991) aimed at producing tools of variable sizes. Most notably, small flakes were produced in both ramified procedures (Rios-Garaizar et al. 2015; Romagnoli et al. 2018), which mirror the procedures on standard cores, and in small-sized cores adapted to raw material morphometrics, a behaviour that has been observed in other Middle Palaeolithic contexts (Dibble & McPherron 2006). Some of these flakes would have been smaller than the smallest retouched tools in the sample (ca. 20 mm). Therefore, they were either used unretouched or they were transported away from the sample area, or both. The evidence from the assemblage points to a complex interplay of factors regarding task requirement and raw material characteristics (and not necessarily size) contributing to small flake production, which could pertain to the larger discussion on the nature of the so-called Micromousterian in the Eastern Adriatic (Karavanić 2000; Karavanić et al. 2008; Dogandžić & Đuričić 2017; Vujević et al. 2017), if the techno-typological attribution of the chronology of Campanož is corroborated by chronometric data.

Among the retouched tools, most have marginal retouch, which suggests that they were not heavily utilized. Only six tools have been morphologically significantly transformed and it is entirely possible that these represent imported and discarded curated toolkits (Kuhn 1995; Nelson 1991).

Despite the abundance of chert finds (both artefacts and chunks) on the site, whether the site solely reflects the "provisioning of places" part of the raw material provisioning spectrum proposed by Kuhn (1995) can still be debated, as transport on-site and off-site of cores, blanks and finished tools is still understudied. In any case, recycling data suggests that the site could have functioned as a raw material cache, whether as part of a planned strategy or not. Studies of recycled artefacts from sites in Northeastern Italy have shown that the form of recycling is linked to the wider technological and raw material provisioning strategies of a given occupation (Peresani et al. 2015). Because of the availability of raw materials in the local environment around Campanož, it is likely that recycling only played a marginal role within the wider strategy of raw material procurement.

Given the complexity of lithic assemblages observed through high-resolution studies (Romagnoli & Vaquero 2019; Turq et al. 2013), a degree of caution should be exercised regarding the notion of the completeness of the chaîne opératioires at the site before the application of refitting and some method of raw material partitioning, for instance Raw Material Units (Roebroeks 1988). Furthermore, refitting could provide a method to disentangle the palimpsest and study the site formation processes in more detail (Romagnoli & Vaquero 2019).

Naturally, as the future lithic analysis will encompass a larger sample, some quantitative and qualitative relationships in the data may change and new patterns may emerge. Despite that, some general patterns observed in this preliminary analysis could be reasonably expected even in larger samples. These include:

- Evidence of repeated production of tool blanks on-site, with the residual cores abandoned at various stages of exhaustion
- Significant contribution of discoid technology in the assemblage
- Evidence of ramification of the production sequence and purposeful production of small flakes
- Evidence of recycling previously discarded pieces

Conclusion

While site formation processes and temporal data are still understudied, the lithic assemblage of Campanož clearly indicates a Middle Palaeolithic occupation of an open-air site. The character of the assemblage suggests that Neanderthals procured chert nodules and nodule fragments and produced tools on-site, probably during multiple visits over long periods in time. While some evidence suggest that local sources 3-4 km were used, the possibility of the site itself being a secondary source of raw material is not excluded. The abundance of the assemblage and the complexity of the production sequence represents a novelty in the archaeological record of open-air Middle Palaeolithic sites in the Eastern Adriatic, which have been characterized by small assemblages mostly characterised by retouched tools (Vujević et al. 2017). Finally, the geological character of the site indicates that *terra rossa* contexts in the wider Eastern Adriatic could provide relatively well-preserved Middle Palaeolithic sites, the importance of which is crucial in our understanding of wider Middle Palaeolithic settlement dynamics and land use.

Contributor roles: Marko Banda – Conceptualization, Methodology, Investigation, Formal analysis, Writing – Original draft; Francesca Romagnoli – Methodology, Supervision, Writing – Review & Editing; Darko Komšo – Investigation, Writing – Review & Editing; Maja Čuka – Investigation, Writing – Review & Editing; Ivor Karavanić – Supervision, Funding acquisition, Writing – Review & Editing

Acknowledgements: We would like to thank the organisers of the 62nd Annual Meeting of the Hugo Obermaier Society, held in Brno in 2021, and especially Andreas Pastoors and Thorsten Uthmeier for inviting us to contribute to the present issue of Quartär. Part of the research was conducted during a Short-Term Scientific Mission (STSM) at the Departamento de Prehistoria y Arqueología at the Universidad Autónoma de Madrid (Spain). This article is based upon work from COST Action (CA19141) Integrating Neanderthal Legacy: From Past to Present (iNEAL), supported by COST (European Cooperation in Science and Technology). Research on the site of Campanož is part of the project IP-2019-04-6649 "Last Neanderthals at the Crossroads of Central Europe and the Mediterranean", financed by the Croatian Science Foundation. We are extremely grateful to Miroslav Vuković and Martina Rončević, who offered their assistance with part of the figures, to Zlatko Perhoč, for the preliminary information on raw material provenience, and finally to Goran Tomac and Livia del Rosso for their comments and improvements to the English text.

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