HRVATSKA AKADEMIJA ZNANOSTI I UMJETNOSTI
Razred za prirodne znanosti
Zavod za paleontologiju i geologiju kvartara
Nacionalni odbor INQUA

GEOLOŠKI ZAVOD SLOVENIJE

KNJIGA SAŽETAKA

3. znanstveni skup
GEOLOGIJA KVARTARA U HRVATSKOJ
s međunarodnim sudjelovanjem

povodom 130 godina rođenja akademika Marijana Salopeka
i u spomen znanstvenici Maji Paunović na 10. obljetnicu smrti

Zagreb, 21.-23. ožujka 2013.

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GEOLOŠKI ZAVOD SLOVENIJE

BOOK OF ABSTRACTS

3nd scientific meeting

QUATERNARY GEOLOGY IN CROATIA
with international participation

on the occasion of the 130th birth anniversary of Marijan Salopek,
Fellow of the Croatian Academy
and
in memory of Maja Paunović on her 10th death anniversary

Zagreb, March 21th-23rd 2011

P R O G R A M / PROGRAMME

PETAK, 22.3.2013. / Friday

voditelj:

09.30 - 09.50	N. Buzjak, P. Kovač-Konrad, V. Jalžić	Novija istraživanja vrulja Zečica i Modrič (sjeverna Dalmacija)
09.50 - 10.10	M. Surić, R. Lončarić, N. Lončar, N. Buzjak	Monitoring i uzorkovanja za potrebe paleoklimatskih istraživanja u spiljama šireg zadarskog prostora – teorija i praksa
10.10 - 10.30	D. Paar, N. Buzjak, A. Sironić, N. Horvatinčić	Paleoklimatske arhive dubokih jama Velebita

10.30 - 11.00 Pauza / Coffee break

voditelj:

11.00 - 11.20	L. Pičuljan, D. Brajković, S. Radović, B. Sala, P.T. Miracle	Morphometric and taphonomic analysis of the Upper Pleistocene faunal assemblage from Hijenska pećina
11.20 - 11.40	J. Mauch Lenardić	First record of lemmings (genus *Dicrostonyx* GLOGER, 1841; Arvicolidae, Rodentia, Mammalia) in Croatia
11.40 - 12.00	P. T. Miracle, D. Brajković	Pleistocene Environments and Palaeolithic Occupations at Šandalja Cave (Istria, Croatia): Results from New AMS 14C Dates.
12.00 - 12.20	A. Oros Sršen, D. Brajković, S. Radović, P. T. Miracle	Agents of accumulation of the Late Pleistocene bird remains in two caves in southern Istria (Šandalja II and Ljubićeva pećina)
12.20 - 12.40	D. Radovčić, D. Brajković, P.T. Miracle, D. Radić	Preliminary analysis of the Mesolithic human juvenile skeletons from Vela Spila, Korčula
12.40 - 13.00	S. Radović, V. P. Spry-Marqués, A. Oros Sršen, D. Brajković, D. Radić, P. T. Miracle	Vertebrate Remains from the Pleistocene-Holocene transition to the Bronze Age at Vela Cave, Preliminary Results

13.00 - 15.00 Pauza za ručak / Lunch break

voditelj:

15.00 - 15.20	V. Čubrić-Čurik, P. T. Miracle, S. Radović, A. Oros Sršen, I. Čurik, I. Kovač, D. Brajković	Archeogenetics of lagomorphs in Croatia: a preliminary study
15.20 - 15.40	E. Cristiani	Organic Technology of Pleistocene and Early Holocene foragers of the Northern Adriatic region.
15.40 -16.00	I. Karavanić, N. Vukosavljević, R. Šošić-Klindžić	Projekt: "Kasni musterijen na istočnom Jadranu – temelj za razumijevanje identiteta kasnih neandertalaca i njihovog nestanka"
16.00 - 16.30	Diskusija i zaključci	

16.30 - 17.00 Pauza / Coffee break

17.00 - 19.00 GODIŠNJA SKUPŠTINA NACIONALNOG ODBORA INQUA

P R O G R A M / PROGRAMME

ČETVRTAK, 21.3.2013. / Thirsday

09.00 - 12.00	Registracija i postavljanje postera / Registration and poster setup	
moderator: Lj. Marjanac		
10.00	Otvorenje skupa uz uvodnu riječ akademika Zvonka Kusića, predsjednika Hrvatske akademije znanosti i umjetnosti	
	Riječ suorganizatora	
10.30 - 10.45	S. Bahun	O akademiku Marijanu Salopeku
10.45 - 11.00	D. Brajković, I. Gušić	O znanstvenici Maji Paunović
11.00 - 11.40	*OTVORENJE PRIGODNE IZLOŽBE / OCCASIONAL EXHIBITION OPENNING*	*Pauza / Coffee break*
moderator: Mladen Juračić		
11.40 - 12.00	N. Ilijanić, S. Miko, O. Hasan, K. Bakrač, V. Hajek-Tadesse, A. Banak	The Holocene paleolimnology of Lake Vrana (Biograd) and implications to its formation
12.00 - 12.20	V. Hajek –Tadesse	Holocene Nonmarine Ostracoda from Adriatic part of Croatia and their ecological significance
12.20 - 12.40	S. Faivre, T. Bakran-Petricioli, N. Horvatinčić, A. Sironić	Četiri faze kolebanja morske razine na Srednjem Jadranu u posljenjih 1500 godina
12.40 - 13.00	A. Sironić, N. Horvatinčić	Primjene 14C AMS metode datiranja geoloških uzoraka
13.00 - 15.00	*Pauza za ručak / Lunch break*	
15.00 - 15.20	K. Pikelj, L. Jakšić, Š. Aščić, M. Juračić	Mehanizmi i dinamika nastanka mulja u sedimentu kanala istočnog Jadrana
15.20 - 15.40	A. Banak, M. Kovačić, O.	Characteristics and provenance of loess in Baranja
15.40 - 16.00	G. Durn, V. Rubinić, S. Husnjak, N. Tadej	Morphological, chemical and mineralogical properties of pseudogley on loess along a precipitation gradient in the Pannonian region of Croatia
16.00 - 16.20	Lj. Marjanac, T. Marjanac	Sedimentological evidence of extensive Dinaric glaciation
16.20 - 16.40	J. Velić, I. Velić, D. Kljajo, K. Protrka, H. Škrabić, T. Mašić	Sedimentna tijela, oblici i pojave glacijalnih naslaga na Velebitu i Biokovu (Hrvatska)
16.40 - 17.00	T. Marjanac, Lj. Marjanac, L. Blažić, J. Adžić, I. Adžić	First evidence of glaciation of the Medvednica Mt., Croatia (prilog stručnoj ekskurziji)
17.00 - 17.20	*Pauza / Coffee break*	
moderator: Goran Durn		
POSTER SEKCIJA 17:20 - 19:00	I. Felja, M. Juračić	Changes in depositional pattern recorded in sediment core from Mali Ston Bay during younger Pleistocene and Holocene
	N. Ilijanić, I. Razum, S. Miko, O. Hasan, K. Bakrač	Environmental changes during Holocene in Ravni Kotari region - records stored in the former lake Bokanjačko blato
	T. Popit, A. Košir, A. Šmuc	Sedimentological characteristics of Quarternary deposits of the Rebrnice slope area (SW Slovenia)
	T. Vlatković, N. Buzjak	Geomorfološki lokalitet Vranjevina
	N. Bočić, I. Kasunić	Geomorfološka karta doline rijeke Mrežnice
	M. Surić, R. Lončarić, N. Lončar, N. Buzjak	Planirana istraživanja siga speleoloških objekata šireg zadarskog prostora (2012-2015)
	N. Dunato Pejnović	Zbirka fosilne faune kvartara iz špilja riječkog područja
	N. Bočić, S. Faivre, M. Kovačić, N. Horvatinčić	Uloga pleistocenske oledbe na razvoj krša na području sjevernog Velebita
	K. Krklec, D. Domínguez-Villar, D. Perica	Preservation of microscale erosive glacial features in carbonate rocks of Croatia
	U. Stepišnik, M. Žebre	Reconstruction of Late Pleistocene glaciers on the Biokovo massif, Croatia
	L. Wacha, D. Pavelić, M. Kovačić, I. Vlahović & S. Tsukamoto	The Geochronology of Pleistocene Aeolian Dunes on the Island of Hvar, Croatia
	I. Adžić, Lj. Marjanac, L. Blažić, T. Marjanac	Fossil flora from Pleistocene lacustrine sediments (Northern Dalmatia, Croatia)
	L. Blažić, T. Marjanac	Glacial striae from some sites in Croatia: Categorization and variability

SAŽETCI / ABSTRACTS

O akademiku Marijanu Salopeku

Stjepan Bahun
Profesor geologije u mirovini

Poštovani prisutni! Velika mi je čast i zadovoljstvo što mogu govoriti o mojem profesoru akademiku Marijanu Salopeku. Početni dio prikaza koji slijedi kopija je teksta iz Spomenice 120 godina nastave prirodoslovlja i matematike na zagrebačkom sveučilištu.

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Marijan SALOPEK, redoviti profesor, ravnatelj muzeja, utemeljitelj i predstojnik Geološko-paleontoškog zavoda. Rođen je u Karlovcu 1883., a umro u Zagrebu 1967. godine 1903. započinje studij u Zagrebu, ali uskoro s Gorjanovićevom preporukom dobiva stipendiju za studij geologije i paleontologije u Beču. Po stečenom doktoratu iz paleontologije, postaje kustos Geološko-paleontološkog muzeja u Zagrebu. Dvije godine se usavršava u Švicarskoj i Francuskoj, a 1917. se vraća u muzej. Kada je s Kossmatom kartirao Julijske Alpe, a s mađarskim geolozima dio Gorskog kotara, postao je član Geološkog povjerenstva. Habilitirao se u Zagrebu (1919.), a 1920. odlazi u Ljubljanu gdje je bio profesor Filozofskog fakulteta i Tehničke visoke škole, a potom 1928. postaje redoviti profesor na Katedri geologije i paleontologije Filozofskog fakulteta u Zagrebu i ravnatelj pripadnog muzeja. Utemeljitelj je Geološko-paleontoškog zavoda i njegov prvi predstojnik (1928.-1941. i 1945.-1955.). Bavio se paleontologijom cefalopoda, stratigrafskim problemima Hrvatske i Slovenije, a dijelom i tektonikom. Uveo je redovite vježbe, ekskurzije, samostalni i grupni rad studenata na terenu. Mnogo prije uvođenja diplomskog rada iz geologije, od svakog je studenta geologije tražio izradbu geološke karte zadanog terena, geološke profile, skupljanje i odredbu fosila i uzoraka stijena kao i tekst u obliku studije, uz uporabu i navođenje literature. Rezultat tih istraživanja bile su detaljne geološke karte koje još i danas mogu poslužiti kao primjer litostratigrafskog (formacijskog) kartiranja, kao i brojne rasprave o stratigrafiji i tektonici obrađenih područja. Odgojio je velik broj mladih geologa, često privukavši ljude iz srodnih struka (biologija, geografija). To je bilo važno, jer je geologiju i mineralogiju kao glavni predmet u dvadesetak godina upisalo samo šest studenata. Od 1930. je dopisni, a od 1937. redoviti član Akademije znanosti i umjetnosti. Jedno vrijeme je bio umirovljen (1941.-1945.), a potom je vraćen na položaj redovitog profesora (1945.), a obnovljeno mu je i članstvo u Akademiji (1947.) Ponovno je umirovljen 1955., ali je još desetak godina sudjelovao u nastavi. Bio je tajnik Odjela za prirodne znanosti Akademije (1955.-1958.), a 1955. utemeljio je i bio ravnatelj Geološko-paleontološke zbirke i laboratorija za krš Akademije, gdje je djelovao do smrti. Utemeljitelj je Akademijinog časopisa *Paleontologia jugoslavica*, te jedan od utemeljitelja časopisa *Acta geologica* i *Krš Jugoslavije*. Dekan PMF-a (1951.-1952.), prvi predsjednik Hrvatskog geološkog društva, član triju stranih geoloških društava, dopisni član Austrijske i Slovenske akademije znanosti. Nagrađen je republičkom nagradom za životno djelo i Ordenom rada I. reda. Objavio je 77 znanstvenih, 4 stručna, 4 popularno-znanstvena rada, te jedan udžbenik. Važniji radovi su mu: M. Salopek, Über den oberen Jura von Donji Lapac in Kroatien, *Mitt. Geol. Ges* (Wien), 3 (1910), 542-551; M. Salopek, Einige Angaben über das Karbon in Slowenien (Jugoslawien), *Congres de Stratigraphie Carbonifere, Heerlen, 7-11 Juin 1927,* (1928), str. 645-649.; M. Salopek, O gornjem paleozoiku sjeveroistočnog podnožja Velebita i Like, *Prirodosl. Istr. JAZU,* 24 (1948), 101-169.

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Bio sam student, demonstrator i diplomand profesora Salopeka, bio sam s njim na ekskurzijama i dva puta po 40 dana na terenskim istraživanjima, pa zbog potpunosti dojma, želja mi je da osim podataka o znanstvenoj i stručnoj djelatnosti akademika Marijana Salopeka, koji pokazuje njegovu veličinu i doprinos geološkoj znanosti, pokušam prikazati i drugu, „običnu“ stranu njegove ličnosti.

Profesora Salopeka prvi put sam vidio 1951. kad sam postao brucoš. Te godine je Geološko-paleontološki zavod preselio iz Gajeve ulice u Zvonimirovu 8, drugi kat. Stariji studenti opisali su prof. Salopeka kao dosta mrkog čovjeka, a prepoznat ćemo ga po leptir kravati ispod brade. Popeli smo se na drugi kat, vrata su bila zatvorena, pozvonili smo, otvorio nam je doista mrki čovjek u sivoj kuti s leptir kravatom. Mi smo pozdravili s „Dobar dan gosp. Profesore“, malo začuđeni što nam vrata otvara sam profesor. Sutradan, došli smo na predavanje iz Opće geologije, vrata predavaonice se otvaraju, ulazi profesor koji nam je jučer otvorio ulazna vrata, mi ustajemo da ga pozdravimo (tada se još ustajalo kad je nastavnik ulazio u predavaonicu), on mirno na stol stavlja klupicu-govornicu i izlazi. Zbunjeni, tek nakon toga vidimo da u predavaonicu ulazi otmjen, malo podeblji gospodin, izbrijan milimetar ispod kože, u odijelu s prslukom, svježom košuljom i s leptir kravatom pod bradom. To je dakle prof. Salopek, a ono prije, saznali smo kasnije, bio je podvornik Gregor.

Profesor Salopek u predavaonici Geološko-paleontološkog zavoda.
Fotografija iz arhiva profesora S. Bahuna.

Tada je Geološko-paleontološki zavod imao osim predstojnika prof. Salopeka tri asistentice, tajnicu, crtača i podvornika. Zločesti ljudi iz drugih zavoda s obzirom na žensku ekipu, zvali su GPZ „Marijanova kongregacija“. Mi smo prof. Salopeka doživljavali, kao apsolutni autoritet i vlast, kao gospodina (nitko nije niti pomišljao da ga oslovi s „druže profesore“ kako se tada oslovljavalo nastavnike), koji ne želi previše komunicirati niti s podređenima niti sa studentima. Viđali smo ga na predavanjima iz Opće geologije, Stratigrafije i Tektonike, na ispitima i na hodniku. Nakon što je ušao u Zavod, skinuo bi šešir i sako, obukao crnu kutu (ljeti) odnosno skinuo zeleni hubertus i sako, obukao crnu kutu, na nju sako (zimi) i kad je izlazio na hodnik obavezno je zimi na glavu stavljao kapu „šiltericu“. Hodnikom je često potiho fićukao.

Predavanja prof. Salopeka bila su veoma posjećena prije svega zbog nedostatka udžbenika iz svih spomenutih kolegija. Budući da je u predavanjima bilo dosta puta nerazgovjetnih dijelova, po trojica dežurnih u prvoj klupi hvatali smo riječi kako smo najbolje znali i mogli. Što se tiče Tektonike, profesor bi počeo crtati tektonske profile na lijevoj strani ploče i dovršio ih na kraju predavanja na desnom kraju ploče bez velikih komentara. Na ispitu bio je veoma osjetljiv na izraze koji bi potjecali iz stranih udžbenika, pa se pričalo da, ako odgovoriš „krovina“ ili „podina“ naći ćeš se ubrzo na stubištu.

Takav je dojam ostavljao „među četiri zida“ no neka mi bude dozvoljeno da prikažem profesora Salopeka s druge strane, kada su se pomalo topili hladni odnosi i kada je postupno pokazivao one svakodnevne obične karakteristike: razgovorljivost, smijeh, znatiželju itd..

Vodio nas je na terensku nastavu da bi nakon toga odabrao nekolicinu studenata koji će ići s njim preko ljeta na terenska istraživanja. Tako, smo zbog dogovora smjeli doći čak u njegovu sobu. Jednom takvom prilikom zazvonio je telefon i profesor kaže jednom od nas neka digne slušalicu i neka reče da njega nema. Dok je kolega manipulirao oko telefona, profesor se sakrio iza ormara, virio iza njega i od tamo šapatom nekoliko puta rekao: „*Nema me! Nema me!*“. Tako smo saznali da i vrhovni šef ima sasvim uobičajene reakcije. To je sve češće i više dolazilo do izražaja u terenskom radu i životu, tako da smo shvatili da je profesor u stvari ugodan i duhovit sugovornik i da kad mu se probije distanca koju smo znali iz Zagreba, uvidjeli smo da on u stvari voli društvo, razgovor, šalu. Na terenu bi nosio crne boksane gojzerice, sokne, dokoljenke, kratke sive platnene hlače, bijelu pamučnu majicu, ponekad crveni rubac oko vrata i bijelu kapu.

On je osim toga vjerovao izabranima suradnicima što pokazuje i ovaj događaj: Putovali smo na teren u Rijeku kasnim putničkim vlakom. Oko 3.30 ujutro profesor kaže:

> „*No, no.... Vas dvojica izaći ćete iz vlaka na stanici Plase. Spustite se do Triblja, tamo se smjestite, karte i kompas imate, počnite raditi, a vidimo se sljedeće nedjelje u 9 sati na rivi u Crikvenici.*“

Biti ću slobodan da s nekoliko anegdota u kojima sam sudjelovao ilustriram navedeno.

Č E K I Ć

Vraćali smo se s terena i bili dosta umorni. Sjeli, popili vode i zapalili. Kad smo krenuli jedan kolega zaboravio je uzeti čekić, mi smo ga pobrali i na sljedećem odmorištu mu ga neprimjetno spakirali u naprtnjaču. Sve je to pomno i bez riječi pratio profesor i uključio se u igru. „*Noooo, kolega uzmite uzorak ove stijene na kojoj smo*“. Kolega je u času shvatio da nema čekića, priznao je to, ali profesor igra dalje: „*Noooo....morate ga pronaći, znate da je to skup čekić i uostalom kako će te nastaviti raditi.*“ Uputio se kolega tražiti čekić, vratio se snužden nakon pola sata, dakako bez čekića. Krenuli smo kući i naš grešnik osim traume zbog izgubljenog osnovnog rekvizita, izdatka koji slijedi, morao je otrpjeti i naša, povremeno i profesorova, podbadanja. Kad smo ponovno sjeli jadnik je bio žedan, otvorio naprtnjaču da uzme čuturicu s vodom i gle, čekić je tu. Nitko sretniji od njega, skoro pa je zaplesao ne pitajući kako se čekić našao u naprtnjači. A profesor. Smijuljio se pod brk i bez komentara s nama o događaju održao svima „bukvicu“ o čuvanju čekića, kompasa, aneroida, olovke, gumice, karte i bilježnice, koje „*ako ne drugačije treba špagom vezati uz sebe*“. Jasno početak govora je bio s neizostavnim „*Noooo......!*“

K A M I O N

Negdje u graničnom području između Gorskog kotara i Primorja, nakon naporne ture vraćajući se umorni u bazu naišli smo na cesti na kamion otvorene „haube“ pod kojom je šofer, jadan sav znojan i uprljan od ulja, želio popraviti nastali kvar. Računajući da bi nas eventualno mogao povesti barem dio puta, prof. Salopek priđe kamionu i upita šofera:

- Molim Vas, a kuda Vi idete?

Šofer se niti ne pomakne, niti progovori. Prof. će ponovno, ali malo povišenim glasom

- Molim Vas, kuda Vi idete?

Opet nema odgovora, ali prof. Salopek se nije dao smesti već će i treći put:

- Molim Vas, pa kuda Vi idete?

Šofer se sada izvuče ispod „haube“, znojan, prljav i bijesan unijevši se profesoru u lice reče:

- *Pustite me na miru! Idem u ....* (izgovarajući sintagmu dosta čestu u sličnim slučajevima)

Profesor, ustuknuvši korak, tada reče:

- No, no…. Hvala lijepa, onda nećemo s Vama.

V I J A K   Z A   S A T

U Dragi, kod Škrljevca, cesta i željeznička pruga su veoma blizu, tako da sam hodajući prugom, lupkajući po alveolinskim vapnencima i mjereći položaje slojeva, lako mogao čuti kako još netko, gotovo paralelno sa mnom lupka po kamenju ali cestom ispod mene. Popeo sam se na malu uzvisinu i vidio kako to lupkanje dolazi od prof. Salopeka, koji me je, dakako došao kontrolirati, kako sam izvršio jučerašnji zadatak. Budući da se nedaleko cesta i pruga križaju, odlučio sam malo iznenaditi profesora, pa sam ga pričekao da dođe do prelaska ceste preko pruge, naglo sam izašao pred njega i pozdravio ga:

- *Dobro jutro gospon profesor, kaj ste me došli malo kontrolirati?,* računjajući s tim da će mi reći jesam li jučer napravio sve kako treba ili ne.

Iako iznenađen i mojom pojavom i pitanjem, brzo se snašao i odgovorio:

- *A ne, ne! Znate bio sam i jučer ovdje i baš ovdje sam navijao sat. Tom prilikom ispao mi je iz ure onaj vijak za navijanje sata, pa sam ga danas došao potražiti! Ali nema ga, pa idem sad dalje. Vi ćete lijevo, zar ne? Ja ću desno prema Rijeci.*

D O J E Z D I L I

Nije bilo druge nego da zbog pomanjkanja soba u tadašnjem „Crvenom križu“ u Rijeci, kolega i ja spavamo u istoj sobi s prof. Salopekom. Sve je bilo u redu osim što smo i dio dana kada nismo radili geologiju bili s njim. Jedne večeri, pod izgovorom da moramo posjetiti neku rodbinu u Rijeci, otišli smo ali na ujutro dogovoreni sastanak s dvije znanice koje su bile slobodne tek kasnije, tako da smo šetnju korzom počeli tek iza 22 sata. Šećemo nas četvero čavrljajući, kad prema nama u šetnji eto ti prof. Salopeka. Znali smo da nas je vidio, ali s obzirom na naše društvo mi smo se pravili kao da ne vidimo njega. Sad što je, tu je! Mi smo ostali vani do kasno u noć, bolje reći skoro do jutra. No trebalo je još ući i u sobu! Pred vratima smo se skinuli do donjeg rublja, potiho smo se ušuljali u krevete osluškujući pri tom duboko disanje, pa i pomalo hrkanje profesorovo. Kad smo već mislili da je sve dobro prošlo, profesor se snažno okrene s boka na leđa i svojom pjevajućom intonacijom reče:

- *Nooooo! Jeste li dojezdili? A sutra?* ..... I nastavi hrkati.

Dakako, bilo nam je sve jasno, jer, poznavajući ga, ono „dojezdili“ nije bilo slučajno izrečeno, već jako dobro izabrano, ali je tura tog dana bila znatno kraća nego inače.

Š P A G E T I   U   U M A K U

Bilo je vraški vruće ljeto i svi smo bili u kratkim hlačama i bijelim majicama s kratkim rukavima. Sve je bilo dobro dok nismo došli na ručak i naručili gulaš sa špagetima. Profesor među nama dvojicom borio se kao i mi, da od gulaša ne ostanu tragovi na bijeloj majici. Ali što se moralo dogoditi, dogodilo se. „Navijajući“ špagete profesor je tako savršeno na bijeloj majici kolege našpricao lentu od crvenog umaka da je i sam ostao zapanjen:

- *Oprostite kolega, dogodilo se, inače nije moj običaj da špricam ljude za stolom, ali nadam se da će se dati oprati.*

Bila je nedjelja, s takvom majicom se baš nije moglo ići na promenadu, ali kolega je dakako rekao:

- *Ništa, ništa gospodine profesore imam ja još jednu bijelu majicu*.

Nastavili smo jesti, pa smo se čak usudili našaliti i na profesorov račun i pri završetku jela jadan kolega počeo je koricom kruha brisati umak s tanjura. Tvrda korica, tupa vilica i skliski tanjur katapultirali su poveću koricu, punu žarko crvenog umaka na sredinu grudi profesorovih, ostavljajući na lijepoj bijeloj profesorovoj majici crveno-smeđu masnu mrlju veličine povećeg džepnog sata. Kolega S. je skoro poletio za kruhom, da bi spriječio katastrofu, ali sve je bilo uzalud! Slomio se od silnih isprika, zaboravivši da se i njemu maloprije slično dogodilo. Kad smo se kolega i ja malo sredili, uvidjeli smo da je prof. Salopek to prilično mirno prihvatio pa je, uz svoj poznati osmijeh u brk rekao:

- Noooo! Sad smo mladi kolega 1:1, samo ste Vi meni zabili veći gol. Vi B. ovdje pričekajte a ja i kolega S. idemo na pranje i presvlačenje.

S L A V I N A

Spavali smo u đačkom domu u Rijeci, nas četvorica u jednoj sobi, prof. Salopek sam u drugoj. Dakako, imali smo svoj režim lijeganja i redovito nam je manjkalo sna, tako da je buđenje predstavljalo dosta veliki problem, ali ipak smo stizali na vrijeme sve učiniti. To se profesoru nije baš svidjelo, a nije nam htio otvoreno reći što ga muči. Postojala je međutim, u praonici između ostalih i jedna slavina koja je, ali samo, na određenom položaju „udarala“ tako da je, ako ste se potrudili puštati vodu na tom položaju, orila čitava kuća. Mi tu slavinu nismo upotrebljavali, ali kad je to otkrio, profesor nam je svako jutro u šest sati otvorio baš tu slavinu i pustio nam „muziku“ za buđenje. To smo prihvatili kao svakodnevnicu, ali smo jednog dana jednostavno zatvorili dovodni ventil ispod umivaonika i tako isključili profesorovu „budilicu“. Nekoliko dana kasnije profesor se počeo raspitivati:

- Znade li netko od vas popravljati slavine?

- Ne, gospodine profesore. A zašto vam to treba?

- Ma nije važno, ali u praonici se baš pokvarila ona slavina, koja mi je davala najljepši mlaz vode za pranje.

Budući da nitko od nas nije znao popraviti taj kvar riješili smo se „budilice“, a profesor se morao umivati na jednoj od preostalih pet slavina na malo manje lijepom mlazu!

Ovih nekoliko zajedničkih doživljaja pokazuju da je akademik Marijan Salopek osim dojma, koji je ostavljao o velikom autoritetu i apsolutnom „gazdi“, bio jednostavna, društvena, duhovita i ugodna osoba.

Hvala mu na svemu što nas je naučio kao veliki znanstvenik i naš profesor i učitelj i ne samo u geologiji.

O znanstvenici Maji Paunović (1952. – 2003.)

Dejana Brajković, Ivan Gušić

Zavod za paleontologiju i geologiju kvartara, HAZU

Maja Paunović (r. Štefanac) rođena je u Zagrebu 1952. godine. Po završenoj Klasičnoj gimnaziji diplomira (1976) i magistrira (1984) na Geološkom odsjeku Prirodoslovno-matematičkog fakulteta Sveučilišta u Zagrebu a 1987. godine, na Zajedničkom studiju iz područja geologije (RGNF, PMF) Sveučilišta u Zagrebu, brani disertaciju pod naslovom *Morfometrijske i morfogenetske osobine zubi vrste* Ursus spelaeus *Rosenm. & Heinrot iz spilja sjeverozapadne Hrvatske*. U Zavodu za paleontologiju i geologiju kvartara, tada Jugoslavenske akademije znanosti umjetnosti, koji je vodio akademik Mirko Malez, zaposlila se kao asistent 1981. godine, te napredovala do zvanja višeg znanstvenog suradnika. Nakon umirovljenja i prerane smrti M. Maleza 1990. godine, voditeljstvo Zavoda preuzima akademik Milan Herak, a Maja Paunović imenuje se upraviteljicom. Krajem veljače 2003. godine, na tom ju je radnom mjestu zadesila prerana i iznenadna smrt.

Nastavljajući i šireći interdisciplinarna istraživanja kvartara, M. Paunović je predano i uspješno organizirala i koordinirala istraživački i znanstveni rad *Zavoda*, posvećujući posebnu pažnju proučavanju biostratigrafije kvartara, paleoherpetologiji, evoluciji ursida i hominida. S odgovornošću i savjesno upravljajući Zavodom, M. Paunović je pridavala veliku važnost usmjeravanju mladih znanstvenika, interdisciplinarnom radu i međunarodnoj suradnji. Na poslijediplomskom studiju prirodnih znanosti, područje Geologija – smjer Paleontologija i biostratigrafija, držala je kolegije: *Fosilni vertebrati Jugoslavije* (1990/1991), *Odabrana poglavlja iz paleontologije vertebrata* (1991/1992 – 1996/1997) i *Geologija kvartara* (od 1997/1998 – 2003), a na području Biologija – smjer Antropologija, kolegije *Evolucija: principi i mogućnosti* (1993/1994 – 1997/1998) i *Paleoantropologija* (od 1997/1998 – 2003). Bila je ko-mentor ili mentor pri izradi šest pred-diplomskih, osam diplomskih, devet magistarskih radova i dvije disertacije.

Kao gostujući znanstvenik M. Paunović je u više navrata boravila u institucijama: Naturhistorisches Museum Wien, Institut für Palaeontologie – Universität Wien, Institut für Archaeometrie – Universität Frankfurt, Institut de Paléontologie Humaine (Paris), Musée de Préhistoire de Tautavel i Max Planck Institut u Leipzigu.

Kao glavni istraživač vodila je znanstvene projekte:

- 1990/1991 godine: *Paleontološka i kronostratigrafska istraživanja vertebrata i evolucije hominid*a;
- 1990 – 1995. godine: *Paleontologija vertebrata i kronostratigrafija kvartara*;
- 1996 – 2002. godine: *Korelacija paleolitika i mezolitika Hrvatske*;
- 2002. godine započela je voditeljstvo projekta *Paleolitik i mezolitik Hrvatske: naseljavanje istočnog Jadrana u pleistocenu*.

Maja Paunović nastavila je okupljati i širiti timove vrsnih domaćih i inozemnih stručnjaka iz područja antropologije, arheologije, arheozoologije, palinologije, paleobiologije te ostalih srodnih znanosti, te je kroz nekoliko projekata ulazila u problematiku antropogenog utjecaja na spiljske sedimente, sastav faune, biostratigrafske i paleoklimatske odnose, kao i tijesno povezana uz njih, istraživanja materijalnih kultura i porijekla sirovinskog litičkog materijala.

Znanstveni doprinos M. Paunović u istraživanjima paleontologije kvartarnih vertebrata i paleoantropologije obilježen je i brzim priključivanjem u nova područja istraživanja koji se nastavlja odvijati kroz međuakademijske projekte: *Chronologie kroatischer und slowenischer Höhlen* (1991 – 1995); OWP-56, Österreichische Akademie der Wissenschaften und Künste); *Tercijarni i kvartarni sisavci Hrvatske i Slovenije*, (1995 – 2000) i *Korelacija tercijarnih i kvartarnih vertebratskih fauna Hrvatske i Slovenije*, (Slovenska akademija znanosti in umetnosti); i međunarodne i međuinstitucijske projekte *Zooarchaeological evidence of transhumance, and subsistence changes across the Pleistocene-Holocene boundary in Croatia* (1996 – 2003); (McDonald Institute Cambridge, Zavod za arheologiju Filozofskog fakulteta, Arheološki muzej Pula), IGCP project 442, *Neolithic raw materials*, (2000 – 2002).

M. Paunović je od 1999. godine sudjelovala u radu istraživačke skupine koji je predvodio Svante Pääbo (Max Planck Institute for Evolutionary Anthropology, Leipzig), a rezultati projekta *Molecular preservation and DNA retrieval from the Vindija site*, objelodanjeni 2006. godine, i posthumno potvrđuju značajan znanstveni doprinos M. Paunović suvremenim spoznajama evolucije hominida.

M. Paunović uspješno je usmjeravala, usklađivala i povezivala interdisciplinarna istraživanja kvartara Hrvatske s cijelom Europom, a njezin znanstveni i stručni doprinos prezentiran je na sedam domaćih i 20 međunarodnih znanstvenih skupova. Znanstveni utjecaj M. Paunović ponajbolje je iščitavati kroz brojne znanstvene radove objavljene u domaćim (27) i inozemnim časopisima (21), poglavlja u knjigama (3), zbornicima domaćih (4) i međunarodnih (15) znanstvenih skupova i 18 znanstveno-popularnih, stručnih i ostalih radova, a posthumno je, također u prestižnim međunarodnim časopisima, publicirano još sedam koautorskih znanstvenih radova.

U izdavačkoj djelatnosti M. Paunović sudjeluje od 1990. godine, kao tehnička urednica edicija *Acta geologica* i *RAD Razreda za prirodne znanosti Hrvatske akademije znanosti i umjetnosti*, i članica je uredničkog odbora edicije *Spelaeologia Croatica* i Organizacijskih odbora skupova *IX kongres speleologa* (1984, Karlovac) i *The Krapina Neandertals and human evolution in Central Europe* (1999, Zagreb – Krapina).

M. Paunović bila je članica Hrvatskog geološkog društva, Nacionalnog odbora IGCP-a, European Paleontological Association i potpredsjednica Nacionalnog odbora INQUA-e.

Bibliografija Maje Paunović dostupna je u ediciji *Zavod za paleontologiju i geologiju kvartara 1955. – 2005.* (ur. B. Sokač), Hrvatska akademija znanosti i umjetnosti, Zagreb, i na stranicama hrvatske znanstvene bibliografije CROSBI.

Fossil flora from the Pleistocene lacustrine sediments at Ždrilo and Seline (Northern Dalmatia, Croatia)

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Plant macrofossils, mostly leaf impressions, were found in the Pleistocene lacustrine sediments at the seashore outcrops of the South Velebit Channel (locations Ždrilo and Seline), and for the first time a total of 79 specimens were collected during 2011-2012 research period (research still in progress) and 13 taxa were determined, belonging to 9 families (Adžić 2012). The plant macrofossils are apparently of Middle Pleistocene age or even older, according to 339.4±61.4 years minimum age of the overlying glacial sediment at Ždrilo location (Marjanac, 2012). The sediments deposited in a proglacial lake, which occupied the southern part of present Velebit Channel, are associated to glaciers of the South Velebit Mt. at the onset of Mindel Glacial (Skamnelian Stage) (Marjanac, 2012).

The Seline lacustrine sediments are varved-like, but consist of predominantly massive silt to clayey-silt beds, otherwise vaguely laminated. Dropstones are common and more frequent than in Ždrilo sediments. Ostracods are found in sediments of both sections, while only at Seline section occur moulds of large gastropods and *Unio*-type mollusks. The sediment succession represents a proximal depositional zone of a proglacial paleo-lake (Adžić, 2012; Marjanac, 2012).

The Ždrilo Lacustrine sediments are typical varved glaciolacustrine sediments consisting of alternation of clay, silt-clay and clayey-silt laminae or thin beds (Adžić et al, 2012; Marjanac, 2012). Besides abundant plant fossils (Fig. 1), there are well preserved ostracod shells and poorly preserved juvenile mollusk shells. These varvites deposited in a more distal zone of a proglacial paleo-lake than Seline sediments. The plant remains predominantly occur as leaf impressions, commonly on bedding plains and locally within a massive clayey-silt beds.

The most abundant fossil plant is *Taxodium* leaf type (absent in the Seline section sediments). Only one fossil fruit was found in the Ždrilo section and it is interpreted as *Ulmus* sp. fruit. All the specimens are relatively small in size, ranging from 10-80 mm, with mean value 30,9 mm. The most common blade class is microphyll (LAWG, 1999). Following by the number of specimens are oak leaves (*Quercus* spp.) and zelkova (*Zelkova* cf. *carpinifolia*), found both at the Ždrilo and Seline sections. Taxodium is typical relict taxa today prevalent on the east coast of the Northern America. Recent areal of the genus *Zelkova* is restricted to Asia, Sicily and Crete (Søndergaard & Egli 2006). Zelkova disappeared gradually on the European continent (Foglieri et al 1986). Two fossil leaf impressions of *Liquidambar* cf. *europea* were found at Ždrilo. Recent distribution of the genus Liquidambar comprises the area of the North America and East Asia (Komarnik, 2004). The *Quercus* spp. leaves were also relatively common in both sections represented by three different types of leaves, one ascribed to the *Quercus* cf. *trojana* leaf type. Other determined taxa are *Alnus* sp., *Pterocarya* sp., *Castanea* sp., *Fagus* sp., *Acer* cf. *rubrum*, *Buxus* sp., *Tilia* sp. The plant taphocoenosis found in lacustrine sediments represents mixed temperate forest vegetation, based on modern vegetation distribution pattern. The mixed temperate forest vegetation belt comprises large area and cannot be associated only with mild temperatures. Most of the determined taxa belong to genera that form different climax phytocoenosis today, which indicates that the vegetation was well developed and zoned.

Very recently, a number of new specimens were collected that will hopefully yield new data for more precise reconstruction of Pleistocene vegetation in this region.

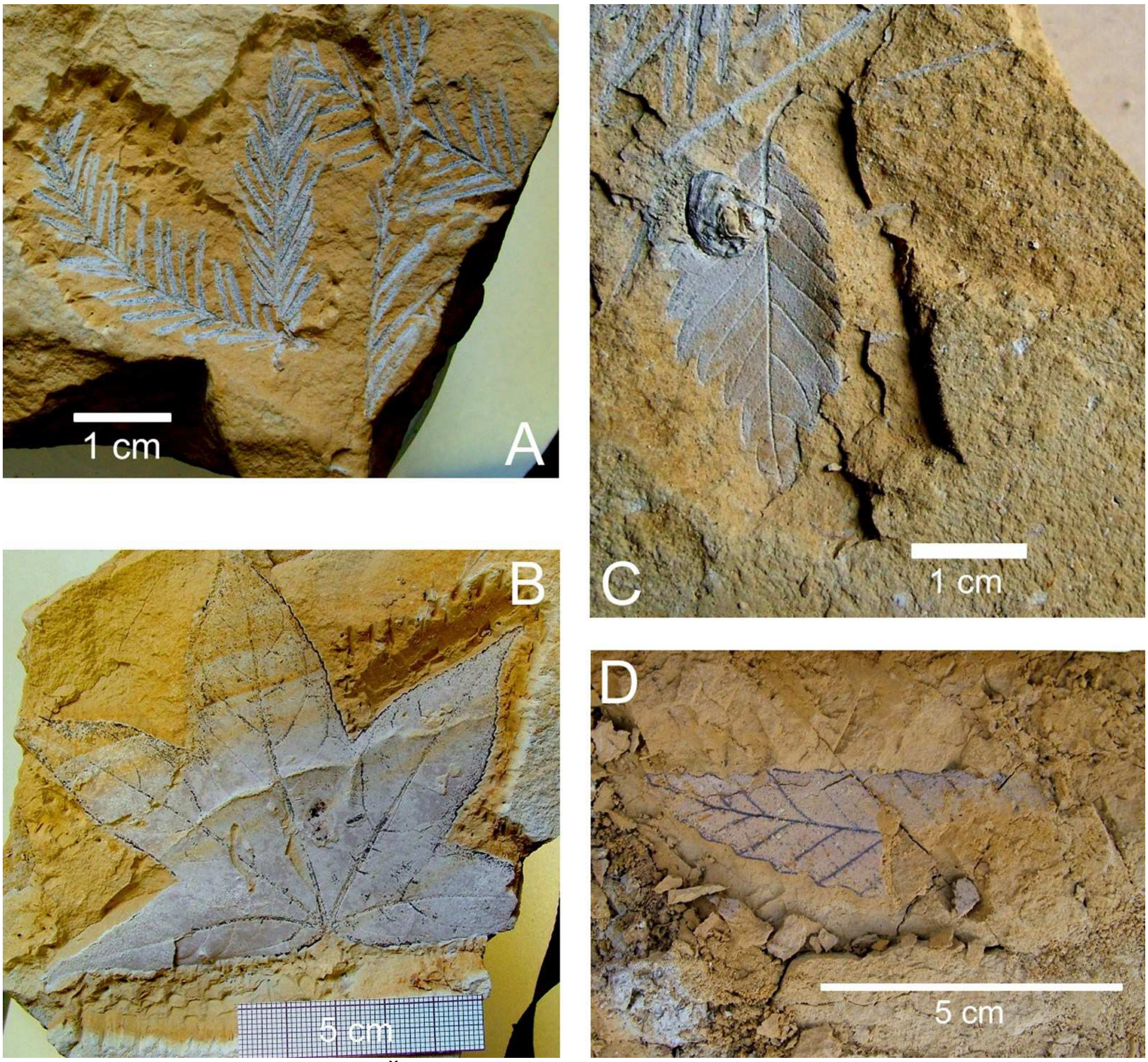

Figure 1. Plant macrofossils from Ždrilo varved sediments. A – *Taxodium* sp., B – *Liquidambar* cf. *europea*, C – *Zelkova* sp., D – *Quercus* cf. *Trojana*.

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Characteristics and provenance of loess in Baranja

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Loess is terrestrial clastic sediment, composed dominantly of silt-sized particles formed by the accumulation of wind-blown dust. Small percentage of sand-sized particles are also present in loess deposits. Loess is usually inter-bedded with soil horizons forming loess-paleosol successions (LPS). Thickest LPS in Croatia are found in Baranja, region bounded with two big rivers, the Danube and the Drava. Two loess profiles on slopes of Bansko brdo were investigates. The results from grain-size, modal and SEM analyses provide information about source material and wind direction in different time periods during Pleistocene. Garnet, epidote and amphibole mineral group are most abundant heavy minerals in samples of the Danube River sediment. Comparing heavy mineral assemblage from studied LPS with that data, it is obvious that the main source area for loess in Baranja was the Danube alluvial plain and the main transport direction was from the North or North-West. However, the concentration of amphiboles higher in studied LPS (mean 26.3% in HMF) then in the Danube alluvial plain suggests additional source area. Western Carpathians with Neogene calc-alkaline volcanic rocks is a major source of that mineral in the Pannonian Basin. Alternatively, they could originate from locally exposed volcanic and metamorphic rocks. Hence, amphibolites are known from nearby Slavonian Mts. − Mt. Krndija and Mt. Papuk − adjoining the study area to the southwest. In that case, small amount of silty material of the Baranja loess would be transported by WSW winds. Except for that difference implying diversity and shifting of source area for Baranja loess during Late Pleistocene, the present results stay in good congruence with results from other LPS loess localities in the Pannonian Basin.

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Glacial striae from some sites in Croatia: Categorization and variability

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Striae are linear abrasion features on the rock surfaces, which are produced by relative motion of rock particles in contact (Atkins, 2004). Their genesis is reflected in morphology, orientation and relative position on the particle surface. Thus, they can be used as a tool to distinguish glacigenic from other diamictons and fault zones. So far, glacial striae have been found on 25 locations with Pleistocene in NW and SW Croatia. The locations in external Dinarides were described by Marjanac, 2012, whereas those in inland sections around Zagreb are currently under study.

The studied glacial striations can be categorized by morphology (size, curvature and complexity), orientation, grouping and relationship (see Fig 1). The size categories are: **microstriae** (<0,1 mm wide), **normal sized** (0,1-2 mm wide and/or [illegible]50 mm long), **large** (10-20 mm wide and/or 50-100 mm long) and **very large** (>10 mm wide and/or >100 mm long). The curvature categories are: **straight**, **curved** and **very curved** whereas the complexity categories are: **simple**, **grooved** and **complex**. The orientation of striae is observed relative to clast long axis and can be **(sub)parallel**, **oblique** and **perpendicular**. The grouping categories are: **single**, **chaotic/noise**, **parallel** and **grouped**. The mutual relationship of striae can be described as **spaced**, **in contact**, **superimposed** and **radial**.

The relationship of development of striae on clast lithology, size and shape is studied on clasts from 25 localitites in Dinarides, both External and Internal. The striations are well developed on calcerous clastics (Jelar breccia and Promina conglomerates) and limestones, but are less developed on dolomites and quite poor on sandstones. Their development potential is smaller in softer lithologies and that also applies to weathered magmatic and metamorfic rocks. The clast size shows no apparent relationship to abundance of striae but there is dependance of their sizes, where larger clasts by the rule harbour larger striae. Sphericity is also not in apparent relationship to abundance of striae while higher roundness normally supports more striations. Striations were found on most bullet shaped clasts.

Conclusion

The studied glacial striae are easy to distinguish from tectonic and antropogenic striae, although not always readily apparent to the untrained eye. Unlike tectonical striae (which are generally uniform, parallel, and developed on only one or on (sub)parallel clast faces) and antropogenic striae (which are shallow, often unweathered, with serrated edges due to small exerted pressure), glacial striae are variable in morfology, orientation, grouping and relationship. Their overlapping and divergent relationship documents rotation of clasts, and their number documents the abundance of hard objects within the moving mass of debris under heavy load of the overlaying ice. Recognition of glacial striae is crucial in correct interpretation of the genesis of glacigenic diamictons.

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Uloga pleistocenske oledbe na razvoj krša na području sjevernog Velebita

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Oledba naših prostora, a posebno Velebita, odavno je privlačila znanstvenike (npr. Hranilović 1901, Gavazzi 1903). Istraživanja su pokazala da je veliki dio prostora Velebita bio zahvaćen pleistocenskom oledbom. Detaljnije su se provodila na području južnog Velebita (npr. Nikler, 1973). Oledbu sjevernog Velebita prvi detaljnije istražuje Bauer (1935), dok se o oledbi srednjeg Velebita manje znalo. Istraživanja oledbe sjevernog i srednjeg Velebita su se posebno intenzivirala u posljednjih 20-ak godina (Bognar et al. 1991, Bognar & Faivre 2006, Velić et al. 2011). Pri tom su diferencirani različiti tipovi ledenjaka te su pronađeni površinski morfološki (denudacijski i akumulacijski) dokazi o njihovom rasprostiranju i njihovim značajkama. Navedeni rezultati potakli su i pitanja o utjecaju glacijacije na razvoj podzemnih krških oblika – špilja i jama na području Velebita. Ovo pitanje dosada je istraživano na područjima van Dinarida (npr. Glover, 1977, Kunaver 1983, Mylroie 1984, Audra 2000). U okviru ovog rada istražuje se utjecaj pleistocenske glacijacije na razvoj krša na području sjevernog i dijela srednjeg Velebita. Poseban naglasak u istraživanju daje se na utjecaj oledbe na razvoj i morfologiju speleoloških objekata na području Velebita koji je analiziran i prikazan na nekoliko primjera.

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Geomorfološka karta doline rijeke Mrežnice

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Dolina rijeke Mrežnice većim je dijelom formirana u krškom području sjevernog dijela dinarskog prostora Hrvatske tj. dio je Unsko-Koranske zaravni, dok je manji dio doline formiran u peripanonskom području sjeverozapadne Hrvatske. Istraživano područje kojem je okosnica dolina Mrežnice pruža se pravcem sjever-jug. Površina mu je oko 370 km^2, a obuhvaćeno je područje širine 6-12 km. Glavni cilj rada bilo je utvrđivanje morfometrijskih, morfografskih i morfogenetskih obilježja prostora te izrada geomorfološke karte u mjerilu 1:50.000.

Geomorfološka karta izrađena je u skladu sa standardima (Gams i dr. 1985) koji se primjenjuju na projektu „Geomorfološko kartiranje RH", a prikazuje tri grupe podataka. Morfometrijski podaci prikazani na geomorfološkoj karti su nagibi padina podijeljeni u šest standardnih kategorija. Uz to analizirane su hipsometrijske značajke, vertikalna raščlanjenost reljefa te gustoća ponikava. Morfogenetska obilježja prikazana su kroz standardne morfogenetske kategorije reljefa zabilježene na istraživanom području (krški, fluviokrški i fluviodenudacijski tip). Morfografska obilježja prikazana su različitim simbolima za denudacijske i akumulacijske reljefne oblike koji su utvrđeni kartiranjem na terenu te analizom topografskih karata i satelitskih snimaka.

Navedeni podaci osnova su za daljnja geomorfološka istraživanja posebno evolucije reljefa te za vrednovanje i zaštitu georaznolikosti budućeg zaštićenog područja doline Mrežnice.

Novija istraživanja vrulja Zečica i Modrič (sjeverna Dalmacija)

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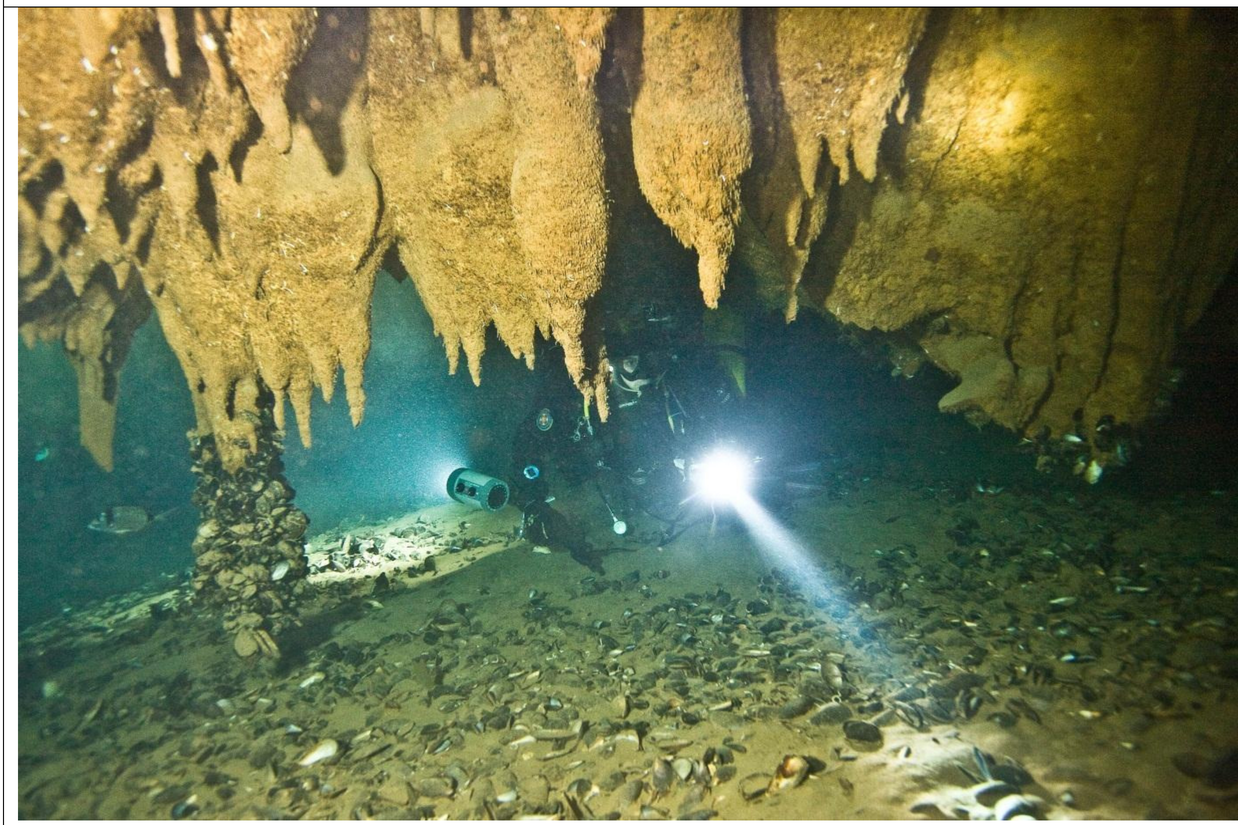
S obzirom na gustu pojavu vrulja i priobalnih izvora jedno od zanimljivijih područja hrvatske obale Jadranskog mora je priobalni pojas od Starigrada do Rovanjske u sjevernoj Dalmaciji. Njihov geografski raspored, međusobni odnosi i značajke rezultat su geoloških i hidrogeoloških uvjeta, geomorfoloških procesa, klime i antropogenog djelovanja. U novije vrijeme u tom se području nastavljaju speleoronilačka istraživanja dviju velikih i speleoroniocima dostupnih vrulja - Zečice i Modrič.

Ulaz u vrulju Zečicu nalazi se u JI dijelu Velebitskog kanala 7,8 km JI od Starigrada. To je povremena vrulja aktivna samo nakon obilnih padalina i otapanja velikih količina snijega u velebitsko-ličkom krškom zaleđu (sl. 1). Iako je roniocima i speleoroniocima odavno poznata, od 2011. godine u njoj se obavljaju sustavna istraživanja čiji je cilj detekcija prolaznih šupljina, izrada speleološkog nacrta i temeljno geomorfološko istraživanje. Ulaz vrulje se nalazi na blago nagnutom pjeskovitom dnu na dubini od 6 do 9 m. Slijedi vertikalni jamski kanal koji se na dubini od 37,5 m spaja s horizontalnim spiljskim kanalom. Nakon niza urona preronjeno je oko 650 m kanala od čega je topografski snimljeno 197 m. Najdublja točka je na dubini od 43 m. U topografski snimljenom dijelu spiljski kanal je širine do 17 m i visine do 5 m, a sličnih je karakteristika i u svom nastavku. Kanali su oblikovani u području građenom od intenzivno okršenih naslaga krednih vapnenaca i Jelar breče. Predisponirani su pukotinskim sustavima pravca pružanja I-Z, SI-JZ i SSI-JJZ. Generalno su lećastog presjeka, karakterističnog za oblikovanje u freatskim uvjetima, ali snažno modificirani destruktivnim i akumulacijskim procesima. Duž istraženog dijela ispunjeni su obilnim naslagama siga i klastičnih sedimenata različitog postanka, sastava i granulacije (pijesak, šljunak, kršje, blokovi) te povremeno talozima organskog porijekla (ostaci školjaka; sl. 2). Obilne naslage siga svjedoče o trajnijoj vadoznoj etapi oblikovanja kanala. Prestanak njihovog taloženja bio je uvjetovan gornjopleistocensko-holocenskom transgresijom. Osim onih u primarnom položaju rasta, u kanalu su brojne polomljene i prevrnute sige što je posljedica neotektonskih pokreta, a recentno je rezultat snažnog mehaničkog djelovanja vode tijekom povremene hidrološke aktivnosti vrulje. Dokaz tome su i brojne polomljene ljušture školjaka na stjenkama kanala i u debelim nanosima na njegovom dnu.

Vrulja Modrič nalazi se uz obalu istoimene uvale 1 km sjeverno od naselja Rovanjska i poznata je speleoroniocima koji su je već istraživali. Također se radi o povremenoj vrulji. Ulaz je u dnu vertikalnog usjeka koji se s dna uvale spušta do dubine od 33 m. Teže je prolazan jer je sužen pjeskovito-šljunkovitim sedimentom, granjem i otpadom bačenim s ceste čiji je rub neposredno iznad. Do kraja 2012. godine istraženo je oko 500 m kanala. Od ulaza kanal se u istraženom dijelu uspinje do 15 m dubine. Oko 380 m od ulaza ronioci su otkrili haloklinu i ušli u tijelo slatke vode sa slatkovodnom faunom. Osim stalaktita i stalagmita zanimljivo je otkriće kaskada i zasiganog tla na dnu kanala - tragova speleogeneze u vadoznim uvjetima.

Istraživanja vrulja, iako su u pogledu opreme i stručnih znanja speleoronilaca zahtjevna, daju nove podatke o uvjetima speleogeneze, hidrogeološkim i geomorfološkim značajkama, te o interakcijama fizikalno-kemijskih uvjeta u priobalnim krškim vodonosnicima. Interesantne su i kao završni element krške cirkulacije između zaleđa i obale. Analize sedimenata daju vrijedne podatke o paleoklimatskim i paleoekološkim uvjetima jadranskog područja. Osim kao mjesta istjecanja slatke vode u more, zbog mogućnosti direktnog istraživanja one pružaju vrijedne podatke o prodiranju morske vode u priobalne vodonosnike. U ovom slučaju utvrđeno je da ono, ovisno o morfologiji kanala i hidrološkim uvjetima, tijekom neaktivnosti vrulja prelazi 600 m od linije obale. Posljedica prodiranja mora je zaslanjenje - degradacija kvalitete vode u priobalnom krškom vodonosniku potencijalno pogodne za piće i gospodarstvo što je, s obzirom na recentne klimatske trendove i sezonske probleme hrvatskog priobalja s vodoopskrbom sve veći praktični problem.

Slika 1: Ekstremna aktivnost vrulje Zečice 21. 1. 2013. izazvana naglim otapanjem snijega u zaleđu praćenog obilnom kišom (foto N. Buzjak).



Slika 2: Sedimenti i obraštaj školjkama (dagnje) u horizontalnom glavnom kanalu vrulje Zečice (foto P. Kovač-Konrad)

Organic Technology of Pleistocene and Early Holocene Foragers of the Eastern Adriatic Region. Data from Vela Spila and Šandalja II.

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Formal organic technologies represent one of the main components of Late Pleistocene and Early Holocene foragers' equipment, which have played a major role in the success of human adaptations in the Adriatic region during the Upper Palaeolithic and Mesolithic. Yet, the significance of antler and bone tools for our understanding of Palaeolithic and Mesolithic lifeways and subsistence strategies in the region is rarely emphasized when compared to the studies of knapped stone tools.

In this paper the author presents the rich Upper Palaeolithic and Mesolithic organic assemblages from the sites of Šandalja II (Istria) and Vela Spila (Korčula). Morphological and techno-functional data related to bone and antler tools from the two sites will be discussed in order to trace the role of organic industry in human adaptations and cultural traditions of the eastern Adriatic region.

Archeogenetics of lagomorphs in Croatia: a preliminary study

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Archeogenetics is a discipline based on molecular and population genetics with target to analyse ancient biological remains (ancient DNA). It is mainly oriented to ancient DNA from humans and domestic animals and plants, although, analyses of other materials might come to use. The full exploitation of archeogenetic information is heavily dependent on the interdisciplinary research as the sound explanations would require knowledge on a number of diverse disciplines (paleontology, zooarchaeology, archaeology, molecular genetics and population genetics). We built a small team of researchers involved in all required disciplines in order to analyse faunal remains present in Croatia with focus on domestic animals and their wild relatives. While our interests are wide with respect to a number of domestic species and their wild relatives we decided to start with lagomorphs. This decision has been very much influenced by the activities of a COST RGB project entitled "A collaborative European Network on Rabbit Genome Biology - RGB-Net " where we are participating (WG1: Refinement of the European rabbit genome resource and development of genome-based platforms and WG4: Genetics and comparative genomic aspects for the study, exploitation and management of wild lagomorphs). Currently, the status of literature overview is the following. MtDNA (mitochondrial DNA) has been determined from a large number of lagomorph species at the individual level and the comparison of those DNA sequences represents a mainstay of phylogenetics, in that it allows biologists to elucidate the evolutionary relationships among species and it also permits an examination of the relatedness of populations. MtDNA genetic diversity analysing mitochondrial DNA from remains of archaeological sites with present population theories of origin of *O. cuniculus* were postulated, also other markers were used as well (heteroplasmy, RFLP, mtDNA sequencing–cyt b, tRNA, CR). The study of restriction fragment length polymorphism (RFLP) of the entire rabbit mtDNA molecule revealed the existence of two very distinct maternal lineages (Ennafaa et al., 1987; Biju-Duval et al., 1991). Lineage A was found in the south-west of the Iberian Peninsula and lineage B in the rest of Europe (including northern Spain) and also in domestic breeds. A clear subdivision into two groups was also found when nuclear genes were studied (Van der Loo et al., 1991, 1999; Ferrand, 1995), with a geographical distribution that largely coincides with that of the two mitochondrial clades A and B. Thus clade A was tentatively associated with *O. c. algirus* and clade B with *O. c. cuniculus*, as well as the corresponding nuclear gene pools (Biju-Duval et al., 1991; van der Loo et al., 1991; Ferrand, 1995; Branco & Ferrand, 1998).

Even during the coldest periods, three regions in the Mediterranean area had temperate climates; the Iberian and Italian peninsulas, and the Balkans (Bennet *et al*. 1991). When the temperature decreased, the northern populations of many species became extinct, but the species may have survived during hostile times in these Mediterranean refugia. From plant and animal remains it is clear that most organisms presently distributed across Europe were in refugia in the south at the height of glaciations 18 000 BP, many in the peninsulas of Iberia, Italy and the Balkans, and some possibly near the Caucasus and Caspian Sea (Hewit, 1999). Present lagomorphs in Croatia are *Lepus europaeus* and *Oryctolagus cuniculus.* Taxonomic identification of lagomorphs remains in this preliminary study is based exclusively on their morphometric characteristics.

Future work is the ancient DNA analysis, sequencing of whole mtDNA by new technology, and filling gaps with Balkan refugia which we missed in literature.

Zbirka fosilne faune kvartara iz špilja Riječkog područja

Nadia Dunato Pejnović

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Zbirka fosilne faune kvartara iz špilja riječkog područja Prirodoslovnog muzeja Rijeka utemeljena je tijekom prvih sustavnih znanstvenih istraživanja koje je za Prirodoslovni muzej Rijeka od 1970. do 1974. g. proveo dr. sc. Mirko Malez, geolog u Zavodu za paleontologiju i geologiju kvartara Hrvatske akademije znanosti i umjetnosti. Tijekom paleoantropoloških istraživanja na području Liburnije istraženo je 25 špilja u kojima su pronađeni fosilni ostaci pretpovijesnog čovjeka, brojna pleistocenska fosilna fauna (dijelovi kostura, lubanje, čeljusti i zubi ledenodobnih životinja) i artefakti (izrađeni od kamena, minerala rožnjaka, kosti, željeza, bakra i keramike) koji se čuvaju u zbirci. Zbirka se kasnije dopunjavala, najveća akvizicija je bila 1976. g. kada je akademik Mirko Malez ustupio 58 primjeraka fosilne faune iz Medvjeđe pećine u Gorskom kotaru. Od 1979. g. o zbirci se brine kustosica geolog-paleontolog Koraljka Klepač koja je sastavila prvi inventar zbirke i tijekom novih paleontoloških istraživanja špilja sakupljanjem materijala pridonijela njenom obogaćenju. Zbirka ima 2.984 primjerka (2722 primjerka sakupljena su do 1976. g. i 262 primjerka sakupljena od 1979. do 2012. g.). Dokumentacija zbirke se vodi u računalnoj bazi podataka od 1997. godine. Eksponati u zbirci koji imaju najveću znanstvenu vrijednost su primjerci vrsta različitih izumrlih životinja – špiljskoga medvjeda, stepskoga bizona, golemog jelena i divljeg polumagarca koji pripadaju geološkom razdoblju pleistocena. Najbrojniji su ostaci špiljskoga medvjeda. Uz izumrle vrste znanstvenu vrijednost u zbirci ima i značajan broj drugih primjeraka vrsta (alpski kozorog, snježni zec, planinski svizac, snježna jarebica, planinski kos) koje su uslijed klimatskih promjena migrirale u druga područja gdje žive i danas – nastanjuju sjevernija područja Europe i Azije, te se ne nalaze južno od Alpa. Rezultati istraživanja su objavljeni u kongresnim publikacijama, znanstvenim i stručnim časopisima. Zbirka je temelj za stručne i znanstvene radove, a uz to ima veliku obrazovnu važnost i povijesni značaj.

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Morphological, chemical and mineralogical properties of pseudogley on loess along a precipitation gradient in the Pannonian region of Croatia

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We sampled three pseudogleys developed on loess across a zone of 300 mm mean annual precipitation (MAP) gradient in the Pannonian region of Croatia in order to determine their morphological, chemical and mineralogical properties and to evaluate the degree to which climate influenced their genesis. Soil profiles 1, 2 and 3 were opened within MAP zones of 900-1000, 800-900 and 700-800 mm, respectively. The same provenance of pedogenetically modified loess parent material was confirmed by the almost identical La/Ce and Sm/Nd ratios of C horizons in all three profiles. In all three profiles clear redoximorfic features (RMF) were observed from A horizons downwards. Generally, the abundancy of RMF was highest in Btg and Cg horizons, in which highest Fe_d values were also observed. Substantial morphological (A and Eg horizons thicknesses and colors, Btg horizons stagnic color patterns) and chemical (pH, base saturation, topsoil organic C content) properties of the investigated profiles are consistent with the precipitation gradient. On the other hand, vertical distribution of clay size fraction along soil profiles appears to be a function of actual soil pH, rather than MAP. Nevertheless, we consider clay illuviation to have been the main process in creation of vertical texture contrast between the eluvial and illuvial soil horizons of all investigated profiles. This is supported with illuvial nature of accumulated clay observed in thin sections, as well as with Chemical Index of Alteration (CIA) and Ti/Al ratio distributions along analyzed soil profiles. Significant differences in clay minerals distribution among investigated profiles were observed. While the content of illitic material, kaolinite and NN mixed-layer clay mineral is fairly constant with depth in all profiles, distributions of chlorite, smectite, vermiculite and chlorite-vermiculite mixed layer mineral (C-V MLM) vary among analyzed profiles. We consider that chlorite, illitic material, kaolinite and probably smectite are inherited from parent material, while C-V MLM and vermiculite are formed as a result of chlorite destabilization. C-V MLM, an intermediate mineral phase during the process of vermiculization, is most stable in profile 3 with the lowest MAP. Its complete transformation to vermiculite in profile 1 can probably be attributed to the low pH of the profile 1 compared to profiles 2 and 3. We conclude that, due to partial heterogeneity of loess parent material, investigations and interpretations of pseudogley climosequences in the Pannonian region of Croatia need to be approached with caution.

Četiri faze kolebanja morske razine na Srednjem Jadranu u posljenjih 1500 godina

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Na temelju bioloških markera načinjena je nova rekonstrukcija kolebanja morske razine tijekom posljednjih 1500 godina na području Srednjeg Jadrana. Na otocima Visu, Biševu i Ravniku pronađene su i analizirane mediolitoralne biokonstrukcije koje grade koralinske alge, naročito vrsta *Lithophyllum byssoides*, koje se smatraju iznimno preciznim markerima (± 10 cm) morske razine (Laborel i dr., 1994). Izabrane su 3 lokacije, na svakom otoku po jedna, gdje su algalni vijenci najbolje razvijeni širine i do 1,8 m, dok maksimalne vrijednosti zabilježene u Mediteranu dosežu 2 m. Postojanje tako velikih i dobro razvijenih algalnih vijenaca općenito upućuje na izdizanje morske razine. Algalne biokonstrukcije su kartirane i datirane pomoću metode ^{14}C.

Rezultati upućuju na četiri faze kolebanja morske razine. Od oko 550 do oko 770 cal AD morska razina je bila relativno stabilna za vrijeme hladnog perioda. Potom, za vrijeme toplog Srednjeg vijeka (770 do 1330 cal AD), morska razina se počinje izdizati brzinom od 0,71 mm/god. Za vrijeme Malog ledenog doba (1330 do 1640 cal AD) morska je razina ponovo relativno stabilna. Potom morska razina ponovo znatno brže raste, osobito tijekom aktualnog toplog razdoblja (Faivre i dr., 2013). Dobiveni rezultati su uspoređeni s lokalnim procjenama glacio-hidro-izostatičkih modela temeljenih na posljednjem Glacijalnom ciklusu (Lambeck i dr. 2004; Lambeck i Purcell, 2005).

Rezultati istraživanja pokazuju da su se veliki algalni vijenci najbolje razvijali u fazama kada je morska razina bila stabila tj. kroz dva hladnija perioda, te da su najveći vijenci širine do 1,8 m nastali tijekom ~300 godina stabilizacije morske razine na Srednjem Jadranu.

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Changes in depositional pattern recorded in sediment core from Mali Ston Bay during younger Pleistocene and Holocene

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For the purpose of building Pelješac bridge, several research boreholes were drilled in the Mali Ston Bay. These boreholes showed thickness of sediment cover between 12 and 112 meters to the basement rock (Buljan et al. 2012). One of this cores, 96 meters in length, from the borehole S10-33 (Fig. 1), was analyzed for granulometric and mineral characteristics and carbonate share in our department. The aim of this research is to reconstruct changes in sedimentation pattern in the broader Neretva River delta area during younger Pleistocene and Holocene (deltaic Quaternary sediments on land - white in Fig. 1).

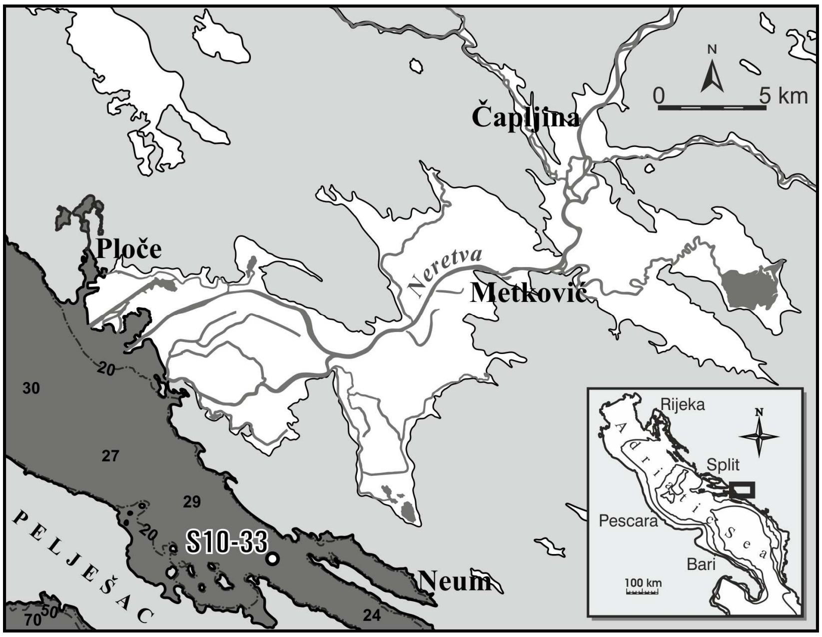

Figure 1. Location map of borehole S10-33

The results showed significant changes along the core. Grain size analysis showed domination of muddy fraction, while sand and gravel part consisted mostly of shell fragments (gastrpods and bivalves). There was a considerable difference in clay to silt ratio in mud fraction (7% to 64% of clay). Carbonate share was between 1 and 95%. Also, as indicated on Fig. 2, one can distinguish several cycles of increase and sharp decrease in carbonate share. Samples in which more quartz and clay minerals were found suggest a stronger terrigeneous input whereas those with more biogenous calcite indicate sedimentation of carbonate mud in marine environment.

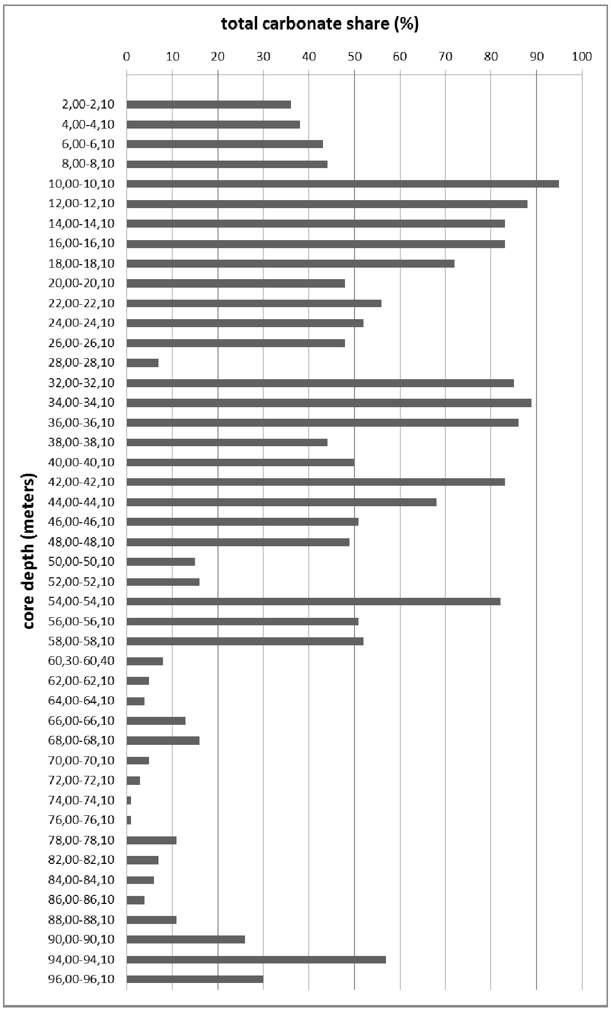

Figure 2. Total carbonate share in samples from the core S10-33 in Mali Ston Bay

Former results of ^{14}C measurements of adjacent core indicated sediment age of 8580 years on 5.5 meters depth and age of 17 100 years on 35.5 meters (Buljan et al., 2012).

One of the further steps of this research is to determine ^{14}C age for deeper horizons within the core in order to get precise data for sedimentation rates in periods before and after maximum glaciation. The goal is better understanding and a more precise reconstruction of different depositional environment in broader Neretva River delta area due to significant climate and sea level changes during younger Pleistocene and Holocene.

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Holocene Nonmarine Ostracoda from Adriatic part of Croatia and their ecological significance

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The current knowledge on Holocene nonmarine ostracoda distribution in the Adriatic part of Croatia remains poorly known. In an attempt to improve the situation present study reports on ostracoda collected from different types of lacustric habitats in the Adriatic region.

The aim of my research was to give the first comprehensive picture of the Holocene nonmarine ostracod fauna from karst area on the eastern coast of the Adriatic sea and resented ostracods assemblages data from cores samples which are located in two largest lakes, both known by the same name of Vrana Lake (Island Cres and Dalmatia) and three marshy karst lakes of Adriatic Island Mljet.

Lake Vrana is a deep and large freshwater karst lake on the northern Adriatic Island of Cres, Croatia. It is one of the most interesting karst water phenomena within the Dinaric karst and Adriatic Islands. Lake surface area is 5.73 km^2, maximum length is 5.5 km and maximum width is 1.5 km. The lake is situated in a depression, with maximum depth of 75 m. The present study is based on three drilled cores (85 to 90 cm long) located in different places and water depths. The determination of Holocene ostracod assemblages of the Lake Vrana documents the distribution of freshwater species: *Candona candida*, *Pseudocandona hartwigi*, *Ilyocypris bradyi*, *Metacypris cordata*, *Darwinula stevensoni*, *Cypria ophtalmica*, *Cypridopsis vidua*, *Cytherissa lacustris* and *Herpetocypris brevicaudata.*

The second Lake Vrana in Dalmatia is the largest natural lake in Croatia. The area of the lake is 30.7 km^2, maximum length is 13,6 km and maximum width is 1,4-3,5 km. It is characterised by very shallow water, divided from the sea by a narrow karst ridge and it is connected with the sea through the channel Prosika. Analysed samples were taken from undisturbed core PP Vrana 2 (0 to 1100 cm). In these samples sequence from freshwater to brackish ostracods have been tracked. The brackish ostracods assemblages dominated by species *Cyprideis torosa*, *Heterocypris salina* and *Candona angulata*. Typical species for freshwater sequence are *Limnocythere inopinata, Ilyocypris bradyi, Eucypris elliptica*, *Herpetocypris reptans*, *Candona neglecta and Darwinula stevensoni.*

The three marshy lakes Blato, Sobra and Prožura are located on the Island of Mljet. It has been drilled one pilot core in each three marshy lakes. At the marshy lake Blato (depth 125 cm); at marshy lake Prožura (depth 145 cm) and at the marshy lake Sobra (depth 198 cm). The freshwater to brackish ostracod assemblages of marshy lakes on the Island of Mljet dominated by *Candona angulata, Candona neglecta, Cypris bispinosa, Ilyocypris bradyi, Cyprideis torosa, Candonopsis sp., Cypridopsis vidua, Heterocypris salina* and etc. The difference in the abundance of the above mentioned species from three marshy lakes varies and it mainly depends on individual lake location, subsurface connection with the sea and the depths of the cores.

All cores samples revealed presence of well-preserved ostracod fauna which were used to interpret ecological changes in different lakes environment. The Holocene ostracods were used to interpret signals in terms of hydrological changes, eutrophication, salinity and temperature.

Environmental changes during Holocene in Ravni Kotari region - records stored in the former lake Bokanjačko blato

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Bokanjačko blato is a typical karst depression, mainly covered by Quaternary pond and lake sediments. Together with its catchment area, it belongs to Ravni Kotari region, mostly composed of Cretaceous and Eocene karstified carbonate rocks and Eocene flysch deposits. Numerous springs occur in the catchment. It is today important water supply area for the adjacent town Zadar and its surroundings. Bokanjačko polje was dried out back in 1960-ies, for agriculture purposes. Quaternary lake sediments contain many indicators of environmental changes, including geochemical markers, mineralogical fingerprint of the catchment and pollen remains of ancient land use dynamics. Undisturbed sediments from the lowermost part of the Bokanjačko polje were collected in length of 7,8 m. Longer core (length 23m) drilled by commercial company Geokon was also included in the investigation. Mineralogical composition, determined by X-ray diffraction, shows high carbonate content, followed by quartz and rare feldspars in the upper part (~10 m). In the deeper parts of the core, there is no calcite; dominant mineral phases are quartz, clay minerals kaolinite and illite, and Fe-oxides and hydroxides (goethite and hematite). Dominant clay mineral phases are illite and kaolinite, in the deeper sediments, and together with goethite and hematite, are main constituents of the „red soils“. Optical microscopy was used to determine light and heavy mineral fraction. Light fraction is represented mainly by quartz, but in upper parts down to depth 12 m, some gypsum and feldspar, in most cases orthoclase and only few grains of microcline can be found. Share of heavy mineral fraction varies between 23% to only 0,4% for depths 6 m and 21 m, respectively. It is mainly represented by opaque minerals which content varies between 40% to 96% for core depths 10 and 6 m, respectively. Transparent minerals are represented by epidote group, mainly clinozoisite, garnet and amphibole in upper parts of the core, in the lower parts (>13m) ultra-stable minerals as zircon, tourmaline and rutile are dominant. In virtually all samples staurolite, kianit and galucophane were also found. Boreal period can be evidenced by pollen analysis on 760 cm, which is similar to 910 cm of the Lake Vrana core (mostly herbaceous plants), located in the south eastern part of the Ravni Kotari. Also, 500-600 cm of both core belong to the Atlantic period of the wet and warm climate (mixed deciduous–evergreen forest). Due to its location near the sea, significant changes during the Holocene can be tracked, followed by the sea level rise. Ice melting after Younger Dryas and prolonged pluvial period enhanced erosion in Late Holocene, evidenced by magnetic susceptibility measurements. Until this investigation, it was suspected that the Holocene deposits are making up to 18 m of the deposits, but likely it is not more than 10 m. Based on AMS radiocarbon dating, 760 cm is calculated to 8990 BP. Specific structures occur on the 1050 cm of the core, where evidences of subaeral exposure like desiccation cracks are visible. After that period, the lake could have been formed.

The Holocene paleolimnology of Lake Vrana (Biograd) and implications to its formation

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Paleolimnology uses the physical, chemical and biological informations contained in lake sediments to assess past environmental characteristics. Based on multiproxy investigations of an 1100 cm long sediment core from Lake Vrana and a 765 cm core from the Pirovac bay marine lagoon, a reconstruction of palaeoenvironmental dynamics in the lake catchment and the influence of sea level rise during the Holocene, is proposed. Evidences from mineralogy, geochemistry, nutrients (C and N), palynology, macrofossils and ostracods fauna show that Lake Vrana experienced changes during the Holocene. Lake Vrana is the largest natural lake in Croatia and is situated near the Adriatic Sea (1 km). It is characterized by very shallow water, sometimes intruded by sea with chloride contents reaching 4500 mg/l, with an average depth of 2,4 m. It is mostly supplied by the rainfall, freshwater stream input and also by the groundwater springs in its catchment. It is connected to the sea through the channel Prosika, excavated in the late 19th century to drain the water from the adjacent Vransko polje, used for agriculture and vineyards. This channel today presents danger to the lake fauna as sea water enters the lake through it during low lake levels and high tides. Lake salinity also increases due to decrease in rainfall, which allows the intrusion of the salt water through permeable limestone rocks. The bottom of Lake Vrana lies about 3 m bellow the present sea level, while Pirovac bay has its maximum depth about 25 m in the middle, while on the edges it is surrounded by the sea ridges with the max depth of 6,5 m. Pirovac bay was a lake that coexisted with Vrana lake during the early Holocene and was flooded by the rising sea. Ostracod freshwater fauna is introduced by *Heterocypris salina* and *Ilyocypris bradyi* in the deeper sediments in Pirovac bay, followed by abrupt domination of marine fauna and ostracod species *Pterygocythereis jonesii* on 264-265 cm, dated on cal 6590 +/-40 BP. In Lake Vrana sequence from freshwater to brackish ostracods can be tracked. Such ostracod assamblage, together with macrofossils, dominated by *Bithynia tentaculata* and *Lymnea peregra*, constrain the paleohydrology of the lake. According to pollen analysis (mixed conifer-deciduous forests dominated by *Pinus*, and open areas with herbaceous xerophytic communities and grasses), the oldest sediments (885-1100 cm) could belong to Preboreal and Boreal period. The middle part belongs to Atlantic period while vegetation was dominated by Mediterranean oak. Younger sediments could reveal population from Roman period until present times. These multiproxy analyses combined with chronologies based on AMS ^{14}C dates and suggest that the intrusion of the sea could have occurred around 7 kyr BP. During this period the lake evolved from an open freshwater lake to a more saline lake. Mineralogy of the lake sediments was compared to the rocks in the catchment area to find a possible source. Catchment area consists of carbonate rocks, flysch deposits, loess like deposits and a thin soil cover of terra rossa and cambisols. There are strong erosion processes within the catchment, followed by the strong winds (eolian erosion), which contribute material to the lake. Dominant terrigenous input is characterized by detrital quartz, feldspars and clay minerals. Calcite and aragonite are dominant endogenic minerals within lake sediments. These multiproxy studies provide an important new environmental and paleoclimate reconstruction for the Holocene of the middle eastern Adriatic coastal area.

Projekt:
"Kasni musterijen na istočnom Jadranu – temelj za razumijevanje identiteta kasnih neandertalaca i njihovog nestanka"

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Neandertalci odnosno njihovi biološki i kulturni ostaci imaju veliki odjek u svijetu znanosti. Kraj srednjeg paleolitika, nestanak neandertalaca i pojava anatomski modernih ljudi predstavljaju jednu od najintrigantnijih znanstvenih rasprava u arheologiji i paleoantropologiji (Cartmill i Smith 2009).

Obitavanje kasnih neandertalaca dobro je dokumentirano u Hrvatskom zagorju (Higham sur 2006.). Iako fosilni ostaci neandertalaca nisu pronađeni u Dalmaciji, mnogobrojna nalazišta s izrađevinama srednjeg paleolitika svjedoče o njihovom boravku na tom prostoru. Štoviše, rezultati kronometrijskog datiranja musterijenske kulture stavljaju dalmatinske neandertalce prije i u vrijeme pojave anatomski modernih ljudi u Europi (Churchill i Smith 2000; Rink et al 2002;. Smith dr. 2005;. Trinkaus 2005; Peresani 2008; Cartmill i Smith 2009, Higham sur 2011;. Benazzi sur 2011). Musterijenska industrija i faunistički ostaci pogodni su za utvrđivanje identiteta kasnih neandertalaca i rekonstrukciju njihova ponašanja. Projekt, koji financira Hrvatska zaklada za znanost, usmjeren je na iskopavanja srednjopaleolitičkih nalazišta Dalmacije, koja su nedovoljno istražena, te pronalaženje novih nalazišta. Predviđena su trogodišnja sustavna iskopavanja Velike pećine u Kličevica kod Benkovca, probna iskopavanja Matatine pećine i lokaliteta na otvorenom - Giljanovići iznad Kaštela, nastavak istraživanja podvodnoga paleolitičkog nalazišta Kaštel Štafilić te rekognosciranje zaleđa Kaštela i dijela Ravnih Kotara. Usporedba dobivenih rezultata s drugim musterijenskim nalazištima u jadranskoj regiji i središnjoj Europi pokazati će sličnosti i razlike između neandertalskog ponašanja u dvije različite ekološke zone. Uz utvrđivanje kronologije, industrijske varijabilnosti i osnovne paleoekologija srednjeg paleolitika Dalmacije, unaprijediti će se razumijevanje života i mobilnosti srednjopaleolitičkih lovaca, te pružiti dodatni podaci o prilagodbi neandertalaca u Europi.

Preservation of microscale erosive glacial features in carbonate rocks of Croatia

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Mountain glaciers have a high climate-sensitivity and are ideal records of changes in climate during past glaciations (Owen et al., 2009). The mountain paleoglaciers in Dinarides attracted the attention of early researchers (e.g., Hranilović, 1901; Cvijić, 1917). However, the poor chronological control of this features limited its paleoclimate application in comparison with other records. Thus, the study of past glaciations became less relevant for decades. However, the improvements on dating techniques during the last decade restored the interest for the study of paleoglaciers, including the Mediterranean region (Hughes et al., 2006; Hughes & Woodward, 2008). In Croatia, despite the early pioneer studies and the punctual subsequent contributions (e.g. Nikler, 1973; Belij, 1985; Marijanac & Marjanac, 2004; Bognar & Faivre, 2006; Velić et al., 2011; Marjanac, 2012), there is no complete detailed catalogue/cartography of glaciated areas. Therefore, further basic geomorphology and Quaternary geology on this topic is to be developed in the region.

Microscale glacial erosion features (e.g., polished surfaces, striations, small grooves) are geomorphic indicators to support the evidence of glaciation (Bennett & Glasser, 2009). However, preservation of carbonate surficial features depends on weathering. Morphologically similar features can result from agents different than a glacier (e.g., tectonic, anthropogenic). Therefore, considering the preservation criteria of these features since deglaciation could help to constrain its genesis.

Weathering of carbonate rocks depends on many parameters including climate (Dreybrodt, 1988; Appelo & Postma, 1993), rock properties, and local context (Wainwright, 2009). In Croatia several weathering rate studies have been conducted in different locations (Pahernik, 1998; Perica 1998; Perica & Orešić, 1999; Krklec, 2011). Despite the variability in weathering rate, all results at surface conditions are within the same order of magnitude (i.e., 4 to 7 mm/ka). Subsurface weathering rates are frequently higher (e.g., >10 mm/ka) than those in the surface (e.g. Pahernik, 1998, Perica & Orešić, 1999). In this context, the dissolution is the principal weathering process, but physical and biological erosion may also be important. It should be noted that for the dissolution, the surface of the features have to be in contact with unsaturated water in an open system (i.e., water flow). Thus in buried microscale glacial erosion features, the weathering is expected to be higher unless the cementation/cohesion of sediments prevents water circulation along rock/clast surface.

The figure 1 represents a theoretical approach showing the time needed for a microscale glacial erosion feature on the surface of a rock (or clast) to be lost. In general terms, glacial polish surfaces disappear within 1 or 2 decades, and all striations could disappear in less than 200 years. Thus, only grooves could be identified after longer time periods. This is a theoretical approach, but gives the range of magnitude for the preservation of these delicate geomorphic elements. In Croatia glaciers disappeared from the mountains thousands of years ago (e.g., Belij, 1985). Thus, the preservation of glacial erosion microscale features in Croatia is expected to be null under surface conditions. Only two scenarios could allow their preservation in other settings: 1) a burial context under impermeable sediments due to their cementation and/or cohesive properties, or 2) a recently exposed rock (or clast) that was under the previous scenario. Any other subsurface scenario should result in weathering of these fine morphological elements.

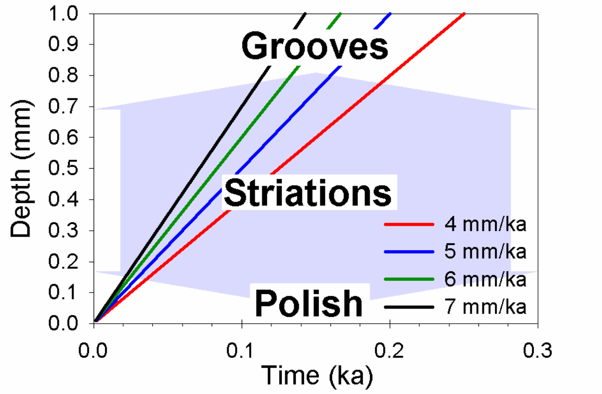

Fig. 1. Surficial carbonates erosion rates. Lines in colour represent different rates of erosion (typical values measured in Croatia). The depth of glacial polish, striations and grooves are represented (note grey arrows as rough boundaries). Subsurface erosion rate is expected to be higher, limiting the potential preservation unless a specific context is given (see text).

We have studied glacial sediments from Paklenica National Park, in the Malo Rujno moraines. Although microscale glacial erosion features were not expected, one section provided gravels with striations. The gravels are pebbles in size and show striations <1 cm in length (normally some millimetres) with different orientations, typical for gravels rotating during glacial transport (Benn & Evans, 2007). The depth of the striations reaches several hundreds of micrometres, showing a good preservation. They were found in loose sediments with almost no carbonate cements. However, the cohesion of the deposit is high due to the presence of micrite (silt/clay size) in the matrix that minimizes porosity. The clast supported sediment has massive structure and shows occasional orientation of elongated pebbles, suggesting some deformation of the sediment by the glacier push within or shortly after sedimentation.

This study demonstrates that the preservation of delicate erosion morphologic elements after deglaciation in Croatia is possible. However, this requires a burial history of the rocks (or clasts) under very specific conditions where dissolution would be prevented.

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The History of study of Dinaric glaciation

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Gjuro Pilar, professor of geology at the University of Zagreb, wrote first account on glaciation of Dinaric mountains ever in 1877, 37 years after Agassiz' Neuchatel lecture. However, the idea of glaciated Dinaric mountains was not readily accepted, but was strongly criticized by Dragutin Gorjanović (1902, 1907) who wrote that he wanted "t*o settle the debate once and for all.*" Gjuro Pilar died in 1893, and did not witness fierce battle between Gorjanović and Hinko Hranilović over the evidence of glaciation of the Dinaric mountains, Velebit and Medvednica in particular in the year of 1906. Not only Gorjanović opposed any idea of Dinaric glaciation, but also his successor Josip Poljak (1947) who made strong effort to silence all proponents of the glaciation in these regions. So, it was not before 1973, when Nikler wrote his paper on a moraine ridge Rujanska kosa on the southern Velebit Mt., and thereafter the Dinaric glaciation became accepted at least locally, but nearly 100 years after Pilar's paper. Although it may seem that after this discovery, the study of glacial traces in Dinarides would be accelerated, it actually did not imply significant progress until 1980-es and 1990-es, at least in respect to the number of published papers. Indeed, a lot of field research was performed, and the first Master's Thesis on glacial history of the Velebit Mt. was defended at the University of Beograd by Srđan Belij in 1984. The progress in research was nevertheless very slow, partly because the lack of specific knowledge and experience in paleoglaciological study, partly because of general scepticism about glaciation in central Europe, so the next defended Doctoral Thesis was by Ljerka Marjanac in 2012, almost 30 years later. Herein we present a historical overview of all published papers, thesis, abstracts and field guides related to glaciation of the Croatian Dinarides. The list is not fully completed, because some old publications are hard to obtain, but it provides a source of information on the available publications.

Chronological list of publications related to research and debate on glaciation of the Dinarides
(publication main topics: GEO = geology, GM = geomorphology)

YEAR	REFERENCE	GEO	GM
1877.	Pilar Gj. (1877): Tragovi oledbe na podnožju zagrebačke gore. Rad Jugosl. Akad. Znan. Umj. 39, 142-150.	✔	
1900.	Penck, A. (1900): Die Eiszeit auf der Balkanhalbinsel. Globus 78, 133-178.		✔
1901.	Hranilović H. (1901): Geomorfološki problemi iz Hrvatskog Krasa. Glasnik Hrv. Naravosl. društva 13/1-3, 93-133.		✔
1902.	Gorjanović D. (1902): Geomorfološki problemi iz hrvatskog krasa. Glasnik Hrv. naravosl. društva 13/4-6, 193-196.		✔
1902.	Hranilović H. (1902): Odgovor g. prof. dr. D. Gorjanoviću na kritiku "Geomorfološki problemi iz hrvatskog Krasa". Glasnik Hrv. naravosl. društva 13/4-6, 196-203.		✔
1902.	Gorjanović D. (1902): Odgovor Hraniloviću. Glasnik Hrv. naravosl. društva 13/4-6, 203-205.		
1903.	Gavazzi A. (1903): Tragovi oledbe u našem kršu. Glasnik Hrv. naravoslovnog društva 14, 174-175.		✔
1903.	Gavazzi A. (1903): Trag oledbe na Velebitu? Glasnik Hrv. naravoslovnog društva 14., 459.		✔
1904.	Hranilović H. (1904): Topusko (crtice iz poluzaboravljenog kraja). Hrvatski planinar 7-8, 49-57.		✔

1906.	Gorjanović, D. (1906): Da li je bila gora zagrebačka oleđena i kako je postala zagrebačka terasa? Narodne novine 72/121, 3-4.	✔	
1906.	Gorjanović, D. (1906): Da li je bila gora zagrebačka oleđena i kako je postala zagrebačka terasa? Narodne novine 72/122, 3-4.	✔	
1906.	Hranilović H. (1906): Odgovor g. prof. Gorjanović-Krambergeru na njegovo predavanje: Da li je bila zagrebačka gora oledjena i kako je postala zagrebačka terasa? Narodne novine 72/147, 3-4.	✔	
1906.	Gorjanović, D. (1906): Protuodgovor g. prof. Hraniloviću na njegove primjedbe o mom predavanju o tobožnjoj oledbi Zagrebačke gore. Narodne novine 72/148, 3.	✔	
1906.	Hranilović H. (1906): Gosp. prof. Gorjanoviću na njegov "Protuodgovor". Narodne novine 72/152, 4-5.	✔	
1907.	Gorjanović, D. (1907): Da li je bila gora Zagrebačka oleđena i kako je postala zagrebačka terasa. Glasnik Hrv. Naravoslovnog društva 19, 37-43.		✔
1908.	Gorjanović, D. (1908): War das Zagraber Gebirge vergletschert und wie ist die Zagraber Terasse entstanden? Bull. Soc. hongroise geogr., 36/3, Budapest, 33-46.	✔	
1909.	Schubert R. (1909): Geologija Dalmacije. Matica Dalmatinska, Zadar, 3-183.	✔	
1915.	Gregory J.W. (1915): Pseudo-Glacial Features in Dalmatia. The Geographical Journal 46/2, 105-117.		✔
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Sedimentological evidence of extensive Dinaric glaciation

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Sedimentological study was conducted for more than 20 years in the area of coastal Dinarides. The main goal was to find evidence of a hypothesized extensive glaciation of the Adriatic and the Dinarides. This paper gives a summary of the doctoral thesis (Marjanac 2012) and some new data as part of this ongoing research. Finding true evidence of Dinaric glaciation was crucial to support all pioneer advocates of glaciated Dinarides. For convenience of better understanding the research history is reviewed by Marjanac & Marjanac (this publication).

The sedimentological research concentrated on field study of the Quaternary sediments in the regions of Kvarner (the Krk, Rab and Pag Islands, Senjska Draga and Jablanac), South Velebit (Rujno and Velika Paklenica, Kusača, Seline and the coast of Velebit Channel), and in Northern Dalmatia (south coast of the Velebit Channel, Novigrad Sea, Karin Sea, Obrovac, Paljuv and Smilčić), by methods of detailed logging and outcrop mapping.

The research provided data for glacigenic interpretation of studied sediments, and the following ones were determined:

Glacial sediments are diamicts determined as tills or tillites and interpreted in terms of ground, medial or lateral moraines. The main characteristics of glacial origin are clasts with glacial striae, ice-shaped (faceted, bullet-shape and conical) and ice-shattered clasts.

Glacifluvial sediments comprise both glacial outwash deposits of braided streams and flood plains, and fluvial deposits of meandering rivers, represented with sand and gravel deposits. Their glacigenic origin is based on facies association, meaning that they occur with tills or tillites, and contain glacially-derived boulders and blocks, sometimes also lithologically exotic debris.

Glacilacustrine sediments comprise two types, clay-silt sediments with classic varves, and varve-like calcisiltites, both with drop-stones, which is the main diagnostic criterion for their proglacial character.

Glacideltaic sediments are represented by conglomerate, calcarenite and calcisiltite lithofacies in alternation. Significant characteristics for glacial attribution are ice-striated clasts which were found in conglomerates, and their association with glacilacustrine sediments.

The following depositional palaeoenvironments were reconstructed:

Glacial environment where deposition occurs in contact with ice, regarding terminoglacial environment and ice-contact zones between the ice-margin and valley slopes. Glacial palaeoenvironment is documented by determined ground and lateral moraines. The ground moraines are indentified as Rujno, Paklenica and Novigrad members in terms of lito-, allo- and morphostratigraphy, and two tentative members Sklopine and Raduč. The Paklenica member, found also on Krk and Rab Islands, documents the furthest extent of glaciation. Another characteristic landform of ice-contact zone are kame terraces well preserved on the Krk and Pag islands.

Proglacial environment which is influenced by melting ice and glacial outwash processes is evidenced by glacifluvial sediments widespread in Northern Dalmatia, and proglacial lacustrine sediments of Ždrilo, Seline and Novigrad.

Periglacial palaeoenvironment, less influenced by ice, but dominantly by permafrost, was recognized in sediments of Novigrad section, were many sediment wedges interpreted as ice-wedge casts and kettle-forms occur, which indicate freezing and thawing effects on sediment due to grounded and buried ice-blocks.

The sedimentological research showed that glacigenic sediments are widespread in this north Adriatic region and in Northern Dalmatia, which proves the far seawards extent of the Dinaric glaciation. At the most advanced phase of glaciation the ice covered islands of Krk, Rab and Pag, a large part of Northern Dalmatia, and the whole Velebit Channel as evidenced by distribution of moraines. When the ice retreated, proglacial lakes were formed as evidenced by glaciolacustrine sediments at Ždrilo, Seline and Novigrad. The palaeoenvironment sequences also indicate on ice fluctuation and its at least three advances and retreats.

Tentative chronostratigraphic correlation of sediments was established by combining the litho-, morpho- and allostratigraphy, and the provided ^{14}C and U-series ages of sediments, which allowed attribution of the Middle Pleistocene age to most of the studied sediments. The Paklenica Member, as the most significant, regionally correlates with Ninkovići Member in Montenegro found at altitude of 500 and 800 m, which are attributed to Skamnelian stage MIS 12 (Hughes, 2011). Together with evidence of low-altitude moraines in Boka Kotorska (Stepišnik & Žebre, 2010), the Paklenica Member represents the most westwards or north-westwards reaches of the proposed Dinaric ice-cap (Fig. 1).

The chronostratigraphic interpretation of glacigenic sediments (Marjanac 2012), especially those on Veliko and Malo Rujno, contradicts all previous researchers who attributed glacigenic sediments and geomorphological features of the Velebit Mountain to the Late Pleistocene or LGM. Accordingly, the age of glacigenic sediments in other parts of the NW Dinarides (Risnjak Mt., Northern Velebit Mt., Middle Velebit Mt.) should be revised.

Thereafter, the extensive Dinaric glaciation is apparent, thus new avenues of research are open, regarding its total extent, both inland and seaward, precise timing, and associated glaciotectonic deformations.

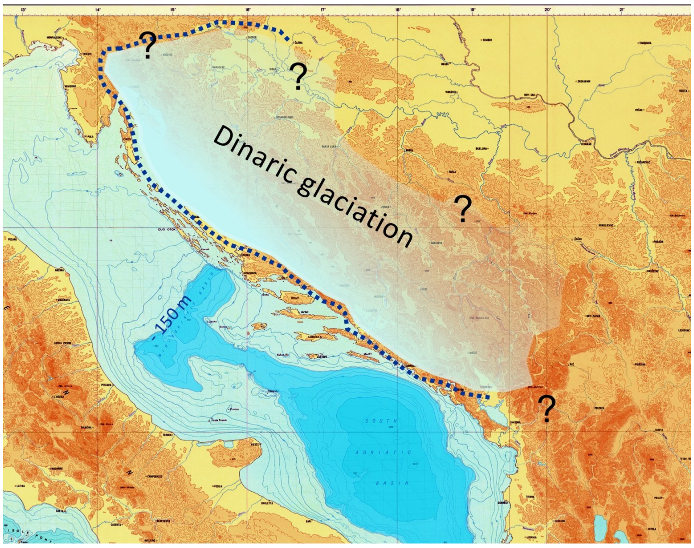

Figure 1. Probable range of Dinaric glaciation. Question-marks indicate unknown relation to Alpine glaciation, NE and SE extent. This proposed Dinaric ice-cap will be hopefully documented by further research.

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First record of lemmings (genus *Dicrostonyx* GLOGER, 1841) in Croatia

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Among small mammal selected skeletal remains from the Romualdo (Romualdova pećina) or Lomardo Cave in western Istria the teeth of lemmings (genus *Dicrostonyx* GLOGER, 1841) have been determined for the first time from the Late Pleistocene/Holocene? sediments in Croatia. The modern areal of this genus is Russia and Canada, and it has circumpolar distribution. During the Late Pleistocene, geographical distribution of these animals, which some authors (e.g. Prost et al., 2010) call „a key species of the arctic community“, was more southern, what is documented by the findings from some European countries such as: England, France, Czech Republik, Hungary, Ukraine etc. (Nadachowski, 1982; Jánossy, 1986; etc.). These new specimens from Croatia push this border even more to the south. As the typical „ice-age element“ in the fauna of middle and southern European localities, *Dicrostonyx* is good indicator of cold and dry climate. Today these animals live in tundra and northern parts of forest-tundra areas, thus it can be concluded that similar habitats they used also in the past.

The small sample of 11 teeth (first, second and third lower /$M_{1\text{-}3}$/ and first upper /M^1/ molars) originate from the sediments of the Romualdo Cave in western Istria. The findings were found in the selected small mammal collection of the Institute for Quaternary paleontology and geology of the Croatian Academy of Sciences and Arts, which is part of the faunal remains discovered by M. Malez and his team during the excavation seasons in 1960 and 1962 (Malez, 1962). The stratigraphic proveniance of the sample is not sure, but it is most probable that it originates from the layer B of the Holocene age (after Malez's original signatures, because they were mixed with other findings from the same sample).The *Dicrostonyx* molars have been morphometrically analysed, and the resemblance has been observed in morphology, while some metric parameters differ slightly in comparison to the findings from some other European localities (e.g. Poland and Austria). The lenght of M_1s for Croatian sample is bigger than for Austrian ones (Nixloch and Merkenstein Caves; Nagel, 1992, 1997), while is smaller than for the Polish findings (Nadachowski, 1982). The differences in A/L and C/W1 indices have also been observed between samples from the Romualdo Cave and Polish sample of the Holocene age, in the way that Croatian teeth show higher values of A/L index, while C/W1 index is lower, respectively. Such small sample could not provide enough informations for more precise specific determinations. As good indicator of cold and dry climate, the lemmings from the Romualdo Cave give support to the conclusion that this part of Europe was refugial region for this and some other small mammal species during the expansions of the ice cover, and reflect Quaternary environmental fluctuations, which were frequent and pronounced at the end of this period.

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Paleoklimatske arhive dubokih jama Velebita

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Proučavanja špiljskih sedimenata kao paleoklimatskih arhiva teme su niza aktualnih studija u svijetu. Duboke jame Velebita (Paar i dr., 2008; Paar i dr., 2013) su kompleksni sustavi u kojima su zabilježene i sačuvane informacije o geološkim, geomorfološkim, hidrološkim i ekološkim uvjetima i procesima zbog čega predstavljaju odličnu sredinu za proučavanje i paleo- i recentnih klimatskih promjena Današnja prisutnost višegodišnjeg leda u jamama koje se nalaze ispod snježne granice potiče na razmišljanja o kontinuitetu i zadržavanju leda u prošlosti, općim klimatskim i mikroklimatskim uvjetima njegove geneze i akumulacije, te o utjecaju glacijalnih i periglacijalnih procesa na speleogenezu (Buzjak i dr., 2009; Buzjak i Paar 2011; Bočić i dr., 2012; Kern i dr., 2011). Led u jamama je kompleksna pojava jer ledeni blokovi nisu stabilni u obliku i volumenu i kontinuirano se mijenjaju nizom procesa, od višegodišnje akumulacije snijega i nastanka firna, sezonskog topljenja i smrzavanja, prodora i smrzavanja cijedne vode, do topljenja samih ledenih blokova. O porijeklu i mijenama leda pod utjecajem vanjskih i unutarnjih čimbenika ovisi njegov sastav i mikrostruktura te izotopni sastav što otežava interpretaciju paleoklimatskih uvjeta tijekom njegovog nastanka. Jedna od metoda kojom je moguće procijeniti starost i uvjete postanka leda je analiza u ledu konzerviranih organskih ostataka koji su na taj način sačuvani od prirodnog propadanja.

U 1421 m dubokom Jamskom sustavu Lukina jama-Trojama (ulaz na 1475 m n. v.) ustanovljena je prisutnost leda do dubine od 560 m ispod razine današnjih ulaza, što je trenutno lokacija s najdublje zabilježenim ledom u speleološkim objektima na Svijetu. U okviru ovog istraživanja izvedeno je datiranje ostataka drveta pronađenih u ledu 2011. godine na 120 m i 160 m dubine sa ciljem utvrđivanja gornje starosti leda. Analize uzoraka su pokazale LSC ^{14}C datiranjem gornju starost 410 ± 75 godina.

Uzorci drveta iz 536 m duboke Ledene jame u Lomskoj dulibi (ulaz na 1235 m n. v.) uzeti 2012. godine s lokacije na 50 m dubine koja je bila pod debelim slojem leda imaju starost 525 ± 40 godina što je u popriličnoj korelaciji s rezultatom iz Lukine jame i ukazuje na povezanost paleoklimatskih uvjeta na Velebitu i u tim jamama. Ti rezultati su u suglasnosti s prethodnim istraživanjima uzoraka iz Ledene jame izvedenim tijekom 1994. i 1995. godine kada je u jami istraživana velika ledena naslaga, debljine 40 m i promjera 15 m (Horvatinčić i Božić, 2001). Na bazi izotopnih analiza uzoraka leda (analiza tricija ^{3}H) te uzoraka drveta nađenog u ledu (datiranje metodom ^{14}C) tada je procijenjena starost ledene naslage od približno 500 godina. S obzirom da su komadi drveta uzorkovani 2011. i 2012. prikupljeni s dobro očuvanih ostataka debla te da se njihova starost poklapa s Malim ledenim dobom (1500-1600. g.) daljnje analize dati će interesantne podatke o ekološkim uvjetima na Velebitu toga doba.

Radi se o značajnoj starosti s obzirom da su najveće procijenjene starosti leda u svijetu oko 1000 godina i to u alpskim špiljama sa znatno većim količinama leda.

Odgovor na to pitanje o paleoklimatskim uvjetima prije holocena mogu dati stabilniji i stariji sedimenti, posebice sige ako su taložene u odgovarajućim uvjetima izotopne ravnoteže. U dubokim jamama sige nisu česti sedimenti, pa je važno njihovo otkriće na većim dubinama u Lukinoj jami. Preliminarno AMS ^{14}C datiranje siga uzorkovanih na 945 m dubine dalo je starost do 50300 ± 1100 godina što je na granici ^{14}C metode dartiranja pa bi uzorak sige trebalo datirati i U-Th metodom. Sige su značajan materijal za daljnja istraživanja što može dati informacije o paleoklimatskim, geomorfološkim i hidrogeološkim uvjetima tijekom glacijala. Jednogodišnja istraživanja mikroklimatskih uvjeta koja su obavljena u Lukinoj jami pokazala su izuzetnu stabilnost mikroklimatskih uvjeta na većim dubinama, dok su na manjim dubinama u zadnjih 20 godina u Lukinoj jami i Ledenoj jami zabilježene značajne promjene u količinama ledenih naslaga što je još jedna potvrda recentnih klimatskih promjena.

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Morphometric and taphonomic analysis of the Upper Pleistocene faunal assemblage from Hijenska pećina

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We present taxonomic, metric and taphonomic analysis of the Upper Pleistocene faunal assemblage found in Hijenska pećina („Hyena cave“), a fossil cave discovered through quarrying activities in 1972, that was excavated and briefly published by Mirko Malez (1973; 1975; 1986; Malez et al., 1974). The fossil material from Hijenska pećina consists of 453 bones, bone fragments and teeth plus eight hyena coprolites.

There are 20 different taxa present in the assemblage, including large and small mammals and one reptile. Total number of identified specimens NISP is 278 which is 61,4% of the whole assemblage. The remaining 175 specimens are unidentifiable. Taxonomic analysis of the faunal assemblage has confirmed the presence of some of the taxa determined by Malez (1986), but also it has added some new taxa and taken away some others (Table 1.). Bones and teeth belonging to *Crocuta crocuta spelaea* are the most abundant with 41% of the total NISP. The assemblage consists of mostly adult individuals, several infants and a few subadults and old individuals.

Taphonomical analysis has shown that most of the bones, due to the microenvironmental coditions inside the cave, show some degree of weathering and 42,1% of the bones are covered with calcium carbonate. Traces of gnawing, mostly rodent gnawing, are present on 59 bones. The *Bos primigenius* tibia, displays interesting marks on one side of the diaphysis, which could be either cut marks, trampling marks or incisor marks produced by very young hyenas. Two main possible factors responsible for the accumulation were identified: hyenas as bone accummulators and/or the cave having a vertical opening and acting as a natural trap. However, we do not exclude the possibility of other factors contributing to the accumulation.

Taxon	Malez (1986)	Pičuljan (2012)
Erinaceus sp.	-	+
Chiroptera indet.	-	+
Rodentia indet.	-	+
*Chionomys nivalis**	-	+
Lepus sp.	-	+
Crocuta crocuta spelaea	+	+
Lynx lynx	-	+
Panthera leo spelea	+	+
Canis lupus	+	+
Vulpes/Alopex	-	+
Meles meles	+	+
Ursus spelaeus	+	+
Stephanorhinus cf. *hemitoechus*	-	+
Equus caballus fossilis (*Equus ferus*)	+	+
Asinus cf. *hydruntinus* (*Equus hydruntinus*)	+	-
Sus scrofa	+	+
Megaloceros giganteus	-	+
Cervus elaphus	+	+
Alces alces	+	-
Capreolus capreolus	+	+
Bos primigenius	+	+
Bison cf. *priscus*	+	-
Bos/Bison	-	+

Table 1. The Pleistocene mammal assemblage from Hijenska pećina determined by Malez (1986) and by Pičuljan (2012). *- Determined by Mauch Lenardić (unpublished data). Taxa that is present is indicated with "+" while taxa that is not present is indicated with"-".

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Mehanizmi i dinamika nastanka mulja u sedimentu kanala istočnog Jadrana

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Muljevi u morskim okolišima mogu biti različitog porijekla. Mjesta njihovog taloženja najčešće su okoliši vrlo niske energije okoliša, ispod valne baze ili na mjestima izrazito snažnog donosa muljevitog sedimentnog materijala (pr. ušća rijeka). U skladu s tim, mulj je u sedimentu na području istočne strane Jadranskog mora značajnije zastupljen na dubljim dijelovima međuotočnog područja (dijelovi Kvarnera, Srednjeg kanala, Korčulanskog kanala) te u prostorima značajnijeg donosa s kopna (prodeltno područje rijeke Po, Neretvanski kanal). Površinski sediment istočne strane Jadrana je pretežito biogenog porijekla i karbonatnog sastava s relativno malim udjelom siliciklastične komponente za koju je pretpostavljeno da se nalazi uglavnom u muljevitoj frakciji (Pikelj, 2010; Pikelj i Juračić, 2012). Kako bi se detaljnije okarakterizirao mulj u površinskom sedimentu, analizirano je deset uzoraka muljevite frakcije (<63 µm) iz sedimenta s područja od Kvarnerića do Elafitskih otoka, različitog s obzirom na tip sedimenta i udio karbonatne frakcije. Na muljevitoj frakciji provedeno je određivanje udjela karbonata i mineralnog sastava kako bi se utvrdile razlike u odnosu na cjelokupni sediment. Mikroskopska analiza vapnenačkog nanoplanktona i mikroplanktona je provedena kako bi se odredilo porijeklo i starost čestica u sedimentu, te sastav biogene frakcije (prema Perch-Nielsen, 1985).

Udio karbonatne komponente u muljevitoj frakciji je u devet od deset uzoraka manji u odnosu na cjelokupni uzorak. Dobivene razlike nisu velike, što znači da se u muljevitoj frakciji osim pretpostavljene siliciklastične nalazi i značajan udio karbonatne komponente. Dio karbonatne komponente je biogenog porijekla, na što ukazuje prisutnost aragonita i magnezijskog kalcita. Za siliciklastičnu komponentu se pretpostavljalo da ima izvor u flišu koji izdanjuje na otocima i obali što je potvrđeno prisutnošću kvarca, klorita, albita, rutila i muskovita, tipičnih u mineralnom sastavu fliša. Kako je taloženje materijala rijekama koje dreniraju fliš ograničeno na ušća (Juračić i dr., 1994; Janković i dr., 1995; Sondi i dr., 2008), alternativni mehanizam kojim flški materijal dolazi u more može biti denudacija i obalni procesi. Prisutnost dolomita u muljevitoj frakciji također ukazuje na donos terigenog porijekla.

U biogenoj frakciji mulja pronađen je vapnenački nanoplankton, foraminifere, karbonatno skeletno kršje, te dijatomeje, spikule, radiolarije i silikoflagelati, što ukazuje na karbonatni i nekarbonatni (opalni) udio u biogenoj komponente. Na temelju determiniranih vrsta vapnenačkog nanoplanktona dobiveni su različiti stratigrafski rasponi. Za vapnenački nanoplankton čiji se stratigrafski raspon proteže kroz eocen (pr. *Chiasmolithus grandis* (Bramlette i Riedel, 1954) Radomski, 1968) pretpostavlja se da je pretaložen iz naslaga fliša. Samo jedna vrsta vapnenačkog nanoplanktona kredne starosti (*Watznaueria barnesiae* (Black u Black i Barnes, 1959) Perch-Nielsen, 1968) određena je u jednom uzorku. Može se pretpostaviti da je pretaložena prvo iz krednih naslaga u eocenski fliš, pa zatim trošenjem eocenskog fliša u površinski sediment Jadrana. Za vapnenački nanoplankton čiji se raspon proteže kroz paleocen, eocen i/ili oligocen (pr. *Coccolithus formosus* (Kamptner, 1963) Wise, 1973; *Dictyococcites bisectus* (Hay, Mohler i Wade, 1966) Bukry i Percival, 1971) se pretpostavlja da je također pretaložen iz fliša, jer paleocenske i oligocenske stijene nisu karakteristične za obalu i otoke. Vapnenački nanoplankton čiji se stratigrafski raspon proteže od početka neogena do danas vjerojatno je pleistocenske starosti ili je recentan, s obzirom na malu rasprostranjenost miocenskih i pliocenskih naslaga u obalnom području. Vapnenački nanoplankton pleistocenskog i holocenskog stratigrafskog raspona (pr. *Emiliana huxleyi* (Lohmann, 1902) Hay i Mohler u Hay i dr., 1967) potvrđuje zaključke ranijih istraživanja da se na dnu istočne strane Jadrana nalazi mješavina recentnog i subrecentnog sedimenta (Pikelj i dr., 2009; Pikelj i Juračić, 2012). Od ostalih čestica biogenog porijekla u analiziranom mulju je vrlo zastupljeno karbonatno kršje koje u karbonatnom sedimentu umjerenih i visokih širina nastaje fizičkim i kemijskim razaranjem većih skeleta (Farrow i Fyfe, 1988).

S obzirom na mineralni i fosilni sastav, muljevita frakcija analiziranog sedimenta očito sadrži značajnu količinu biogenog i terigenog materijala porijeklom iz fliša. Naslage fliša danas nisu značajno rasprostranjene na otocima i u obalnom prostoru istočnog Jadrana (6% ukupne duljine istočno-jadranske obale; Pikelj i dr., 2013). Kako su kanali potopljene sinklinale s dnom građenim od fliških stijena, velika je mogućnost da je dio površinskog sedimenta porijeklom iz flišnih naslaga danas prekrivenih morem (Pikelj i dr., 2009). Pretpostavlja se da je značajniji dio tog fliša trošen u vrijeme niže razine mora, kad je bio izložen atmosferskim utjecajima.

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Sedimentological characteristics of Quarternary deposits of the Rebrnice slope area (SW Slovenia)

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Rebrnice are a SW facing slope that borders the Vipava Valley with the NE-lying Nanos Plateau. The slope instabilities encountered during recent motorway construction works on Rebrnice posed a considerable geotechnical challenge. Extensive excavations also enabled insight into the structure of slope sediments. The area is a part of a fold and thrust structure of External Dinarides and is defined by a thrust front of Mesozoic carbonates of the Hrušica Nappe, thrust on Tertiary flysch of the Snežnik Nappe. The upper part of the slope is marked by steep carbonate cliffs, while middle and lower parts of slope are more gently sloping and are composed of mudstone and sandstone bedrock, covered by an apron of coarse-grained Quaternary deposits. The carbonate cliffs represent the main source of the material for these deposits which have been mostly described as scree. Our geological mapping and sedimentological investigation during the construction of the Razdrto-Vipava motorway revealed that they represent an array of composite fan-shaped sedimentary bodies with diverse composition, internal structures and textures, indicating complex depositional history and polyphase genesis.

The complexity of the Rebrnice slope deposits is presented here on the basis of sedimentary facies and stratigraphy of a single, well-defined sedimentary body named the Šumljak fan. The Šumljak fan covers an area of more than 700.000 m^2 and reaches 19 m in thickness. The fan is composed of three lithostratigraphic units. The lower part is composed of laterally discontinouous layers (lense-shaped in cross sections) of matrix- to clast-supported gravel of carbonate and/or sandstone clasts. The middle part of the fan is represented by a thin paleosol horizon overlain by several dm to more than 1 m thick bed of detrital calcareous tufa. The tufa is composed of coated grains, 1-5 cm in diameter, mud- to sand-grade calcareus sediment, cm-size dendritic phytoherms and decimetric crusts. The upper unit of the Šumljak fan is is composed of several beds of matrix-supported gravel and pure, open framework carbonate gravel.

Previous studies have generally regarded the slope sediments of Rebrnice as a talus of carbonate gravel accumulating at the toe of the carbonate cliff and gradually moving over weathered flysch rocks in the lower part of the slope by creep and occasional slides. However, the sedimentary texture, structure and architecture of the Šumljak fan clearly indicate multiple depositional events and various gravity mass-movement processes ranging from slides to flows. The paleosol horizon and tufa deposits provide particularly firm evidence of episodic deposition of the slope deposits. Furthermore, AMS radiocarbon dating of charred wood extracted from the tufa oncoids (45�1 ka) shows considerable time-span of slope sediments, reaching at least to the last glacial cycle (MIS 3). Present-day climate and geomorphic processes thus do not provide a reliable framework for the understanding of the Rebrnice slope sediments.

Pleistocene Environments and Palaeolithic Occupations at Šandalja Cave (Istria, Croatia): Results from New AMS ^{14}C Dates.

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In this paper we present the first results of a recent project to radiometrically date the animal remains from the fossil cave of Šandalja II (Istria, Croatia). Šandalja is an extremely important Palaeolithic site in southern Europe because of a 15-m depth of stratified deposits (Malez 1964, 1990; Miracle 1995, 1996, 2007), rich Upper Palaeolithic artifact assemblages (Janković et al. 2012, Karavanić 2003; Malez 1987; Montet-White and Kozlowski 1983), a diversity of ice-age mammals (Brajković 2000; Miracle 1995, 1996, 2007), and associations with human fossils (Janković et al. 2012; Malez 1972). Adequate and reliable dating of its sequence is crucial for our understanding of the timing and pacing of the appearance of the Upper Palaeolithic, use of the region as a "refugium" by Upper Palaeolithic populations during the Last Glacial Maximum, and the timing and rate of demographic expansion at the end of the last ice age. Here we report on the results of over 20 new AMS ^{14}C samples on animal bones made using the "ultra-filtration" technique at the Oxford Radiocarbon Accelerator Unit. We discuss the implications of these new dates for reconstructions of Pleistocene environments and associated human occupations at the site.

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Preliminary analysis of the Mesolithic human juvenile skeletons from Vela Spila, Korčula

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Within the Mesolithic layers of Vela Spila cave on the island of Korčula, Eastern Adriatic, the remains of four human juvenile skeletons have been recovered during the excavations in the late 1980s (Čečuk and Radić, 2001, 2005). One of the juvenile skeletons has been directly carbon dated to c. 9000 B.P. (Miracle pers. comm. from Wallduck, 2009). Four juvenile skeletons are all of different ages, all 6 to 12 months apart, starting with the fetus that is estimated to be 7 to 9 months *in utero* at the time of death (Šlaus, 2004). Considering their exceptional preservation and the nature of the sample containing children remains at different ontogenetic stage, the Vela Spila juveniles can thus provide invaluable insight into the developmental changes and the biology of the population living during the transition from hunter-gatherer to sedentary lifestyle. This paper's goal is to: 1) present a preliminary analysis of the juvenile remains from Vela Spila, and 2) compare the Vela Spila specimens to the juvenile remains of Upper Paleolithic, Mesolithic and more recent juvenile remains from the Eastern Mediterranean region and Central Europe.

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Vertebrate Remains from the Pleistocene-Holocene transition to the Bronze Age at Vela Cave, Preliminary Results

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Vela Spila is a cave on the western end of Korčula island, Croatia. The first archaeological excavations date back to mid-20th century, and since the 1970s systematic research has been carried out. The zooarchaeological analysis of larger mammal remains shows interesting shifts in taxonomic representation. There are interpreted in terms of the nature and intensity of human occupations, changes in past human diet, ecological changes (climate and sea level rise), and demographic/cultural changes caused by the spread of farming in the Eastern Adriatic region. This paper presents an analysis of animal remains from Trench 2 (NISP = 1784) excavated in 2010 and 2011 (Fig. 1).

During the final stages of the Late Pleistocene and transition to the Early Holocene a significant increase in leporid remains can be seen, while big game (e.g. red deer) is decreasing and in some layers is almost completely missing. This could indicate a somewhat different pattern of a use of the cave by people during that period, in which other animals used it more often. Later in the early Holocene and on into the Mesolithic one finds a very different assemblage composed of small to medium-sized carnivores (mostly red fox), roe deer, marine mammals (dolphins), and a small number of other small animals (e.g. hedgehog) of which some remains have clear cut marks indicating human agency. Significantly, hare is absent from this assemblage. These data suggest a very specialized diet focused mostly on foxes and roe deer. Although relatively common, none of the dolphin remains have evidence of human activity, so the significance of their presence in the assemblage has yet to be determined.

The Early Neolithic is characterized by the appearance of domestic taxa (mainly sheep and/or goat with occasional pig remains), indicating a dramatic shift in human diet. During the initial stages of the Early Neolithic remains of small to medium-sized carnivores (red fox in particular) can still be traced in the assemblage suggesting that certain elements of the Mesolithic tradition continue during the first Neolithic occupations at the cave. There is little evidence of the hunting of larger game (e.g. roe and red deer). These layers also revealed a few dog remains. In overlying Neolithic layers (Early, Middle, and Late Neolithic) the fauna is composed almost exclusively of sheep and/or goat remains. At the end of Neolithic and continuing into the Copper and Bronze Ages, other domestic taxa (pig and especially cattle) become more common.

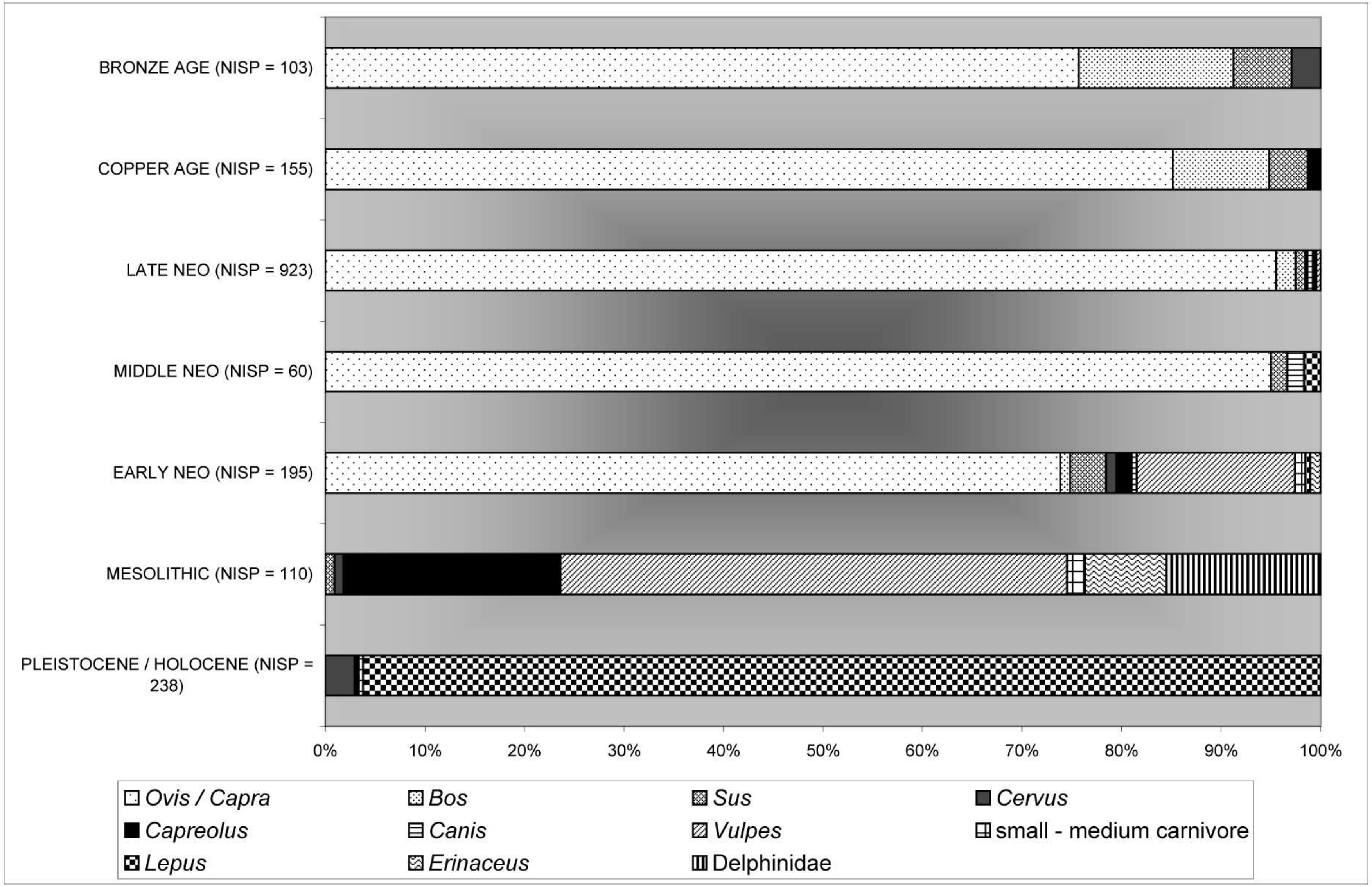

Fig. 1 – Vela spila. Relative frequency of the main larger mammals through all horizons in Trench 2 (excavated 2010-11).

Primjene ^{14}C AMS metode datiranja geoloških uzoraka

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U Laboratoriju za mjerenje niskih radioaktivnosti na Institutu „Ruđer Bošković“, uz radiometrijsku metodu određivanja ^{14}C tekućinskim scintilacijskim brojačem (LSC), od 2007. se primjenjuje tehnika akceleratorske masene spektrometrije (AMS). U Laboratoriju je razvijena metoda za kemijsku pripremu uzorka u obliku grafita, a ^{14}C u grafitnim metama se mjeri na akceleratoru u Scottish University Environmental Research Center (SUERC) u Glasgowu (Krajcar Bronić et al. 2010; Sironić et al. 2013). Prednost AMS metode u odnosu na LSC je znatno manja količina uzorka potrebnog za ^{14}C analizu. Za AMS metodu, treba oko 1000 puta manja količina uzorka (10-100 mg drva, 40 mg karbonata, 500-1000 mg kosti/zuba). Mogućnosti ^{14}C analiza se znatno proširuju upotrebom AMS metode u arheologiji, paleontologiji, geologiji, paleoklimatologiji i ekologiji. Tako se na pr. u geologiji /paleoklimatologiji mogu precizno datirati slojevi siga, sedimenta (organskog i karbonatnog djela), koralja i školjaka, što omogućava znatno bolju rezoluciju u praćenju promjene ^{14}C.

U našem Laboratoriju je do sada ^{14}C AMS metoda datiranja primijenjena na više vrsta geoloških uzoraka. Analizirani su uzorci siga iz Lukine jame na Velebitu, algalnih trotoara sa otoka Visa, sa ciljem praćenja promjena razine Jadranskog mora (Faivre et al. 2013), školjaka (Vis, Brusnik), paleontološki uzorci životinjskih kostiju (Špilja u Zubu Buljme, Velebit, Špilja Vjeternica, Popovo polje, BiH (Miculinić 2012), Spila nad procjepom, Mljet) te organskog dijela jezerskih (Plitvička jezera (Sironić 2012)) i fluvijalnih sedimenata (Brest-Ljubljana). Također su analizirani suvremeni uzorci sedri, otopljenog ugljika u vodi te recentnog sedimenta iz krških jezera u svrhu otkrivanja principa interakcije biogenog, hidrološkog i geološkog aspekta u formiranja krša (Sironić 2012).

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Agents of accumulation of the Late Pleistocene bird remains in two caves in southern Istria (Šandalja II and Ljubićeva pećina)

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The fossil cave of Šandalja II and the cave Ljubićeva pećina are located in Cretaceous limestones 4 and 13 km, respectively, to the east and northeast of the city of Pula. Although these sites today are located within a few kilometres of the coast, during the late glacial period (MIS 2), due to global regression of the sea, the sites were situated on the northern edge of the Great Adriatic Plain and the coastline was many kilometres to the south.

Aim of this research was to examine, through detailed taxonomic and taphonomic analysis what were the main taphonomic agents of accumulation of birds remains, and do they change over time. A total of 1016 bird remains were identified (NISP - number of identified specimens). From the order Passeriformes, only the family Corvidae was analyzed; other remains were only recorded as Passeriformes (NISP = 538). A total of 478 complete and fragmented bird bones were anatomically, taxonomically and taphonomically analyzed. Rich assemblages of bird remains have been found in Šandalja II (older assemblage: layers Cs – B/C and younger assemblage: layers Bd – Bg) and Ljubićeva pećina (trench B, two assemblages: "older"/ca. 15-16 cal BP and "younger"/ca. 10-13 cal BP). Following orders are represented: Podicipediformes, Pelecaniformes, Ciconiiformes, Anseriformes, Falconiformes, Galliformes, Gruiformes, Charadriiformes, Columbiformes, Strigiformes and Passeriformes. The avifauna from these sites indicates the existence of the various habitats in southern Istria during the late glacial period: aquatic, open, forest steppe, rocky, forest and mixed. The bird bone surfaces are generally well preserved and bear evidence of cut marks, burning, and gnawing. There are some weathering features, including eroded surfaces, fine line fractures, and slight root etching. The frequency of bone surface modifications does not vary dramatically by site or over time, with the exception of the unusually high frequency of burning in the "older" assemblage at Ljubićeva pećina as well as absence of gnawing marks in both assemblages from the same site (Figure 1.). The different taphonomic agents accumulated bird remains. Birds such as rock dove, raven, yellow-billed chough, red-billed chough, kestrel and owls probably roosted or nested in the caves or crevices near the caves and might have died naturally there, although some of them were prey of human or animal predators. Other species do not use caves and probably were brought there by humans or animal predators. Small carnivore gnaw marks are found on bones of falcons, ducks, hazel grouse, black grouse, great bustard, small bustard, and yellow-billed chough at Šandalja II. The relative abundance of the remains of small passerines is probably related to the activities of birds of prey (owls and falcons) that fed on them and regurgitated pellets under their roost and nest sites. Cut marks and to a lesser extent burned bones are evidence that humans used the birds. Some birds probably were hunted for food (e.g. ducks, grouses, partridges and bustards) but others might have been used not only for food, but also for other, symbolic purposes. Humans were important agents of accumulation of bird bones at both sites, which was expected since both caves are important archaeological sites.

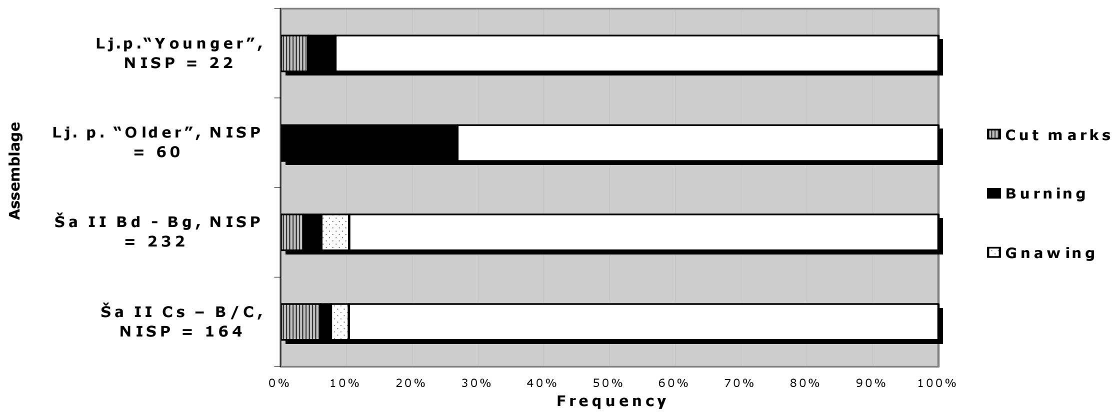

Figure 1. Relative frequency of bone surface modifications at Šandalja II and Ljubićeva pećina.

Reconstruction of Late Pleistocene glaciers on the Biokovo massif, Croatia

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The Biokovo massif is situated in the coastal part of the Dinaric Mountain range in Croatia. Around the highest section of the massif evidences of glacial erosion and accumulation were stated by Roglić (1931). Some authors also identified glaciogenic features on much lower altitudes (Telbisz, Dragušica, Nagy, 2009; Protrka et al., 2011).

Within research of the glaciation we reconstructed glaciers based on field morphographic and morphometric data, determined equilibrium line altitude (ELA) by applying accumulation-area ratio, median elevation of glaciers and area-weighted mean altitude methods and reinterpret previous findings about glaciation of Biokovo.

Detailed morphographic mapping was used to identify glacial features and related sediments. Evidences of glaciation were found in the highest part of Biokovo, near the peak Sveti Jure (1762 m). Northeast of the peak Sveti Jure there are two cirques with glacial pavements and roche moutonnées on their backwalls. Non-lithified glacial deposits cover most of the cirque floors and slopes below the cirques where they form a series of small moraine ridges. The lowest glacial deposits on Biokovo were found in the karst depression below the northern cirque at the elevation of 1240 metres. Hardly preserved patches of lithified glacial deposits were found scattered over much wider area of the Biokovo plateau.

According to lithification and preservation of glacial deposits we assume existence of at least two glacial periods in the area. Chronology and spatial distribution of glacial deposits on Biokovo were compared with deposits on other massifs along the Adriatic coast. Results from Orjen and some other mountain ranges in the central part of Montenegro (Hughes et al., 2010; Hughes et al., 2011) have shown that the most extensive glaciation occurred during the Middle Pleistocene (MIS 12 and MIS 6) while in the Late Pleistocene (MIS 5d-2) glaciation was limited to cirques and valleys. According to lithification of glaciogenic deposits lithified and well corroded deposits were hypothetically linked to the Middle Pleistocene glaciations while well preserved moraine ridges of non-lithified deposits are assumed to be of the Late Pleistocene glacial events. Moreover, lithified deposits extend over much wider area of the massif while non-lithified are limited only to smaller areas indicating larger extent of Middle Pleistocene glaciations.

Glacier topography and equilibrium line altitude were reconstructed only for the Late Pleistocene because well preserved glacial material belongs to that period of time. According to our research the Late Pleistocene glaciation in the Biokovo massif occupied two cirque glaciers with total area of about 0.8 km^2, which is largely consistent with research of Roglić (1931). The average equilibrium line altitude of the glaciers was calculated to 1515 metres, which is 55 metres below the value defined by Roglić (1931).

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Planirana istraživanja siga speleoloških objekata šireg zadarskog prostora (2012-2015)

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U razdoblju 2012.-2015. g. planira se provedba znanstvenog projekta *Rekonstrukcija regionalnih paleoklimatskih promjena – zapisi iz siga sjeverne Dalmacije* kojeg financijski podržava Sveučilište u Zadru.

Svrha je istraživanja rekonstruiranje promjena u okolišu u širem zadarskom području koje su se događale tijekom geološke prošlosti, a koje su ostale zapisane u sigama u vidu mineraloških i petrografskih promjena, te varijacija stabilnih izotopa i elemenata u tragovima. Područje istraživanja je transekt od Dugog otoka do vršne zone Velebita koji uključuje spilje Strašnu peć (Dugi otok, 70 m nv), Manitu peć (Paklenica, 570 m nv) te Špilju u Zubu Buljme (Južni Velebit, 1305 m nv). Podaci koji će se ovim projektom dobiti iz siga Manite peći bit će uspoređeni s rezultatima dobivenim iz već ranije detaljno istražene i analizirane Modrič spilje koja se nalazi na obali Velebitskog kanala (32 m nv). Konačna slika o paleoklimatskim i paleookolišnim uvjetima na transektu kroz prostor današnjih otoka, obale i priobalja bit će u budućnosti još upotpunjena detaljnim analizama siga i vode Strašne peći i Spilje u Zubu Buljme u kojima će se ovim projektom uspostaviti monitoring.

Odabrani će uzorci siga biti datirani metodom U/Th na MC-ICPMS. Petrografske analize bit će provedene kako bi se utvrdile mineraloške i teksturne značajke siga, od kojih su neke iznimno osjetljive na klimatske promjene (prvenstveno na količinu vode tj. oborina). Omjeri stabilnih izotopa ($^{18}O/^{16}O$ i $^{13}C/^{12}C$) bit će analizirani da bi se utvrdile njihove varijacije tijekom prošlosti. Naime, izotopi kisika u sigama reflektiraju izotopni sastav vode prokapnice u spiljama, kao i o temperaturi ovisnu izotopnu frakcionaciju koja se odvija pri taloženju kalcita iz vode.

Cilj ovog istraživanja je dobiti uvid u raspon i intenzitet klimatskih uvjeta koji su varirali tijekom prošlih tisućljeća, čime bi se dobio okvir za procjenu sličnih utjecaja budućih klimatskih promjena na ovom prostoru. Pretpostavka je da je u nižim područjima taloženje siga (pa i ostali procesi karstifikacije) bilo neprekinuto i tijekom najhladnijih razdoblja, no ipak s izraženim razlikama u količini vlage tijekom glacijala i interglacijala odnosnno stadijala i interstadijala. Nasuprot tome, više planinske zone, a posebno vršna zona, tijekom glacijala je vjerojatno bila pod ledenjacima koji su onemogućavali taloženje siga. Budući da je takva situacija prevladavala u ostatku Europe, odnosno sjevernije od područja Velebita, pokušat će se dokazati da se upravo duž današnje hrvatske obale prostirala granična zona između dva područja bitno različitih odgovora na globalne klimatske promjene. Pozornost će prvenstveno biti usmjerena na: (i) utvrđivanje mogućnosti da se taloženje siga odvijalo tijekom posljednjeg glacijalnog maksimuma (prije ~20 000 g) i tijekom mlađeg Dryasa (prije ~11 600 g), (ii) određivanje početka i intenziteta semi-aridnih uvjeta kojim je ovo područje bilo izloženo ranije ustanovljenim holocenskim sušnim epizodama u Sredozemlju (prije 4000 i 1200 godina).

Razumijevanje ovih ključnih epizoda pružit će puno bolji uvid u ranjivost i osjetljivost ovog prostora na buduće promjene temperature i oborinskog režima što bi u slučaju priobalnog dijela Hrvatske između ostalog, moglo imati bitan utjecaj na turizam, kao i na vodoopskrbu i poljoprivredu.

Monitoring i uzorkovanja za potrebe paleoklimatskih istraživanja u spiljama šireg zadarskog prostora – teorija i praksa

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U srpnju 2012. g. započela su istraživanja u okviru znanstvenog projekta *Rekonstrukcija regionalnih paleoklimatskih promjena – zapisi iz siga sjeverne Dalmacije* kojemu je cilj rekonstrukcija kvartarnih promjena u okolišu koje su zabilježene u sigama šireg zadarskog područja. Istraživanjem su obuhvaćeni speleološki objekti na potezu od Dugog otoka do vršne zone Velebita:spilja Strašna peć (Dugi otok, 70 m n. v.), spilja Manita peć (dolina V. Paklenice, NP Paklenica, 570 m n. v.), i Spilja u Zubu Buljme (Buljma, NP Paklenica, 1305 m n. v.).

Prva faza ovog trogodišnjeg projekta obuhvaća isključivo terenski rad, monitoring, te uzorkovanje. U okviru monitoringa prate se temperatura i relativna vlažnost zraka u svim spiljama, te intenzitet prokapavanja u Manitoj peći i Strašnoj peći. Što se tiče uzorkovanja, na mjesečnoj se bazi uzimaju uzorci vode prokapnice i kišnice na prostoru sva tri objekta, dok su uzorci siga uzeti samo iz Manite peći. Unatoč razmjerno jednostavnom protokolu monitoringa i prikupljanja uzoraka, vremenske (ne)prilike, tehnički zahtjevi uređaja, pa i ljudski faktor u određenoj su mjeri poremetili predviđeni tijek aktivnosti. Tijekom godine, na jednoj su se lokaciji pojavili problemi zbog duljeg sušnog perioda, drugi lokalitet je bilježio oborine iznimne količine i intenziteta, dok su se na trećoj lokaciji javile poteškoće zbog snježnog pokrova. Tehničku prijetnju jednom od logera koji bilježi intenzitet prokapavanja predstavlja vrlo intenzivno zasigavanje koje bi moglo narušiti njegovo ispravno funkcioniranje. Mogućnost uzorkovanja siga bila je bitno ograničena jer su gotovo sve dostupne stalagmite polomili raniji posjetioci spilje, a zbog sličnog neodgovornog ponašanja ostali smo i bez jednog dijela opreme, unatoč obavijesti da se radi o znanstvenom istraživanju.

No, i uz navedene poteškoće, projekt se i dalje odvija predviđenim ritmom i nakon sljedeće godine, kojom će dominirati mjerenja i analize, očekuju se kvalitetni rezultati koji će proširiti dosadašnje spoznaje o kvartarnim uvjetima u okolišu današnjeg priobalja. U sljedećoj fazi istraživanja ovog tipa naglasak će biti stavljen na usporedbu kontinentalnog i priobalnog kvartarnog paleookoliša.

Sedimentna tijela, oblici i pojave glacijalnih naslaga na Velebitu i Biokovu (Hrvatska)

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Mnogobrojni radovi publicirani o kvartarnim oledbama u hrvatskom dijelu Krških Dinarida pretežito su geomorfološke tematike, a rijetko i s geološkim sadržajima. Tako su Marjanac et al. (1990) opisali glacijalne i periglacijalne sedimente oko Novigradskoga mora, a kasnije Velić & Velić (2009), Velić et al. (2010, 2011) glacijalne naslage, oblike i pojave na Sjevernom Velebitu te Protrka et al. (2011) na Biokovu.

Istraživanja glacijalnih naslaga na Velebitu i Biokovu intenzivirana su tijekom posljednjih desetak godina što je vidljivo prema citiranim uradcima. Prema dosadašnjem stupnju istraženosti Sjeverni Velebit ima brojne ostatke glacijalnih tijela i pojava. Utvrđeno je nekadašnje postojanje nekoliko manjih dolinskih ledenjaka, a najbolje su istražene tvorevine Alanskoga ledenjaka u Tudorevu i Mirovu (Velić et al., 2011). Leže na nadmorskoj visini od 1290m do 1410m.

Glacijalne naslage Velebita i Biokova predstavlja til – kaotični, nesortirani, heterogeni i pretežito vapnenački sediment. Izgrađen je isključivo od kršja karbonatnih stijena u dolinama kroz koje su se ledenjaci kretali. Dimenzije klasta su od veličine pijeska do različitih blokova volumena i iznad 1m^3. Sve su ledenjačke doline „U" oblika/profila.

Oblicima sedimentnih tijela i pojavama najbogatije su glacijalne pojave Alanskoga ledenjaka. Utvrđeni su: temeljna morena, završna morena i recesijska (stadijalna) morena, zatim drumlini, eskeri (sl.1), eratički blokovi, kotlići i strijacije. Područje Mirova, zbog učestalih pojava drumlina, predstavlja pravo drumlinsko polje. Orijentacije drumlina, eskera i ledenjačke „U" doline te završne i recesijske morene determiniraju kretanje ledenjaka od cirkova u Tudorevu prema jugozapadu u Mirovo, pa prema jugu do Baričević doca, gdje se nalazi i završna morena. Istaložena je poprečno na „U" dolinu i izgrađuje recentni greben Bilo sa čije je sjeverne strane postojalo i ledenjačko jezero. Put ledenjaka bio je dugačkak oko 4 km. Odnosi između pojedinih sedimentnih tijela poput položaja recesijske morene na starijem drumlinu i temeljnoj moreni, slučaj da mlađi drumlin leži preko starijega u Bilenskome Mirovu svjedoče o višefaznom otapanju i stvaranju Alanskoga ledenjaka.

Ostatci glacijalnih naslaga, vjerojatno od ledenjaka koji se je kretao prema jugoistoku, utvrđeni su u Bilenskom padežu, Dundović padežu i u Štirovači. Dva sjevernija ledenjaka od kojih je jedan ostavio glacijalne naslage u Velikome i Malom Lubenovcu i Begovoj dragi, a drugi u Škrbinim dragama i Lomskoj dulibi, kretali su se također prema jugoistoku, prema Kosinjskome Bakovcu, odnosno prema Lipovu polju. Od glacijalnih oblika u ovim naslagama utvrđeni su drumlini i kotlići.

Najpoznatije glacijalne naslage u Južnome Velebitu nalaze se na Rujnu gdje izgrađuju Rujansku kosu, na nadmorskim visinama od 800 m do 950 m. U njima je Nikler (1973) opisao bočnu morenu. Radi se o velikom izduženom, preko 1 km dugačkom tijelu, najvjerojatnije središnjoj moreni uz koju su u bokovima istaloženi drumlini i eskeri. Njihov međusobni odnos ukazuje na višekratno otapanje i generiranje ledenjaka na istom smjestištu. Njegovo je ishodište bilo u cirkovima Oglavinovca (1240 m) i Javornika (1300 m), a kretanje do Maloga Rujna (750 m do 800 m) oko 5 km. Nedostaje završna morena koja je vjerojatno erodirana, a materijal pretaložen u glaciofluvijalne naslage.

Značajne su, a dosada neopisane glacijalne naslage na Strugama. Sastoje se pretežito od drumlina čije orijentacije ukazuju na kretanje ledenjaka prema jugu-jugozapadu u paklenički kanjon Brezimenjače. Nalaze se na nadmorskoj visini između 1350 m i 1390 m. Vjerojatno je da glacijalnih naslaga ima i na Dušicama, ali su za sada nedostupne istraživanju jer je teren miniran.

Glacijalne naslage u Biokovu utvrđene su i istražene u tipičnoj „U“ dolini Bukovačka draga sjeveroistočno od Brela (Protrka et al., 2011, sl.2). Radi se o tri drumlina čija orijentacija ukazuje na kretanje leda prema sjeverozapadu na nadmorskim visinama od 1050 m do 1030 m.

Glaciofluvijalne naslage najraširenije su na Malom Rujnu, a utvrđene su još u Južnome Velebitu na Libinju te u Krasnom i na više mjesta na Alanu u Sjevernom Velebitu. Sigurno je da njih, kao i glacijalnih naslaga, ima i na drugim mjestima.

Slila 1. Esker istaložen na temeljnoj moreni u Dundović Mirovu, Sjeverni Velebit

Slika 2. Glacijalne naslage u Bukovačkojdragi,istočno od Brela, Biokovo

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Geomorfološki lokalitet Vranjevina

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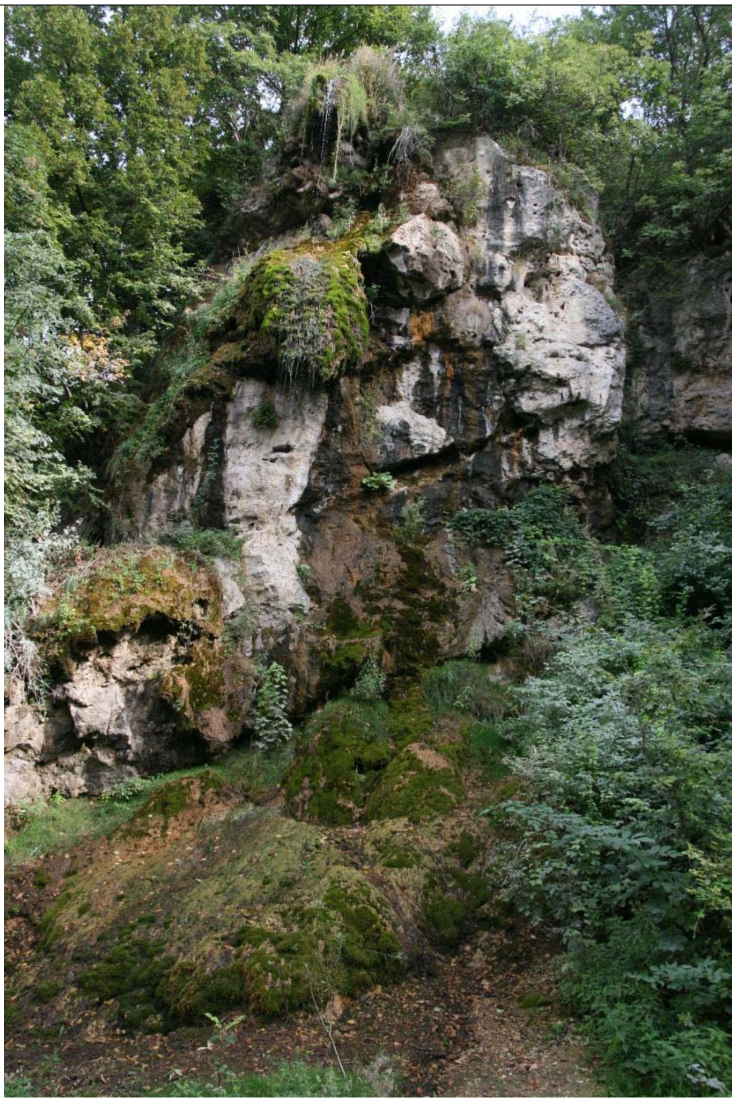
Unutrašnjost Hrvatske karakterizira pojava izoliranog kontinentalnog krša. Na području Zapadnog Papuka istočno od Daruvara ona je, između ostalog, vezana uz pojavu naslaga trijaskih dolomita. Na tom se terenu javljaju brojni geomorfološki procesi i oblici, te zanimljivi geomorfološki lokaliteti. Najistaknutiji među njima je geomorfološki lokalitet Vranjevina koji je udaljen 3,5 km zapadno od centra Daruvara.

Specifičnost geomorfološkog lokaliteta Vranjevina je strukturni strmac preko kojeg se istaložila sedra. Stijene koje grade Vranjevinu su dijagenetski dolomiti srednjeg trijasa. Strmac je predisponiram reversnim rasjednom pravca pružanja I-Z i pretpostavljenim reversnim rasjednom pravca pružanja približno SZ-JI. Visok je 22 metara, te je djelomično prekriven naslagama fosilne i recentne sedre debljine do 2 m. Fosilna, denudirana, tlom i djelomično vegetacijom prekrivena sedra je opažena i na blagim padinama jugozapadno od strmca. Uzvodno od strmca nalazi se izvor iz kojeg pritječe manji potok. Desetak metara prije ruba strmca, umjetnim je putem iskopano korito te je potok tako doveden do vrha strmca, preko kojeg se preljeva, tvori vodopad te taloži recentnu sedru. Izvor je najvjerojatnije preljevnog tipa i njegov nastanak povezan je uz lijevi transkurentni rasjed pravca pružanja SZ-JI. Na mjestu umjetnog korita nalazi se manji oblik geomorfološkog sedla i dvije jaruge, jedna pravca pružanja SZ–JI, druga SI–JZ. Ove jaruge su tragovi nekadašnjeg povremenog otjecanja potoka prije uređivanja korita. Sedra istaložena preko strmca puno je veće površine nego što je kapacitet taloženja današnjeg potoka. To dokazuje da je voda i prije uređenja spomenutog korita protjecala preko strmca u većim količinama, budući da je istaložena sa svih strana, a ne samo na jednom dijelu kao recentna. Ispod strmca, na dnu vodopada, nalazi se umjetno stvoreno jezerce elipsastog oblika dimenzija 7 x 4 m iz kojeg istječe potok te dalje otječe 300-tinjak metara do ušća u rijeku Toplicu, mjestimično taložeći sedru. U radijusu od 30-ak metara od tektonskog strmca nalazi se mjestimično kompaktna i razlomljena sedra taložena u zoni prskanja vode. Za potrebe istraživanja, obavljena je i analiza vode te je dokazana razlika u vrijednostima tvrdoće vode između izvora i vodopada koja ukazuje da se sedra i danas taloži budući da se vrijednost nizvodno smanjuje. Od sedrenih oblika, na fosilnoj sedri preko koje više ne teče voda, uočavaju se sedreni zastor, sedrena konzola i sedrena polica. Sedreni zastor i polica svjedoče o nekadašnjoj razini vode koja se akumulirala u jezercu pod vodopadom. Na recentnoj se sedri od oblika primjećuju sedrena brada, podbradak, polušpilje i sedreni čunj.

Za potrebe istraživanja metodom geomorfološkog kartiranja izrađena je geomorfološka karta šire okolice lokaliteta. Dominantnu ulogu u oblikovanju recentnog reljefa imaju fluviodenudacijski i padinski procesi, te je na terenu najistaknutiji je proces jaruženja. Dolinu Toplice karakteriziraju akumulacijski procesi kojima se na terenu taloži materijal donesen iz viših izvorišnih dijelova rijeke.

Najveću prijetnju lokalitetu predstavlja neposredna blizina kamenoloma "Batinjska rijeka". Kontinuiranim miniranjem kamenolom može utjecati na intenziviranje padinskih procesa uslijed detonacijama izazvanih vibracija. Također, vjeruje se da je upravo kontinuirano miniranje razlog tome što u nekim periodima izvor na Vranjevini presuši što naposljetku ima utjecaj na održavanje sedre. Postoji određena tendencija u presušivanju vode na Vranjevini. Vodotok presušuje svakih 5–6 godina pa se opet pojavi u trajanju od otprilike 1 godine. Utjecajem daljnjeg razvijanja kamenoloma smanjiti će se šumski pokrov u neposrednoj blizini lokaliteta, dok se detonacijama i obradom kamena prostorom širi prašina koja štetno djeluje na vegetaciju.

Metodom geoekološkog vrednovanja analizirane su vrijednosti lokaliteta. Lokalitet posjeduje visoku znanstvenu vrijednost. Predstavlja školski primjer nastanka sedre iskoristiv u edukativne svrhe. Ekonomska vrijednost, kao i estetska, srednje je razine. Iznimno niska je razina kulturne vrijednosti budući da lokalna zajednica nije stvorila nikakve kulturne veze s lokalitetom. Analiziran je i trenutni stupanj i način korištenja. Budući da se lokalitet trenutno koristi samo za izletničke svrhe te da nema nikakve infrastrukture niti propagande povezane s njim, nizak je stupanj i način korištenja. Vrijednost turističkog potencijala je srednje razine, no ona se u budućnosti može povećati. Kvalitetnom propagandom i upravljanjem, može se razviti važan geoturistički lokalitet od značenja za šire područje.



Strmac i sedra na Vranjevini (foto N. Buzjak)

The Geochronology of Pleistocene Aeolian Dunes on the Island of Hvar, Croatia

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Aeolian deposits can be traced all along the Mediterranean coast forming dunes and filling topographic basins. Same deposits can be seen along the eastern Adriatic coast, especially on the islands. Such deposits were described in detail by Pavelić et al. (2011) on the island of Hvar. There a dune field represented predominantly by aeolian fine- to medium-grained sand and intercalated with alluvial coarse-grained sands and breccias was investigated by means of sedimentological analysis and facies analysis. The aeolian sands are composed of grains released by the breakdown of older sedimentary, igneous and metamorphic rocks, with the dominant clastic carbonate component. Based on the mineral composition as well as the palaeotransport directions and palaeocurrent measurements, the Dinarides were determined as the provenance area of the material. The alluvial breccias and sands originated from the nearby steep hill-ridges. Furthermore, the dunes migrated mostly westward and southward, i.e. in the seaward direction different from most other similar dunes in the Mediterranean area.

A detailed geochronological investigation of the dunes described by Pavelić et al. (2011) using the luminescence dating method is presented in this study. The dating was performed on separated coarse feldspar grains using the modified single aliquot regenerative (SAR) dating protocol, the elevated temperature post-IR IRSL dating protocol as proposed by Thiel et al. (2011) using a 290°C stimulation temperature for IRSL after IR bleaching at 50°C. This protocol was used because it was previously proven that it is applicable for dating of older deposits (Middle Pleistocene) and has also the advantage of circumventing fading corrections, a tiresome step for the correction of the feldspar age underestimation due to the athermal signal loss. The preliminary dating results show that the dunes deposited as a result of climatic fluctuations at the end of the Penultimate Glacial cycle (OIS6-5) during a relatively short time period.

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STRUČNA EKSKURZIJA / FIELD TRIP

P R O G R A M / PROGRAMME

SUBOTA 23.3.2013. / SATURDAY

STRUČNA EKSKURZIJA / FIELD TRIP

VODITELJI: Tihomir Marjanac (Geološki odsjek PMF), Ljerka Marjanac (Zavod za paleontologiju i geologiju kvartara, HAZU), Miloš Bavec i Marijan Poljak (Geološki zavod Slovenije)

«Pliokvartarni i kvartarni sedimenti podnožja Medvednice i Krškog bazena - nove osnove za reviziju starosti i geneze»

PLAN PUTA

-	08:00	**polazak iza dvorane LISINSKI (bus sa 30 mjesta)**
-	08.30 – 11:00	Točke 1 i 2 (geologija)
-	11:00 – 12:00	pauza u Konobi Medvednica
-	12:00	polazak prema Sloveniji
-	13:00 – 16:00	Točke 3 i 4 (geologija)
-	16:00 – 19:00	druženje uz fino jelo, piće i geo-priče
-	20:00	dolazak u Zagreb

«Plio-Quaternary and Quaternary sediments at Medvednica foothills and in Krško Basin – new data for revision of their age and origin»

TRAVEL PLAN

-	*08:00*	***departure from parking behind LISINSKI music hall***
-	*08.30 – 11:00*	*Stops 1 i 2 (geology)*
-	*11:00 – 12:00*	*break in Konoba Medvednica*
-	*12:00*	*departure for Slovenia*
-	*13:00 – 16:00*	*Stops 3 i 4 (geology)*
-	*16:00 – 19:00*	*dinner, social- and geo-time*
-	*20:00*	*arrival to Zagreb*

First evidence of glaciation of the Medvednica Mt., Croatia

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Gjuro Pilar wrote in 1877 about glaciation of the Medvednica Mt. and claimed that several striated pebbles were found by one of his students, as evidence of glacigenic origin of the Medvednica “terrace”. He wrote (p. 148) that in total 12 striated pebbles were found in a trough west of Tuškanac, and described the best sample as 5 cm thick triangular-shaped rock, with clear quite large striations on one of the clast side faces, oriented obliquely to the clast longer axis. Gjuro Pilar also claimed on p. 149 that "*Erratics* [he here referred to allochthonous debris] *occur along the whole length of the* [Medvednica] *mountain*, *from vicinity of Sused all the way to Novaki. The center of most intense glacial effects is between Vrapče and Bliznec brooks, and marginal moraine is most shifted to the south near Zagreb. I estimate that the thickness of glacial deposits locally attains 30 m (100 ft) at most*" (translated from Croatian). Gjuro Pilar died in 1893, and his striated pebbles were apparently lost. Dragutin Gorjanović-Kramberger rejected Pilar's evidence in 1902 in heated polemics with Hinko Hranilović (Gorjanović 1907) who adopted Pilar's ideas about glaciation of the Dinaric range.

The 2012 reconnaissance of the Medvednica “terrace” in the foothills of the suthwest Medvednica Mt. revealed diamictons with striated pebbles and cobbles, many of bullet-shape, which inspired detailed study of the diamicton fabric, grain-size and composition (Fig. 1).

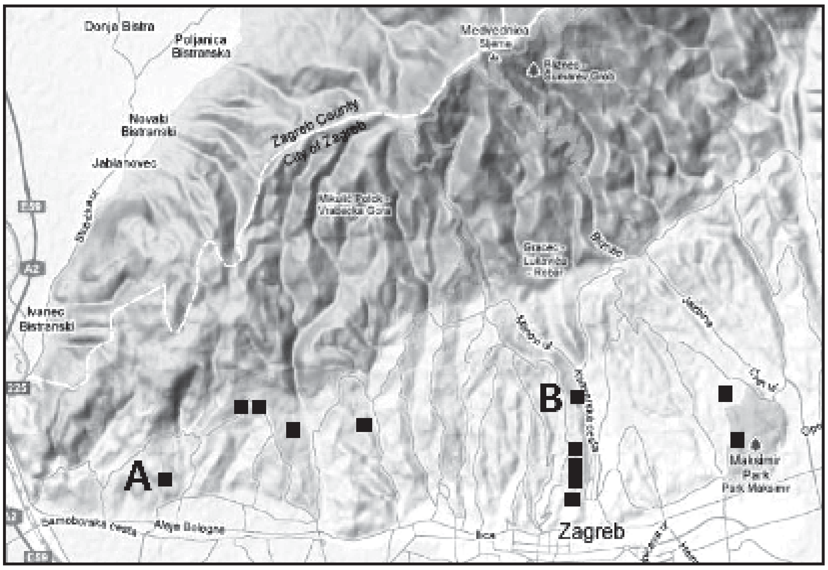

Figure 1. Study locations at the foothills of southwest Medvednica Mt.. Locations A (Lisičina, 224 m a.s.l.) and B (Cmrok, 217 m a.s.l.) are studied in detail.

Diamictons at studied locations on the Zagreb 'terrace' are rich in bullet-shaped clasts (A, Fig. 2), shattered clasts with fissures filled with matrix (B, Fig. 2), and striated clasts (C, Fig. 2), which all indicate glacigenic origin of the sediments that are interpreted as lodgement till. Glacial striations are apparent on surfaces of many pebbles and cobbles, preferentially on limestone clasts but also on magmatic rock clasts.

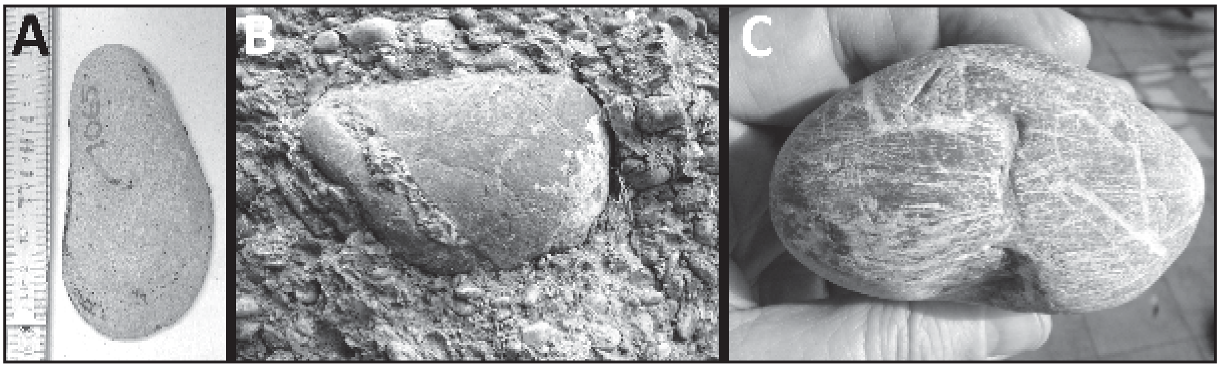

Figure 2. Clast properties. A) bullet-shaped clast, B) shattered clast, C) striated clast.

The till fabric is massive at most locations, but also stratified in the upper part of the Lisičina section (A at Fig. 1). Granulometric and petrographic study of the debris showed no major difference between the underlying massive and overlying stratified facies, thus the stratified fabric is attributed to reworking of the underlying massive diamicton. The stratification dip indicates the north-northeast transport direction, which correlates with glaciotectonic deformations trend in the base of massive diamicton at the same section.

Preliminary study of debris composition shows variety of lithofacies that are not common, even unknown on the Medvednica Mt., so these may be referred to as exotic debris, equal to Pilar`s "erratics" of 1877. Tills studied at locations shown in Figure 1 show apparent compositional variations of the debris; limestones being present at all locations, but at the central part of the "terrace" clasts of metamorphic rocks with provenance on the Medvednica Mt. (greenshists and fillites) predominate. Further detailed study of lithofacies represented in debris composition will hopefully reviel their provenance, and ice-raft directions.

Presence of glacigenic debris and sediment composition confirm Pilar's hypothesis on glaciation of the Medvednica Mt., although the glaciers probably extended from far regions in the north, not from the local cirques as proposed by Pilar.

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Contribution to the origin and age determination of some Quaternary sediments in the Krško Basin

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Introduction

During the preparation of the Geological map of the Krško basin in scale 1:25 000, a number of Quaternary units have been mapped and defined as alloformations. In addition to their spatial position, lithological content, origin, and other characteristics, their ages are of particular interest. Thus, we present here some results of the U/Th radiometric age dating of Middle Pleistocene sediments in the Krško basin, in addition to new ideas of their origin.

Geological setting

The Middle Pleistocene sediments are exposed along the northern and southern rims of the Krško basin. They form morphological terraces in at least two levels (Fig. 1). The terrace is cut into pre-Quaternary basement rocks, as well as into so called Plio-Quaternary unit that forms a higher and presumably older river terrace. Two younger (Late Pleistocene and Holocene) terraces are cut into the Middle Pleistocene terrace.

The Middle Pleistocene sediments consist predominantly of gravel with minor sand lenses. Most of the material is unconsolidated, however, some lenses of gravel are poorly to well cemented with sparry calcite. Lithologically, the composition of the material corresponds to the general lithology of the Slovenian part of the Southern Alps and Dinarides. Pebbles as well as sand grains are formed of various sedimentary carbonate and siliciclastic rocks from Carboniferous to Cretaceous age, in addition to rare magmatic rocks such as Triassic keratophyre and Oligocene andesite. The carbonate component generally dominates the silicious one. The maximum exposed thickness of these sediments is around 10 meters.

Origin of the sediments

On the geological map of this area, the sampled sediments are labeled as a Pleistocene river terrace (a_3), which is cut into older Sava river sediments, and into which two younger Holocene terraces are cut (Šikić et al., 1978; 1979). The authors connect all these sediments with both the Sava and Krka Rivers. T. Verbič (2004) names this unit the Brežice Alloformation of Middle Pleistocene age, and relates it to the Sava only.

A detailed facies analysis on the best preserved exposure of this terrace at the Leskovec village (Fig.1) indicates that this sediment also carries signs of its glacial origin. Sediment characteristics, clast morphology (common shapes typical for subglacial transport), and well preserved striae of presumably glacial origin indicate proglacial paleoenvironment, which needs to be studied further.

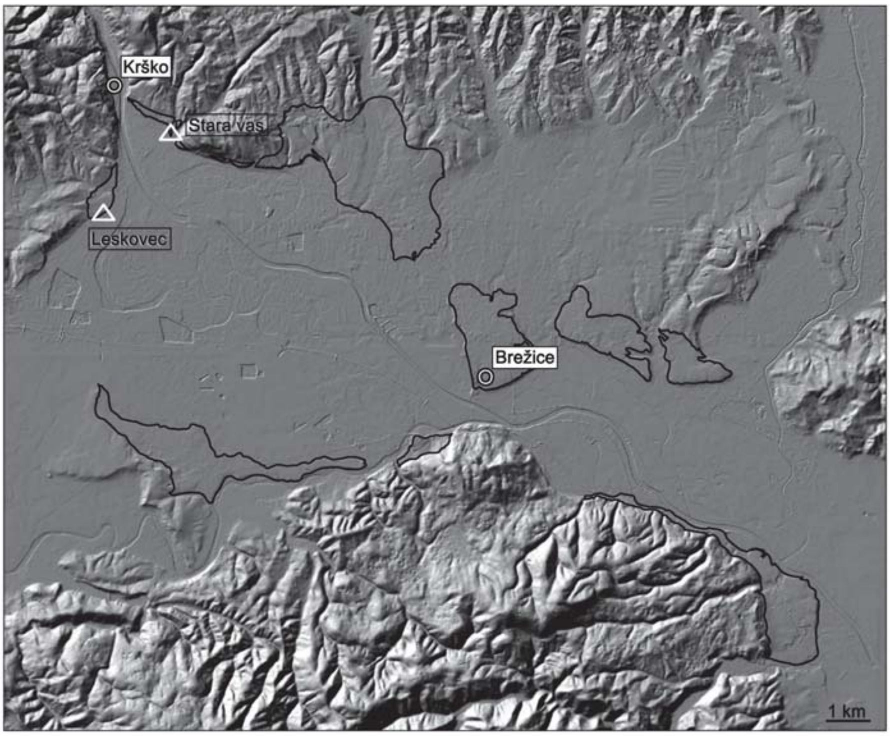

Figure 1. Position of the Late Middle Pleistocene sediments (Brežice Alloformation) in the Krško basin. Sampling locations are marked with triangles.

The age of the Alloformation

The Middle Pleistocene age of the Brežice Alloformation was previously determined by the thermoluminiscence from a sand lens within carbonate and silicate gravel at Dolenja Vas village. The obtained results were 139 500 ±11 840 and 151 710±14 810 a. b.p. (Verbič, 2008) from which the author estimates the most probable age to 145 000 a. b.p.

During our investigation, we have sampled the Middle Pleistocene sediments on two locations; near Leskovec and Stara Vas on the northern rim of the Krško basin. In both cases, the samples have been taken in the lower terrace level from lenses of cemented gravel that contains calcite.

We first analysed samples from Leskovec (Leskovec 1a sample) and from Stara Vas (Stara vas 1b sample) but both have large contributions from detrital material (125% and 104%). The age calculation for Stara Vas-1b sample does not converge on a sensible value. Detrital correction for Leskovec -1a sample is essential but age calculation, is realistically impossible. A further 2 scrapings from the same hand specimen achieved somewhat lower detrital contributions, 34% for Leskovec -1b sample and 2.5% for Stara Vas - 1a samples. Both give acceptable detrital-corrected ages (Table 1 in italics) but still with large uncertainties. The increase in uncertainty for the detrital corrected ages is due to the uncertainty in the ^{232}Th concentration determination. The $^{232}Th/^{238}U=3.13$ for detritus is an assumption and is for an average continental sediment. It is possible that a large component of the detrital material is actually old limestone, with a much lower $^{232}Th/^{238}U$ ratio, and then the calculated ages would actually be mixing ages between the authigenic carbonate precipitation age and secular equilibrium.

There is unambiguous evidence for U-series disequilibrium in all samples and thus for ages <350 ka. Cleaner samples collected from sites with low energy sedimentation during authigenic precipitiation may yield more satisfactory results.

Table 1: ratios in brackets are activity ratios calculated from analytical data using decay constants: λ^{238}U: 1.55125^{-10}, λ^{232}Th: 4.94750^{-11}, λ^{234}U: 2.82629^{-06}, λ^{230}Th: 9.15771^{-06}. Unc is 1 sigma uncertainty apart from the values in ages, OC indicates that the value was overcorrected and NC indicates that the age calculation did not converge. Values calculated using an assumed ^{232}Th/^{238}U ratio for the detrital contributions are in italics.

Name	**Leskovec**	**unc**	**Leskovec-**	**unc**	**Stara Vas-**	**unc**	**Stara Vas-**	**unc**
Weight g	0.2773		0.5986		0.2043		0.2952	
^{238}U ppm	0.1616	0.000	0.1839	0.001	5.3836	0.028	0.5623	0.003
^{232}Th ppb	616.4	111.7	190.5	34.5	406.1	73.6	1786.3	323.6
(^{230}Th/^{232}Th)	1.1060	0.071	2.9253	0.188	36.9940	2.382	1.1313	0.072
(^{230}Th/^{234}U)	0.9674	0.030	0.9323	0.029	0.9232	0.029	1.1300	0.035
(^{234}U/^{238}U)	1.4063	0.012	1.0533	0.009	0.9881	0.009	1.0351	0.010
convergence=1	1.000		1.000		1.000		0.924	
AGE ka	247		273		285		NC	
2 * uncertainty		44		58		67		NC
2 * uncertainty		-52		-84		-102		NC
%err 2se	19.4		25.9		29.7			
Blank contribution %	1.17E-07		3.78E-07		1.77E-07		4.03E-08	
^{230}Th/U	3.8143		1.0359		0.0754		3.1766	
^{232}Th/^{238}U detr mol rat	3.13		3.13		3.13		3.13	
detrital fraction in %	125.0		34.0		2.5		104.1	
(^{230}Th/^{234}U) corr	*0.7064*	*0.055*	*0.9002*	*0.047*	*0.9212*	*0.041*		
(^{234}U/^{238}U) corr	*OC*		*1.0807*	*0.016*	*0.9878*	*0.013*		
convergence=1			*1.000*		*0.999*			
AGE ka			*234*		*284*			
2 * uncertainty				*67*		*94*		
2 * uncertainty				*-92*		*-147*		
%err 2se			*34.1*		*42.5*			

Conclusion

On the basis of our investigations presented in this paper, we can draw two main conclusions.

Firstly, indications of probable glacial origin of Middle Pleistocene sediments in the Krško basin, if they are confirmed by facts in further studies, suggest that the Pleistocene Alpine ice cover might have a much larger extend than previously interpreted (e.g. Bavec & Verbič, 2011).

Secondly, the age dating results of the same sediments obtained by thermoluminiscence and uranium-series (U/Th) method, taking into account restrictions due to quality of analyzed material, suggest that sedimentation during the Late Middle Pleistocene (Rissian) glaciation took place within larger time span then previously interpreted.

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NAPOMENA / NOTE

Ovaj članak je pripremljen za 22. Posvetovanje slovenskih geologov, Ljubljana, 2013.

This paper is prepared for the 22nd Meeting of Slovenian Geologists, Ljubljana 2013.

Plio-Quternary sediments in Krško Basin

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General description and age

The older Sava River sediments of the Krško Basin (the so- called Plio-Quaternary deposits) are referred to as the Globoko alloformation (Verbič, 2004). They occupy the edges of the Krško basin and are inferred to correlate to sediments in the central part of the basin that are covered by younger sediments. At the rims of the Krško basin, the highest elevation of these sediments is at around 330 m a.s.l. Toward the east, nearly identical deposits are exposed at the surface in the Kapele hills. Their eastward continuation to the Marija Gorica hills is less clear. Šikić et al. (1978, 1979) mark Plio-Quaternary sediments also on the left Sotla River bank whereas Verbič et al. (2000) suggest these are more likely a lag of locally reworked Pontian-series gravels.

Lithologically, the Plio-Quaternary sediments are composed of gravel containing rare sandy lenses. The pebbles are exclusively non-carbonate. The absence of the carbonate component has been explained by dissolution during transportation.

The Globoko alloformation is not chronologically characterized between the Brežice formation (app. 150 ka) and the Pontian deposits (app. 5 Ma). Verbič (2004) estimates that the age of this series is between 1 and 2 Ma. In the past the age and stratigraphic span have been inferred to be of Upper Pliocene to Lower Pleistocene age (Heritsch & Seidl, 1919; Pleničar & Ramovš, 1954; Šikić et al., 1978, 1979]). Minimum age estimate was done by application of TL and OSL dating of Plio-Quaternary sediments from the Globoko open pit (Bavec, 2000, unpublished). The minimum age of sediment was estimated at 306.000 years ± 2σ, however this estimate was largely driven by properties of the sediment and capability of the dating method at the time. Thus this is only the estimate of minimum possible age and by no means the estimate of age.

In Krško Basin pronounced erosional relief is known at the series' lower boundary (e.g. Verbič, 2004). Moreover, also the upper boundary of the series was uneven after deposition. Although terraces were not observed within the Globoko formation in Krško basin, they have been reported in the area app. 20 km upstream Sava (Bavec, 2003).

Thus, given available information this formation is actually a post-Pontian and pre-Middle-Pleistocene and could be either entirely Pliocene, or entirely Pleistocene or really Pliocene and Pleistocene.

Setting in Globoko

In Globoko open clay pit, the PLQ series overlies the Pontian sands with clay and coal (Figure 1). The thickness of the series here is more than 20 m. Architecture of the succession resembles its fluvial origin with several sedimentary hiata manifested by horizons of buried soils. The series consists of gravels at the bottom and is followed by gravel/gravely sand/sand. Paleosoil horizons (silt, sandy silt) are generally few centimeters thick. The topomost soil is several meters thick.

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Figure 1.

A generalized sedimentary log of the Globoko alloformation deposits in the Globoko open pit

LITHOLOGY
DESCRIPTION
SAMPLES (HIGHT)
4. terrace
3. terrace
2. terrace
1. terrace
present-day excavation terrace surface
soil; upper surface partly anthropogenic
silty sand and sand, upward coasening, heavily pedogenized, "marmorized pseudogley", clayey silt intercalations
G18 (19,40m) G17 (18,90m) G16 (18,20m) G15 (17,65m) silty sand
silt, "marmorized", "pseudogley" (?)
G14 (16,25m) silt
silty sand, upward fining toward clayey silt, marmorized at the top; with a "layer" of limonite accumulation
G13 (15,80m) G12 (15,50m) G11 (15,15m) silty sand
clayey silt with a "layer" of limonite accumulation,"gley/marmorized"
G10/2 (14,80m) G10/1 (14,60m) G9/2 (14,40m) G9/1 (14,30m) clayey silt
sand with a "layer" of limonite accumulation
G8/3 (13,30m) G8/2 (13,10m) G8/1 (12,80m) G7/1 and G7/2 -paralel samples (12,50m) sand
gravel with 60% sandy matrix
limonite accumulation
coarse sand
sand
sand with rare pebbles (pebbles up to 1 cm)
G6/1 - coarse sand G6/2 - sand (both 11,90m)
sand with 10% pebbles (oxidised)
sand with rare pebbles
gravel (avg clast size 8 cm, max. clast size 15 cm)
sandy silt ("pseudo gley", "marmorized")
G5/1 and G5/2 (9,10m) paralel samples
sand (silty sand)
G4/1 and G4/2 (8,90m) paralel samples
sandy gravel with sand intercalations
at the top sandy silt (6 cm), gravel with sandy matrix (avg. grain size 1 cm), at the bottom silty sand (5 cm)
G2 - silty sand (8,05m) G3 - sandy silt (8,58m) taken with sorounding g.
gravel with sandy matrix(avg. grain size 1cm) with two lences (2 cm) of sandy silt , at the bottom sandy silt (3 cm)
G1 (8,05m) taken in sandy silt lance with sorounding gravel
gravel with sandy matrix (avg. grain size 4 cm)
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
Legend
silt
sand
gravel with sandy matrix
sand with pebbles
sandy silt
silty sand
clayey silt
limomnite accumulation
coarse sand
soil
Position of terraces
4
3
2
1

HVALA VAM NA SUDJELOVANJU

Thank you for your participation

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