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RADOVI ARHEOLOŠKOG ZAVODA  
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O F A R C H A E O L O G Y

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Zlatko PERHOČ & Rainer ALTHERR

## LITIČKI NALAZI S OTOKA SUŠCA

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## LITHIC FINDS FROM THE ISLAND OF SUŠAC

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*Na pojedinim srednjodalmatinskim otočkim prapovijesnim nalazištima nađeni su litički artefakti za čiju je izradu korištena sirovina brana iz šljunka. Valutična okorina tih artefakata upućuje na porijeklo kamene sirovine s izdanaka šljunka ili drugih klastičnih sedimenata. Petrografija artefakata i specifični znakovi trošenja površine kamena, topografija regionalnih i izvanregionalnih izdanaka odnosnih stijena – u korelaciji s predmetnim arheološkim nalazištima – u materijalnoj analizi litičkih artefakata dopuštaju više načina interpretacije porijekla kamene sirovine kao regionalno primjenjivih modela. Na primjeru arheološkoga nalazišta na otoku Sušcu prikazujemo model interpretacije porijekla sirovine primjenjiv za nalaze s Gradine iz Visa, Divjenih doca kod Sućurja na Hvaru i Rata kod Ložišća na Braču.<sup>1</sup>*

*Ključne riječi: litički artefakti, silicijske stijene, porijeklo sirovine, neolitik, Sušac, Hrvatska*

*Prehistoric stone artefacts made from gravel materials have been found at various sites on several islands in central Dalmatia. The pebble rind of these artefacts suggests that the raw material is derived from outcrops of gravel or other clastic sediments. The petrography of the artefacts, the specific signs of abrasion on the surface and the topography of regional and extra-regional outcrops of the relevant rock, in correlation with the pertinent archaeological sites, allow for several interpretations of the origin of the raw materials as regionally applicable models. Using the example of the archaeological sites on the island of Sušac, we use a model for interpretation of the origin of the raw materials applicable to finds from Gradina in Vis, Divjeni Doci at Sućuraj on the island of Hvar and Rat at Ložišće on the island of Brač.<sup>1</sup>*

*Key words: lithic artefacts, silicic rock, origin of raw material, Neolithic, Sušac, Croatia*

<sup>1</sup> Fotografije i mikrosnimke: Z. Perhoč, 2005–2011. (karta 1: S. Forenbaher, 2011; sl. 15: A. Varychev, 2010).

<sup>1</sup> Photographs and microscopic images: Z. Perhoč, 2005–2011 (map 1: S. Forenbaher, 2011; Fig. 15: A. Varychev, 2010).

## UVOD – INDIKATIVNA VRIJEDNOST LITIČKIH ARTEFAKATA S VALUTIČNOM KOROM U ISTRAŽIVANJU PORIJEKLA SIROVINE U PRAPOVIJESNOJ LITIČKOJ PROIZVODNJI

Modeli interpretacije litičkih artefakata temelje se na skupu obilježja geoloških i arheoloških pojava promatranih na području srednjodalmatinskih otoka pri istraživanju porijekla litičke sirovine (Perhoč 2009b: *passim*). Osim od petrografije u analizi litičkih artefakata polazi se od njihovih specifičnih sekundarnih strukturnih obilježja – veličine, sferičnosti, zaobljenosti, uglačanosti, udarnih napuklina i patine stijene od koje su izrađeni. Ta obilježja nastaju fizičkim i kemijskim trošenjem defragmentiranih stijena tokom transporta u sedimentacijskome ciklusu. U kombinaciji s općim geološkim podacima o ležištima i izdancima matičnih stijena struktura klasta može biti od pomoći pri određivanju približnog porijekla stijene od koje je artefakt izrađen. Modeli interpretacije indikativne su naravi i regionalno primjenjivi, nemaju svrhu izravnog dokazivanja geološkoga porijekla nekog sedimenta te ne nastoje, s arheološkog aspekta, biti isključivim dokazom načina nabave sirovine u prapovijesnoj litičkoj industriji. Osnovu predloženim modelima interpretacije čine litički inventari arheoloških nalazišta Vele spile u Veloj Luci na Korčuli, pećine Zale kod Tounja u Gorskom kotaru te otoka Sušca. Podrobnijim razradama donjih skica modela bavit ćemo se drugom prilikom, dok je primjer Sušca tema ovoga rada.

### MODEL VELA SPILA

Neobično raznolika petrografija litičkog inventara epigravetijenskih i mezolitičkih slojeva nalazišta Vela spila u Veloj Luci na Korčuli (Čečuk & Radić 2005: *passim*) pruža zahvalnu podlogu u našem istraživanju provenijencije sirovine u prapovijesnoj litičkoj industriji Dalmacije. Među artefaktima s valutičnom korom do sada su u inventaru izdvojeni oni izrađeni od radiolarita i rožnjaka (Perhoč, neobj. istraž. 2010).

Radiolarit je biogeni varijetet rožnjaka koji nastaje litificiranjem dubokomorskog silicijskog taloga bogatog radiolarijama (Füchtbauer & Müller 1970: 479–490). Primarnih depozita radiolarita nema ni na otočju ni na obalnome dijelu srednje Dalmacije, pa je pitanje odakle ta sirovina potječe, odnosno na kojem je sekundarnom izdanku radiolarit bran i dopremljen na otok. Najbliži mogući izvor velospilskih artefakata izrađenih od radiolaritnih valutica jest rijeka Neretva. Pretraživanjem recentna

## INTRODUCTION – THE INDICATIVE VALUE OF LITHIC ARTEFACTS WITH PEBBLE RIND IN RESEARCH INTO THE ORIGINS OF RAW MATERIALS IN PREHISTORIC LITHIC PRODUCTION

The interpretive models of the lithic artefacts are based on a set of features of geological and archaeological phenomena observed in the territory of the central Dalmatian islands in the course of research into the origin of lithic raw materials (Perhoč 2009b: *passim*). Besides petrography, the analysis of lithic artefacts takes into account specific secondary structural features: size, sphericity, roundness, smoothness, impact marks and patina of the stone from which an artefact is made. These features emerged due to physical and chemical abrasion of defragmented rock during conveyance in the sedimentation cycle. In combination with geological data on host rock deposits and outcrops, the structure of clasts may aid the determination of an approximate origin of the rock from which the artefact was made. Interpretive models are indicative in nature and regionally applicable and their purpose is not to directly prove the geological origin of a given sediment nor are they intended – from the archaeological standpoint – to serve as exclusive evidence of the method of procuring raw materials in prehistoric lithic industries. The basis of the proposed interpretive models consists of the lithic inventories of the archaeological sites at Vela Spila, in Vela Luka, Korčula, Zala Cave near Tounje in Gorski Kotar and the island of Sušac. A more detailed breakdown of the models outlined below will be dealt with on another occasion, while the example of Sušac is the topic of this work.

### THE VELA SPILA MODEL

The unusually diverse petrography of lithic inventories of the Epigravettian and Mesolithic layers of the Vela Spila site in Vela Luka, on the island of Korčula (Čečuk & Radić 2005: *passim*) offers a productive basis for our research into the origin of raw materials in the prehistoric lithic industry of Dalmatia. Among the artefacts with pebble rinds, those made of radiolarite or chert have thus far been set aside in the inventory (Perhoč, unpublished research, 2010). Radiolarite is a biogenic variety of chert formed by the lithification of deep-sea silicic sediment rich in radiolaria (Füchtbauer & Müller 1970: 479–490). There are no primary radiolarite deposits on either the Dalmatian islands or coastal belt, so there is a question as to whence this raw material came, i.e. the secondary outcrop at which this radiolarite



nanosa i terasa Neretve u šljunku smo osim nodularnog rožnjaka ustanovili i manju koncentraciju valutica crvenog (crvenozelenog i crnog) radiolarita solidne tehničke kakvoće. Radiolarit u Neretvu dospjeva vjerojatno u njenu gornjem toku iz zone bosanskog fliša, a jednim dijelom iz ladinika okoline Konjica, Jablanice i Drežnice (prema osob. priop. dr. Hazima Hrvatovića, 2010; usp. Pamić 2000: 70; Hrvatović 2006: 76; petrografska odredba Perhoč, neobj. istraž. 2009). Sljedeći mogući izvor radiolarita jesu žala Crnogorskog primorja. Izdanci mezozojskih sedimenata s radiolaritima na istočnome Jadranu, od Kamenara u Boki kotorskoj do Bara, prostiru se po obroncima crnogorskoprivlanskih planina sve do mora (Goričan 1994: 81). Žala s naročito velikim udjelom radiolaritnih valutica (pored slojevitog i nodularnog rožnjaka) našli smo na obali Budve i Sv. Stefana.

No prostorno najobuhvatniji izvori radiolaritnih valutica jesu šljunčani agregati bosanskih rijeka i potoka u centralnoj ofiolitnoj zoni unutrašnjih Dinarida. Radiolariti su petrogenetski povezani s ofiolitima, koji se u Europi pojavljuju na više sjevernih područja, u jurskim Alpama, a na jugu od Sredozemlja do Karpata, te se dalje protežu prema Srednjem istoku (Grunau 1965: 157, 191). Ofioliti su zajednica intruzivnih i efuzivnih stijena te silicijskih i klastičnih sedimenata koji se na području našeg interesa protežu od Banovine preko Bosne u pravcu Makedonije (Pamić & Hrvatović 2000: 60). Radiolariti, preslojeni sa šejlom i vapnencem, dolaze u radiolarit-formaciji koja se proteže duž krajnje jugozapadne margine dinaridne ofiolitne zone, ali se pojavljuju u ofiolitnom *mélangeu* (Pamić 2000: 70; Hrvatović 2006: 78). Ofiolitni *mélange* u kompleksu Krivaja-Konjuh čine fragmenti radiolarita, grauvake, bazalta, tufa, dijabaza, gabra, serpentiniziranog peridotita i egzotičnog vapnenca (Pamić & Hrvatović 2000: 60–61). Fragmenti radiolarita iz ležišta ofiolitnog *mélangea*, odnosno radiolarit-formacije, erozivnim procesima dospjevaju u bosanske rijeke u kojima se zaobljuju u valutice i oblutke (usp. Pamić 2000: 70; Pamić & Hrvatović 2000: 67; Halamić & Šošić Klindžić 2009: 21). Prilikom prospekcije u dolini Bosne i njenih pritoka s ciljem istraživanja radiolarita u šljunčanome nanosu rijeka zapazili smo brojne izdanke ležišta češće crvenosmedeg, rjeđe zelenosivog i crnog radiolarita, primjerice na brdu Bistričak sjeverno od Zenice. Kršje radiolarita nalazili smo kako u tlu oranica na visokim obroncima Bistričaka tako i u potoku Bistričaku, koji se kod Nemile ulijeva u Bosnu. Osjetno veći udio radiolarita u šljunku rijeke Bosne zabilježili smo u njenom srednjem toku nizvodno od pritoka Krivaje i Gostovića, rijekâ koje ležišta

was gathered and brought to the island. The closest possible source for the Vela Spila artefacts made of radiolarite pebbles is the Neretva River. By examining the recent fluvial deposits and terraces of the Neretva River, we ascertained that the gravel contained, besides nodular chert, a small concentration of red (red-green and black) radiolarite with sound technical quality. Radiolarites probably make their way into the Neretva in its upper course from the Bosnian flysch zone, and partially from the Ladinic in the area around Konjic, Jablanica and Drežnica (according to personal communication from Hazim Hrvatović, 2010; cf. Pamić 2000: 70; Hrvatović 2006: 76; petrographic classification, Perhoč, unpublished research, 2009). The next possible radiolarite source is the beaches of the Montenegrin coast. Outcrops of Mesolithic sediments containing radiolarites on the Eastern Adriatic seaboard, from Kamenar in Boka Kotorska to Bar, extend along the foothills of the Montenegrin mountains down to the sea (Goričan 1994: 81). Beaches with particularly large shares of radiolarite pebbles (in addition to layered and nodular chert) have only been found at seashores of Budva and Sveti Stefan.

However, the spatially most extensive sources of radiolarite pebbles is the gravel aggregates of the Bosnian rivers and their tributaries in the central ophiolite zone of the internal Dinarides. Radiolarites are petrogenetically linked to the ophiolites which mostly appear in the northern zones of Europe, in the Jurassic Alps, and in the south from the Mediterranean to the Carpathians, and onward toward the Middle East (Grunau 1965: 157, 191). Ophiolites are a group of igneous and volcanic rocks and silicic and clastic sediments, which in the region pertinent to this work extend from Banovina, in Croatia, through Bosnia and on toward Macedonia (Pamić & Hrvatović 2000: 60). Radiolarites, interspersed with shale and limestone, come in a radiolarite formation which extends all along the extreme south-western margin of the Dinaric ophiolite zone, but they also appear in an ophiolite *mélange* (Pamić 2000: 70; Hrvatović 2006: 78). The ophiolite *mélange* in the Krivaja-Konjuh complex consists of fragments of radiolarite, greywacke, basalt, tuff, diabase, gabbro, serpentinitized peridotite and exotic limestone (Pamić & Hrvatović 2000: 60-61). Fragments of radiolarite from the ophiolite *mélange*, i.e., the radiolarite formation, makes its way into Bosnian rivers by erosion, and once there they are disaggregated into pebbles and cobbles (cf. Pamić 2000: 70; Pamić & Hrvatović 2000: 67; Halamić & Šošić Klindžić 2009: 21). During prospecting in the valley of the Bosna River and its tributaries with the aim of researching radiolarites in the gravel deposits in this area, we noticed numerous outcrops of (more

radiolarita zahvaćaju na području ofiolitnog kompleksa Krivaja-Konjuh (Perhoč, neobj. istraž. 2011).<sup>2</sup> Osim velospilskih crvene radiolaritne artefakte na dalmatinskim otocima pronašli smo u litičkim inventarima prapovijesnih nalazišta pećine Kopačine kod Donjeg Humca na Braču (Vukosavljević *et al.* 2011), Vele Palagruže, Sušca i pećine Vlakno na Dugom otoku (Perhoč, neobj. istraž. 2010–2011). Pored artefakata od crvenih radiolaritnih valutica u litici Vele spile i pećine Kopačine na Braču zastupljeni su i artefakti od zelenog radiolarita. U litici Vele spile upadljiva je grupa sivozelenih fragmenata valutice nastalih od stijene laminarne strukture i silicij-sko-glinovito-karbonatnog sastava.<sup>3</sup> Ti su nas nalazi zbunjivali jer je to kamen nepogodan za bilo kakvu proizvodnju – mekan je i kalav po slojnim ploham – dok nismo našli artefakte izrađene od vrlo kvalitetna zelenog radiolarita, koji je manjim dijelom sjedinjen s navedenom glinovito-karbonatnom stijenom. Izgleda da su stanovnici Vele spile brali petrografski kompozitne valutice nastale od stijene sastavljene od silicij-sko-glinovito-karbonatnog i radiolaritnog sloja, od kojih su za izradu alatki odlamali tvrđi kremeni dio, a mekši odbacivali. Porijeklo tih valutica ni nakon pretraživanja brojnih terena u Crnoj Gori, Bosni i Hercegovini i Hrvatskoj nismo uspjeli utvrditi. Našu pretpostavku da su navedene valutice nastale od stijena u kojima se radiolariti pojavljuju s mikritima i šejlovima, a čije izvore treba tražiti u bosanskim ofiolitima, te da potječu iz rijeke Bosne, pretraživanjem rijeke i njenih pritoka nismo mogli potvrditi.

## MODEL ZALA

U litičkom inventaru mezolitičkoga sloja pećine Zala kod Tounja u Gorskom kotaru (Karavanić *et al.* 2008: 303) ustanovljeno je više petrografskih skupina. Jednu skupinu čine artefakti od amorfne homogene silicij-ske stijene zelenih tonova, čije porijeklo treba tražiti u trijaskim klastično-vapnenačko-glinovitim sedimentima flišolikoga tipa Like i sjevernog Velebita (Ščavničar 1973: 139). U lito-loški heterogenim naslagama uz potok Popovača kod Donjeg Pazarišta u Lici, nastalima u taložnom okolišu obilježenom vulkanskom aktivnošću, pored proslojaka devitificiranih tufova razvijene su nodule, leće i proslojci rožnjaka te silicificirani vapnenci i silicificirane gline (Sokač *et al.* 1974; 1976: 12, 29).<sup>4</sup>

<sup>2</sup> Geologu dr. Hazimu Hrvatoviću (Federalni geološki zavod BiH, Sarajevo) zahvaljujemo na susretljivosti prilikom navedene prospekcije.

<sup>3</sup> Za pomoć u petrografskom određenju zahvaljujemo geologinji ing. Milki Sarkotić-Šlat (Hrvatski geološki institut, Zagrebu).

<sup>4</sup> Zahvaljujemo geologu dr. Josipu Halamiću (Hrvatski geološki institut, Zagreb), koji nas je uputio na navedeni izdanak.

frequent) red-brown and (rarer) green-grey and red radiolarites, for example on Bistričak Hill north of Zenica. We found radiolarite debris both in the soil of plough-fields on the high slopes of Bistričak and in Bistričak Stream, which flows into the Bosna at Nemila. We noted a manifestly higher share of radiolarites in the Bosna's gravel in its middle course downstream from its Krivaja and Gostović tributaries, rivers which encompass the radiolarite deposits in the area of the Krivaja-Konjuh ophiolite complex (Perhoč, unpublished research, 2011).<sup>2</sup>

Besides those from Vela Spila, thus far we have found red radiolarite artefacts on the Dalmatian islands in the lithic inventories of the prehistoric sites in Kopačina Cave at Donji Humac on Brač (Vukosavljević *et al.* 2011), Vela Palagruža, Sušac and Vlakno Cave on Dugi (Perhoč, unpublished research, 2010–2011). Besides artefacts made of red radiolarite pebbles in the lithics of Vela Spila and Kopačina Cave on Brač, there are also artefacts made of green radiolarite. Notable in the Vela Spila lithics is a group of grey-green pebble fragments formed from rock with a laminary structure and silicic-clay-carbonate composition.<sup>3</sup> These finds puzzled us, for this is a type of stone unsuitable for any type of production – it is soft and prone to splitting along its layer surfaces – and we did not find any artefacts made of high-quality green radiolarite, which in small part bonded to the aforementioned clay-carbonate rock. It would appear that the inhabitants of Vela Spila gathered the petrographically composite pebbles that emerged from rock composed of the silicic-clay-carbonate and radiolarite layer, from which they broke off the harder stone portion using tools while discarding the softer part. We could not ascertain the origin of these pebbles even after examining a great deal of terrain in Montenegro, Bosnia-Herzegovina and Croatia. Our hypothesis is that these pebbles emerged from rock in which radiolarites appear with micrites and shales, and their sources should be sought in the Bosnian ophiolites originally from the Bosna River, although we could not confirm this in our investigation of the river and its tributaries.

## THE ZALA MODEL

Several petrographic groups were ascertained in the lithic inventory of the Mesolithic layer of Zala Cave at Tounje in Gorski Kotar (Karavanić *et al.*

<sup>2</sup> We would like to thank geologist Hazim Hrvatović (Federal Geology Department of Bosnia-Herzegovina, Sarajevo) for his kind assistance during this prospecting.

<sup>3</sup> We would like to thank geologist Milka Sarkotić-Šlat (Croatian Geology Institute, Zagreb) for her assistance in petrographic classification.

Naša preliminarna analiza mikrofacijesa potvrdila je veliku sličnost artefakata iz Zale i makroskopski neobično sličnih klasta iz potoka Popovača i Tisovac kod Donjeg Pazarišta. Artefakti iz te skupine na prirodno su nastalim bridovima tek neznatno ili nimalo zaobljeni, kao i kršje iz navedenih potoka. Oba potoka kratka su toka pa kršje stijena tokom transporta nije ni približno doseglo uobičajenu zaobljenost i sferičnost valutica i to je – pored petrografske sličnosti – dodatan pokazatelj srodnosti predmetnih artefakata i sirovine vjerojatnog izvora udaljenog od mezolitičkog staništa oko 64 km zračne linije.

Drugu petrografsku skupinu čine artefakti izrađeni od radiolaritnih valutica. Radiolaritne valutice i druge tipove rožnjaka te fragmente konglomerata s valutičnim komponentama koje petrografski i strukturalno odgovaraju slobodnim valuticama našli smo u šljunku Kupe. Izdanke iz kojih šljunak dospjeva u rijeku našli smo na terasi Kupe u šljunčarama Jezera kod Gornjeg Pokupja, zatim u Ozlju i u okolici grada. Ti izvori radiolaritnih valutica udaljeni su od pećine Zale oko 35 km zračne linije. Ozaljske sedimente povezujemo s aluvijem notranjsko-kraške regije u predalpskome području južne Slovenije, tragovima pleistocenske erozije i glaciofluvijalnog transporta (usp. Meze 1979: 123–128). Ti su sedimenti za prapovijesne kamenare bili neiscrpan izvor lako dostupne i prirodno “selektivne” kamene sirovine. To potvrđuje litika eneolitičkog nalazišta iz Ozlja-Grada (Perhoč, neobj. istraž. 2009).<sup>5</sup> Dodajemo da Kupa od izvora kod Razloge u Gorskom kotaru pa do Ozlja ne nosi valutice radiolarita ni rožnjaka (Perhoč, neobj. istraž. 2009, 2011).

## MODEL SUŠAC

Većina litičkih artefakata s neolitičkog nalazišta na Sušcu izrađena je od nodularnog rožnjaka tehnikom lomljenog kamena. No središnja tema ovoga rada malobrojni su sušački litički artefakti proizvedeni od valutica nastalih od silicijskih stijena s izdanaka rijetka tipa u srednjoj Dalmaciji (karta 1; Perhoč 2009a: 29; 2009b: *passim*). Te valutice u ovome će radu biti obuhvaćene skupnim nazivom *rožnjačke valutice*, osim ondje gdje je – u ovoj fazi istraživanja – bilo moguće i potrebno podrobnije petrografsko određenje. Posebnost i zajedničko obilježje sušačkih valutica jest način njihova postanka, transporta i recentno mjesto sedimentiranja. Matične stijene tih valutica nodularni su rožnjaci (možda i slojeviti rožnjaci, sasvim rijetko radiolariti) iz grupe silicijskih

2008: 303). One group consists of artefacts made of homogenous silicic rock with green hues, whose origin should be sought in the Triassic clastic-limestone-clay sediments of flysch-like type in Lika and northern Velebit (Ščavničar 1973: 39). Besides embedded layers of devitrified tuffs, nodules, lenses and embedded chert layers and silicified limestones and silicified clays (Sokač *et al.* 1974; 1976: 12, 29) developed in the lithologically heterogeneous layers along Popovača Stream at Donje Pazarište in Lika, formed in a sedimentation environment marked by volcanic activity.<sup>4</sup> Our preliminary analysis of microfacies has confirmed the great similarity between the artefacts from Zala and the macroscopically unusually similar clasts from the Popovača and Tisovac Streams at Donje Pazarište. The artefacts from this group on the naturally formed edges are only negligibly or not at all rounded, like the debris from the aforementioned streams. Both streams have short courses, so during transport the rock debris did not attain nearly the customary rounded edges and sphericity of pebbles, and this – besides the petrographic similarities – is an additional indicator of similarities between the artefacts in question and the raw materials whose probable source is roughly 64 km in a straight line from the Mesolithic habitat.

The other petrographic group consists of artefacts made of radiolarite pebbles. We found radiolarite pebbles and other chert types and fragments of conglomerates with pebble components, which petrographically and structurally correspond to free pebbles, in the gravels of the Kupa River. The outcrops from which the gravel makes its way to the river, we found on the Kupa terrace in the gravel pits of Jezero near Gornje Pokupje, in Ozalj and around this town. These sources of radiolarite pebbles are roughly 35 km from Zala Cave in a straight line. We linked the Ozalj sediments with alluvium of the Inner Carniolan/Karst region in the pre-Alpine zone of southern Slovenia, traces of Pleistocene erosion and glaciofluvial conveyance (cf. Meze 1979: 123-128). These sediments were an inexhaustible source of easily attainable and naturally “selected” stone raw materials for prehistoric stone-workers. This is confirmed by the lithics from an Eneolithic site from Ozalj Grad (Perhoč, unpublished research, 2009).<sup>5</sup> We should add that from the sources at Razloge in Gorski Kotar up to Ozalj, the Kupa carries neither radiolarite pebbles nor chert (Perhoč, unpublished research, 2009; 2011).

<sup>5</sup> Zahvaljujemo arheologinji Branki Stergar (Muzej grada Ozlja), koja nam je omogućila objavu navedenih litičkih nalaza.

<sup>4</sup> We would like to thank geologist Josip Halamić (Croatian Geology Institute, Zagreb), who pointed this outcrop out to us.

<sup>5</sup> We would like to thank archaeologist Branka Stergar (Ozalj Town Museum), who allowed us to publish these lithic finds.



stijena (usp. Füchtbauer & Müller 1970: 493–497) i silicificirani vapnenci, odnosno vapnenački pješčenjaci tipa kalkarenit i kalklitit, koji pripadaju litičkim arenitima (klasifikacija prema Pettijohn *et al.* 1972: 186–197; usp. Tišljar 2004: 151), odnosno – a s obzirom na to da su primarne karbonatne komponente dobrim dijelom potisnute silicifikacijom – kvarcnim dijagenetskim sedimentima ili kvarcnim kemogenim stijinama (usp. Tišljar 2001: 96). Radi se o valuticama sedimentiranim u crveničkom tlu koje smo pronašli na otocima Sušcu i Visu. U kontekstu do sada poznatih izvora rožnjaka u širem krugu srednjodalmatinskih prapovijesnih nalazišta taj tip klasta svojim obilježjima djeluje egzotično, pa je obrada pojave važna da se izbjegnu nagađanja o izvanregionalnom porijeklu, odnosno nabavi takve sirovine. Ta geoarheološka pojava bit će pobliže razmotrena na primjeru Sušca.

Rezultati sondirajućih iskopavanja na otoku Sušcu 1997. i 1998. te 2000. g. (Radić *et al.* 1999: *passim*; 2000: *passim*) bili su poticaj da se 2005. g. u sklopu istraživanja izvora rožnjaka s arheološkog aspekta u srednjoj Dalmaciji (Perhoč 2009b: *passim*) poduzme pregled otoka s ciljem nalaženja eventualnih lokalnih izdanaka.<sup>6</sup> Sljedeće godišnje prospekcije (2006–2010. g.) pokazale su da površinskih nalaza litičkih artefakata razne petrografije ima na više položaja, posebno brojnih na zapadnoj strani otoka. Autohtoni izdanci rožnjaka na otoku za sada nisu pronađeni. Sušački nalazi kamenih alatki i njima petrografski srodnih proizvodnih ostataka iz svih faza operativnog lanca pokazuju da je izrada alatki obavljena na otoku, gdje su rabljene i odbacivane. Pregledom litičkih artefakata zapaženo je više vrsta korištene kamene sirovine, što pretpostavlja i više tipova izvora iste. Cilj daljnega istraživanja bio je utvrditi porijeklo korištene sirovine, kao prilog interpretaciji komunikativne uloge otoka u prapovijesti (usp. Radić 2003: *passim*; Forenbaher 2009: *passim*).

## ARHEOLOŠKA NALAZIŠTA NA SUŠCU

Sušac je (karta 1; sl. 1, 2) otok lastovskog arhipelaga (srednja Dalmacija, Hrvatska), površine oko 4 025 km<sup>2</sup>, koji leži približno 12 nm južno od Korčule i 13 nm zapadno od Lastova (Duplančić Leder *et al.* 2004: 13). Litološku građu otoka čine naslage grebenskih vapnenaca starosti gornje jure. Geološki izvori ne spominju pojavu rožnjaka na otoku.

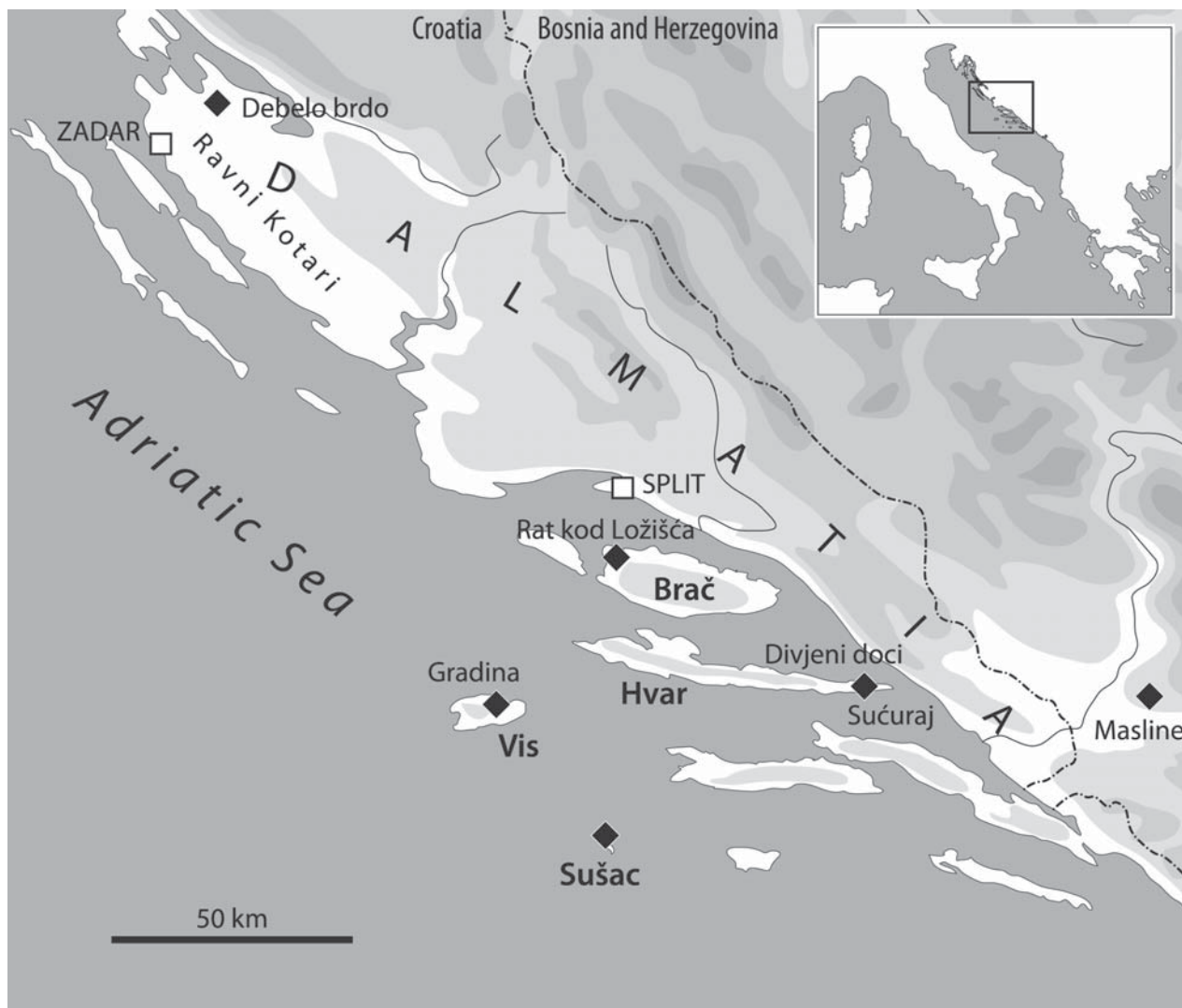
<sup>6</sup> Arheologu Dinku Radiću (Centar za kulturu Vele Luke), koji nam je omogućio istraživanje i objavu litičkih nalaza sa Sušca, zahvaljujemo na povjerenju i suradnji. Velolučanu Jerku Andreisu zahvaljujemo za brođenje tokom terenskih istraživanja.

## THE SUŠAC MODEL

Most lithic artefacts from the Neolithic sites on Sušac were made of nodular cherts by knapping technique. But the central topic of this work is the few Sušac lithic artefacts made from pebbles composed of silicic rock from outcrops of a rare type in central Dalmatia (map 1; Perhoč 2009a: 29; 2009b: *passim*). In this work, these pebbles will be classified in a group called *chert pebbles*, except where – at this phase in the research – it was possible and necessary to make a more detailed petrographic classification. The specificity and common features of the Sušac pebbles lie in the method of their emergence, conveyance and recent position in sedimentation. The parent rocks of these pebbles are nodular cherts (perhaps also layered cherts, and quite rarely radiolarites) from the silicic rock group (cf. Füchtbauer & Müller 1970: 493–497) and silicified limestones, or calcarenite and calcilutite lime sandstones, which belong to the lithic arenites (classification based on Pettijohn *et al.* 1972: 186–197; cf. Tišljar 2004: 151), or – since these are primary carbonate components largely overcome by silicification – quartz diagenetic sediments or quartz chemogenous rocks (cf. Tišljar 2001: 96). These are pebbles sedimented in terra rossa soil which we found on the island of Sušac and Vis. In the context of the thus far known chert sources in the broader sphere of central Dalmatian prehistoric sites, this clast type seems exotic based on its features, so an analysis of the phenomenon is important in order to avoid conjecture about its origin or the procurement of such raw materials. This geoarchaeological phenomenon will be examined in greater detail based on the example of Sušac.

The results of test excavations on the island of Sušac conducted in 1997 and 1998, and 2000 (Radić *et al.* 1999: *passim*; 2000: *passim*), served as the impetus for undertaking an inspection of the island in 2005 as a component of research into chert sources in central Dalmatia from the archaeological perspective (Perhoč 2009b: *passim*) with the goal of finding potential local outcrops.<sup>6</sup> The subsequent annual prospecting campaigns (2006–2010) showed that the surface finds of lithic artefacts of varying petrography could be found at various sites, and they were particularly numerous on the island's western side. Autochthonous chert outcrops on the island have thus far not been found. The Sušac finds of stone tools and petrographically similar manufactured

<sup>6</sup> We would like to convey our gratitude to archaeologist Dinko Radić (Vela Luka Culture Centre), who made it possible for us to research and publish the lithic finds from Sušac, for his confidence and cooperation. We would also like to thank Vela Luka native Jerko Andreis for transporting us by boat during our field research.



Karta 1. Topografija nalazišta litičkih artefakata, odnosno rožnjačkih valutica tipa Sušac. Osnova karte: T. Kaniški, obrada: Z. Perhoč, 2011.

Map 1. Topography of the lithic artefact (Sušac-type chert pebble) site. Base map: T. Kaniški, prepared by: Z. Perhoč, 2011.

Strukturalno je otok Sušac, kao i čitav lastovski arhipelag, ostatak rasjedima poremećene i morem potopljene antiklinale. Otok čine dva kraka nastala u orogenetskim procesima na prijelazu iz gornje krede u paleogen te do kvartara (Korolija *et al.* 1977: 10, 20–23, 35). Kraći i viši krak otoka čine bregovi Sušac (239 m), Veli Grk (207 m) i Mali Grk (161 m), zarasli u vrlo gustu makiju i šumarke česmine (sl. 2; toponimi prema Anon 1984). Sjevernu i zapadnu obalu rube klifovi ili je strma, dok je južna strana nisko položena. Uži i niži krak otoka vrlo je strm na sjeverozapadnoj strani (uvale Mali i Velji kolač), položen prema jugoistoku (uvale Dol, Portić i Manćina) i obrastao ružmarinom. Tu teren nije viši od 50 m n. v., osim poviše Gradeške (Kanule), na kojoj je svjetionik. Crvenice na otoku ima posvuda, u manjim ponikvama i terasastim dragama. Na najnižem dijelu otoka, na zaravni tektonsko-erozivnog

remains from all phases of the operating chain show that tools were crafted on the island, where they were also used and discarded. Several types of stone raw materials were noted in the inspection of the lithic artefacts, which implies several types of sources. The objective of further research was to ascertain the origin of the raw materials used to contribute to an interpretation of the communicative role of the island in prehistory (cf. Radić 2003: *passim*; Forenbaher 2009: *passim*).

## THE ARCHAEOLOGICAL SITES ON SUŠAC

Sušac (map 1; Fig. 1, 2) is an island of the Lastovo archipelago (central Dalmatia, Croatia), with a surface area of approximately 4,025 km<sup>2</sup>, which lies roughly 12 nm south of Korčula and 13 nm west of Lastovo



Slika 1. Otok Sušac, pogled s obronka istoimenog brijega na položaje neolitičkih nalazišta 027 i 002 (oznake položaja prema Radić *et al.* 2000).

Figure 1. The island of Sušac, view from the eponymous hill at the Neolithic sites 027 and 002 (designations of position according to Radić *et al.* 2000).

postanka između vrhova Sušac i Gradeška, ponikve su najbrojnije i najprostranije. Godine 1953. zabilježeno je 25 stanovnika (Rogić 1961: 380), dok danas na otoku osim posade svjetionika i pastira nema stalnih stanovnika.

Tokom višegodišnjih prospekcija pregledani su sljedeći krajevi i staze na otoku (sl. 2): sjeverna padina Malog Grka, draga Grk, kozja staza od Grka preko južne padine vrha Sušac do drage Dol, položaj u okolici crkvice Sv. Mihovil sjeverno od uvale Portić, Mjesečeva staza, uvala Mančina i brijeg Gradeška (Kanula). Istočne padine Malog i Velog Grka gotovo su bez raslinja pa je tlo na strminama izloženo snažnoj eroziji. Tu su nalazi prapovijesne i antičke keramike rijetki kao i litički artefakti, uglavnom lomljevina. Na terasastoj padini drage Grk nađen je fragment eneolitičke keramike i dosad najveći primjerak neobrađena rožnjačkog oblutka na otoku (Perhoč & Radić, neobj. istraž. 2007; mjere oblutka su  $68 \times 47 \times 20$  mm). Na kozjoj stazi od Velog Grka preko južne padine vrha Sušac približno do drage Dol bilo je više nalaza litičkih artefakata i fragmenata vjerojatno prapovijesne keramike, koju je zbog trošnosti teško pobliže odrediti. Dragu uvalu Portić, uvalu Mančina (češće zvanu Duga) i brijeg Gradeška (Kanula) dobrim dijelom spaja *Mjesečeva staza* (naziv prema Dinku Radiću), koja se ističe svojom pravocrtnošću i ukupnom duljinom oko 1 700 m i širinom do dva metra. Na stazi, crveničkim čistinama uz stazu i na padini prema moru brojni su površinski nalazi kamenih alatki i lomljevine te keramičkih fragmenata razne kulturne pripadnosti.



Slika 2. Topografija arheoloških nalazišta na otoku Sušcu (crvene točke – kozja staza, žute – Mjesečeva staza). Osnova satelitska snimka: Google Earth, 2010; obrada Z. Perhoč, 2011.

Figure 2. Topography of the archaeological site on the island of Sušac (red dots – livestock trail, yellow – Mjesečeva staza). Basic satellite image: Google Earth, 2010; prepared by Z. Perhoč, 2011.

(Duplančić Leder *et al.* 2004: 13). The lithological materials from the island consist of deposits of Upper Jurassic reef limestones. Geological sources do not mention the appearance of cherts on the island. Structurally the island of Sušac, like the entire Lastovo archipelago, is a remainder of anticlines disturbed by faults and flooded by the sea. The island consists of two spurs which emerged as a result of orthogenetic processes at the transition from the Upper Cretaceous into the Palaeogene up to the quaternary (Korolija *et al.* 1977: 10, 20–23, 35). The island's shorter and higher spur consists of the hills called Sušac (239 m), Veli Grk (207 m) and Mali Grk (161 m), which are overgrown with maquis and holly oak groves (Fig. 2; toponyms according to Anon 1984). The northern and western coasts are edged by cliffs or they are very steep, while the southern side lies low. The island's narrower and shorter spur is very steep on the north-west side (the coves of Mali and Veli kolač), facing the south-east (the coves of Dol, Portić and Mančina) and covered with rosemary bushes. Here the terrain never exceeds an elevation of 50 m above sea level, with the exception of the rather higher Gradeška (Kanula), on which there is a lighthouse. There is terra rossa everywhere in smaller sinkholes and terraced coves. In the lowest part of the island, between peaks of Sušac and Gradeška, on a plateau made by tectonic and erosive origins, the sinkholes are the most numerous and most spacious. In 1953, a total of 25 inhabitants were recorded (Rogić 1961: 380), while today the island has no permanent residents besides the staff of the lighthouse and shepherds.





Slika 3. Neolitičko nalazište na položaju 027, tzv. Velo i Malo poje na Sušcu.  
Figure 3. Neolithic site at site 027, so-called Velo and Malo poje on Sušac.

Na jugozapadnoj strani otoka, na vrhu Gradeška (80 m n. v.), austrijski je svjetionik sagrađen 1878. g. Na sjeveroistočnome podnožju Gradeške crveničke su ponikve očišćene od vapnenačkog kršja i ograđene suhozidom, koje se povremeno obrađuju. Na površini tih polja rasuti su brojni fragmenti litičkih artefakata. Padina ponad uvale Manćina arheološki je zanimljivija od navedenih položaja jer obiluje površinskim nalazima ranoneolitičke *impresso*-keramike i litičkim artefaktima. Na tom položaju i drugdje na otoku nađene su i glačane sjekirice od kamena razne petrografske pripadnosti (Radić *et al.* 1999: 56; Della Casa & Bass 2001). Prilikom naših prospekcija na padini i na žalu uvale Manćine nađeno je nekoliko sitnijih rožnjačkih valutica bez tragova obrade.

### NEOLITIČKO NALAZIŠTE NA POLOŽAJU 027

Istraživanjem koje je tema ovog rada obuhvaćeni su površinski litički geološki i arheološki nalazi s položaja ponad uvale Portić u blizini ranokršćanske crkvice sagrađene na temeljima rimskog sklopa s cisternom (Fisković 1980: 236). Na tom prostoru ima više crveničkih polja ograđenih suhozidom. Najviša zaravan, sa sjeverozapadne strane odrezana

Over the course of many years of prospecting, the following sections and trails on the island were explored (Fig. 2): the northern slope of Mali Grk, Grk Cove, the livestock trail from Grk across the slopes of Sušac to Dol Cove, the site near the small Church of St. Michael north of Portić Cove, the Mjesečeva ("Moon") trail, Manćina Cove Gradeška (Kanula) Hill. The eastern slopes of Mali and Veli Grk have almost no vegetation, so the steep ground is subject to erosion. Finds of pottery from prehistory and Antiquity are rare here, as are lithics, which are generally *débitage*. The terraced slopes of Grk Cove, an Eneolithic potsherd was found, as well as the largest example of an unretouched chert cobble on the island (Perhoč & Radić, unpublished research, 2007; the cobble's dimensions are 68 × 47 × 20 mm). On the livestock (goat) trail running from Veli Grk across the south slope of Sušac Hill roughly to Dol Cove, there were several finds of lithic artefacts and fragments of what is probably prehistoric pottery, which could not be more precisely specified due to their extreme wear. The coves named Portić and Manćina (more often called Duga) and Gradeška (Kanula) Hill are largely connected by the *Mjesečeva* – "Moon" – Trail (so called according to Dinko Radić), which stands out thanks to its

klifovima uvale Mali kolač, arheološki je položaj 027 (Radić *et al.* 2000: 61), površine oko 7 000 m<sup>2</sup> (sl. 1–3). Makija, visoko žbunje i pokoje stablo dijele položaj u povremeno obrađivane vrtove zvane *Malo* i *Velo poje*. Vjetar i kiša na površini položaja neprestano otkrivaju nove kamene artefakte, fragmente prapovijesne keramike te keramike mlađih kulturnih perioda. Teren je položen prema klifu pa je konzervatorska zaštita položaja 027 – zbog erozije sedimenta – prijeko potrebna. Istražnim sondama na tom položaju otkriven je *impresso*-keramički sloj te sloj s jednojono i dvobjono oslikanom i fino glačanom keramikom s plastičnim izbočenjima. Keramika je srodna tipu *ceramica dipinta a fasche large*, odnosno srednjoneolitičkoj, velolučkoj kulturi (Radić *et al.* 2000: 61). Sušački nalazi artefakata od opsidijana liparskoga porijekla brojnošću se ističu na istočnoj jadranskoj obali, a lomljevinu govori da su alatke izrađene na položaju (Radić *et al.* 1999: 57; Radić & Perhoč, neobj. istraž. 2006–2010).

## LITIČKI ARTEFAKTI

Nalazi litičkih artefakata na položaju 027 naročito su brojni. U površinskim nalazima, kao i u onima iz istražne sonde, zastupljene su gotove alatke, tehnološke predjezgre, jezgre i lomljevinu u tehnici lomljenog kamena, što znači da se proizvodilo izravno na položaju. Prema petrografskoj analizi tih artefakata za njihovu izradu korištena je raznolika sirovina. Dominiraju artefakti izrađeni od nodularnog rožnjaka dopremljenog iz nekog autohtonog ili paraautohtonog izdanka (mjesto postanka rožnjaka i dostupnosti u stijeni domaćinu ili erozije u njenoj neposrednoj blizini), dok su artefakti od rožnjačkih valutica iz alohtonog izdanka (mjesto udaljeno od postanka, na kojem je rožnjak nataložen nakon što je erodirao iz stijene domaćina i tokom transporta preoblikovan u valuticu), pronađeni na manjem dijelu položaja – malobrojni. Kako u geološkoj literaturi ne nalazimo obavijesti ni o kakvim izdancima silicijskih stijena na otoku Sušcu, postavilo se pitanje porijekla, nabave i dopreme kamene sirovine na položaj (usp. Della Casa & Bass 2001).

## ARTEFAKTI OD NODULARNOG ROŽNJAKA

U litičkom inventaru sušačkog nalazišta prevladavaju artefakti izrađeni od nodularnog rožnjaka. Rožnjak (engl. *chert*, njem. *Hornstein*, fr. *silex*) vrsta je čvrste monomineralne silicijske sedimentne stijene, kemijskog ili biogenog postanka, izgrađene od mikrokristalastog, kriptokristalastog kvarca (hrv. *kremen*) i vlaknastog kalcedona. U stijeni domaćinu (karbonatne stijene) rožnjak se pojavljuje u obliku nodula,

linearity and overall length of approximately 1,700 m and widths reaching up to two meters. Numerous finds of stone tools and débitage, as well as potsherds of various cultures were found on the trail, in the terra rossa clearings adjacent to it and on the slope toward the seashore. The Austrian lighthouse constructed on the south-western side of the island, on the peak of Gradeška (80 m ASL) in 1878. At the north-eastern foot of Gradeška, the terra rossa sinkholes have been cleared of limestone debris and enclosed by stacked-stone fences, which are occasionally repaired. Numerous fragments of lithic artefacts are scattered over these fields. The slope above Manćina Cove is archeologically more interesting than the aforementioned sites, because it abounds in surface finds of Early Neolithic Impressed ware and lithic artefacts. Polished hatchet blades made of petrographically diverse stone have been discovered at this site and elsewhere on the island (Radić *et al.* 1999: 56; Della Casa & Bass 2001). During our prospecting on the slope and beach of Manćina Cove, we found several smaller chert pebbles without traces of working.

## NEOLITHIC SITE 027

This research encompassed the surface geological and archaeological lithic finds from the site above Portić Cove near a small Early Christian church constructed on the foundations of a Roman complex with a cistern (Fisković 1980: 236). In this area there are a number of terra rossa fields enclosed by stacked-stone walls. The highest plateau, on the north-west side cut off by the cliffs at Mali kolač Cove, is archaeological site 027 (Radić *et al.* 2000: 61), covering a surface of approximately 7,000 m<sup>2</sup> (Fig. 1-3). Maquis, high brush and the occasional tree separate the site into occasionally cultivated gardens known as *Malo and Velo poje* ("Small and Large Field"). Wind and rain on the site's surface constantly reveal new stone artefacts, fragments of prehistoric pottery and pottery from younger cultural eras. The terrain runs toward the cliff, so that conservation of site 027 is absolutely essential due to erosion. Test trenches at this site have uncovered an Impressed ware layer and monochrome and bichrome painted and finely polished pottery with sculpted protrusions. The pottery is similar to the type known as *ceramica dipinta a fasche large*, i.e., the Middle Neolithic, Vela Luka culture (Radić *et al.* 2000: 61). The high number of Sušac artefacts made of obsidian from Lipari stand out on the Eastern Adriatic seaboard, while the débitage indicates that tools were crafted at the site (Radić *et al.* 1999: 57; Radić & Perhoč, unpublished research, 2006–2010).





Slika 4. Alatkne od rožnjaka s mliječnobijelom patinom; Sušac, položaj 027.

Figure 4. Tools made of chert with milky white patina; Sušac, site 027.



Slika 5. Alatkne od nodularnog rožnjaka s okorinom; Sušac, položaj 027.

Figure 5. Tools made of nodular chert with rind; Sušac, site 027.

odnosno gomolja, grumenova i leća (*nodularni* ili *gomoljasti rožnjak*) ili slojeva i proslojaka (*slojeviti* ili *prugasti rožnjak*; Füchtbauer & Müller 1970: 494–497). Površina lomne plohe većine sušaćkih artefakata izrađenih od nodularnog rožnjaka prekrivena je mliječnobijelom patinom pa je nedestruktivna petrografska analiza, koja bi dala više podataka o varijetetu korištenog rožnjaka, otežana ili potpuno nemoguća (sl. 4). Na veliku dijelu tih artefakata, kako na alatima (sl. 5) tako i na proizvodnim ostacima, vidljiva je *nodularna okorina*. Nodularna okorina (engl. *nodular rind*, *crust*, njem. *Knollenrinde*, *Kreiderinde*) genetska je kora nodularnog rožnjaka. To je periferni sloj nodule koji čini prijelaznu zonu prema stijeni domaćinu, nekoj karbonatnoj stijeni. Od jezgre nodule, tj. petrografski zrele dijela nodule, okorina se

## LITHIC ARTEFACTS

The lithic artefacts on the site 027 are particularly numerous. The surface finds, like those from the test trench, include finished tools, knapping pre-cores, cores and débitage made by knapping, which means that production was done on site. According to the petrographic analysis of these artefacts, a diversity of raw materials were used to make them. The predominant artefacts are made of nodular cherts from an autochthonous or para-autochthonous outcrop (the origin place of the chert and its accessibility in the host rock or erosion in its immediate vicinity), while the artefacts made of chert pebbles from an allochthonous outcrop (a place distant from the point of origin, at which the chert accumulated after it eroded from the host rock, and reformed into pebbles during conveyance) found in a small part of the site – are few. Since the relevant geological literature contains no information on any outcrops of silicic rock on the island of Sušac, the question of the origin, procurement and bringing of the raw stone to the site arises (cf. Della Casa & Bass 2001).

## ARTEFACTS MADE OF NODULAR CHERT

Artefacts made of nodular chert predominate in the lithic inventory of the Sušac site. Chert (Cro. *rožnjak*, Ger. *Hornstein*, Fr. *silex*) is a type of firm monomineralic silicic sediment rock, created chemically or biogenetically, composed of microcrystalline or cryptocrystalline quartz (Cro. *kremen*) and fibrous chalcedony. Chert appears in the host rock (carbonate rock) in the form of nodules, respectively nuggets and lenses (*nodular chert*) or in layers and interlayers (*layered* or *ribbon chert*; Füchtbauer & Müller 1970: 494–497). The surfaces of the knapped faces of most Sušac artefacts are composed of nodular chert covered with a milk-white patina, so a non-intrusive petrographic analysis, which would yield more data on the variety of chert used, is rendered difficult if not entirely impossible (Fig. 4). A *nodular rind* is visible on a considerable portion of these artefacts, both on tools (Fig. 5) and retouch remains. The nodular rind (also crust, Cro. *nodularna okorina*, Ger. *Knollenrinde*, *Kreiderinde*) is the genetic crust of nodular chert. This is a peripheral layer of the nodule which forms a transitional zone toward the host rock, which may be a carbonate rock. The rind differs from the nodule's core, i.e., the petrographically "mature" part of the nodule, in terms of colour, structure, density and degree of resistance to abrasion. It consists of quartz, the mineral of the host rock (carbonate or, more rarely, mineral clays), while relics of the host rock (structure, detritus, fossils) are not infrequently less affected by

razlikuje bojom, strukturom, tvrdoćom i stupnjem otpornosti na trošenje. Sastoji se od kvarca, minerala stijene domačina (karbonatni, rjeđe minerali gline), a relikti stijene domačina (struktura, detritus, fosili) nerijetko su manje zahvaćeni silicifikacijom i stoga bolje očuvani nego u jezgrenom dijelu. Okorina predmetnih artefakata nije sasvim svježja, ali je očuvana, trošenjem slabo nagrizena, crvenkasto i smečkasto obojena oksidima željeza te umrljana crvenicom. Do pojave žutih, crvenih i smeđih tonova na sedimentnim stijenama, pa i na rožnjacima, dolazi uslijed prijelaza dvovalentnog željeza sadržana u piritu i drugim akcesornim mineralima vapnenaca u trovalentno ili oksidacijom stijene uzrokovane oborinskim vodama (Tišljarić 2004: 11; usp. Adams & MacKenzie 2001: 6).

Prema rečenomu može se zaključiti da je za navedene artefakte kao sirovina uglavnom korišten nodularni rožnjak ubran na nekom autohtonom izdanku. Tomu u prilog govori činjenica da na nodularnoj okorini većine nalaza iz te grupe nema tragova habanja do kojeg dolazi u vodenom transportu. Malobrojniji su nalazi koji ukazuju na porijeklo sirovine s nekog paraautohtonog izdanka. Na jednim je nodularna kora vidljivo pohabana, glatka i načeta udarnim napuklinama, a na drugima je uz nodularnu koru vidljiva i valutična. Naime nodularna kora sasvim je istrošena na izbočenim mjestima koja su pri transportu izložena habanju i koja pokazuju tipične udarne napukline, dok je okorina u udubljenjima ostala potpuno sačuvana od fizičkog trošenja. Takva nodula bila je kratkotrajno izložena transportu ili se proces odvijao u vodi niske energije, možda na obali mirnijeg mora ili u rijeci kratka toka. Nalazi fragmenta jedne povećane nodule rožnjaka (Della Casa & Bass 2001; cca 20 × 20 × 5 cm i 1,7 kg) te više fragmenata manjih nodula, odnosno tehnoloških jezgri i odbojaka s očuvanom nodularnom okorinom koji strukturalno odgovaraju predmetnoj skupini artefakata s ovog i drugih položaja na otoku, dokazuju da je sirovina na položaj na kojemu je obavljena proizvodnja rukotvorina dopremana iz nekog za sada nepoznatog izvora jer autohtono ležište nodularnog rožnjaka i nakon višekratnih obilaženja otoka na Sušcu nismo otkrili. Ako na Sušcu rožnjaka doista nema, od mogućih izvora u obzir dolaze brojni izdanci na istočnoj strani Jadrana, prije svega u Dalmaciji (Perhoč 2009bc: *passim*), zatim u Bosni i Hercegovini (Hrvatović 2006: *passim*), a na zapadnoj strani u Apuliji (Lernia *et al.* 1995: *passim*). Dodajmo da među sušačkim artefaktima od nodularnog rožnjaka s okorinom ima nalaza od silicificiranog vapnenaca s okorinom i strukturom sličnom sitnozrninom konglomeratu (sl. 6) i breči. Njima srodni nalazi s Palagruže (sl. 7) te srodnost

silicification and are thus better preserved than in the core portion. The rind of these artefacts is not entirely fresh, but it is preserved, only slightly corroded by abrasion, coloured reddish or brownish by iron oxides and stained with red soil. The appearance of yellow, red and brown hues on sedimentary rock, including cherts, is caused by the transition of bivalent iron contained in pyrite and other accessory mineral limestones into a trivalent or oxidized rock caused by precipitation (Tišljarić 2004: 11; cf. Adams & MacKenzie 2001: 6).

Based on the above, one may conclude that nodular chert gathered at some autochthonous outcrop served as the raw material for the aforementioned artefacts. This is backed by the fact the nodular rind on most of the finds from this group exhibit no traces of the abrasion caused by waterborne conveyance. Finds exhibiting raw materials originally from some para-autochthonous outcrop are fewer in number. On some the nodular crust is visibly worn, smooth and pitted with impact marks, while on others a pebble rind is visible in addition to the nodular crust. The nodular crust is entirely worn at protrusions, which were exposed to abrasion during conveyance and which exhibit typical impact marks, while the rind in the depressions remained entirely preserved from physical wear. Such a nodule was briefly exposed to conveyance or the process proceeded in low-kinetic water, perhaps at the shore of a more tranquil sea or in a short river. The discovery of fragments of a rather large chert nodule (Della Casa & Bass 2001; cca 20 × 20 × 5 cm and 1.7 kg) and several fragments of smaller nodules, i.e., knapping cores and flakes with preserved nodular rind which structurally correspond to the relevant set of artefacts from this and other sites on the island shows that the raw material on the site at which handicrafts were produced was brought from some thus far unknown source, for even after several tours of the island of Sušac we have not found an autochthonous deposit of nodular chert. If there truly are no cherts on Sušac, possible sources that may realistically considered are the numerous outcrops on the Eastern Adriatic seaboard, above all in Dalmatia (Perhoč 2009bc: *passim*), and then in Bosnia-Herzegovina (Hrvatović 2006: *passim*), and on the western side of Apulia (Lernia *et al.* 1995: *passim*).

It should be added that among the Sušac artefacts made of nodular chert with rind there are finds of silicified limestones with rind and a structure similar to fine-grain conglomerate (Fig. 6) and breccia. Finds similar to it from Palagruža (Fig. 7) and the similarity between the Palagruža and Sušac artefacts indicate the need for further research into prehistoric lithics from these two outlying sites on the trans-Adriatic route between the Apennine and





Slika 6. Alatka od silicificiranog vapnenca s okorinom; Sušac, položaj 027.

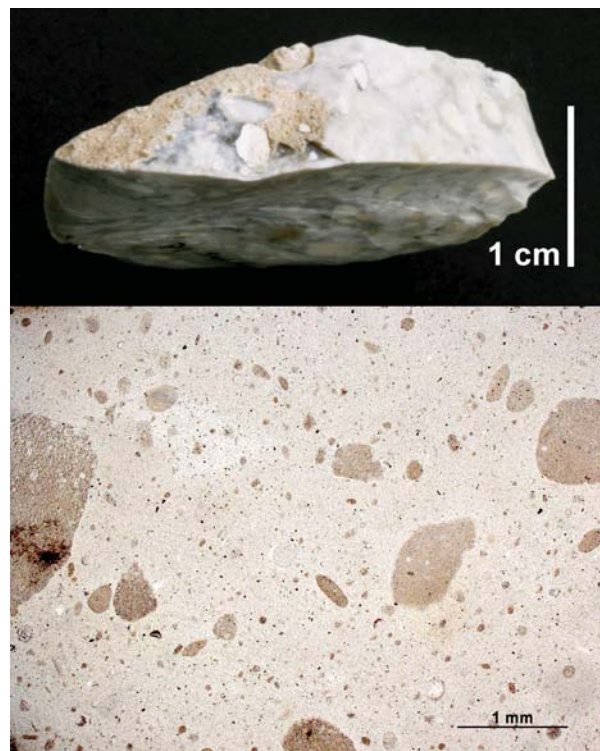
Figure 6. Tools made of silicified limestone with rind; Sušac, site 027.

palagruških i sušačkih artefakata iz drugih petrografskih skupina pobuđuju na daljnje istraživanje prapovijesne litike s tih dvaju isturenih nalazišta na transjadranskome putu između apeninske i dinarske strane, toliko više što na Palagruži, osobito na Maloj Palagruži, ležište rožnjaka postoji (Della Casa & Bass 2001; Forenbaher & Kaiser 2005: 16; Perhoč 2009b: 33).

## ROŽNJAČKE VALUTICE – SIROVINA LITIČKIH ARTEFAKATA

Tokom istraživanja na Sušcu nalaženje rožnjačkih valutica u sedimentu na položajima 027 i 002 prethodilo je nalazima artefakata od sirovine te vrste, odnosno tek su nas nalazi tih valutica upozorili na petrografski srodne artefakte. Arheološki položaj 027 smješten je 300-tinjak m od uvale Portić i 26 m iznad razine mora. Sediment na položaju je crvenica s petrografski heterogenim klastima (sl. 8) koje pored arheološki relevantnih rožnjačkih valutica čine nakupine kalcita, vapnenačko kršje i limonitne kongrecije te valutice vapnenaca, glinjaka, pješčenjaka, sitnozrnog konglomerata i breče. Zaobljenost i sferičnost svih tih valutica vrlo je visoka stupnja. Sudeći prema površinskim nalazima valutica i prema onima iz sonde, šljunčana komponenta prisutna je u cijelu profilu crveničkog sedimenta.

Rožnjačke valutice na položaju 027 i drugdje na otoku (sl. 9, 12) vizualno se malo razlikuju od vapnenačkih u sedimentu ili na žalu otoka. Te relativno malobrojne valutice bjeličaste su ili svijetlosive boje s primjesama crvenkastih i žućkastih tonova, glatke i sjajne ili kavernaste, raspucale *valutične okorine*. Valutična okorina (odnosno *okorina valutice*



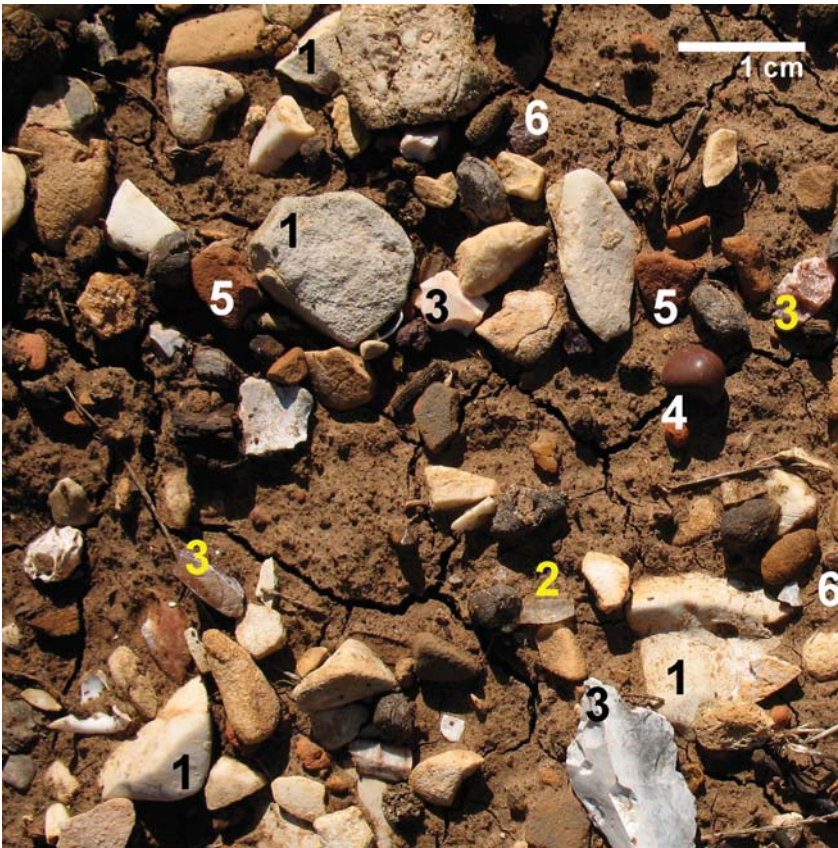
Slika 7. Odbojak od silicificiranog vapnenca s okorinom, dolje mikrosnimka istog; Vela Palagruža. Polarizacijski mikroskop.

Figure 7. Flake made of silicified limestone with rind; micro-image of same below; Vela Palagruža. Polarization microscope.

Dinaric sides, all more so since there is a chert deposit on Mala Palagruža (Della Casa & Bass 2001; Forenbaher & Kaiser 2005: 16; Perhoč 2009b: 33).

## CHERT PEBBLES – THE RAW MATERIAL FOR LITHIC ARTEFACTS

During research on Sušac, the discovery of chert pebbles in the sediment at sites 027 and 002 preceded finds of artefacts made of this type of material, meaning that only the discovery of these pebbles indicated the existence of petrographically similar artefacts. Archaeological site 027 is located roughly 300 m from Portić Cove and it is 26 m above sea level. The sediment at the site is terra rossa containing petrographically heterogeneous clasts (Fig. 8) which – besides archeologically relevant chert pebbles – also contain calcite accretions, limestone debris and limonite concretions and pebbles of limestone, claystone, sandstone, fine-grained conglomerates and breccia. The degree of roundness and sphericity of all of these pebbles is very high. Judging by the surface finds of pebbles and those from the test trench, the gravel component is present throughout the terra rossa sediment's profile.



Slika 8. Crveniĉko tlo na Sušcu, poloŹaj 027 (1. vapnenac, 2. kalcit, 3. roŹnjak, 4. radiolarit, 5. keramika, 6. limonitna konkrecija).

Figure 8. Terra rossa soil on Sušac, site 027 (1. limestone, 2. calcite, 3. chert, 4. radiolarite, 5. pottery, 6. limonite concretion).

ili *oblutka*, njem. *Geröllrinde*, usp. Floss 1994: 94; engl. *pebble rind*) tip je kore trošenja (engl. *weathering rind*, njem. *Verwitterungsrinde*) specifiĉne za šljunak. To je vanjski sloj valutice ili *oblutka* bilo koje vrste stijene na kojoj u sedimentacijskoj ciklusu, naroĉito tokom transporta, dolazi do fizikalnih (pohabanost, zaobljenost, napukline), ali i kemijskih promjena koje su vidljive u promjenama strukture i boje. Analogno tomu *valutiĉna okorina nodule* nastaje habanjem nodularnog roŹnjaka u vodenom transportu, uslijed ĉega je njegova genetska *nodularna okorina* manje-više reducirana, mjestimice prepoznatljiva kao takva, dok je samoj noduli oblik djelomiĉno ili sasvim izmijenjen. Tipovi okorina, *valutiĉna* i *nodularna okorina* te *valutiĉna okorina nodule*, ako su na artefaktu saĉuvane, arheologu omogućavaju oĉitavanje podataka o pojavnom tipu korištenog roŹnjaka i tipu izdanka na kojemu je sirovina za litiĉku proizvodnju nabavljena.

RoŹnjaĉku skupinu ĉine sivobijele valutice (vrlo svijetlosiva, N8; prema *Rock Color Chart* 1991) sa Źutosmeĉim mrljama nastalim od silicificiranog kalkarenita (sl. 9) i od nodularnog roŹnjaka (sl. 12),

Visually, chert pebbles at site 027 and elsewhere on the island (Figs. 9, 12) differ little from their limestone counterparts in the sediment or on the island's beaches. These relatively non-abundant pebbles are whitish or light-grey intermingled with reddish and yellowish hues, with a smooth and shiny or cavernous and fissured *pebble rind*. The pebble rind (or rind of pebbles and cobbles, Ger. *Geröllrinde*, cf. Floss 1994: 94; Cro. *valutiĉna okorina*, *okorina valutice/oblutka*) is a type of weathering rind (Cro. *kora trošenja*, Ger. *Verwitterungsrinde*) specific to gravel. This is the outer layer of a pebble or cobbles of any type of rock, on which the surface experiences physical (abrasion, rounding, cracks) as well as chemical changes during the sedimentation process and particularly during conveyance, which are visible in changes in structure and colour. By way of analogy, *pebble rind of nodule* is formed

during water conveyance, whereby its genetic *nodular rind* is more-or-less reduced, but is recognizable as such at places, while the shape of the nodule itself is partially or entirely altered. The rind types, i.e., *pebble rind*, *nodular rind* and *pebble rind of nodule*, if preserved on an artefact, allow an archaeologist to discern data on the physical type of chert used and the type of outcrop from which the raw material for lithic production was obtained. The chert group consists of grey-white pebbles (very light grey, N8; according to *Rock Colour Chart* 1991) with yellow-brown spots caused by silicified calcarenite (Fig. 9) and nodular chert (Fig. 12), while red-brown pebbles come from radiolarites (Fig. 8: 4, 17).<sup>7</sup> The radiolarite colour is very dark red (10R 2/2) and slightly yellowish-brown (10YR 5/4).

Further research into chert pebbles was undertaken under the assumption that they were used in lithic production on site. Artefacts confirming that pebbles were used as raw materials for a part of the

<sup>7</sup> We are grateful to geologists Hans-Peter Meyer and Oleksandr Varychev (Institut für Geowissenschaften, Rupprecht-Karls-Universität, Heidelberg) who supported us in our laboratory work.



a crvenosmeđe valutice od radiolarita (sl. 8: 4, 17).<sup>7</sup> Boja radiolarita vrlo je zagasito crvena (10R 2/2) i umjereno žućkastosmeđa (10YR 5/4).

Daljnje istraživanje rožnjačkih valutica poduzeto je pod pretpostavkom da su one korištene u litičkoj proizvodnji na položaju. Artefakti koji potvrđuju valutice kao sirovinu za jedan dio litičkog inventara na Sušcu nađeni su na površini nalazišta, što znači da su obrađivane tokom srednjeg neolitika (usp. Radić *et al.* 2000: 61). To djelomično objašnjava njihovu relativnu malobrojnost i ostavlja otvorenim pitanje u kojoj su mjeri takvi artefakti zastupljeni u dubljim slojevima sedimenta. Nalazima su zastupljene sve proizvodne faze u tehnici lomljenog kamena: predjezgre, jezgre, odbojci i alatke (sl. 18–24). Posebnu pozornost privlači fragment valutice s pet sferično glačanih ploha na kojima su unatoč obradi vidljive karakteristične udarne napukline

(sl. 25). Glačanjem facetiranoj valutici vjerojatno se može pripisati funkcija sjekirice, možda simbolična. Važnost analize valutica iz sušačkoga sedimenta na položaju 027 jest u utvrđivanju porijekla tih klasta. Za potrebe arheološkog vrednovanja nalaza bilo je dovoljno ustanoviti da rožnjačke valutice u sušačkom sedimentu nisu antropogenog porijekla, tj. da ih na otok nisu dopremili neolitički pomorci, rukotvorci kamenih alatki. To potvrđuju valutice milimetarskog reda veličine u sedimentu iste ili srodne petrografije onim valuticama koje su upotrijebljene u litičkoj proizvodnji *in situ*. Arheološki litički nalazi s valutičnom okorinom navode na traženje izvora valutica (a time i putova nabave sirovine) na najbližem mogućem mjestu, a to su u marinskom okolišu šljunčana žala. Ako u sastavu bližih i udaljenijih žala takvih valutica nema ili, kao u primjeru uvale Kremenjača na Korčuli kod Vele Luke, valutice potječu isključivo od nodularnih rožnjaka na kojima je genetska okorina slabo pohabana, odnosno gotovo sasvim očuvana, a fragmentirani primjerci slabo



Slika 9. Valutice od silificiranog kalkarenita; Sušac, položaj 027.

Figure 9. Pebbles made of silicified calcarenite; Sušac, site 027.

lithic inventory on Sušac were found on the surface of the site, which means that they were worked during the Middle Neolithic (cf. Radić *et al.* 2000: 61). This partially explains their relatively small number and leaves open the question of the extent to which such artefacts are present in the deeper layers of the sediment. The finds represent all production phases in knapping technique: pre-cores, cores, flakes and tools (Figs. 18-24). Particularly notable is a pebble fragment with five spherically polished surfaces on which, despite retouching, typical impact marks are visible (Fig. 25). An axe function, perhaps symbolic, may be ascribed to the pebble faceted by polishing. The importance of analysis of the pebbles from the Sušac sediment at site 027 lies in the establishment of the origin of these clasts. For the needs of archaeological evaluation of the finds, it was sufficient to ascertain that the chert pebbles in the Sušac sediment did not have an anthropogenic origin, i.e., that they were not brought to the island by Neolithic seafarers who were stone tool craftsmen. This is confirmed by the pebbles with sizes in the millimetre scale found in the sediment which have the same or similar petrographies with those pebbles used in lithic production *in situ*. The archaeological lithic finds with pebble

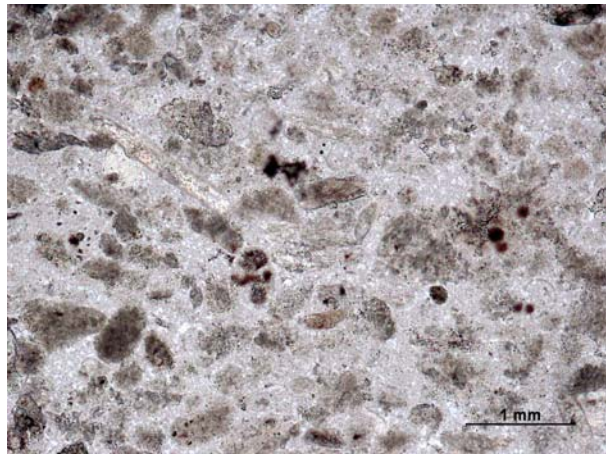
<sup>7</sup> U laboratorijskome radu podržali su nas geolozi dr. Hans-Peter Meyer i dr. Oleksandr Varychev (Institut für Geowissenschaften, Rupprecht-Karls-Universität, Heidelberg), na čemu im zahvaljujemo.





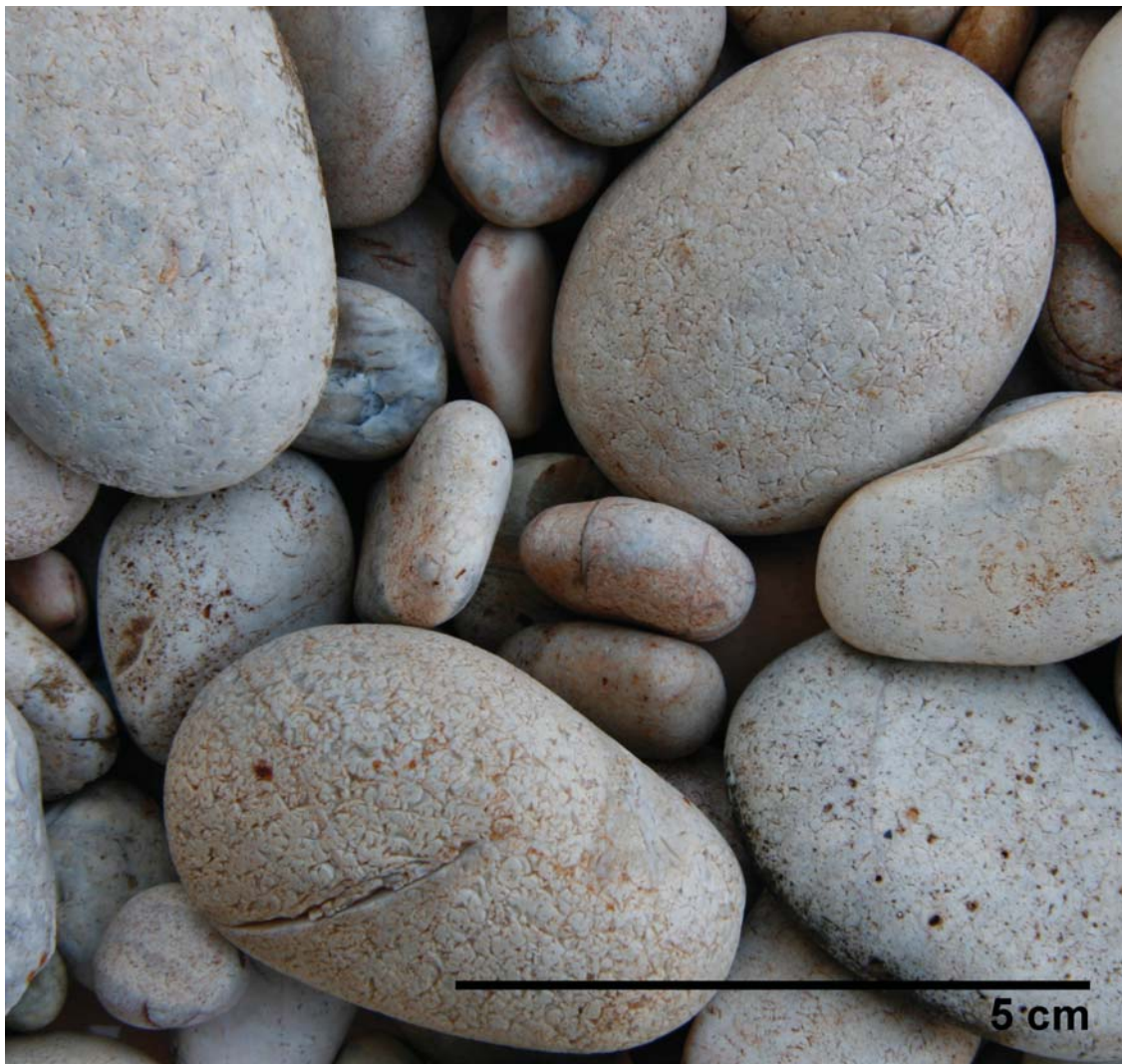
Slika 10. Valutica od silicificiranog kalkarenita (prerezana za izradu mikroskopskog izbruska); Sušac, položaj 027.

Figure 10. Pebble made of silicified calcarenite (sliced to make microscopic thin section); Sušac, site 027.



Slika 11. Mikrosnimka valutice (sl. 10) od silicificiranog kalkarenita; Sušac, položaj 027. Polarizacijski mikroskop.

Figure 11. Micro-image of pebble (Figure 10) made of silicified calcarenite; Sušac, site 027. Polarization microscope.



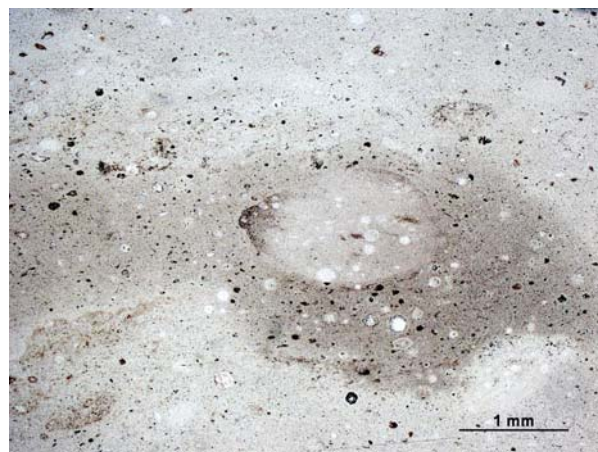
Slika 12. Valutice od nodularnog rožnjaka; Sušac, položaj 027.

Figure 12. Nodular chert pebbles; Sušac, site 027.



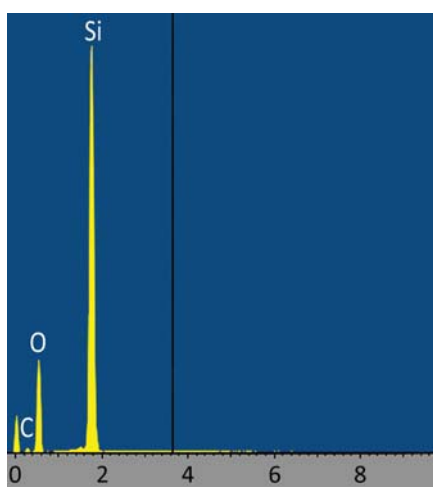
Slika 13. Valutica od nodularnog rožnjaka (prerezana za izradu mikroskopskog izbruska); Sušac, položaj 027.

Figure 13. Nodular chert pebble (sliced to make microscopic thin section); Sušac, site 027.



Slika 14. Mikrosnimka valutice od nodularnog rožnjaka (sl. 13); Sušac, položaj 027. Polarizacijski mikroskop.

Figure 14. Micro-image of nodular chert pebble (Figure 13); Sušac, site 027. Polarization microscope.



Slika 15. Spektar kemijskoga sastava valutice od nodularnog rožnjaka (sl. 14) (spektar pokazuje silicijev dioksid, tj. kvarc koji je jedini mineral u sastavu uzorka na mjestu analize); Sušac, položaj 027. Rasterelektronski mikroskop.

Figure 15. Spectrum of chemical composition of nodular chert pebble (Figure 14) (the spectrum shows silicon dioxide, i.e. quartz which is the only mineral in the sampling composition at the analysis site); Sušac, site 027. Raster electron microscope.

zaobljeni, i to samo na rubovima loma, pa prema tomu ne odgovaraju predmetnim nalazima (sl. 26; Perhoč 2009c: 52), logično se pomišlja na riječni šljunak, koji bi u ovom slučaju trebalo tražiti na dinarsko-dalmatinskoj strani. Pretraživanjem šljunka Cetine i Neretve (sl. 28) ustanovili smo da te rijeke ne nose valutice koje bi petrografski i strukturalno odgovarale litičkim artefaktima sa Sušca. Štoviše, za rijetke rožnjačke valutice nađene u Cetini (sl. 27) nije izvjesno da li se radi o artefaktima (teh-nološke jezgre, odnosno predjezgre od valutica) ili o geofaktima.<sup>8</sup> Stoga je u sušačkome slučaju svrha

<sup>8</sup> Zahvaljujemo arheologu Damiru Kliškiću (Arheološki muzej Split), koji nam je omogućio analizu navedenih litičkih nalaza.



Slika 16. Prelomljene valutice od nodularnog rožnjaka; Sušac, položaj 027.

Figure 16. Fractured nodular chert pebbles; Sušac, site 027.

rinds prompt the search for the sources of these pebbles (and thereby also the routes for procuring raw materials) at the closest possible place, and these are the marine environments of gravel beaches. If there are no such pebbles in the nearby or more distance beaches or, as in the example of Kremenjača Cove near Vela Luka on the island of Korčula, the pebbles come exclusively from nodular cherts on which the genetic rind is lightly abraded or almost entirely preserved, meaning they do not correspond to the relevant finds (Fig. 26; Perhoč 2009c: 52), then it is logical to turn to riverine gravel, which in this case should be sought on the Dinaric-Dalmatian side. In an examination of the gravels along the Cetina and Neretva Rivers (Fig. 28), we have ascertained that these rivers do not convey pebbles that petrographically and structurally correspond to the lithic artefacts from Sušac. Moreover, in the case of the rare chert pebbles found on the Cetina (Fig. 27), it is uncertain as to whether these are artefacts (knapping



istraživanja u dokazivanju korištenja lokalnog alohtonog izdanka sirovine u otočnoj proizvodnji jednog dijela rukotvorina na mjestu njihova nalaza. Izgleda da je boravak na otoku škrtih datosti prisilio neolitičke pomorce da pored odlične nelokalne sirovine, vjerojatno u nuždi, posegnu za lokalnom sirovinom skromnije kakvoće i količine, što govori u prilog njihove sposobnosti prilagođavanja otočkim posebnostima.

## HABITUS ROŽNJAČKIH VALUTICA

Za potrebe ovoga rada analizirano je oko 350 sušačkih valutica (klasifikacija prema Russel – Taylor – Pettijohn, v. Müller 1964: 17, 105, 107). Sve sušačke rožnjačke valutice, uključujući one prelomljene prije taloženja na otoku, vrlo su dobro zaobljene, elipsoidne i pretežno plosnate (sl. 9, 12). Specifičnost sušačkih valutica, *udarne napukline*, nisu standardna tema geološke literature, a arheološke tek iznimno. One nastaju sudaranjem valutica silicijskih stijena i općenito sitnozrnih tvrdih, gustih, homogenih stijena s velikim udjelom kvarca u visoko hidroenergetskom okolišu. Udarne napukline (engl. *impact marks*, *crush marks*, *percussions marks*, *crescentic impact marks* – Pettijohn 1957: 71, njem. *Rindenvernarbung*, *Schlagnarben* – Floss 1994: 98–99) sporedna su strukturna značajka okorine krupnijeg šljunka, tj. valutica i oblutaka (sl. 29, 30). Napukline su površinski lik konkavno-konveksnog loma (tzv. *školjkasti lom*) na valutičnoj kori. Do napuknuća stijene dolazi kad se lom ne može potpuno stožasto razviti, tj. kad se udareni dio kamena ne odlomi, a lomna pukotina bude zaustavljena, odnosno kad je kinetička sila podređena inerciji mase kamena (usp. Feustel 1985: 40–42). Napukline imaju kružni ili polukružni oblik i na okorini valutica oblikuju tipičnu mrežu plićih i dubljih lučnih brazdi i bradavica. Na valuticama su napukline vidljive prostim okom, a one sitnije, submilimetarskih mjera, tek pod lupom s desetokratnim povećanjem ili pod mikroskopom. Na valuticama nodularnog rožnjaka udarne napukline daleko su izraženije nego na valuticama od silicificiranog kalkarenita jer je rožnjak tvrdi i krhkiji od potonje stijene.

## PETROGRAFSKI TIPOVI ROŽNJAČKIH VALUTICA

S obzirom na petrografska obilježja od više tipova rožnjačkih valutica koje se pojavljuju u sedimentu na položaju 027 i drugdje na otoku u ovome radu izdajamo *silicificirane kalkarenitne* (sl. 9–11) i *valutice od nodularnog rožnjaka* (sl. 12–15) koje je

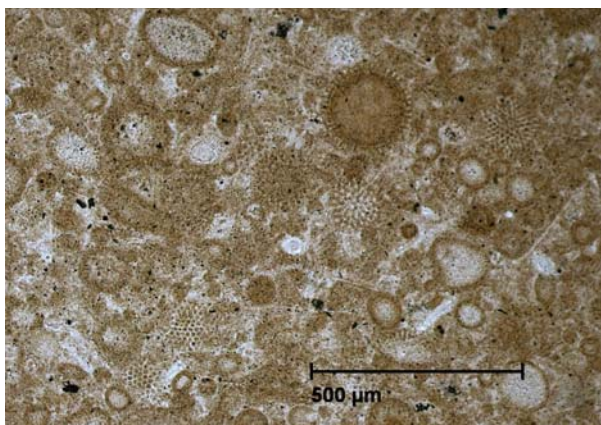
cores, or pre-cores made of pebbles) or geofacts.<sup>8</sup> Thus in the Sušac case, the purpose of research is to prove use of local, allochthonous outcrops of raw materials in island production of a portion of the handicrafts at the site of their discovery. It would appear that this island, with its unyielding environment, compelled Neolithic seafarers to use, besides excellent non-local materials, local materials of more modest quality and quantity, probably in dire need, which demonstrates their ability to adapt to the island's conditions.

## HABITUS OF CHERT PEBBLES

For the needs of this work, approximately 350 Sušac pebbles were analyzed (classification based on Russel-Taylor-Pettijohn, see Müller 1964: 17, 105, 107). All Sušac chert pebbles, including those fractured prior to sedimentation on the island, are very well rounded, ellipsoid and largely flattened (Fig. 9, 12). The specific aspect of the Sušac pebbles, *impact marks*, is not a standard topic of the geological literature, and only exceptionally in the archaeological equivalent. They appear as a result of the collisions between the pebbles of silicic rock and generally fine-grain, hard, dense, homogenous rock with high quartz content in a highly hydrokinetic environment. Impact marks (also crush marks, percussion marks, crescentic impact marks – Pettijohn 1957: 71; Ger. *Rindenvernarbung*, *Schlagnarben* – Floss 1994: 98–99; Cro. *udarne napukline*) are an ancillary structural feature on the rinds of larger gravel, i.e., pebbles and cobbles (Fig. 29, 30). These marks are a surface manifestation of concave-convex fractures (so-called *conchoidal fractures*) on the pebble rind. The impact mark is formed on the rock when the fracture cannot entirely progress conically, i.e., when the impacted part of the rock does not break off, and the fracture crack is stopped – when the kinetic force is subordinated to the inertia of the stone's mass (cf. Feustel 1985: 40–42). Impact marks have circular or semi-circular shapes and on the pebble rind they form a typical lattice of shallower and deeper arched grooves and protrusions. On pebbles impact marks are visible to the naked eye, while on tinier examples with sub-millimetric dimensions, they are only visible with the help of a magnifying glass with minimum magnification of ten times or under a microscope. Impact marks are far more prominent on nodular cherts than on silicified calcarenite pebbles, because chert is harder and more fragile than the latter rock.

<sup>8</sup> We would like to thank archaeologist Damir Kliškić (Archaeological Museum in Split), who allowed us to analyze these lithic finds.





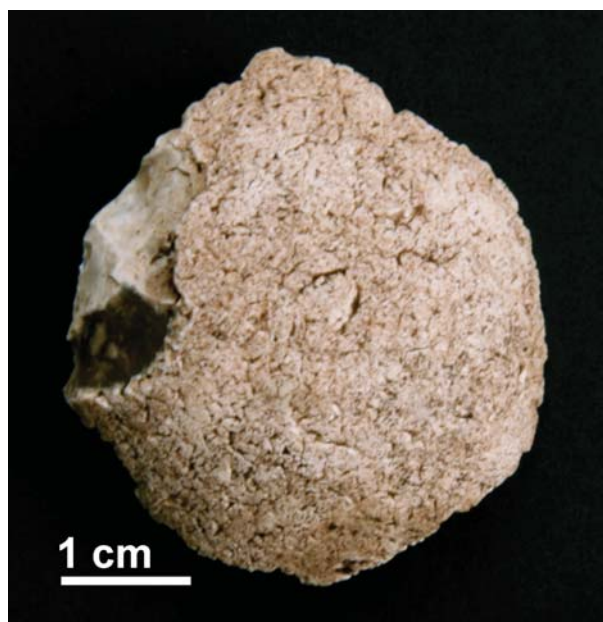
Slika 17. Izbrusak radiolaritne valutice s fosilnim skeletima radiolarija; Sušac, položaj 027. Polarizacijski mikroskop.

Figure 17. Thin section of radiolarite pebble with fossilized radiolaria skeletons; Sušac, site 027. Polarization microscope.



Slika 18. Tehnološka predjezgra od valutice, sječivo i odbojak od silicificiranog kalkarenita; Sušac, položaj 027.

Figure 18. Knapping pre-core made of pebble, blade and flake made of silicified calcarenite; Sušac, site 027.



Slika 19. Tehnološka jezgra od rožnjačke valutice (na dorsalnoj strani valutična okorina s napuklinama); Sušac, položaj 027.

Figure 19. Knapping core made of chert pebble (on dorsal side of pebble rind with impact marks); Sušac, site 027.



Slika 20. Mliječnobijela patina na ventralnoj strani tehnološke jezgre od rožnjačke valutice (sl. 19); Sušac, položaj 027.

Figure 20. Milky white patina on ventral side of knapping core made of chert pebble (Figure 19); Sušac, site 027.

moguće korelirati s artefaktima izrađenima od takve sirovine *in situ*.

Izrazom *valutice od silicificiranog kalkarenita* ovdje označavamo fragment silicificiranog vapnenačkog pješčenjaka tipa kalkarenit (i kalklitit), odnosno silicificiranog detritičnog vapnenca erodiranog iz matične stijene i u vodenom transportu zaobljenog do valutične forme. Toj oznaci, koja je radnoga karaktera, pribjegavamo jer nijedno strukturalno ni teksturalno

## PETROGRAPHIC TYPES OF CHERT PEBBLES

Given the petrographic features of several types of chert pebbles which appear in the sediment at site 027 and elsewhere on the island, in this work we are distinguishing *silicified calcarenite* (Fig. 9-11) and *nodular chert pebbles* (Fig. 12-16) which may be correlated with artefacts made of such materials *in situ*.

obilježje tih valutica ne ukazuje da bi primarna pojavna forma stijene mogla biti nodula, leća ili sloj (slojeviti rožnjak). Matična stijena od koje su nastali mikrofacijalno ispitani primjerci dobro silicificiranih kalkarenitnih, odnosno kalklititnih valutica većinom je sastavljena od submilimetarskih, dobro sortiranih, primarno subangularnih zrnaca mikritnog vapnenca i kvarca, fosilnog detritusa i obavijenih zrna s intergranularnim prostorom ispunjenim kriptokristalnim kvarcom te fibrozim i sferulitnim kalcedonom (sl. 10, 11; klasifikacija prema Pettijohn *et al.* 1972: 186–197). U kalklitita su uočeni rijetki fragmenti ljuštura školjaka, poneki ooid ili srodno obavijeno zrno, ostaci organske materije i željezni oksid raspršen u intergranularnom prostoru ili izlučen po rubovima zrna, a u kalkarenita još sasvim ili djelomično silicificirane globigerine (odredba fosila prema Flügel 1978: 222–228; Adams *et al.* 1984: 67–75). Kalkareniti spadaju u litične arenitne kojima udio matriksa ne prelazi 15%. Treba napomenuti da primarni udio matriksa u našim nalazima nije moguće jednoznačno utvrditi jer su karbonatna zrna dobrim dijelom silicificirana pa je vjerojatno da je silicifikacija zahvatila kako matriks tako i primarni kalcitni cement, a kvarc ispunio dio pora. Isto tako, u građi pretpostavljamo klastnu potporu. Na valuticama je ponekad vidljiva uslojenost.

Izrazom *valutice od nodularnog rožnjaka* označavamo cijele ili fragmentirane nodule rožnjaka, erodirane iz stijene domaćina, kojima je u vodenom transportu nodularna okorina manje-više abradirana i primarna sferičnost povećana.

## VALUTICE OD SILICIFICIRANOG KALKARENITA

Valutice nastale od silicificiranog kalkarenita imaju okorinu šupljikave, kavernaste strukture, dok je jezgri dio vidljivo gušći. Šupljikavost je dijagenetski uvjetovana intergranularna poroznost pješčenjaka koja nastaje pri sedimentiranju zrna, bez ili s malo matriksa, koji inače ispunjava intergranularni prostor, odnosno uslijed djelomičnog ispiranja ili topljenja matriksa i/ili zrna tokom dijageneze i trošenja stijene (Tišljar 2001: 158; 2004: 158). Čestice crvenice iz okolnog tla zapunile su poroznu okorinu tih valutica, kao i kavernastu površinu artefakata izrađenih od takve stijene (lako smo je odstranili pranjem nalaza u razrijeđenoj solnoj kiselini; sl. 23), pa se u tom slučaju ne radi o patini.

Povezanost artefakata i sirovine demonstriramo primjerom teksturne srodnosti neobrađene valutice iz sedimenta na položaju (sl. 10, 11) i stijene od koje je izrađen artefakt (sl. 23 desno, sl. 24). Komparacijom malih neobrađenih valutica i velikih krhotina i odbojaka bez valutične okorine, ali iste petrografije,

The expression *pebbles made of silicified calcarenite* is here used to designate a fragment of silicified lime sandstone of the calcarenite (and calcilutite) type, i.e. silicified detrital limestone eroded from the parent rock and rounded to pebble form during waterborne conveyance. We have resorted to this designation, which has a provisional character, because not one structural nor textural feature of these pebbles indicates that the primary physical form of the rock may have been a nodule, lens, or layer (layered chert). The parent rocks from which the microfacially tested examples of well silicified calcarenite or calcilutite pebbles emerged were largely composed of submillimetric, well sorted, primarily sub-angular grains of micrite limestone and quartz, fossil detritus and warped grains with intergranular space filled with cryptocrystalline quartz and fibrous and spherulite chalcedony (Fig. 10, 11; classification according to Pettijohn *et al.* 1972: 186–197). Rare shell fragments, the occasional ooid or similar coated grains, remains of organic substances and iron oxide scattered in the intergranular space or excreted along the edges of the grain have been observed, while entirely or partially silicified Globigerinida have been observed in the calcarenites (fossil classification based on Flügel 1978: 222–228; Adams *et al.* 1984: 67–75). The calcarenites belong to the lithic arenite group, whose share in the matrix does not exceed 15%. It is noteworthy that the primary share of the matrix in these finds cannot be unambiguously ascertained, because the carbonate grains are largely silicified, so it is likely that silicification encompassed the matrix and the primary calcite cement, while quartz filled a part of the pores. Clast support has been assumed in the material along these same lines. Layering is sometimes visible in the pebbles.

The expression *nodular chert pebbles* here designates whole or fragmentary nodules of chert, eroded from the host rock, on which the nodular rind was more-or-less abraded during waterborne conveyance, while the primary sphericity was increased.

## SILICIFIED CALCARENITE PEBBLES

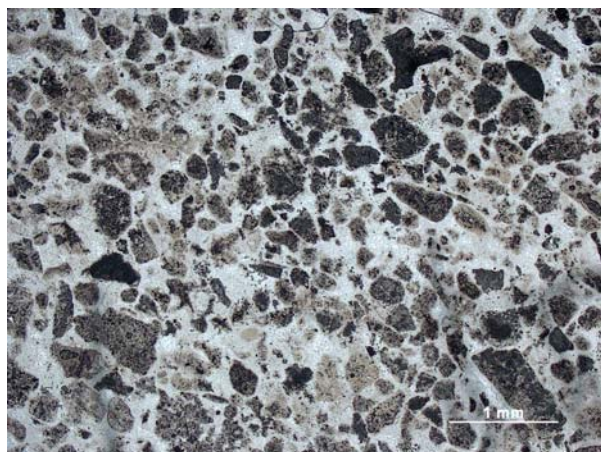
Pebbles formed from silicified calcarenite have a rind with hollowed, cavernous structure, while the core portion is visibly more dense. Cavitation is the diagenetically influenced intergranular porosity of sandstones which emerges during sedimentation of grains, without or with very little matrix, which otherwise fills the intergranular space, i.e., as a result of partial wash-out or dissolution of the matrix and/or grain during diagenesis and weathering of the rock (Tišljar 2001: 158; 2004: 158). The terra rossa particles from the surrounding soil filled the porous rind of this pebbles, as well as the cavernous





Slika 21. Tehnološka jezgra od rožnjačke valutice (plohe loma prekrivene su mlječnobijelom patinom, na bočnim rubovima vidljive udarne napukline); Sušac, položaj 027.

Figure 21. Knapping core made of chert pebble (fracture surfaces are covered with milky white patina, impact marks visible on lateral edges); Sušac, site 027.



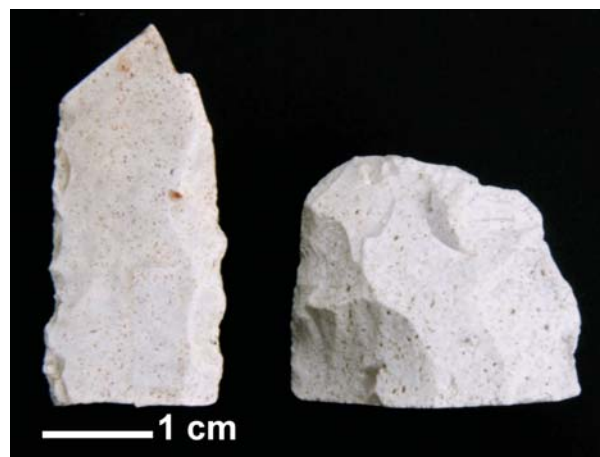
Slika 24. Mikrosnimka tehnološke jezgre od silicificiranog kalkarenita (sl. 23 desno); Sušac, položaj 027. Polarizacijski mikroskop.

Figure 24. Micro-image of knapping core made of silicified calcarenite (Figure 23 right); Sušac, site 027. Polarization microscope.



Slika 22. Jezgre ili alatke na jezgrama; Sušac, položaj 027.

Figure 22. Cores or tools on cores; Sušac, site 027.



Slika 23. Sječivo od silicificiranog kalkarenita i tehnološka jezgra (nalazi su očišćeni otopinom solne kiseline); Sušac, položaj 027.

Figure 23. Blade made of silicified calcarenite and knapping core (finds were cleaned with hydrochloric acid solution); Sušac, site 027.



Slika 25. Glačana rožnjačka valutica s okorinom i udarnim napuklinama; Sušac, položaj 027.

Figure 25. Polished chert pebble with rind and impact marks; Sušac, site 027.



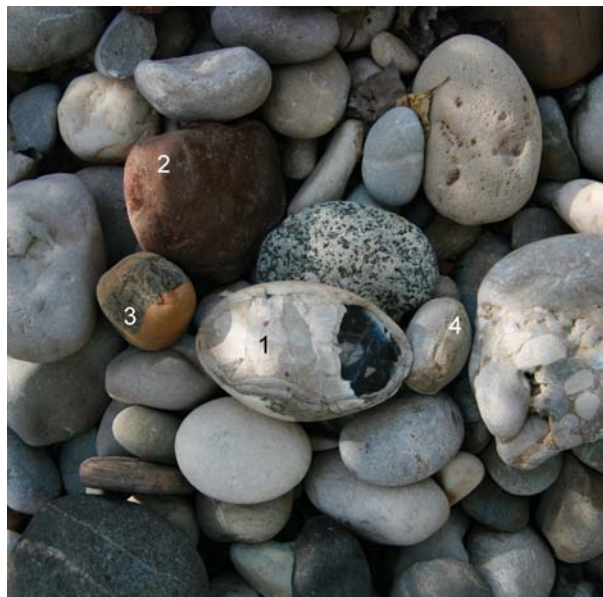
Slika 26. Valutice od nodularnog rožnjaka na žalu uvale Kremenjača; Velolučki zaljev, Korčula.

Figure 26. Nodular chert pebbles on the beach of Kremenjača Cove; Vela Luka Bay, Korčula.



Slika 27. Rožnjačka valutica iz Cetine; Košute kod Trilja.

Figure 27. Chert pebble from the Cetina River; Košute near Trilj.



Slika 28. Neretvanski šljunak (1. nodularni rožnjak, 2. crvenosmeđi radiolarit, 3. crni radiolarit, 4. kompozitna valutica – rožnjak u sredini, bočno vapnenac); Neretva kod Čapljine, Bosna i Hercegovina.

Figure 28. Neretva gravel (1. nodular chert, 2. red-brown radiolarite, 3. black radiolarite, 4. composite pebble – chert in middle, limestone lateral); the Neretva River at Čapljina, Bosnia-Herzegovina.



moгуće je pretpostaviti postojanje krupnijih valutica i oblutaka nego što su do sada nađeni na otoku, što upotpunjuje predodžbu o otočnom potencijalu tog tipa izvora kamene sirovine (sl. 31).

Vežano za valutice i artefakte od silicificiranog kalcarenita s očuvanom valutičnom okorinom skrećemo pozornost na grupu litičkih artefakata nađenih na površini položaja 027, petrografski srodnih gore opisanim valuticama od silicijskih stijena i pripadajućim artefaktima, koji za razliku od njih nemaju valutične karakteristike – i time ističemo složenost istraživanja porijekla sirovine sušačkih litičkih artefakata. To su tehnološka jezgra pripremljena od kamena gomoljasta oblika (sl. 32, 33) i atipična alatka (pijuk) s dvjema korama trošenja (sl. 34, 35); prospekcija nalazišta Perhoč & Radić, neobj. istraž. 2010). Oba nalaza prema obilježjima okorine ne mogu potjecati s predmetnog sušačkog izdanka koji je alohtonog tipa. Naime na površini alatke vidljive su dvije koraste tvorevine različita stupnja trošnosti (vjerojatno površinska i pukotinska ploha stijene), koje nisu proizvod mehaničkoga trošenja u transportu. Plohe tih kora međusobno su u kutnome položaju pa oblutak kao izvorni oblik sirovine nije vjerojatan. Pored rijetkih litoklasta mikrosnimke pokazuju bioklaste, naročito školjke, globigerine, numulite, zatim ootide ili slične kružne tvorevine koje zbog snažne silicifikacije nije moguće pouzdano pobliže odrediti. Tehnološka jezgra preparirana od gomoljasta kamena vrlo slična nodularnom rožnjaku zaobljeni je plastiklast, odnosno muljevita vapnenačka valutica (engl. *mud-pebble*; usp. Tišljar 2001: 27) nastala intrabazenskim pretaložavanjem slabo litificirana karbonatnog sedimenta. Ta silicificirana tvorevina od okolne vrlo porozne stijene odvojena je žutosmeđim željezovitim *liesegangovim prstenom* (njem. *Liesegang'sche Ringe*), što stvara varljiv dojam strukture nodularnog rožnjaka s jezgrenim i okorinskim dijelom. Na mikrosnimkama nalaza zapazili smo litoklaste, koji su zbog snažne silicifikacije slabo uočljivi, a od bioklasta školjke, bodlje ježinaca i foraminifere, i to globigerine i vjerojatno miliolide.

Prema strukturno-teksturnim obilježjima navedeni sušački arheološki nalazi odgovaraju rožnatim stijenama definiranim kao slojeviti rožnjaci koji nastaju silicificiranjem fosilifernih detritičnih vapnenaca u kojima tvore nodule, leće, proslojke ili slojeve jasno razlučive od okolne stijene domaćina (usp. Füchtbauer & Müller 1970: 493–497) ili kao kvarcne kemogene stijene koje nastaju alokemijском ranodijagenetskom silicifikacijom vapnenca, odnosno manje-više ravnomjernom impregnacijom karbonatnih stijena kalcedonom ili kvarcinom, a koje nerijetko sadrže relikte primarnog sastava

surface of the artefacts made of such rock (we easily removed it by washing in diluted hydrochloric acid; Fig. 23), so it was not a case of a patina.

We demonstrate the link between artefacts and raw materials using the example of textural similarity between unretouched pebbles from sediments at the site (Fig. 10, 11) and the rock from which an artefact was made (Fig. 23 right, Fig. 24). A comparison between small unretouched pebbles and large chunks and flakes lacking a rind of pebbles, but with the same petrography, made it possible to assume the existence of larger pebbles and cobbles than those found thus far on the island, which complements speculation on the island's potential for this type of stone raw material source (Fig. 31).

With reference to pebbles and artefacts made of silicified calcarenite with preserved pebble rind, we turn attention to the group of lithic artefacts found on the surface of site 027 – petrographically similar to the above-described pebbles made of silicic rock and the accompanying artefacts – which as opposed to them have not pebble characteristics. Here we underscore the complexity of researching the origin of the raw materials used to make the Sušac lithic artefacts. These are knapping cores prepared from stone with nodular shape (Fig. 32, 33) and an atypical tool (pick-axe) with two weathering rinds (Fig. 34, 35; prospecting of site by Perhoč & Radić, unpublished research, 2010). Based on rind features, both finds could not have come from the relevant Sušac outcrop which is an allochthonous type. For two rind-like formations with varying degrees of wear (probably the surface and fissure face of the rock) are visible on the surface of the tool, and these formations were not the product of mechanical wear during conveyance. The faces of these rinds are at mutual angles, so a cobble as the original shape of the raw material is not likely. Besides rare lithoclasts, micro-images show bioclasts, especially shells, globigerinida, nummulites, then ooids or similar circular constructs which could not be reliably classified due to intense silicification. The knapping core prepared from nodular stone very similar to nodular chert is a rounded plasticlast, i.e. a mud-pebble; cf. Tišljar 2001: 27) formed by intrabazene resedimentation of poorly lithified carbonate sediment. This silicified formation is distinguished from the surrounding porous rock by a yellow-brown ironish Liesegang ring (Ger. *Liesegang'sche Ringe*), which creates the misleading impression of a nodular chert structure with a core and rind. We observed lithoclasts in micro-images of the find, which are difficult to discern due to intense silicification, while of the bioclasts there were shells, echinoderm and foraminifer spines, either globigerinida and probably miliolides.



Slika 29. Rožnjačka valutica s udarnim napuklinama na okorini; Sušac, položaj 027.

Figure 29. Chert pebble with impact marks on rind; Sušac, site 027.



Slika 30. Udarne napukline na okorini valutice (detalj valutice sa sl. 29).

Figure 30. Impact marks on pebble rind (detail of pebble in Figure 29).



Slika 31. Krhotina i valutice od silicificiranog kalkarenita; Sušac, položaj 027.

Figure 31. Chunk and pebble made of made of silicified calcarenite; Sušac, site 027.

i strukture, te mjestimice i sačuvane silicificirane fosile (usp. Tišljar 2001: 96). Bez terenskog istraživanja usmjerenog na traženje odgovarajućih stijena i detaljne tipološke analize navedenih artefakata njihovo porijeklo nije moguće pripisati istočnoj ili zapadnoj strani Jadrana. Stoga ovdje tek navodimo dva primjera takvih stijena prema geološkoj literaturi. Prvi su epigenetski silicificirane klastične karbonatne stijene s ležišta Koljani, Bitelić i Potravlje na Dinari. To su šupljikavi kvarcni sedimenti ili djelomično silicificirani vapnenci, često spužvasta izgleda, žućkasto-crvenkaste i bjeličaste boje te reliktnne strukture kalkarenita s različitim alokemima ili bez relikata klastične teksture (Krkalo *et al.* 1995: 324). Drugi su primjer foraminiferski vapnenci i klastične naslage tercijarnog fliša (breče, brečokonglomerati, kalkareniti i lapori s

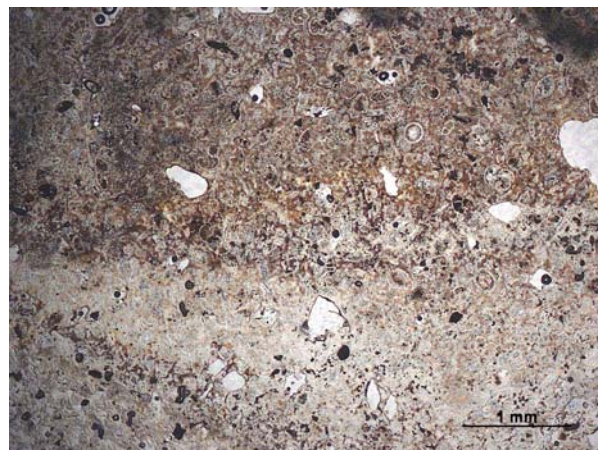
Based on structural-textural features, the aforementioned Sušac archaeological finds correspond to chert-like rocks defined as layered cherts which are formed by silicification fossiliferous detrital limestones in which they form nodules, lenses, interstitial layers or layers discernible from the surrounding host rock (cf. Füchtbauer & Müller 1970: 493-497) or as quartz chemogenous rocks formed by allochemical early-diagenetic silicification of limestones, or more-or-less uniform impregnation of carbonate rocks with chalcedony or quartz, and which often contain relics of primary compositions and structures, and even preserved silicified fossils at places (cf. Tišljar 2001: 96). Without field research aimed at seeking the proper rocks and a detailed typological analysis of these artefacts, their origin cannot be ascribed to the eastern or western shore of the Adriatic. Thus, here we shall only cite two examples of such rocks based on the geological literature. The first such are epigenetic silicified clastic carbonate rocks with deposits at Koljani, Bitelić and Potravlje in the Dinarides. These are hollowed quartz sediments or partially silicified limestones, often with sponge-like appearance, yellowish/reddish and whitish, relic structures of calcarenite with various allochems or with relics of clastic structures (Krkalo *et al.* 1995: 324). The other example is foraminifer limestones and clastic deposits of tertiary flysch (breccia, breccia-conglomerates, calcarenites and marl with





Slika 32. Tehnološka jezgra od silicificirane muljevite valutice; Sušac, položaj 027.

Figure 32. Knapping core made of silicified mud-pebble; Sušac, site 027.



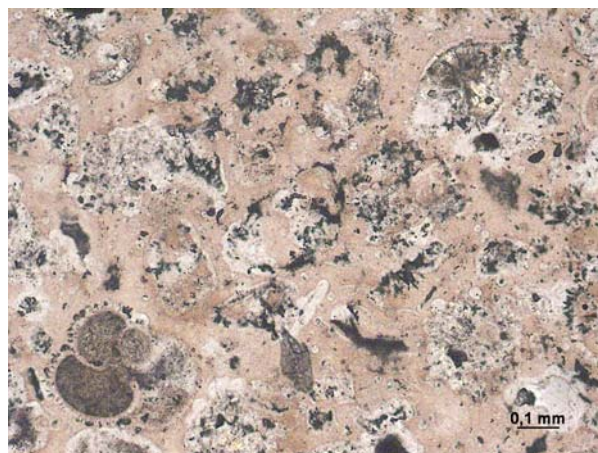
Slika 33. Mikrosnimka tehnološke jezgre od silicificirane muljevite valutice sa sl. 32. Nabrusak, binokularni mikroskop.

Figure 33. Micro-image of knapping core made of the silicified mud-pebble in Figure 32. Polished section, binocular microscope.



Slika 34. Alatka (pijek) od kvarcne stijene (žuti trokuti označavaju kore trošenja); Sušac, položaj 027.

Figure 34. Tool (pick-axe) made of quartz stone (yellow triangles indicate weathering rind); Sušac, site 027.



Slika 35. Mikrosnimka alatke sa sl. 34. Polarizacijski mikroskop.

Figure 35. Micro-image of tool from Figure 34. Polarization microscope.

globigerinsko--globorotalijskom i diskociklinsko-numulitnom asocijacijom foraminifera) iz splitsko-trogirskog kraja. Te stijene udomaćuju nodule, proslojke rožnjaka i interkalacije silicificiranih vapnenačkih pješčenjaka (Magaš & Marinčić 1973: 13).

#### VALUTICE OD NODULARNOG ROŽNJAKA

Na valuticama od nodularnog rožnjaka (sl. 12) vidljivi su relikti nodularne forme koji se prepoznaju po nejednolikoj strukturi valutične okorine (sl. 36). Svjetlije i glađe partije na valutičnoj okorini nastale su na mjestima nodularnih rošćića, tj. sferičnih izraslina koje strše iz osnovnog gomolja i koje se obično odlome prilikom mehaničkog

globigerinida/globorotalia and discocyclinal-numulitic foraminifer associations) from the Split-Trogir area. These rocks host nodules, embedded chert layers and intercalations of silicified lime sandstones (Magaš & Marinčić 1973: 13).

#### NODULAR CHERT PEBBLES

Relics of nodular form are visible on nodular chert pebbles (Fig. 12), which are recognized by the non-uniform structure of the pebble rind (Fig. 36). The lighter and smoother sequence on the pebble rind are at the points of nodular small horn, i.e. spherical outgrowths which protrude from the basic nodule and which normally break off during mechanical



Slika 36. Valutice od nodularnog rožnjaka; Sušac, položaj 027.

Figure 36. Nodular chert pebbles; Sušac, site 027.

odvajanja rožnjaka od stijene domaćina, naročito tokom transporta. Prilikom habanja na mjestu prelomljenog roščića jezgreni dio nodule dospijeva u približno istu ravninu s genetskom okorinom. Zbog nejednake tvrdoće jezgre i okorine pri transportu i habanju površine nodule nastaje razlika u strukturi – gotovo sasvim pohabana i izglačana okorina razlikuje se od jezgre bojom i glatkoćom te strukturom udarnih napuklina. Napukline su na površinama jezgre finije, pliće i kraće od onih na okorinske dijelu i nerijetko zamjetljive tek pod lupom. Na prelomljenim primjercima valutica vidljivo je da se jezgra bojom i strukturom razlikuje od valutične okorine (sl. 16). Mliječnobijela patina na tom tipu valutica redovita je na okorini, dok je na jezgrenome dijelu ima ako je bila izložena trošenju u uvjetima koji pogoduju stvaranju patine. Patina je obojeni, tanki površinski sloj nastao trošenjem kamena, zapravo isto što i *kora trošenja* (Luedke 1992: 152; Rottländer 1989: *passim*). U geologiji izraz *patina* nije uobičajen u tom smislu, a izraz *kora trošenja* na mjestu fizičke dezintegracije i u značenju kemijske dekompozicije stijene ima šire značenje. Na svježije prelomljenim primjercima vidljiva je homogena struktura jezgre, voštanog sjaja, izrazito svjetlopropusna, a zapaženi su i *fosilni duhovi* koji se pojavljuju kao magličaste difuzne mrlje (sl. 13). Smatra se da su *fosilni duhovi* potpuno silicificirani i zbog toga neprepoznatljivi fosili koji se često pojavljuju u intenzivno silicificiranim rožnjačkim konkrecijama (Tišljar 2004: 217). Sudeći prema nalazima iz istražne sonde, litički

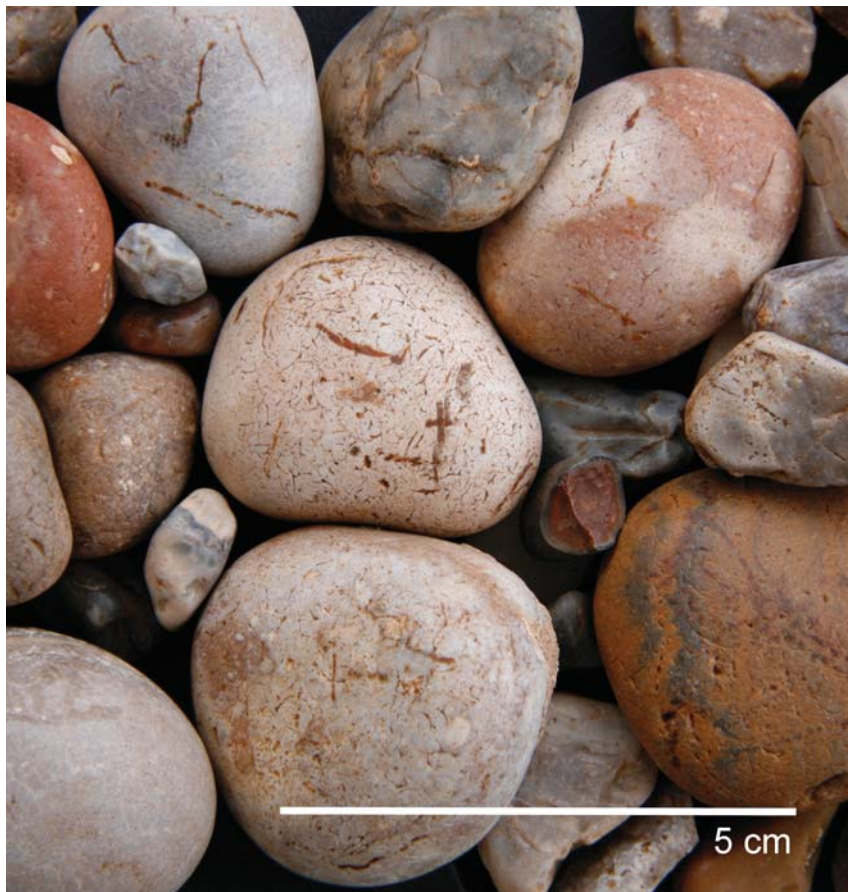
removal of the chert from the host rock, particularly during conveyance. During abrasion at the site of the broken horn, the core part of the nodule comes to approximately the same level as the genetic rind. Due to the unequal density of the core and rind, during conveyance and abrasion of surface of the nodule, a difference in structure emerges: the almost entirely abraded and smoothed rind differs from the core in terms of colour and smoothness and structure of the impact marks. The impact marks on the surfaces of the core are finer, shallower and shorter than those on the rind portion and not rarely only notable under magnification. On the fractured examples of pebbles, it is apparent that the core differs from the rind of pebbles in terms of colour and structure (Fig. 16). The milk-white patina on this type of pebble is customary on the rind, while it can be found on the core portion if it was exposed to wear under conditions which foment the creation of a patina. The patina is a coloured, thin surface layer caused by the abrasion of stone, just like the weathering rind (Luedke 1992: 152; Rottländer 1989: *passim*). In geology, the expression *patina* is not standard in this sense, while the expression *weathering rind* at the point of physical disintegration and in the meaning of chemical decomposition of rock has a broader meaning. On freshly fractured examples, a homogenous core structure is visible, with waxy lustre and exceptionally translucent, while “ghost fossils” are also notable as clouded diffuse spots (Fig. 13). It is believed that these “ghost fossils” are entirely silicified and thus irrecognizable fossils that often appear in intensively silicified chert concretions (Tišljar 2004: 217). Judging by the finds from the test trench, lithic artefacts appear throughout the entire profile of the sediment, like the chert pebbles, so the obvious conclusion is that the soil was at least partially dug over by human activity. Thus far, the question remains as to the extent to which this is a consequence of soil cultivation from prehistory to the present, and perhaps the construction of Neolithic dwellings and targeted extraction or casual gathering of chert pebbles from the soil for the needs of lithic industry. In the latter case, one may speak of the most primitive pit-type mining.

It should be added that thus far, only a single example of a radiolarite artefact was found with a pebble rind (knapping core) near site 027, but without stratigraphic context. Since a whole radiolarite pebble with dimensions corresponding to this artefact has not thus far been found in the sediment, it is impossible to ascertain the origin of the raw material respectively the outcrop type.



artefakti dolaze u cijelu profilu sedimenta, kao i rožnjačke valutice, pa se nameće zaključak da je tlo barem mjestimice bilo prekopavano. Za sada ostaje otvoreno pitanje u kojoj je mjeri to posljedica obrade polja od prapovijesnog doba do danas, možda gradnje neolitičkih nastambi i ciljanoga vađenja ili usputnoga branja rožnjačkih valutica iz tla za potrebe litoindustrije. U potonjem slučaju moglo bi se govoriti o najprimitivnijem jamskom tipu rudarenja.

Dodajmo da je do sada pronađen tek jedan primjerak radiolaritnog artefakta s valutičnom okorinom (tehnološka jezgra) u blizini položaja 027, ali bez stratigrafskog konteksta. S obzirom na to da u sedimentu do sada nije pronađena cjelovita radiolaritna valutica koja bi dimenzijama odgovarala tom artefaktu, nije moguće utvrditi porijeklo sirovine, odnosno tip izdanka.



Slika 37. Rožnjačke valutice; Martvilo na Gradini iz Visa.

Figure 37. Chert pebbles; Martvilo at Gradina, from Vis.

## PORIJEKLO ROŽNJAČKIH VALUTICA

Kako je današnja razina Jadrana rezultat nagle fluktuacije mora započete u kasnome Würmu (Šegota 1968: 29; Van Andel 1989: 736; Lambeck *et al.* 2002: *passim*), valutice u sušačkoj crvenici na položajima osjetno višima od morske razine morale su biti sedimentirane u ranijem pleistocenskom razdoblju ili još starijoj seriji. Sušačke valutice sedimentirane u crvenici polja udaljenog oko 300 m od južne obale, na 26 m iznad morske razine, prema tomu su trag hidrodinamičkih procesa starijih od posljednjeg glacijala (usp. Surić 2009: 182). Variranje Jadrana u geološkoj prošlosti očitivalo se u transgresiji mora na istočnu obalu tokom eocena, u miocenu i pliocenu na zapadnu obalu, da bi potkraj pliocena more ponovo transgrediralo na dinarsko kopno. U pleistocenu je nekoliko puta došlo do spuštanja i uzdizanja morske razine sa stometarskim amplitudama (Alfirević 1964: 87; Šegota 1968: 35). Pleistocenska fluktuacija mora u cjelini bila je veća od recentne würmsko-holocenske. Na otocima istočne strane Jadrana o tome svjedoče diluvijalni sedimenti nadmorske visine od preko 80 m (Alfirević 1964: 77, 90). Mirko Malez izvještava o svojim zapažanjima

## ORIGIN OF CHERT PEBBLES

Since the present-day level of the Adriatic is a result of the sudden fluctuation of the sea which began during the late Würm glaciation (Šegota 1968: 29; Van Andel 1989: 736; Lambeck *et al.* 2002: *passim*), pebbles in the Sušac terra rossa at positions palpably higher than sea level had to be sedimented in the earlier Pleistocene era or an even older series. The Sušac pebbles sedimented in a terra rossa flat approximately 300 m from the southern coast, at 26 m above sea level, so they are a vestige of hydrodynamic processes older than the final glaciation (cf. Surić 2009: 182). Variations in the Adriatic's geological past have manifested themselves in the transgression of the sea on the eastern coast during the Eocene, on the western coast in the Miocene and Pliocene, so that by the end of the Pliocene the sea once more transgressed to the Dinaric mainland. Declining and rising sea levels with hundred-meter amplitudes occurred several times during the Pleistocene (Alfirević 1964: 87; Šegota 1968: 35). The Pleistocene fluctuation of the sea as a whole was greater than the recent Würm-Holocene. Diluvial sediments at

marinskih terasa koje svjedoče o razini Jadrana višoj od današnje: "Marinske kvartarne naslage razvijene su u bazenu Jadranskoga mora ili uz njegovu obalu. Sačuvani su i ostaci pleistocenskih terasa na nekim otocima, a u njima su uklopljene kućice morskih školjaka i puževa. Preliminarna proučavanja upućuju da neke terase koje leže na 2–4 m više od današnje razine mora treba označiti kao epi-monastirian, terase na 6–8 m kao kasni monastirian (= Tyrrhenian III), a one koje leže na 15–18 m više odgovaraju glavnom monastirianu (= Tyrrhenian II), što se vremenski podudara od interglacijala riss-würm do kasnog glacijala (dryas)" (Malez 1979: 204). Izražena zaobljenost i sferičnost valutica, posebno u slučaju silicijskih stijena koje su rezistentne na kemijsko i fizičko trošenje, znači dugotrajan transport ili transport u turbulentnim vodenim tokovima visoke energije (usp. Tišljar 2004: 129). Temeljem izloženoga opravdana je pretpostavka da je silicificirana šljunčana komponenta sušačkog crveničkog sedimenta vjerojatno nastala u glaciofluvijalnom, odnosno marinskom transportu i transgresivnom taloženju.

## SREDNJODALMATINSKE OTOČNE PARALELE

Na području srednje Dalmacije zabilježeno je nekoliko geoarheoloških pojava sušačkoga tipa (karta 1). Na Gradini u Visu (sl. 37, 38), na položaju Martvilo uz bedem antičke Isse, zapaženi su rijetki tragovi sedimenta s valuticama sušačkoga tipa i za sada nekoliko njima petrografski srodnih, vjerojatno prapovijesnih artefakata, nažalost bez čvrsta stratigrafskog konteksta.<sup>9</sup> Površinske nalaze srodne petrografske strukture iz Rata kod Ložišća na Braču (sl. 39) pribrajamo pojavi istoga tipa.<sup>10</sup> Arheolog Nikša Vujnović temeljem površinskih nalaza zabilježio je u crveničkom sedimentu ponikve u Divjenim docima kod Sućurja na Hvaru tragove eneolitičkoga nalazišta (Vujnović 2002: 54).<sup>11</sup> Komparacijom grupe sušačkih rožnjakih valutica i nalaza iz Sućurja, među kojima smo zapazili odbojke od valutica tipa nodularnog rožnjaka s karakterističnim napuklinama na valutičnoj okorini i jezgru od silicificiranog kalkarenita, arheološki primjer sušačkoga tipa pretpostavili smo i na Hvaru te u kraćem obilasku terena u Divjenim docima 2009. g. to i potvrdili nalazom

elevations over 80 m testify to this on the eastern side of the Adriatic (Alfirević 1964: 77, 90). Mirko Malez reported on his observation of marine terraces which testify to Adriatic sea levels higher than that of the present: "Marine quaternary deposits developed in the basin of the Adriatic Sea or its coast. The remains of Pleistocene terraces have also been preserved on certain islands, and sea shells and sea snail shells have been incorporated into them. Preliminary study has indicated that some terraces which lie at 2-4 m above the present sea level must be designated as Epi-Monastirian, while terraces at 6-8 m as Late Monastirian (= Tyrrhenian III), while those which lie at 15-18 m correspond more to the Main Monastirian (= Tyrrhenian II), which chronologically corresponds to the Riss-Würm interglacial to late glacial (Dryas)" (Malez 1979: 204). The marked roundness and sphericity of the pebbles, particularly in the case of silicic rock which are resistant to chemical and physical wear, signifies long-term conveyance or conveyance in turbulent, highly-kinetic watercourses (cf. Tišljar 2004: 129). Based on the aforementioned, a justified assumption is that the silicified gravel component of the Sušac terra rossa sediment emerged as a consequence of glaciofluvial respectively marine conveyance and transgressive sedimentation.

## CENTRAL DALMATIAN ISLAND PARALLELS

Several geoaerchaeological phenomena of the Sušac type have been recorded in the territory of Central Dalmatia (map 1). At Gradina in the town of Vis on the eponymous island (Fig. 37, 38), at the Martvilo site, next to the defensive wall of the ancient city of Issa, several rare traces of sediments with Sušac-type pebbles were noted, as well as several thus far petrographically similar, probably prehistoric artefacts, unfortunately without a firm stratigraphic context.<sup>9</sup> The surface finds from the similar petrographic structure from Rat, near Ložišće on the island of Brač (Fig. 39) are attributed to the same type of phenomenon.<sup>10</sup> Based on surface finds, archaeologist Nikša Vujnović recorded traces of an Eneolithic site in the terra rossa sediment of a sinkhole in Divjeni Doci at Sućuraj on the island of Hvar (Vujnović 2002: 54).<sup>11</sup> Based on a comparison

<sup>9</sup> Nalaznici su arheolozi Boris Čargo (Arheološki muzej Split) i Dinko Radić (Centar za kulturu Vele Luke) (2007), kojima zahvaljujemo na suradnji, te Zlatko Perhoč (2008).

<sup>10</sup> Nalazniku arheologu Vedranu Barbariću (Filozofski fakultet Split) (2007) zahvaljujemo na suradnji.

<sup>11</sup> Zahvaljujemo arheologu Nikši Vujnoviću iz Sućurja, koji nam je omogućio analizu navedenih litičkih nalaza.

<sup>9</sup> Discovered by archaeologists Boris Čargo (Archaeological Museum in Split) and Dinko Radić (Vela Luka Culture Centre) (2007), whom we thank for their cooperation, and Zlatko Perhoč (2008).

<sup>10</sup> Discovered by archaeologist Vedran Barbarić (Faculty of Arts and Letters, Split) (2007), whom we thank for his cooperation.

<sup>11</sup> We thank archaeologist Nikša Vujnović from Sućuraj, who made it possible for us to analyze these lithic finds.





Slika 38. Fragment rožnjačke valutice s udarnim napuklinama na okorini; Martvilo na Gradini iz Visa.

Figure 38. Fragment of chert pebble with impact marks on rind; Martvilo at Gradina, from Vis.



Slika 40. Artefakti od rožnjaka (1. tehnoška predjezgra od rožnjačke valutice, 2. odbojak s valutičnom okorinom, 3. fragment nodule s valutičnom okorinom); Divjeni doci kod Sućurja na Hvaru.

Figure 40. Artefacts made of chert (1. knapping pre-core made of chert pebbles, 2. flake with pebble rind, 3. fragment of nodule with rind of pebbles); Divjeni Doci near Sućuraj on the island of Hvar.

predjezgre od valutice nodularnog rožnjaka (sl. 40). Daljnja istraživanja na Hvaru i Braču bit će usmjerena na traženje depozita valutica sušačkoga tipa.

Rijetki na otocima, sedimenti sušačkoga tipa nisu ograničeni na maritimni dio dalmatinske regije. To pokazuje naš nalaz rožnjačkih valutica sušačkog tipa u crvenici ponikve u naselju Masline blizu epigravetijenskog nalazišta Badanj na Bregavi u istočnoj Hercegovini (Perhoč, neobj. istraž. 2010). Arheolog Dario Vujević (2009: 3) svojim nas je istraživanjem izvora rožnjaka za srednjopaleolitičke artefakte u Ravnim kotarima upozorio na kvartarne naslage na položaju Debelo brdo kod Radovina. Dosadašnjim istraživanjem u tom kraju na više izdanaka naslaga crvenice ustanovili smo obilje šljunka srodna sušačkom u petrografiji s mnogim u ovome radu opisanim sekundarnim obilježjima. Klasti iz kvartarnih naslaga Ravnih kotara vjerojatno su bili jedan od izvora sirovine ne samo u lokalnoj srednjopaleolitičkoj litičkoj proizvodnji nego i, prema dosadašnjem



Slika 39. Detalj valutične okorine s udarnim napuklinama na odbojku; Ložišća kod Rata na Braču. Binokularni mikroskop, povećano 20 puta.

Figure 39. Detail of pebble rind with impact marks on flake; Ložišće near Rat on the island of Brač. Binocular microscope, magnified 20 times.

of the Sušac chert pebble group and the finds from Sućuraj, among which we noted flakes from nodular chert-type pebbles with typical impact marks on the pebble rind and core made of silicified calcarenite, we also assumed the existence of an archaeological example of the Sušac type on Hvar, and we confirmed this after a brief tour of the terrain in Divjeni Doci in 2009 by finding a pre-core made of a nodular chert pebble (Fig. 40). Further research on Hvar and Brač will be directed toward the search for deposits of Sušac-type pebbles.

Rare on the islands, Sušac-type sediments are not limited to the maritime section of the Dalmatian region. This is shown by our find of Sušac-type pebbles in the terra rossa of a sinkhole in the settlement of Maslina near the Epigravettian site of Badanj at Bregava in eastern Herzegovina (Perhoč, unpublished research, 2010). Archaeologist Dario Vujević (2009: 3), in his research into chert sources for Middle Palaeolithic artefacts in Ravni Kotari, pointed out the quaternary deposits at the Debelo Brdo site near Radovine. In all previous research in this region at several outcrops of terra rossa deposits, we have ascertained an abundance of gravel similar to that of Sušac in terms of petrography and many of the secondary features described in this work. Clasts from the quaternary beds of Ravni Kotari were probably one of the sources of raw materials not only in local Middle Palaeolithic lithic production but also, according to previous research into

istraživanju litike iz pećine Vlakno na Dugom otoku, epigravetijenskoj i mezolitičkoj (Perhoč, neobj. istraž. 2010–2011).

## ZAKLJUČAK

Ovim zapažanjima o sušačkom sedimentu s rožnjačkim valuticama i petrografski srodnim artefaktima želimo dati osnovnu obavijest o pojavi, dok će buduća geološka istraživanja pružiti konkretnije spoznaje o nastanku i porijeklu opisanog sedimenta, a arheološka detaljniji uvid u opseg korištenja tog izvora u litičkoj proizvodnji u regiji. Poznavanje sušačkog izvora sirovine treba pomoći prepoznavanju takvih geoloških i arheoloških pojava na drugim položajima u srednjoj Dalmaciji ili šire. S arheološkog aspekta izvjesno je da je dio sušačkih kamenih artefakata proizveden na otoku korištenjem valutica najmanje dvaju petrografskih tipova iz sedimenta na samu nalazištu. Korištenje sušačkog izvora kamene sirovine odraz je prilagodljivosti otočkim okolnostima i izraz vještine prapovijesnih kamenara. Brački, hvarski i viški nalazi pokazuju da sušački slučaj nije iznimka, nego mogući geoarheološki model interpretacije porijekla sirovine litičkih artefakata s valutičnom okorinom.

the lithics from Vlakno Cave on the island of Dugi, Epigravettian and Mesolithic (Perhoč, unpublished research, 2010-2011).

## CONCLUSION

Our intention in these observations concerning the Sušac sediment, with chert pebbles and petrographically similar artefacts, is to provide some basic information on the phenomenon, while future geological research will provide more concrete knowledge on the emergence and origin of this sediment, and archaeological research will provide a more thorough insight into the extent of use of this source in lithic production in the region. Familiarity with the Sušac source of raw materials should help in the recognition of such geological and archaeological phenomena at other sites in central Dalmatia and beyond. From the archaeological standpoint, it is certain that a part of the Sušac stone artefacts were made on the island through the use of pebbles of a minimum of two petrographic types from the sediment at the site itself. The use of a Sušac source of stone material indicates an adaptability to island conditions and an expression of the skill of prehistoric stone-workers. The Brač, Hvar and Vis finds show that the Sušac case is no exception, rather it is a possible geoarchaeological model for interpretation of the origin of the raw materials for lithic artefacts with pebble rinds.

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