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PORIJEKLO RANOBRONČANODOBNIH SJEKIRA OD ZELENOG KAMENA IZ MONKODONJE

PROVENANCE OF THE EARLY BRONZE AGE GREENSTONE AXES FROM MONKODONJA

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U članku su prikazana tri ulomka kamenih sjekira s gradine Monkodonja, za koje je obavljena petrografska analiza. Prikazani su načini analize i dobiveni rezultati o vrsti i porijeklu kamena. Sirovine za njihovu izradu - žad, serpentinit i meta-dijabaz - potječu iz različitih izvora. Ti su materijali najčešće u uporabi kroz mlađi neolitik i eneolitik, a na Monkodonji je njihovo korištenje datirano još barem kroz prvu polovicu 2. tisućljeća pr. n. e.

KLJUČNE RIJEČI: *Monkodonja, sjekire, žad, serpentinit, meta-dijabaz*

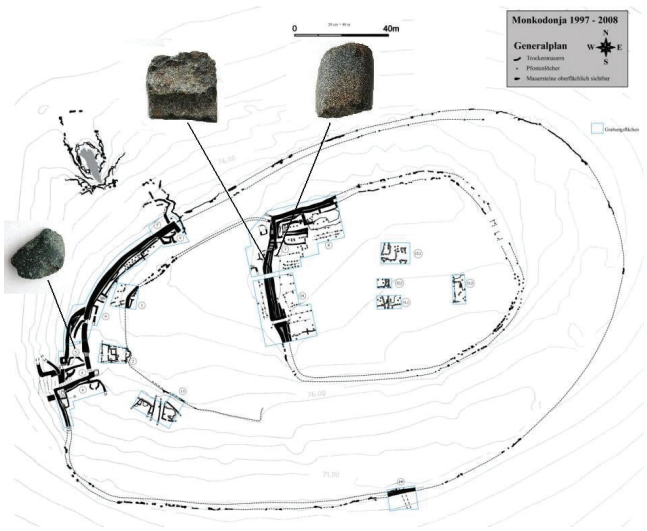
This article covers three fragments of stone axes from the hillfort of Monkodonja, for which a petrographical analysis was performed. Shown here are the methods employed for this analysis and the obtained results regarding the types and origins of stone. The raw materials used for their manufacture, jade, serpentinite and meta-diabase, stem from different sources. Most often these materials were in use throughout the Late Neolithic and Eneolithic, and in the case of Monkodonja, their use was also dated at least through the first half of the 2nd millennium BC.

KEY WORDS: *Monkodonja, axes, jade, serpentinite, meta-diabase*

PREDGOVOR

Utvrđeno visinsko naselje na Monkodonji kod Rovinja, kao značajan predstavnik kasteljerske kulture brončanog doba u Istri, bilo je tijekom jednog desetljeća predmetom sustavnih arheoloških istraživanja. Iskopavanja su se odvijala u sklopu međunarodnog projekta (Institut für Prähistorische Archäologie Freie Universität Berlin, Arheološki muzej Istre, Zavičajni muzej grada Rovinja i Oddelek za arheologijo Filozofske fakultete Univerze u Ljubljani), svake godine po četiri tjedna, najčešće tijekom rujna, a u njima su sudjelovali brojni arheolozi i drugi stručnjaci te studenti iz različitih zemalja. S obzirom da smo o našim istraživanjima već više puta objavljivali u časopisu Histria archaeologica (28, 1997; 31, 2000; 36, 2005; 38-39, 2007-2008; 42, 2010), ovom prigodom ćemo se ograničiti samo na najosnovnije podatke o nalazištu.

Gradina Monkodonja spada među veća naselja u Istri. Označava je iznimno kompleksno koncipiran obrambeni sustav, čiji su bedemi na više mjesta vrlo dobro sačuvani. Kamene zidine su izgrađene tehnikom suhozida, s velikim kamenim blokovima, što im daje "kiklopski" izgled. U naselje su vodila bar troja vrata, od kojih glavni ulaz na zapadnoj, prema moru okrenutoj strani u svojoj zadnjoj fazi djeluje poput labirinta. U središnjem dijelu nalazi se još dodatna masivna utvrda, akropola, oko koje su bile koncentrično nanizane građevinske terase gornjega i donjega grada. Izvan naselja, pod glavnim bedemom prepoznaju se tragovi predgrađa i poseban "kultni prostor" oko jame, koja se nalazi na sjevernom podnožju uzvisine (sl. 1).



Sl. 1 Plan gradine Monkodonja i mjesta nalaza sjekira.
Fig.1 Plan of the Monkodonja hillfort and the findspots of the axes.

FOREWORD

The fortified hillfort settlement of Monkodonja, located in the vicinity of Rovinj, is an important representative of the Bronze Age castellieri culture in Istria and has as such been the subject of systematic archaeological explorations for over a decade. The excavations took place within the framework of an international project (Institut für Prähistorische Archäologie Freie Universität Berlin, Arheološki muzej Istre, Zavičajni muzej grada Rovinja and Oddelek za arheologijo Filozofske fakultete Univerze u Ljubljani) that each year lasted for four weeks, mostly during the month of September. Numerous archaeologists and other experts as well as students from different countries participated in it. As we have repeatedly reported about our excavations to date in the Histria Archaeologica Bulletin (28, 1997; 31, 2000; 36, 2005; 38-39, 2007-2008; 42, 2010), this time around we shall merely concentrate on the most elementary data about the site.

The Monkodonja hillfort is classified as a major settlement in Istria. It stands for an intricately planned, extremely complex defensive system whose walls are very well preserved on a number of spots. The stone walls were erected in the drywall technique, using large boulders, giving them a "cyclopean" appearance. At least three gates led into the settlement, the main one amongst these is on the western side facing the sea and in its last phase it functioned like a labyrinth. An additional massive fortification in the form of an acropolis is located in the central section, with terraces pertaining to the Upper and Lower Town running concentrically around it. Outside of the settlement proper, underneath the main defensive wall, traces of the outskirts are still discernible together with a special "cult-related area" around the cave located at the northern foot of the elevation (Fig. 1).

The excavations resulted in a systematic exploration of most of the defensive walls and larger areas within the settlement, the western and northern gates and the area alongside the wall located between them, the northwestern area of the acropolis, and two larger trenches excavations on the western and southern terraces of the Lower Town. These works exposed the remnants of a large number of different structures, and yielded an enormous amount of pottery and bone finds. Bronze and stone finds were not as numerous but nonetheless very interesting and important as indicators

Iskopavanjima su sustavno bili istraženi veći dijelovi bedema i veće površine unutrašnjosti naselja, zapadna i sjeverna vrata te prostor uz bedem između njih, sjeverozapadni prostor akropole, više manjih sonda u istočnom dijelu akropole i dvije veće sonde na zapadnoj i južnoj terasi donjeg grada. Tim su radovima otkriveni ostaci brojnih različitih građevnih objekata, kao i ogromna količina keramike i koštanih nalaza. Brončani i kameni nalazi bili su manje brojni, ali unatoč tome posebno zanimljivi i značajni kao indikatori različitih djelatnosti i događanja u naselju. Među kamenim predmetima, među kojima prevladavaju brojni odbitci, vjerojatno od manjeg oruđa, ističu se ulomci kamenih sjekira i batova, od kojih ćemo tri zbog vrste kamena predstaviti u našem prilogu. Pokušat ćemo utvrditi porijeklo kamenog materijala.

Sjekire s otvorom za držalo predstavljaju uobičajeni nalaz na prostoru Caput Adriae (sjeveroistočna Italija; zapadna Slovenija te sjeverozapadna Hrvatska). Mnoge od njih napravljene su od serpentinita i meta-dolerita (Bernardini et al., 2008, 2009).

Opis kamenih sjekira:

1. Ulomak sječiva sjekire-čekića od žada (sl. 2), zaglađena površina je djelomično sačuvana. Veličina ulomka 3,6 x 3,15 x 1 cm. Knjiga nalaza - br. 5334.

Točno mjesto nalaza je u kvadrantu O/39 (Z-I 0,80 m, S-J 0,50 m), na apsolutnoj vis. 75,66 m (planum 4, 2. produbljenje) u sondi V, koja je obuhvaćala sjeverno predvorje zapadnih vrata u naselju. Iz položaja možemo zaključiti da je bila u uporabi pri gradnji obrambenog sustava glavnog ulaza u naselje.
Prva objava: Mihovilić, Hänsel, Teržan, Matošević, Kovačić 2009, 43.

for the various activities and events that went on in the settlement. Prominent amongst stone artifacts, prevailing among which are numerous flakes that probably stem from small implements, are the fragments of stone axes and hammers, three of which will be presented in our article on account of the type of stone used. We will try to establish the material provenance.

Shaft-hole axes are common findings in the Caput Adriae (North-eastern Italy; Western Slovenia and North-western Croatia). Many of them are made from serpentinite and meta-dolerite (Bernardini et al., 2008, 2009).

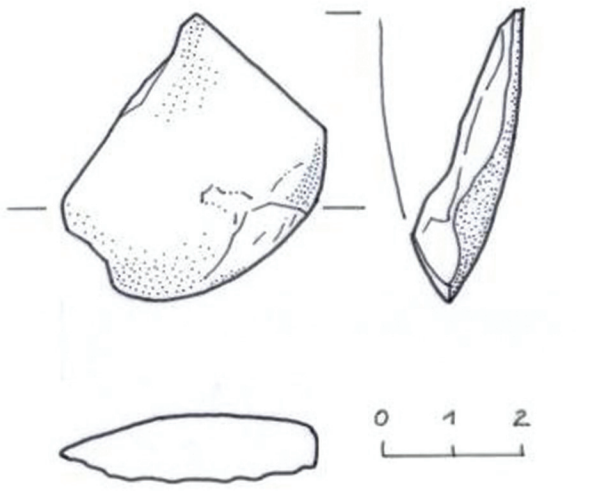
Description of stone axes:

1. Blade fragment of an ax-hammer made of jade (Fig. 2), the polished surface is partially preserved. Fragment dimensions 3.6 x 3.15 x 1 cm. Register of finds - no. 5334.

The exact findspot is located in quadrant O/39 (West-East 0.80 m, North-South 0.50 m), 75.66 m above sea level (stratum 4, 2nd deepening) in trench V, which comprised the northern forecourt of the western gate of the settlement. From the position we can conclude that it was used during the erection of the defensive system of the main entrance into the settlement.
First published: Mihovilić, Hänsel, Teržan, Matošević, Kovačić 2009, 43.

2. Fragment of an ax-hammer made of serpentinite, featuring a partially preserved, polished surface and a section of the shaft-hole (Fig. 3). The hitting surface shows clear signs of usage (Fig. 4). Fragment dimensions 4.9 x 4.8 x 2.7 cm. Register of finds - no. 30879.

Sl. 2 Ulomak sjekire od žada.
Fig. 2 A fragment of a jade ax.

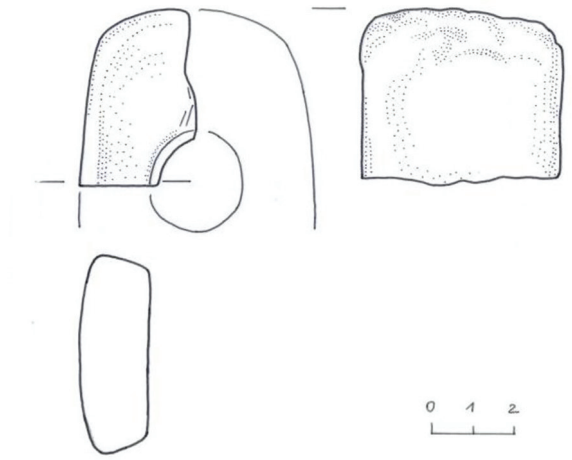


Sl. 3 Ulomak sjekire od serpentinita.
Fig. 3 A fragment of a serpentinite ax.

2. Ulomak sjekire-čekića od serpentinita, s djelomično sačuvanom zaglađenom površinom i dijelom rupe za nasad drške (sl. 3). Na udarnoj površini se jasno prepoznaju tragovi uporabe (sl. 4). Veličina ulomka 4,9 x 4,8 x 2,7 cm. Knjiga nalaza - br. 30879.

Točno mjesto nalaza je u kvadrantu BB/-4 (I-Z 0,71 m, J-S 0,78 m), na apsolutnoj vis. 80,84 (planum 3), u sondi III, koja je obuhvaćala sjeverozapadni dio bedema akropole, dio akropole i dio gornjega grada uz sam bedem. Kvadrant u kojem je pronađen ulomak sjekire-čekića nalazi se na prostoru ruševine dijela zapadnog bedema akropole i uz granicu prema dijelu bedema koji je istražen u sklopu sonde X. Iz tog je područja uzorak čiji radiokarbonski datum upućuje na povremeni boravak čovjeka na ovom prostoru već sredinom 3. tisućljeća pr. n. e. (Hänsel, Teržan, Mihovilić 2007, 14, sl. 2). Drugi radiokarbonski datumi iz uzoraka s tog područja bedema akropole datiraju gradnju bedema oko 1800. g.pr. n. e. (Hänsel, Teržan, Mihovilić 2007, 15-16, sl. 2, 4) ili čak nešto ranije, dogradnje oko stoljeće kasnije, kao i pojačanja nakon još jednog stoljeća (Hänsel, Teržan, Mihovilić 2007, 17, sl. 2, 5).

Sl. 4 Tragovi uporabe na dijelu čela sjekire od serpentinita.
Fig. 4 Traces of wear on the back section of a serpentinite ax.



The exact findspot is located in quadrant BB/-4 (East-West 0.71 m, South-North 0.78 m), 80.84 m above sea level (stratum 3) in trench III, which comprised the northwestern section of the acropolis wall, part of the acropolis and part of the upper town alongside the defensive wall. The quadrant, where the ax-hammer fragment was discovered, is located in an area featuring the ruins of a section of the western acropolis wall, and alongside the border towards a section of the wall that was explored within the framework of trench X. From this area originates a radiocarbon date that leads us to the conclusion that it was temporary inhabited by man already in the middle of the 3rd millennium BC (Hänsel, Teržan, Mihovilić 2007, 14, Fig. 2). Other radiocarbon dates from samples gathered in this area of the acropolis wall, date the erection of the defensive wall to approximately 1800 BC (Hänsel, Teržan, Mihovilić 2007, 15-16, Fig. 2, 4), or even somewhat earlier, the additions being built a century later, the reinforcements after yet another century (Hänsel, Teržan, Mihovilić 2007, 17, Fig. 2, 5).

3. Fragment of an ax-hammer made of meta-diabase. There are four polished surfaces (Fig. 5). Fragment dimensions 4.8 x 2.9 x 3.6 cm. Register of finds - no. 30198.

The exact findspot is located in quadrant U/-5, 80.80 m above sea level (stratum a) in trench III. This is an area within the acropolis, located approximately 3-4 m from the defensive wall, perhaps in a small street between two structures from the first phase of the settlement.

Sl. 5 Ulomak sjekire od meta-dijabaza.
Fig. 5 A fragment of a meta-diabase ax.

3. Ulomak sjekire-čekića od meta-dijabaza. Zaglađena površina je sačuvana na četiri plohe (sl. 5). Veličina ulomka 4,8 x 2,9 x 3,6 cm Knjiga nalaza - br. 30198.

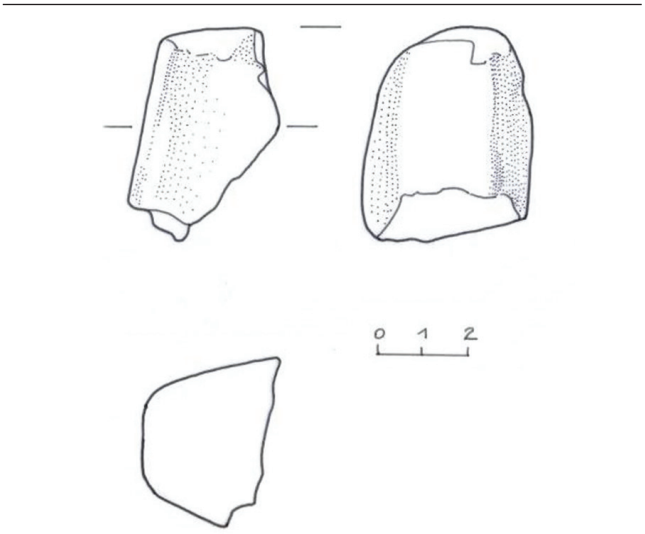
Točno mjesto nalaza je u kvadrantu U/-5, na apsolutnoj vis. 80,80 (planum a) u sondi III. Radi se o predjelu unutar akropole, cca. 3-4 m udaljenom od bedema, možda u uličici među dvjema građevinama prve faze naselja.

METODE ISTRAŽIVANJA

Za karakteriziranje zelenih sjekira iz Monkodonje korištene su posebne znanstvene metode. Uzorci su bili očišćeni u destiliziranoj vodi, a nakon toga su osušeni, ne bi li se tako uklonili svi slojevi premaza. Najprije su korištene nedestruktivne stereomikroskopske leće. Mineraloško-petrografske analize izveli smo na izbruscima, u skladu sa standardnom metodom. Mikroskopske analize obavili smo na mikroskopu NIKON Eclipse E600POL.

Ne bismo li potvrdili mineralni sastav XRD praha, bile su izvedene analize na Naravoslovnotehniškom fakultetu u Ljubljani, a pritom je bio upotrijebljen Philipsov difraktometar opremljen CuKα radijacijom. Prikupljeni podaci su u rasponu $2^\circ \leq 2\Theta \leq 70^\circ$.

Uzorci sve tri zelene sjekire ispitani su skenirajućim elektronskim mikroskopom s energo-disperzivnom spektrometrijom (SEM/EDS), ne bi li se dobio mineralni i polu-kvantitativni kemijski sastav. SEM/EDS analiza provedena je visoko-vakuumskom metodom, koristeći pri tome JEOL JSM 6490LV SEM, zajedno s Oxford INCA Energy EDS-om. Uzorci su obloženi ugljikom i promatrani metodom povratno



METHODS OF INVESTIGATION

Selected scientific methods were used in order to characterise the green axes from Monkodonja. The samples were cleaned with distilled water and dried to remove any layers of coats. First, non-destructive stereo microscopic lens was used. The mineralogical-petrographical analyses were done on thin sections made according to the standard method. The microscopic analyses were performed on a NIKON Eclipse E600POL microscope.

To confirm their mineral compositions powdered XRD analyses were done at the Faculty of Natural Sciences and Engineering in Ljubljana using a Philips diffractometer, equipped with CuKα radiation. Data were recorded in the range $2^\circ \leq 2\Theta \leq 70^\circ$.
Samples from all three green axes were investigated by scanning electron microscopy/energy dispersive spectroscopy (SEM/EDS) for mineral and semi-quantitative chemical composition. SEM/EDS analysis was carried out in high vacuum mode using a JEOL JSM 6490LV SEM, coupled with an Oxford INCA Energy EDS. Samples were coated with carbon and observed in the backscattered electron (BSE) mode. Semi-quantitative chemical composition of particles was measured using EDS point X-ray microanalysis with an acquisition time of 60 s. SEM/EDS investigation was performed in the laboratory at Geological Survey of Slovenia.

RESULTS

The three axes were made from different parental material as it was established by inspection with the naked eye and stereomicroscope. Also, the mineralogical-petrographical investigation of thin sections confirmed the various

raspršenih elektrona (BSE). Polu-kvantitativni kemijski sastav čestica mjeren je uz pomoć EDS rendgenske mikroanalize točke, s vremenom stjecanja od 60 s. SEM/EDS istraživanje provedeno je u laboratoriju Geološkega zavoda Slovenije.

REZULTATI

Sve tri sjekire napravljene su od različitih materijala, kako je bilo moguće ustanoviti već inspekcijom golim okom i stereomikroskopom. Također, mineraloško-petrografska istraga izbrusaka potvrdila je više različitih izvornih materijala - žad (može se upotrijebiti i naziv žadeitit), serpentinita te meta-dijabaza (za istu vrstu stijene se u literaturi upotrebljava i pojam meta-dolerit).

ŽAD

Od sve tri stijene ova je najtvrđa, može rezati staklo. Rukotvorina izrađena od ove stijene tamnozelene je boje, s 2 - 3 mm dugim i 1 mm širokim, igličastim do letvastim, bijelim, žutim do svijetlozelenim zrncima. Makroskopski gledano, izmjenjuju se slojevi gotovo tamnih pojaseva i onih svijetlozelenih koji su debeli od 1 do 0,5 mm. Tamnija zrnca su djelomično vlaknasta, ona svjetlija su idiomorfna do hipidiomorfna, a ponekad pokazuju svijetlozelene korone. Zrnca imaju dobru kalavost i staklasti sjaj. Blaga orijentacija također je vidna u izbruscima. Struktura je porfiroblastična, s većim, do 2 mm idiomorfno letvastim zrncima jadeita /omfacita (piroksen bogat s Na) u matrici istih minerala. Primarne minerale uglavnom zamjenjuju fino zrnati vlaknasti minerali (sl. 6). Također su prisutna mala zrnca rutila te titanita.

Sl. 6 Idiomorfna letvasta zrnca piroksena bogatog s Na (2mm) u matrici istih minerala; paralelne prizme.
Fig. 6 Idiomorphic tabular grains of Na rich pyroxene (2 mm) in the matrix of the same minerals; parallel nicols.

source materials, jade (the term jadeitite may also be used), serpentinite and meta-diabase (the term meta-dolerite for the same rock is preferably used in some literature).

JADE

The axe made from this rock is the hardest of all three, it cuts glass. The rock artefact is dark green colour with 2 - 3 mm long and 1 mm width acicular to tabular white, yellow to light green grains. Macroscopically, the layers of almost dark oriented beds and light green beds of 1 - 0.5 mm alternate. The darker grains are partly fibrous, the lighter ones are idiomorphic to hypidiomorphic and sometimes exhibit light green coronas. The grains have good cleavage and vitreous lustre.

The slight orientation is also seen in thin section. The texture is porphyroblastic with larger, up to 2 mm idiomorphic tabular grains of jadeite / omphacite (Na rich pyroxene) in the matrix of the same minerals. Primary minerals are generally substituted by fine grained fibrous minerals (Fig. 6). Small grains of rutile and titanite are also present.

XRD analysis showed presence of omphacite, jadeite, and some clinochlore. The EDS chemical analyses confirm the results of microscopic analyses, relatively high Na content due to Na rich pyroxenes, chlorite minerals, titanite and apatite.

Closest primary jade sources are in the Western Alps in meta-ophiolitic rocks of the Piemonte zone, Italy (Compagnoni, 2003; Compagnoni et al., 2012). The Alpine jadeite sources that had been exploited during the Neolithic have been known about for a long time (Pétrequin et al., 2006). Pétrequin and his coworkers (2006) report the exploitation of jadeites, omphacites and eclogites at high altitudes (Mont Viso, Italy). The relative frequency of jadeitite among Neolithic implements, compared with its rarity in the field, strongly suggest that this rock was collected in prehistory from secondary deposits, where it had been concentrated by natural agents because of its great durability (Ricq-de Bouard and Fedele, 1993). Secondary deposits of similar rock occur along rivers and alluvial plains and glacial deposits of the Alpine foothills (D`Amico et al., 1995 and the references therein). Therefore, there are many known jade prehistoric artefacts from Southern France (Ricq-de Bouard and Fedele, 1993) and Northern Italy

XRD analizom ustanovljena je prisutnost omfacita, jadeita te nešto klinoklora.

EDS kemijske analize potvrđuju rezultate mikroskopskih analiza, relativno visokog sadržaja Na kao posljedica Na-bogatih piroksena, kloritnih minerala, titanita i apatita.

Najbliži primarni izvori žada nalaze se u zapadnim Alpama, u meta-ofiolitičnim stijenama Piemonta, u Italiji (Compagnoni, 2003; Compagnoni et al., 2012). Alpski izvori jadeita, koji su bili eksploatirani tijekom neolitika, već su odavno poznati (Pétrequin et al., 2006). Pétrequin i njegovi suradnici (2006) izvješćuju o eksploataciji jadeita, omfacita i eklogita na velikim visinama (Monte Viso, Italia). Relativna frekvencija žadeitita među neolitskim oruđima, u usporedbi s rijetkošću na terenu, ukazuje da je ova stijena bila prikupljana u prapovijesti iz sekundarnih depozita, gdje je bila koncentrirana djelovanjem prirodnih agenata zbog svoje velike trajnosti (Ricq-de Bouard i Fedele, 1993). Sekundarni depoziti sličnih stijena pojavljuju se uz rijeke, u poplavnim ravnicama te u ledenjačkim depozitima u alpskom podnožju (D`Amico et al., 1995 te reference u njemu). Dakle, postoje mnoge prapovijesne rukotvorine od žada koje dolaze iz južne Francuske (Ricq-de Bouard i Fedele, 1993) te sjeverne Italije (D´Amico et al., 1995). Nalazi od žada su isto tako poznati iz velikog broja europskih država do 1.000 - 1.500 km od zapadnih Alpa, na primjer u sjevernoj Škotskoj, Skandinaviji, Moravskoj, Slovačkoj, Austriji te Siciliji (D`Amico et al., 1995; D`Amico, 2005 te reference u njemu), što ukazuje na trgovačke i izvozne aktivnosti prapovijesnog čovjeka. Sjekire od žada iz razdoblja od neolitika do brončanog doba već su bile pronađene uzduž jadranske obale, kao i u jadranskom zaleđu u Hrvatskoj (Petrić, 1995; Burić, 2000; Paunović, 2002) i Sloveniji (Bernardini et al., 2008). Treba naglasiti da su sjekire od žada bile oruđa visoke kakvoće te su kao takve bile simboli moći i vlasti, osobito u razdoblju mlađeg neolitika i starijeg bakrenog doba (Burić, 2000).

Zbog slične mineralogije, petrografije, teksture i metamorfne povijesti, podrijetlo ove sjekire vjerojatno je u zapadnim Alpama. Točan položaj je upitan zbog nedostatka informacija. Trgovački i migracijski putovi u cijeloj Europi, koji su postojali za vrijeme neolitika, već su poznati (npr. Thirault, 2005; Paunović, 2002), a rukotvorine od žadeitita su povremeno bile uvožene u Hrvatsku, što je bio slučaj i u drugim dijelovima Europe.

(D´Amico et al., 1995). Jade finds are also known in many European countries, up to 1000 - 1500 km from the Western Alps, e.g. Northern Scotland, Scandinavia, Moravia, Slovakia, Austria and Sicily (D`Amico et al., 1995; D`Amico, 2005 and the references therein), suggesting trade and export activities of prehistoric man. Jade Neolithic to Bronze Age axes have been already found along Adriatic coast and also in the Adriatic hinterland in Croatia (Petrić, 1995; Burić, 2000; Paunović, 2002) and Slovenia (Bernardini et al., 2008). It should be emphasized that jade axes were implements of high quality being symbols of power and authority, particularly in the Late Neolithic and Early Cooper Age (Burić, 2000).

Because of the similar mineralogy, petrography, texture and metamorphic history the provenance of this axe is most probably in the Western Alps. The exact location is questionable because of the lack of information. The trade and migration routes all over Europe from Neolithic period have already been established (e.g. Thirault, 2005; Paunović, 2002) and jadeitite artefacts were occasionally imported to Croatia as was the case in the other parts of Europe.

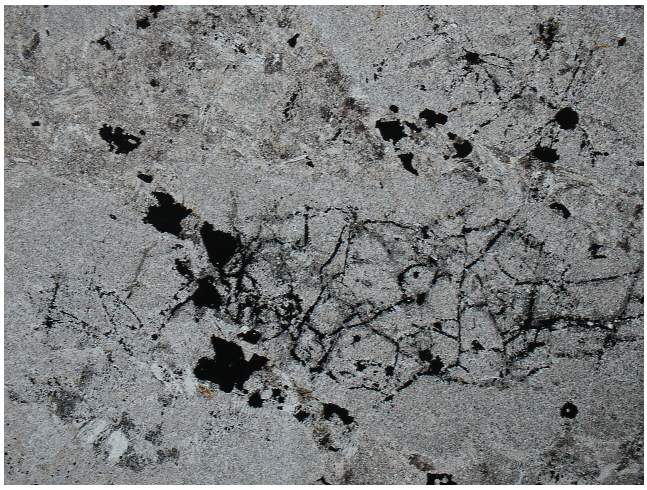
SERPENTINITE

This rock artefact is softer than other two specimens. The colour of the sample is green to greyish with the numerous rounded (spherical to elliptical) to angular (polygonal) dark green to black 1mm - 1cm large spots with mesh texture (black veins and brown fields). They resemble the olivine with corona texture. Some grains seem to be zoned. Some small bipyramidal grains of opaque mineral, possibly magnetite were found.

Thin section and SEM inspection revealed pseudomorphic texture of serpentine minerals over idiomorphic to hipidiomorphic olivine. Typical mesh texture of magnetite can be seen (Fig. 7 and 8). Around the grains is a rim of finer grained serpentine minerals. Tabular grains which could be alteration product of pyroxenes and/or amphiboles are less common. Intergranular places seem to be changed to chlorite. The XRD confirmed presence of serpentine minerals with minor vermiculite/chlorite, some amphibole minerals (possibly e.g. tremolite, actinolite and/or hornblende). Some chromite was also detected by SEM/EDS (Figure 9). In the sample chemical analyses by EDS showed relatively low Si and high Mg and sometimes high Cr contents.

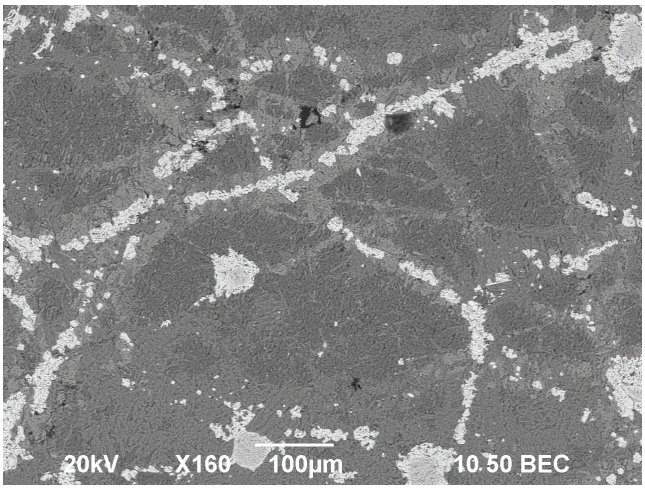
SERPENTINIT

Sjekira od ovog kamena mekša je od drugih dviju. Boja uzorka je sivkasto zelena, s brojnim zaobljenim (okruglim do eliptičnim) do uglastim (poligonalnim) tamnozelenim do crnim, 1mm - 1cm velikim mrljama i mrežaste teksture (crne vene i smeđa polja). One podsjećaju na olivin s korona teksturom. Izgleda kao da se neka zrnca nalaze u pojedinim zonama. Pronađena su i mala bipiramidalna zrnca od nekog neprozirnog minerala, moguće magnetita. Uz pomoć mikroskopske i SEM inspekcije otkrili smo da se pseudomorfna struktura serpentina nalazi preko idiomorfnog do hipidiomorfnog olivina. Zapazili smo i tipično mrežastu teksturu magnetita (sl. 7 i 8). Oko zrnaca se nalazi obruč od finije zrnatih serpentinskih minerala. Letvasta zrnca, koja bi mogla biti promijenjeni produkt piroksena i/ili amfibola, rjeđa su. Čini se da su se intergranularna mjesta promijenila u klorit. XRD je potvrdio prisutnost serpentinskih minerala i malo vermikulita/klorita te nekih amfibolnih minerala (npr. eventualno tremolit, aktinolit i/ili hornblenda). Uz pomoć SEM/EDS-a otkrivena je i manja količina kromita (slika 9). Kemijske analize uzorka po EDS metodi pokazale su relativno nizak sadržaj Si te visok sadržaj Mg, a ponekad i visok sadržaj Cr.

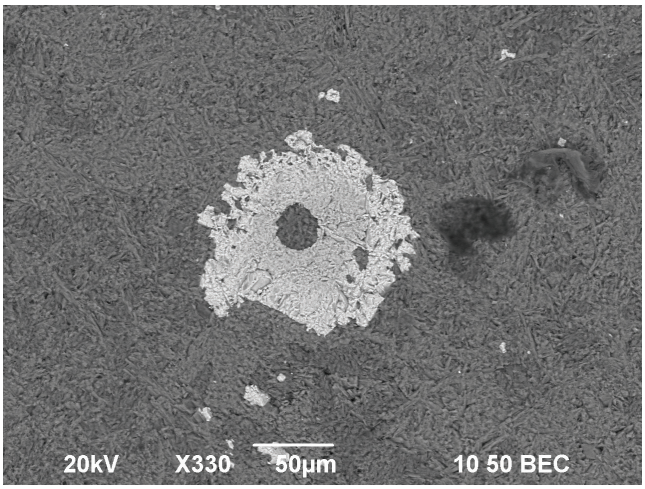


Sl. 7 Mrežasta struktura magnetita u matrici serpentinskih minerala (dulja strana slike je približno 5 cm duga); paralelne prizme.
Fig. 7 Mesh texture of magnetite in serpentine matrix (longer side of the image measures app. 5 cm); parallel nicols.

Važnost ovih stijena porasla je u bakrenom dobu, koje se u zadnje vrijeme povezuje s razvojem ranoeuropske metalurgije (Bernardini et al., 2011, te reference u njemu). Sjekire od serpentinita moguće je naći diljem Europe, npr u Slovačkoj (Hovorka i Illášová, 2000), Poljskoj (Majerowicz et al., 2000), Češkoj (Přichystal, 2000), a izrađene su više ili manje od lokalnih materijala



Sl.8 SEM slika koja prikazuje tipičnu teksturu serpentinita.
Fig. 8 SEM image showing typical serpentinite texture.



Sl. 9 SEM slika koja prikazuje zrnce kromita s obručem od magnetita.
Fig. 9 SEM image of chromite grain with magnetite rim.

The importance of these rocks grew up in Copper Ages, which has been recently linked to the development of early European metallurgy (Bernardini et al., 2011 and the reference therein). Serpentinite axes are found all over Europe, e.g. Slovakia (Hovorka and Illášová, 2000), Poland (Majerowicz et al., 2000), Czech Republic (Přichystal, 2000) and are made more or less from local or neighbouring materials. The presence of serpentinite shaft-hole axes quickly diminishes going from Friuli and central Slovenia to the Istrian Peninsula (Bernardini et al., 2009; 2011). Slovene serpentinites (Hintelechner Ravnik, 1971) are different from described one. Possible provenance for such type of rocks is Austrian Eastern Alps or Balkan Peninsula.

META-DIABASE

The rock artefact exhibits typical ophitic texture with white up to 2 mm plagioclase laths enclosed by dark

ili onih iz susjedstva. Prisutnost sjekira s rupom za nasad drške od serpentinita naglo se smanjuje na potezu iz Furlanije i središnje Slovenije prema istarskom poluotoku (Bernardini et al., 2009; 2011). Slovenski serpentiniti (Hintelechner Ravnik, 1971) razlikuju se od opisanog. Moguća provenijencija za takvu vrstu stijena je austrijsko istočnoalpsko područje ili Balkanski poluotok.

META-DIJABAZ

Proučavana kamena rukotvorina od meta-dijabaza ima tipično ofitičnu strukturu s bijelim, do 2 mm velikim plagijoklasnim letvama koje su ograđene tamnozelenim mineralima. U izbruscima je potvrđena ofitična intergranularna struktura (sl. 10). Jednostavno spojeni letvasti plagioklasi su jako izmijenjeni. Primarne piroksene zamjenjuje zelenkasti, slabo pleokroični, igličasti aktinolit te, rijetko, vlaknasti klorit. Također je nađena i stanovita količina kvarca te neprozirnih minerala.

Sl. 10 Ofitična struktura dijabaza s do 2 mm dugim plagioklasnim kristalima; ukrštene prizme.
Fig. 10 Diabase ophitic texture with up to 2 mm long plagioclase crystals; crossed nicols.

XRD je potvrdio prisutnost plagioklasa, monoklinskih amfibola, klinoklora te nešto kvarca. Uz gore spomenute minerale, SEM/EDS analize također su pokazale prisutnost magnetita, a njega djelomično zamjenjuje ilmenit. Neprozirni minerali često imaju skeletni izgled.

Sjekire iz neolitika i bakrenog doba, izrađene od meta-dolerita, razmjerno su česte u Istri (Bernardini et al., 2009). Mineraloška i petrografska zapažanja ispitane sjekire upućuju nas na moguće ofiolitno porijeklo izvornog materijala. S obzirom na stupanj promjene te veličine mineralnih zrnaca, porijeklo joj nije iz Slovenije (Hinterlechner, 1959). Dijabaze s Kalnika (Hrvatska) sastoje se uglavnom od svježeg plagioklasa (labradorit

green minerals. In thin section, ophitic intergranular texture is confirmed (Fig. 10). Simply twinned tabular plagioclases are strongly altered. The primary pyroxenes are replaced by greenish weakly pleochroic acicular monoclinic amphibole and rarely fibrous chlorite. Some quartz and opaque minerals could also be found.

The XRD confirmed presence of plagioclase, monoclinic amphibole, clinochlore and some quartz. In addition to above mentioned minerals SEM/EDS analyses showed also some magnetite which is partly replaced by ilmenite. Opaque minerals often exhibit skeletal appearance.

Neolithic-Copper Age axes made from meta-dolerites are relatively abundant in Istria (Bernardini et al., 2009). Mineralogical and petrographical observations of the examined axe indicate a possible ophiolitic provenance of source material. Regarding the degree of alteration and size of mineral grains the provenance is not in Slovenia (Hinterlechner, 1959). The diabases from Mt. Kalnik (Croatia) are composed mainly from fresh plagioclase (labradorite - bytownite) and augite to Ti-augite and only rarely the alteration products are observed (Vrkljan and Garašić, 2004). The metabasalts from Mt. Kalnik have porphyritic structure and phenocrysts of clinopyroxene are almost completely converted to calcite or rarely to chlorite (Vrkljan and Garašić, 2004). However, there is similarity with the meta-diabases from Banija Ophiolite Complex, Croatia (Garašić et al., 2004). Furthermore, similar shaft-hole axes from Caput Adriae were reported to have source in Banija Ophiolite Complex in Croatia and are attributed to Neolitic-Copper Age (Bernardini et al., 2009), one of them was even found in Monkodonja hillfort (Bernardini et al., 2009).

CONCLUSION

The particular significance of stone artifacts, and especially of the here discussed axes-hammers from Monkodonja, lies in the fact that the settlement, i.e., its construction and end, are relatively well-dated. The defensive walls were erected around 1800 BC, or even at an earlier date, as is shown by a large number of radiocarbon analyses, mostly of animal bones. The blossoming of the settlement was in the period between the 18th and 16th century BC, when it was thoroughly renovated and fortified anew. After 1500 BC, the settlement began to decline, although individual datings allow for the possibility that it existed until the 12th century BC (Hänsel, Teržan, Mihovilić 2007).

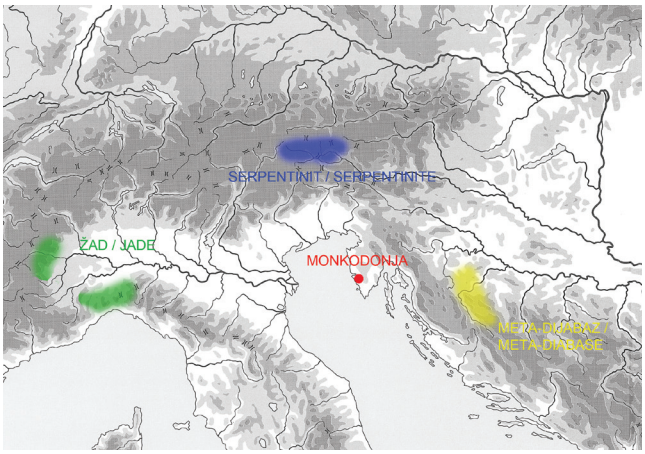
- bytownit) te augita do Ti-augita, a tek je rijetko moguće zapaziti izmijenjene proizvode (Vrkljan i Garašić, 2004). Metabazalti s Kalnika imaju porfirnu strukturu te su fenokristi od klinopiroksena gotovo u potpunosti pretvoreni u kalcit, a iznimno u klorit (Vrkljan i Garašić, 2004). Međutim, postoji sličnost s meta-dijabazama iz banijskog ofiolitnog kompleksa u Hrvatskoj (Garašić et al., 2004). Nadalje, za slične sjekire na uho iz Caput Adriae znamo da su porijeklom iz banijskog ofiolitnog kompleksa u Hrvatskoj te da su datirane u neolitik/bakreno doba (Bernardini et al., 2009), a jedna od njih bila je pronađena i na gradini Monkodonja (Bernardini et al., 2009).

ZAKLJUČAK

Poseban značaj kamenih artefakata, naročito ovdje obrađenih sjekira-čekića iz Monkodonje, jest u činjenici da je naselje, kako njegova izgradnja, tako i kraj, razmjerno dobro datirano. Kako to pokazuju brojne radiokarbonske analize, pretežno provedene na životinjskim kostima, bedemi su bili izgrađeni oko 1800. g. pr. n.e. ili već nešto ranije. Procvat je naselje doživjelo između 18. i 16. st., kada je bilo i temeljito obnovljeno te iznova utvrđeno. Nakon 1500. pr. n. e. započeo je njegov zalazak, iako pojedine datacije dopuštaju mogućnost da je postojalo sve do 12. st. pr. n. e. (Hänsel, Teržan, Mihovilić 2007). To svakako znači da je kameno oruđe, koje je značajno prije svega za razdoblje mlađeg kamenog doba i bakreno doba, ostalo u uporabi također još u rano i srednje brončano doba, odnosno barem još u prvoj polovici 2. tisućljeća pr. n. e., drugdje čak do u rano željezno doba (usporedi npr. Hochstetter 1987, 51 ss., T. 10). Iz uvjeta nalaza na Monkodonji možemo zaključiti da su kamene sjekire-čekići bile u uporabi prije svega kao oruđe, vjerojatno za obradu kamena pri gradnji zidova u suhozidnoj tehnici, a zbog oštećenja su na istome mjestu i odbačene. S obzirom da su sve tri prikazane alatke izrađene od različitog kamenog materijala, različitih geografskih provenijencija - kako to jasno pokazuje analiza (sl. 11) - mišljenja smo da je Monkodonja bila uključena u vrlo razvijenu mrežu razmjena sirovina i drugih dobara između zapadnih i istočnih Alpa te na zapadnom Balkanu.

Posebnu pozornost privlači ulomak sjekire-čekića od žada (sl. 2), izvanredno tvrdog kamena, čiji je izvor, pretpostavlja se, na području Monte Beiguea u Ligurskim Apeninima i Monte Viso u Kotijskim Alpama. Odatle je vjerojatno, u kasnom neolitiku i eneolitiku, tim materijalom opskrbljivana cijela zapadna Europa, sve do Atlantika i Pirineja, dok je istočna granica distribucije artefakata od jadeita tekla na liniji od Labe/Elbe na

This certainly means that stone implements that are especially significant for the Neolithic and Eneolithic, also remained in use during the Early and Middle Bronze Age, i.e., at least during the first half of the 2nd millennium BC, and elsewhere even up to the Early Iron Age (compare, for example, Hochstetter 1987, 51 ss., Taf. 10). From the conditions surrounding the finds from Monkodonja, we can conclude that the stone axes-hammers were primarily used as a tool, probably for stone-dressing during the construction of the walls in the drystone technique, which resulted in their being damaged and eventually discarded. Given that all three of the here discussed implements were made of different stone materials from different geographical provenance - as is clearly indicated by the analysis (Fig. 11) - we are of the opinion that Monkodonja was involved in a highly developed exchange network dealing in raw materials and other goods between Western and Eastern Alps, and the western Balkans.



Sl. 11 Monkodonja, mogući izvorni prostori sirovina.
Fig. 11 Monkodonja, the possible locations of origin of the raw materials.

Particular attention is drawn to a fragment of an ax-hammer made of jade (Fig. 2), an extremely hard stone whose provenance is assumed to be Monte Beiguea in the Ligurian Apennines, and Monte Viso in the Cottian Alps. It was probably from here, in the Late Neolithic and Eneolithic, that the whole of Western Europe was supplied, all the way to the Atlantic and the Pyrenees, whereas the eastern distribution border for artifacts made of jade went along the line from the Laba River / Elbe River in the north, across the Salzburg region, all the way to Istria and along the eastern coast of the Adriatic to the Pelješac Peninsula in the south (Pétrequin 2011, 81; Müller 2009, 100 s., Abb. 106; Petrić 1995, 6, 11, 20, T. I-III). It is indeed significant that already at such an early period of time

sjeveru preko područja Salzburga sve do Istre i duž istočne obale Jadrana do Pelješca na jugu (Pétrequin 2011, 81; Müller 2009, 100 s., Abb. 106; Petrić 1995, 6, 11, 20, T. I-III). Svakako se čini značajnim da su se u Istri već u starijem razdoblju opskrbljivali sirovinom zapadnoalpskog porijekla. To upućuje na zaključak da su Istra i istočna obala Jadrana po pitanju rasprostranjenosti artefakata od žada predstavljale granično područje u odnosu na Balkan i istočni dio srednje Europe. Sjekiru-čekić iz Monkodonje možemo shvatiti kao komad naslijeđenog, starinskog oruđa, koje se sačuvalo u uporabi do ranog brončanog doba, ili kao indikator za nastavak importa te sirovine iz sjeverozapadne Italije još u ranom 2. tisućljeću pr. n. e., odnosno u vrijeme ranog brončanog doba.

Zanimljivo je da možemo slične veze Monkodonje s vanjskim svijetom, kao što ih pokazuju ove tri kamene alatke, prepoznati i na temelju rasprostranjenosti nekih drugih karakterističnih monkodonjskih nalaza, posebno idola u obliku kruščića ("Brotlaibidoli", ili "tavolette enigmatiche" = Mihovilić, Hänsel, Teržan 2011), kao i brončanih sjekira sa zaliscima (Hänsel, Teržan, Mihovilić 2010).

raw materials of Western Alpine provenance were imported to Istria. As far as the occurrence of artifacts made of jade is concerned, Istria and the eastern coast of the Adriatic represent thus the border region facing the Balkans and the eastern part of Central Europe. The ax-hammer from Monkodonja should be regarded as an inherited, ancient implement that remained in use until the Early Bronze Age, or as an indicator for the continued importation of this raw material from northwestern Italy, still in the early 2nd millennium BC, i.e., during the Early Bronze Age.

It is interesting to note that we can detect similar connections of Monkodonja with the outside world, as shown on the basis of the three stone implements, if we take into consideration the occurrence of certain other characteristic finds from Monkodonja, especially idols in the shape of a loaf of bread ("Brotlaibidol", or, "tavolette enigmatiche" = Mihovilić, Hänsel, Teržan 2011), and winged axes made of bronze (Hänsel, Teržan, Mihovilić 2010).

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