GEOLOŠKI VJESNIK	44	55 - 67	3 Tab.	2 Sl.		ZAGREB 1991

PADINSKI TURONSKI SEDIMENTI UVALE BRBIŠNICA NA DUGOM OTOKU

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Ključne riječi : Pretaloženi plitkomorski vapnenci, pelagički vapnenci, padinski klizišni sedimenti, gornja kreda (turon-konijak), Jadranska karbonatna platforma

Key words : Displaced shallow-water limestones, pelagic limestones, slope, slump deposits, Upper Cretaceous (Turonian-Coniacian), Adriatic carbonate platform

Profil u uvali Brbišnica nalazi se u srednjem dijelu Dugog otoka, a geološki je smješten između "pregibnih" facijesa sjeverozapadnog dijela te platformskog razvoja jugoistočnog dijela.

"Oceanizacija" odnosno potapljanje platforme počinje u gornjem cenomanu. U srednjem turonu (zona *Helvetoglobotruncana helvetica*) pelagičkim vapnencima asocirani su resedimentirani ("premješteni") platformni vapnenci. U slijedećoj zoni (zona *Dicarinella primitiva*; g. turon-konijak) dalje se kontinuirano talože pelagički vapnenci. Za potpuniju analizu paleogeografskih odnosa tog dijela Jadranske karbonatne platforme bilo bi potrebno poznavati stratigrafske odnose u jadranskim dubokim bušotinama, jer bez toga nije moguće riješiti da li turonski klizišni sedimenti u uvali Brbišnica predstavljaju rub platforme ili se radi o intraplatformnom koritu.

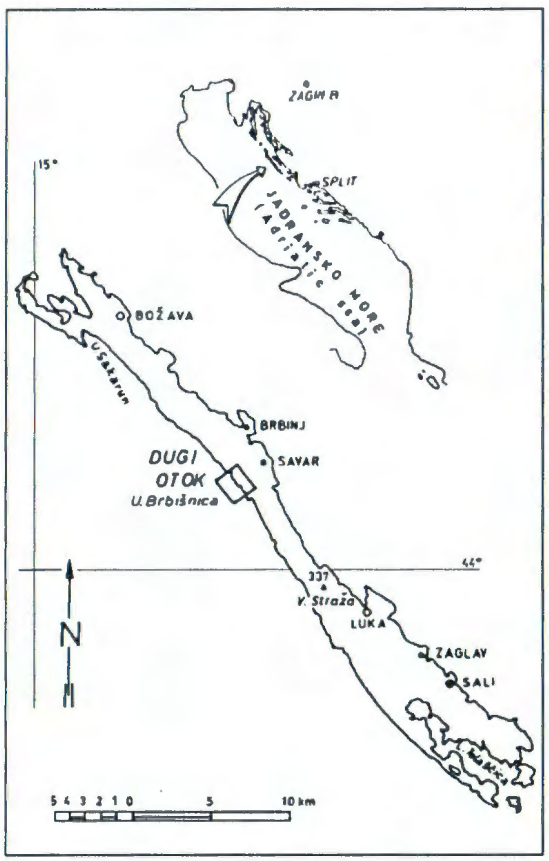
The profile in the Brbišnica Cove is situated in the central part of the Dugi Otok Island, between the slope deposits in the northwest and the platform deposits in the southeast. The "oceanization", that is the drowning of the platform,was initiated in the Late Cenomanian. In the MiddleTuronian (*Helvetoglobotruncana helvetica* Zone), pelagic limestones are associated with displaced platform limestones. The next zone , i.e. *Dicarinella primitiva* Zone (U. Turonian - L. Cenomanian) contains pelagic limestones. The paleogeographic setting of this part of the carbonate platform cannot be adequately established since the stratigraphic data from the Adriatic deep wells are not available. In fact, it cannot be decided whether Turonian slump deposits in the Brbišnica Cove indicate platform margin or represent an intra-platform trough.

1. UVOD

Turonski pelagički vapnenci u području jadranske regije u pravilu leže na plitkomorskim hondrodontnim vapnencima (GUŠIĆ & JELASKA, 1990). Također su prepoznati i na jugoistočnom dijelu Dugog otoka u relativno uskom intervalu koji vremenski odgovara donjem turonu, a nakon čega je, slično prilikama na Braču, obnovljen plitkomorski sustav (FUČEK et al.,1990).

KAPOVIĆ & BAUER (1970) prikazali su, s krajnjeg sjeverozapadnog dijela Dugog otoka, "karbonatno-turbiditnu sukcesiju" raspona gornji turon-senon razlikujući dva superpozicijska člana, "Dugi otok" i "Veli Rat", i smještajući ih u pregibne okoliše. Poredba te sukcesije sa geološkim stupom Brača, na kojem su prva (donjoturonska) i druga (santon-kampanska) pelagička epizoda odvojene plitkomorskim vapnencima formacije Gornji Humac (GUŠIĆ & JELASKA, 1990), pokazuje da, za razliku od Brača, stup sjeverozapadnog dijela Dugog otoka odražava kontinuitet pelagičkog režima u trajanju od kraja cenomana do u santon-kampan.

Profil u uvali Brbišnica nalazi se u središnjem dijelu Dugog otoka (sl.1.). Budući da je smješten između "pregibnih" facijesa na sjeverozapadu otoka odnosno platformnih na jugoistoku, stup Brbišnica u daljnjim će razmatranjima taložnog modela predstavljati važan oslonac.



Slika 1. Položajna skica. Fig. 1. Situation map.

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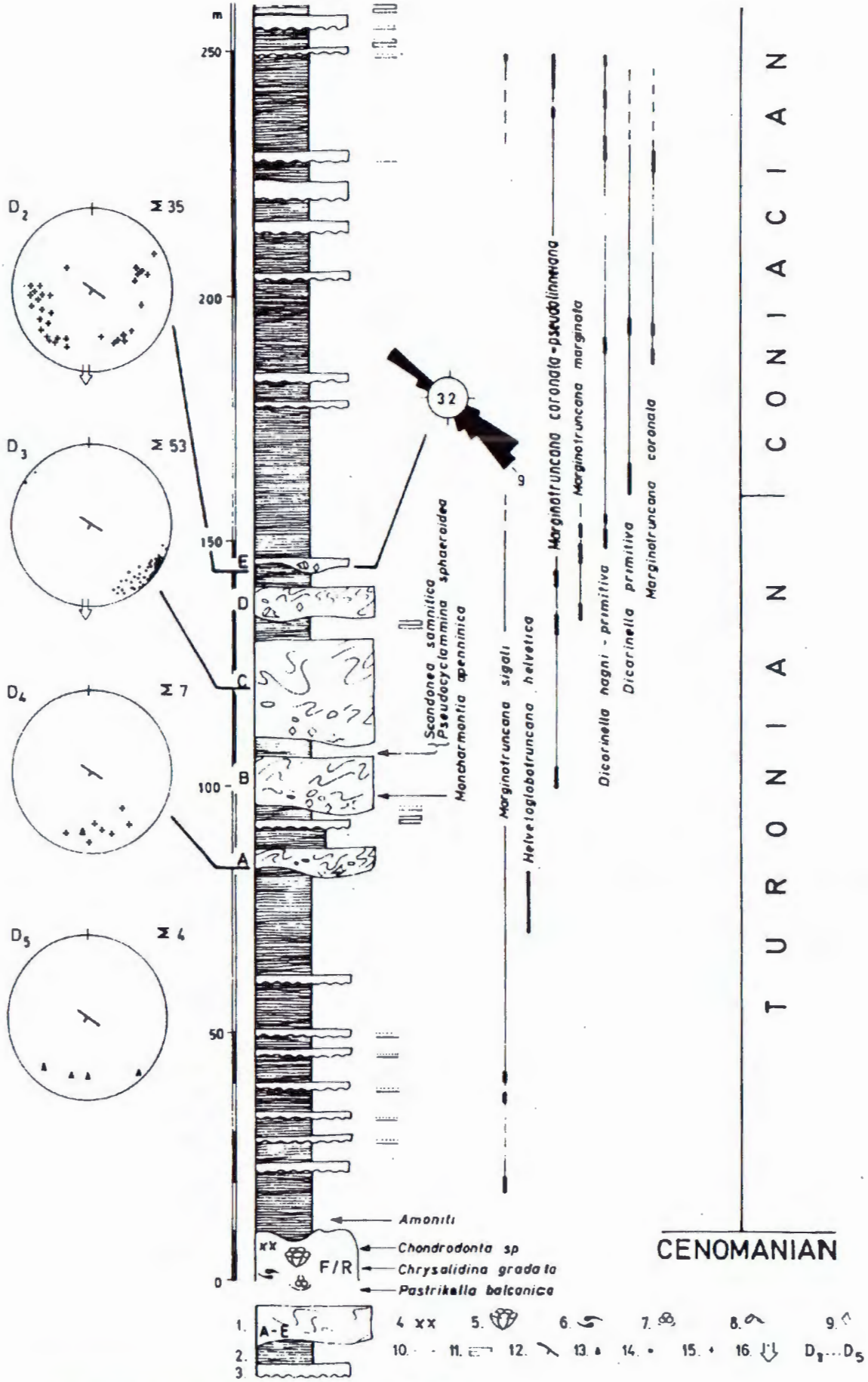

Slika 2. Pojednostavljen stratimetrijski profil uvala Brbišnica.
Fig. 2. Simplified logged section: Brbišnica cove.

TUMAČ ZNAKOVA - LEGEND

1. Kaotične taložine A-E, (kanali, klizišta i slamp bore) - Chaotic deposits A-E (channels, slides and slumps);
2. Pelagički vapnenci - Pelagic Limestones;
3. Pretaloženi skeletni-litoklastični kalkareniti/kalciruditi Redeposited skeletal - lithoclastic calcarenite/ calcirudite;
4. Kristalinična karbonatna stijena - Crystalline carbonate rocks;
5. Rudistna građevina -Rudist buildups;
6. Hondrodonte - *Chondrodonta* "oysters";
7. Bentičke foraminifere - Benthic foraminifera;
8. Fragmenti rudista, premješteni - Broken rudists, displaced;
9. Litoklasti - Lithoclasts;
10. Graduirana slojevitost - Graded bedding;
11. Laminirana građa -Parallel lamination;
12. Pružanje i nagib pretpostavljene padine - Dip and strike of inferred paleoslope;
13. Osi kanala - Channel axes;
14. Os B slampa - B axes of slumps;
15. Položaj bokova kanala - Channel banks positions;
16. Smjer kliženja(generalno) - Downslope direction (generalized) ;

D_1 Rozetni dijagram orijentacije dužih osi rudistnih fragmenata - Rose diagram showing long axes orientation of rudist fragments;

D_2,D_4 Dijagrami bokova kanala - Channel banks diagrams;

D_3 Dijagram b osi slampova -Diagram showing b axes of slumps;

D_5 Dijagram osi kanala (skupni) - Cumulative diagram of channel axes.

2. SLIJED NASLAGA U UVALI BRBIŠNICA

Bazni dio obilježen je jednoličnim sivim mikritima s pitonelama, hedbergelama i globotrunkanama. Ti mikriti, bez vidljivih tragova transgresije, ispunjavaju odnosno izravnavaju izraženi reljef rekristaliziranih bijelih radiolitidno-hondrodontnih vapnenaca tipa floutston-radston. Prateća mikrofosilna zajednica (*Chrysalidina gradata* d'ORB. i *Broeckina (Pastrikella) balcanica* CHERCHI et al.) dokazuje njihovu starost u rasponu srednji-gornji cenoman. Već nakon 10-15 m od neskladnog dodira s hondrodontnim vapnencima suvisli slijed mikrita prekinut je bioklastičnim uloščima, koji se u daljnjih 20-25 m naslaga ritmički ponavljaju u međusobnom razmaku od prosječno 1 m. Njihova debljina varira od 0,3-0,6 m, a prema sastavu to su rudistni floutstoni s rekristaliziranim muljnim matriksom. Donji su slojni dodiri, u pravilu, neravni i oštri u odnosu na muljni sediment na kojem leže (tab II, sl. 7) . Nasuprot tome , vrh je sloja ravan i najčešće postupno prelazi u muljni facijes. Rudistno i drugo skeletno kršje graduirano je razmješteno u muljnom matriksu. U pitanju je, dakle, resedimentirani šelfni materijal , na što upućuje i tijesna asociranost rudistnih floutstona s okolnim pelagičkim vekstonima. U odnosu na unutarnju uređenost resedimentiranih vapnenaca može se zaključiti da su to taložine nastale iz gravitacijskog sedimentnog tečenja (sediment gravity flow). Najsličniji su presječenim Bouma turbiditima (sekvencije tipa Ta). Njihova potpunija interpretacija sa stajališta procesa (mehanizma) bit će moguća tek u okviru šireg razmatranja problematike resedimentiranih vapnenaca Jadranske karbonatne platforme.

Daljnjih 30-35 m stupa obilježava prevaga muljnih facijesa tipa madston-vekston, dok su pojave rudistnih floutstona sporadične. Mikriti su debelo uslojeni i bez vidljivih tekstura, ravnih slojnih dodira i konzistentnog lateralnog protezanja. Zajednica pelagičkih mikroorganizama bogato je zastupljena mnogobrojnim presjecima "oligosteginida" :*Pithonella ovalis* (KAUFMANN), *Calcisphaerulla innominata* BONET, *Stomiosphaera sphaerica* BONET i planktonskih foraminifera iz skupine *Hedbergella-Whiteinella*, a u vrhu ovog paketa utvrđena je zonska vrsta *Helvetoglobotruncana helvetica* (BOLLI) (tab. II, sl. 3-5).

Nakon toga slijed je facijesno nehomogen. Muljnim vapnencima s bogatom zajednicom pelagičkih mikroorganizama asocirani su paketi s kaotičnim razmještajem debrita i kliznih sedimenata, različito debeli i koji se višestruko ponavljaju. Slamp bore su metarske i decimetarske s preferiranim orijentacijama osi sjeverozapad-jugoistok (dijagram D3 na sl.2).

U kliznim listovima uključeni su metarski blokovi odvaljanih plitkomorskih vapnenaca (tab. I, sl. 2) . U debritima je nesortirano skeletno kršje (uglavnom rudistno) i litoklasti koji veličinom variraju od sitnog pijeska do šljunka i oblutaka. Fosilni sadržaj u

litoklastima, kao i onaj iz bioklastičnih uložaka , odgovara onome u donjem dijelu formacije Gornji Humac koju FUČEK et al. (1991) opisuju u jugoistočnom dijelu otoka. Radi se o plitkomorskim bentičkim algama i foraminiferama, od kojih navodimo *Thaumatoporella parvovesiculifera* (RAINERI), *Aeolisaccus kotori* RADOIČIĆ, *Scandonea samnitica* DE CASTRO , *Pseudocyclammina sphaeroidea* GENDROT i *Moncharmontia apenninica* (DE CASTRO). Muljni sedimenti klizišta, jednako kao i neporemećeni autohtoni vapnenci (tab. II, sl.1), sadrže raznovrsnu zajednicu pelagičkih mikroorganizama : *Pithonella ovalis, Calcisphaerulla innominata, Stomiosphaera sphaerica, Marginotruncana coronata* (BOLLI) *-pseudolinneiana* PESSAGNO , *Marginotruncana marginata* (REUSS).

Padinski kompleks pokrivaju muljni vapnenci s pelagičkim mikroorganizmima u kojima je usječen kanal dubok 1 m (tab.I , sl.1). Ispunu kanala sastavljaju manji litoklasti i brojni rudisti i njihovo kršje , duže osi kojih su konzistentno uređene (vidi dijagram D1 na sl. 2) . Okomite su na os kanala, pa je prema tome kotrljanje niz padinu bilo skladno smjeru usjecanja kanalskog sedimenta. Ti podaci podudarni su s orijentacijom osiju kliznih bora (D3, sl. 2) , što upućuje na zaključak da je sedimentni transport bio usmjeren generalno prema jugu (D5, sl. 2).

Pelagički vapnenci , koji se kontinuirano nastavljaju na opisanom kanalu, pripadaju zoni *Dicarinella primitiva.* U planktonskoj foraminiferskoj zajednici, pored brojnih pitonela i kalcisfera, dolaze globotrunkanide od kojih su najznačajniji oblici iz grupe *Dicarinella hagni*-(SCHEIBNEROVA)*-primitiva* (DALBIEZ) , *Marginotruncana marginata REUSS, M. coronata* (BOLLI) i pri samom vrhu snimljenog stupa *M.* gr. *sigali.* Sporadično, u zoni Dicarinella primitiva pojavljuju se *Cadosina* sp. , *Navarella joaquini* CIRY & RAT , sakokome i druge planktonske čestice.

Zonska vrsta *Dicarinella primitiva* (DALBIEZ) karakteristična je , prema FLEURY (1980) i CARON (1985), za viši turon odnosno niži dio konijaka (tab. III, sl. 3-5). S obzirom da je u podini klizišnih pojava određena *H. helvetica* , proizlazi zaključak da su postanak padine, kao i odgovarajući taložni procesi, vremenski vezani uz viši turon.

3. ZAKLJUČAK

Sedimenti u uvali Brbišnica bogati su zapisima o geološkim događajima na Jadranskoj karbonatnoj platformi tijekom turona i donjeg senona. U vertikalnom slijedu očituje se, naime , više razvojnih etapa taložnog sustava šireg područja.

Najniži paket pelagičkih vapnenaca , koji leži preko plitkomorskih vapnenaca s radiolitidima, hondrodontama i sl., usporediv je s formacijom Sveti Duh (GUŠIĆ & JELASKA, 1990; FUČEK et al., 1991). Ta je podudarnost važna za stratigrafiju šireg prostora, s obzirom da epizode potapljanja karbonatnih platformi mogu, u smislu kako je to definirao SCHLAGER (1981), poslužiti kao vremenski "markeri", budući da su u pitanju kratkotrajni ali po učinkovitosti globalni događaji. Doista, u jadranskoj regiji na brojnim lokalitetima, kako pišu GUŠIĆ &JELASKA (1990), plitkomorske vapnence srednjeg i gornjeg cenomana prekrivaju pelagički mikriti turona. No rast morske razine nije bio toliko visok ni toliko brz da bi na čitavom području platforme potpuno eliminirao bentičku biotu, što potvrđuju resedimentirani vapnenci koji su u Brbišnici uloženi u muljne vapnence s pelagičkim mikroorganizmima već u donjem dijelu profila. Iz toga slijedi pretpostavka da je i tijekom turona dubina vode na pojedinim ili nekim dijelovima Jadranske karbonatne platforme bila u fotičkoj zoni , a kako nije bilo daljnjeg rasta vode - nego je naprotiv, sredinom turona došlo do globalne regresije (HAQ et al. ,1987), platforma je ubrzo vlastitom proizvodnjom karbonata ponovo dosegla morsku razinu i obnovila plitkomorski režim. Ti, privremeno potopljeni dijelovi platforme proživjeli su tek početnu fazu oceanizacije, a slijed naslaga u Brbišnici, za razliku od toga, pokazuje kontinuitet pelagičke sedimentacije od gornjeg cenomana. To upućuje na zaključak da su takvi dijelovi platforme, nakon potapljanja krajem cenomana, bili dovoljno spušteni da su kroz dulje vrijeme ostali u domašaju "oceana" . Ovdje nalazimo stanovitu analogiju s atlantskim Blake Plateau-om, gdje su srednjokredni fenestralni vapnenci pokriveni pelagičkim vapnencima gornje krede (SHIPLEY et al. , 1978).

Zahvaljujući biostratigrafskom zoniranju vapnenaca Brbišnice na temelju planktonskih foraminifera, mogli smo datirati glavne događaje na proučavanom dijelu platforme. U zoni *Helvetoglobotruncana helvetica* (srednji turon), pelagičkim su vapnencima asocirani resedimentirani platformni vapnenci. Takav skup naslaga svjedoči da je , nakon potapljanja ("oceanizacije") platforme tijekom donjeg turona, u neposrednom susjedstvu već u srednjem turonu obnovljen plitkomorski sustav, iz kojeg je susjedna platforma putem padine zatrpavala obližnji bazenski prostor. Mehanizmi padine smiruju se u zoni *Dicarinella primitiva* (turon-konijak), a pelagički vapnenci i dalje se kontinuirano talože. Ovdje zasada namjerno samo faktografski ističemo taj podatak, a traženje njegovog uzroka i njegovo objašnjenje bit će predmet posebnog rada, temeljenog na dodatnim istraživanjima. Vjerojatno je tadašnji oceanizirani prostor Jadranske karbonatne platforme, kojem pripadaju i razmatrani dijelovi Dugog otoka, bio povezan s Umbro-markijskim bazenom na zapadu, odnosno područjem Venecijanskih Alpa na sjeverozapadu. Geotektonski položaj tog prostranog pelagičkog ambijenta ilustrirao je JENKYNS (1986, str 367.)

Paleogeografske odnose Jadranske karbonatne platforme i susjednih pelagičkih prostora mogli bismo potpunije analizirati kad bismo poznavali stratigrafiju jadranskih bušotina. Bez tih podataka dvojbeno je da li turonski klizišni sedimenti Brbišnice na Dugom otoku predstavljaju zapis o postanku platformnog ruba, a facijesi

u koje su uklizani da pripadaju kompleksu padinske prostirke ("slope apron"), ili su ipak u pitanju taložine intraplatformnog korita , kako to JELASKA (1973) pretpostavlja.

4. LITERATURA

CARON,M.(1985):Cretaceous planktic foraminifera.- U:BOLLI,H. M., SAUNDERS, J.B. & PERCH-NIELSEN, K. (eds.): Plankton stratigraphy, Cambridge University Press, 17-86, 37 figs.

BILOTTE, M. (1984) : Les grands Foraminifères benthiques du Crétacé supérieur pyrénéen. Biostratigraphie. Reflexions sur les correlations mésogéennes.-Benthos' 83, 2nd Internat. Symp. Benthic Foraminifera (Pau,April 1983), 61-67, Pau.

BILOTTE, M. (1986): Le Crétacé supérieur des plates-formes est-pyrenéenes. - Strata, ser. 2, 5,1-438.

FLEURY, J. J. (1980):Les zones de Gavrovo-Tripolitza et du Pinde - Olonos (Grèce continentale et Peloponèse du Nord). Evolution d'une plate-forme et d'un bassin dans leur cadre alpin. -Publ. Soc. geol. Nord, Villeneuve d'Asq, 4 (2 vol.),475p., 164 fig.

FUČEK, L., GUŠIĆ,I.,JELASKA, V., KOROLIJA,B. & OŠTRIĆ, N. (1991): Stratigrafija gornjokrednih naslaga jugoistočnog dijela Dugog otoka i njihova korelacija s istovremenim naslagama otoka Brača. - Geol. vjesnik,43, 23-33, Zagreb.

HAQ, B. U., HARDENBOL, J. & VAIL, P. R. (1987): Chronology of fluctuating sea levels since the Triassic.-Science, 235, 1156-1167.

GUŠIĆ,I.& JELASKA,V. (1990): Stratigrafija gornjokrednih naslaga otoka Brača u okviru geodinamske evolucije Jadranske karbonatne platforme (Upper Cretaceous Stratigraphy of the island of Brač within the geodynamic evolution of the Adriatic carbonate platform). - Djela Jugosl. akad. znanosti i umjetnosti,69,1-160, Zagreb.

JELASKA,V. (1973): Paleogeografska i naftnogeološka razmatranja zapadnog dijela karbonatnog šelfa Dinarida.- Geol.vjesnik,25, 57-64 Zagreb.

JENKINS, H. C. (1986): Pelagic Environments. - U: Reading,H.G.(ed.):Sedimentary Environments and Facies, Blackwell, 343-397, Oxford.

KAPOVIĆ, B. & BAUER, V. (1970): Sedimentološke, biofacijalne i ambijentalne karakteristike gornjokrednih naslaga otoka Premude i Dugog otoka.-Nafta,22, (12), 561-572, Zagreb.

SCHLAGER, W. (1981): The paradox of drowned reefs and carbonate platforms.Geol. soc. Am. Bull., 92,2, 197-211.

SHIPLEY, T. H., BUFFLER,R.T. & WATKINS,J. S. (1978) : Seismic stratigraphy and geologic historyof Blake Plateau and adjacent Western Continental Margin. - Bull. A. A. P. G., 6, 792-812.

TURONIAN SLOPE DEPOSITS IN THE BRBIŠNICA COVE, DUGI OTOK ISLAND, CROATIA

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1. INTRODUCTION

In the Adriatic carbonate platform realm, the shallow-water Upper Cenomanian Chondrodonta limestones are overlain, as a rule, by pelagic Lower Turonian limestone. On Brač Island (middle Dalmatia), this pelagic limestone has been distinguished as the Sveti Duh Formation and its occurrence has been tentatively explained as the result of global Upper Cenomanian-Lower Turonian eustatic sea-level rise, that caused the drowning of the shallow-water carbonate platform (GUŠIĆ & JELASKA, 1990). Analogous deposits have also been identified in the southeastern part of Dugi Otok Island (northern Dalmatia), its stratigraphic position being the same as on the island of Brač: they overlie the platform Chondrodonta limestone of the Late Cenomanian and are overlain, in turn, again by shallow-water platform limestone sequence, starting with the Upper Turonian and ranging up into the (Upper?) Santonian (FUČEK et al., 1991). Therefore it has been concluded that both regions, though about 150 km apart, belonged to the same carbonate platform that sensitively and uniformly responded to the global eustatic pulse.

On the other hand, on the northwestern tip of Dugi Otok Island, KAPOVIĆ & BAUER(1970) have described a "carbonate turbiditic Upper Turonian-Senonian succession" with two superpositional members: the Dugi Otok Member and the Dugi Rat Member. According to these authors, both members were laid down in platform margin settings. As opposed to Brač, where the first (Late Cenomanian/Early Turonian) and the second (Late Santonian/Early Companian) pelagic episodes are punctuated by the intervening shallow-water Gornji Humac Formation (GUŠIĆ &JELASKA, 1990), the NW Dugi Otok succession indicates the continuity of a pelagic regime during the Turonian-Senonian time span.

In the course of geologic mapping of Dugi Otok Island, the Dugi Otok was supposed to represent a tectonically and paleoenvironmentally homogeneous unity. Therefore it was also expected that the deposits in its central part would show facies types that would agree with their supposed position within the sedimentary system; the present-day direction of strike strongly suggests a model-like transition from the shallow-water

limestones in the southeast to the more "basinward" central northwestern part. However, the logged section in the Brbišnica Cove in the central part of the island (Text-fig. 1) shows more similarity and a pronounced "facies proximity" with the more distant KAPOVIĆ & BAUER (1970) "shelf edge" localities than with the nearby situated platform sequence of Mt. Vela Straža (337m) and Mt.Šišlevica.

2. THE BRBIŠNICA COVE SEQUENCE

The basal part of the sequence consists of monotonous grey micrites with Pithonellas, hedbergellids and globotruncanids. These micrites fill up and level off the irregularities on the surface of the underlying, whitish, recrystallized *Chondrodonta*-radiolitid floatstone/ rudstone. No visible transgression phenomena are present. The *Chondrodonta*-radiolitid limestone contains typical Middle-to-Upper Cenomanian microfossil assemblage, consisting of *Chrysalidina gradata* D'ORBIGNY, *Broeckina (Pastrikella) balcanica* CHERCI et al. , etc. About 10-15 m above the disconformable contact with the Chondrodonta-limestone the homogeneous micrite sequence is interrupted with bioclastic intercalations, which in the following 20-25 m of sequence rhythmically occur at about 1 m intervals. The intercalations are each about 0.3-0.6 m thick and consist of rudist floatstones with recrystallized muddy matrix. Their lower bedding planes are, as a rule, irregular and lithologically sharp in relation to the underlying muddy sediment. In contrast to that, the upper bedding planes are even and most frequently gradually pass upward into the muddy sediment. Rudist and other skeletal debris within each bed are vertically graded in the muddy matrix. Thus, this is a transported shelf (platform) material, which is also indicated by close association of rudist floatstones with surrounding pelagic wackestones. Judging by their composition and texture, the depositional processes producing these displaced deposits originated by sediment gravity flow. They are most similar to Bouma T-a sequences. Their more comprehensive interpretation will be possible only when the displaced Upper Cretaceous deposits are accommodated within the regional framework of the Adriatic carbonate platform.

In the following 30-35 m of the column, muddy lithologies (mudstone-wackestone) predominate and rudist floatstone occurs only sporadically. The micrites have massive texture, even bedding planes, and show a laterally consistent composition. The microfossil assemblage consists of pelagic organisms: *Pithonella ovalis* (KAUFMANN), *Calcisphaerula innominata* BONET and *Stomiosphaera sphaerica* BONET are abundant, and planktonic foramifera of the *Hedbergella-Whiteinella* type are also present. Near the top of that interval, *Helvetoglobotruncana helvetica* (BOLLI), the zonal marker of the Lower Turonian, has been identified (Pl. II, Figs. 3-5).

Above that the sequence shows heterogeneous facies. Pelagic limestones alternate with variously thick and repeatedly occuring intervals consisting of chaotically distributed debrites and slump deposits. The slumps are of metric and decimetric size, the preferential orientation of their axes being NW-SE (see diagram D 3 in Text-fig. 2).

The slump sheets contain meter-sized blocks of allochthonous, gravity displaced shallow-water limestone. The debrites contain unsorted skeletal debris (mainly rudist) and sand- to gravel-sized lithoclasts. The fossil contents, both in the lithoclasts and in the bioclastic intercalations,corresponds to the one in the lower part of the Gornji Humac Formation on Brač (GUŠIĆ & JELASKA, 1990) and in the southeastern part of Dugi Otok Island (FUČEK et al., 1990). These are shallow-water benthic forms which include *Thaumatoporella parvovesiculifera* (RAINERI), *Aeolisaccus kotori* RADOIČIĆ, *Scandonea samnitica* DE CASTRO and *Pseudocyclammina sphaeroidea* GENDROT (Pl. II, Fig. 6), and *Moncharmontia apenninica* (DE CASTRO).

The muddy slump deposits, as well as the non-displaced, undisturbed autochthonous layers of pelagic limestone, contain pelagic microfossils *Pithonella ovalis* (KAUFMANN), *Calcisphaerula innominata* BONET, *Stomiosphaera sphaerica* BONET, and the planktonic foraminifera, hedbergellids and globotruncanids, among which we identified *Marginotruncana coronata* (BOLLI) - *pseudolinneiana* PESSAGNO, *M. marginata* (REUSS) (Pl. III, Fig 2), and, stratigraphically the most valuable, *Dicarinella primitiva* (DALBIEZ) (Pl. III, Figs. 3-5).

To our knowledge, this is also the first time that the first appearance of the above mentioned shallow-water benthic foraminifera (*Scandonea samnitica, Pseudocyclammina sphaeroidea* and *Moncharmontia apenninica*) has been ralatively reliably (i.e., according to planktonic foraminiferal zonation) dated as Late Turonian. Mostly, in the Yugoslav literature in particular, these species were tacitly assumed to have appeared at the beginning of the "Senonian". For example, in the Pyrenees the range of *Scandonea samnitica* seems to be restricted to the Upper Santonian, this age being proved by numerous ammonite species (BILOTTE, 1984, 1986). In Greece (FLEURY, 1980) and on the island of Brač (GUŠIĆ & JELASKA, 1990), however, all these age determinations were rather unreliable (though they proved to be correct), based more on the authors' "feelings" than on unequivocally accepted proofs. Therefore the direct correlation with a generally accepted planktonic foraminiferal zone (*Dicarinella primitiva*) is most imporant.

The slope deposit complex is overlain by pelagic limestones with a cut-in meter-sized channel. The channel infilling is composed of small-sized lithoclasts and numerous rudists and rudist debris. Their longer axes show a consistent arrangement (see diagram D 1 in Text-fig. 2) : they are perpendicular to the channel axis,

which means that they rolled downward along the channel in the direction in which the channel was being c ut. These data are in agreement with the orientation of slump axes (the D 3 diagram in Text-fig. 2), indicating that the direction of sediment transport was generally toward the southern quadrant.

Pelagic limestones of the *Dicarinella primitiva* zone continuously overlie the above mentioned channel deposits. The assemblage of planktonic microfossils contains, along with numerous pithonellas and calcispheres, globotruncanid species, among which we identified the forms belonging to the *Dicarinella hagni-primitiva* group , *Marginotruncana marginata* (REUSS) , *M.coronata* (BOLLI), and , at the very top, *M.* ex gr.*sigali*. In this, the *Dicarinella primitiva* interval, *Cadosina* sp., *Navarella joaquini* CIRY & RAT, Saccocoma sp. and unidentifiable pelagic grains also sporadically occur.

According to FLEURY (1980) and CARON (1985), *Dicarinella primitiva* (DALBIEZ) is characteristic of the Upper Turonian and Lower Coniacian. Because *H. helvetica* has been found in the basal beds of the slump complex, it can be concluded thet the formation of the slope and the associated sedimentary processes occurred in the Late Turonian.

3. CONCLUSIONS

The sediments of the Brbišnica sections offer plenty of signatures left by geological processes and events that occurred on the Adriatic carbonate platform during the Turonian and Lower Senonian . In the facies differentiation that occurred in the vertical sequence of beds, several stages in the evolution of the depositional system of the area investigated can be recognized.

The basal part of the pelagic limestone, that disconformably overlies the shallow-water platform limestone with *Chondrodonta* sp., radiolitids, etc., can be correlated with the Sveti Duh Formation (GUŠIĆ & JELASKA, 1990, FUČEK et al. , 1990). This is important for the regional stratigraphy because the drowning episodes of the carbonate platforms, as pointed out by SCHLAGER (1981), can serve as time-markers because they are caused by comparatively short-lasting but globally recognizable eustatic pulses.The Adriatic region is no exception; GUŠIĆ & JELASKA (1990) have numbered numerous localities (many of them by quoting the existing literature) where middle-to-upper Cenomanian platform limestones are overlain by Upper Cenomanian to Lower Turonian pelagic micrites.

However, the sea level rise has not completely drown the entire Adriatic carbonate platform and thus failed to fully eliminate the shallow-water platform biota. This is evidenced by gravity displaced platform limestones with shallow-water algae and benthic foraminifera, that in the lower part of the Brbišnica section were found within micritic limestone with pelagic microbiota. Thus some (isolated?) parts of the platform have remained within the photic zone, and in the Middle Turonian the platform conditions were re-established over the largest part of the platform. While these parts of the platform experienced only the initial phases of the "oceanization", the Brbišnica sequence , on the other hand, shows the continuity of pelagic sedimentation from the Late Cenomanian well into the Santonian (Campanian?). This case shows some degree of analogy with the Blake Plateau in the Atlantic, where Middle Cretaceous fenestral limestone is overlain with Upper Cretaceous pelagic deposits (SHIPLEY et al., 1978).

Plankton biostratigraphic data made possible a sufficiently precise dating of the main events in the Brbišnica profile. In the *Helvetoglobotruncana helvetica* Zone (Middle Turonian) , pelagic limestones are associated with gravity displaced platform limestones. This association of lithologies proves that , after the Late Cenomanian-Early Turonian oceanization event, as early as in the Middle Turonian the platform re-established itself and was able to yield material into the adjoining basin. In the next, the *Dicarinella primitiva* zone (Turonian-Coniacian), the slope depositional mechanisms faded out and pelagic rain sedimentation continuously followed . This, oceanized part of the Adriatic carbonate platform was possibly connected with the Umbria-Marchia basin in the west, and/or the Venetian Alps area in the northwest. The geotectonic setting of that large pelagic environment is illustrated by JENKYNS (1986, in READING, p.367). The paleogeographic setting of the Adriatic carbonate platform and the adjoining pelagic realms could not be definitely established before the stratigraphic data from the Adriatic deep wells became publicly available. With the lack of these data, it cannot be decided whether the Turonian slump deposits in the Brbišnica Cove represent a true platform margin with the surrounding pelagic facies being a part of a slope apron complex, or they represent the deposits of an intra-platform trough, as postulated by JELASKA (1983).

TABLA - PLATE I

1. Kanalski sediment (u stupu oznaka E). Vidi oštar i neravan dodir s pelagičkim mikritima u podini.
   Channel deposit (E mark in the column). Note sharp and uneven contact with the underlying pelagic micrites.
2. Kaotične taložine (u stupu oznaka C). Vidi metarske blokove plitkomorskih (platformskih) vapnenaca.
   Chaotic deposits (C mark in the column). Note platform limestone block of metre size.
3. Dodir kaotičnog intervala (u stupcu oznaka A) i pelagičkih mikrita.
   Contact between chaotic interval (A mark in the column) and underlying pelagic micrites.

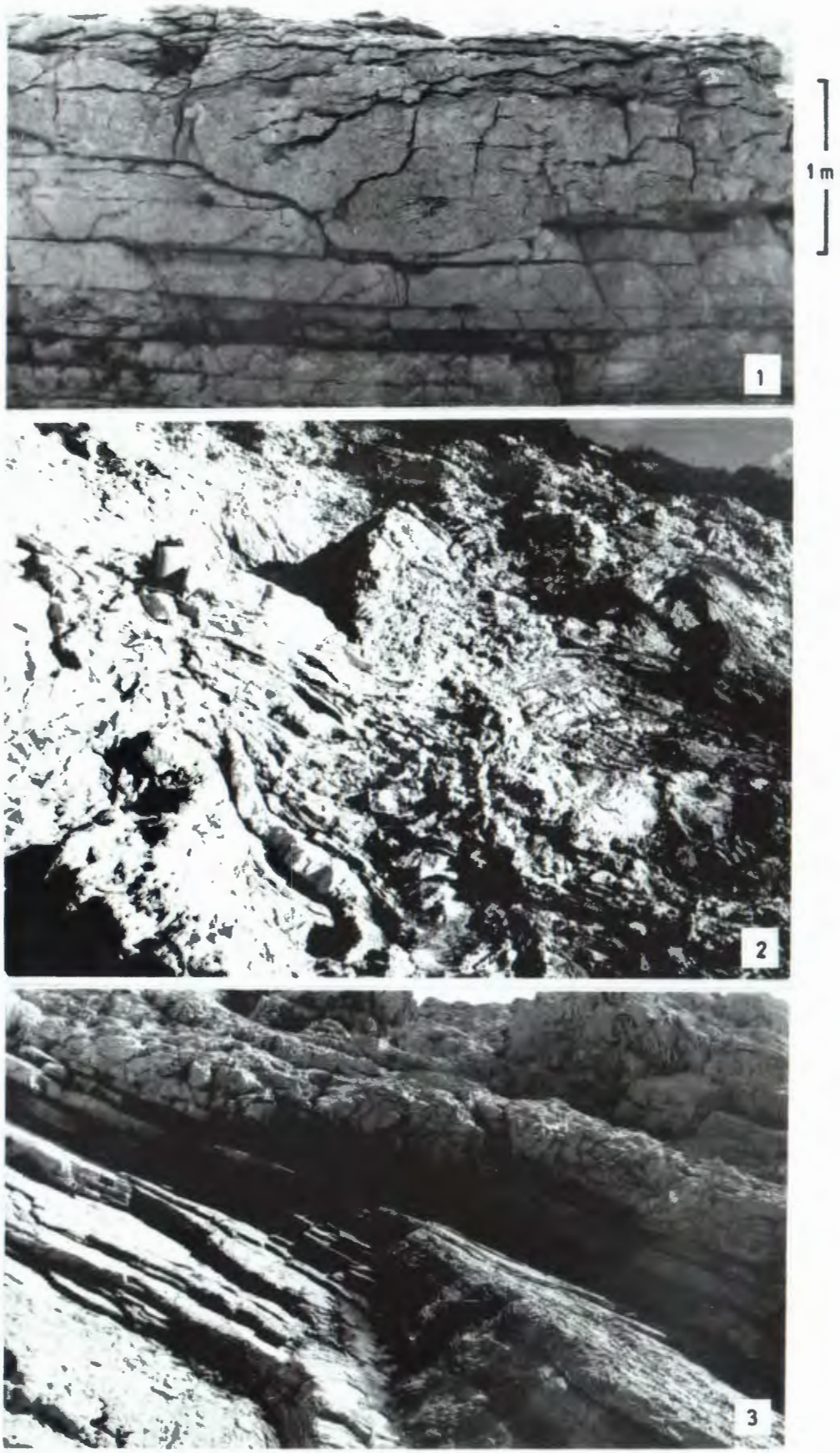
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TABLA - PLATE II

1. Biomikrit s pelagičkim česticama (Biomicrite with pelagic particles):*Pithonella ovalis* (KAUFMANN), *Calcisphaerulla innominata* BONET, *Stomiosphaera sphaerica* BONET, heterohelicide (*Heterohelix sp.*) x 80.
2. *Marginotruncana sigali* (REICHEL) x 100.
3 - 5. *Helvetoglobotruncana helvetica* (BOLLI) x 80.
6. *Scandonea samnitica* DE CASTRO i (and) *Pseudocyclammina sphaeroidea* GENDROT, x 40.
7. Oštar i neravan kontakt između bioklastičnog intervala i pelagičkog mikrita u podini. (Sharp and uneven contact between bioclastic interval and the underlying pelagic micrite) x 25.

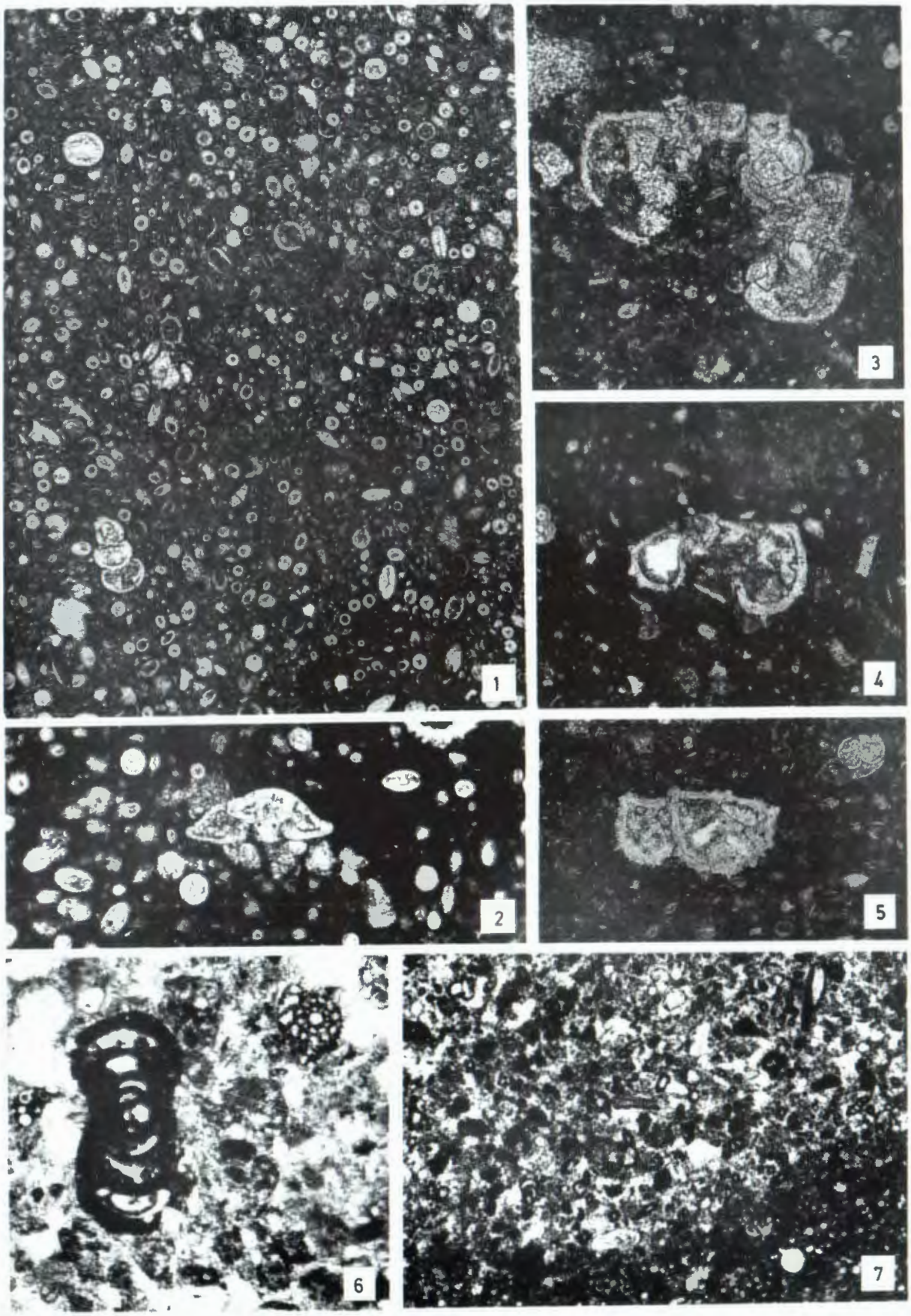
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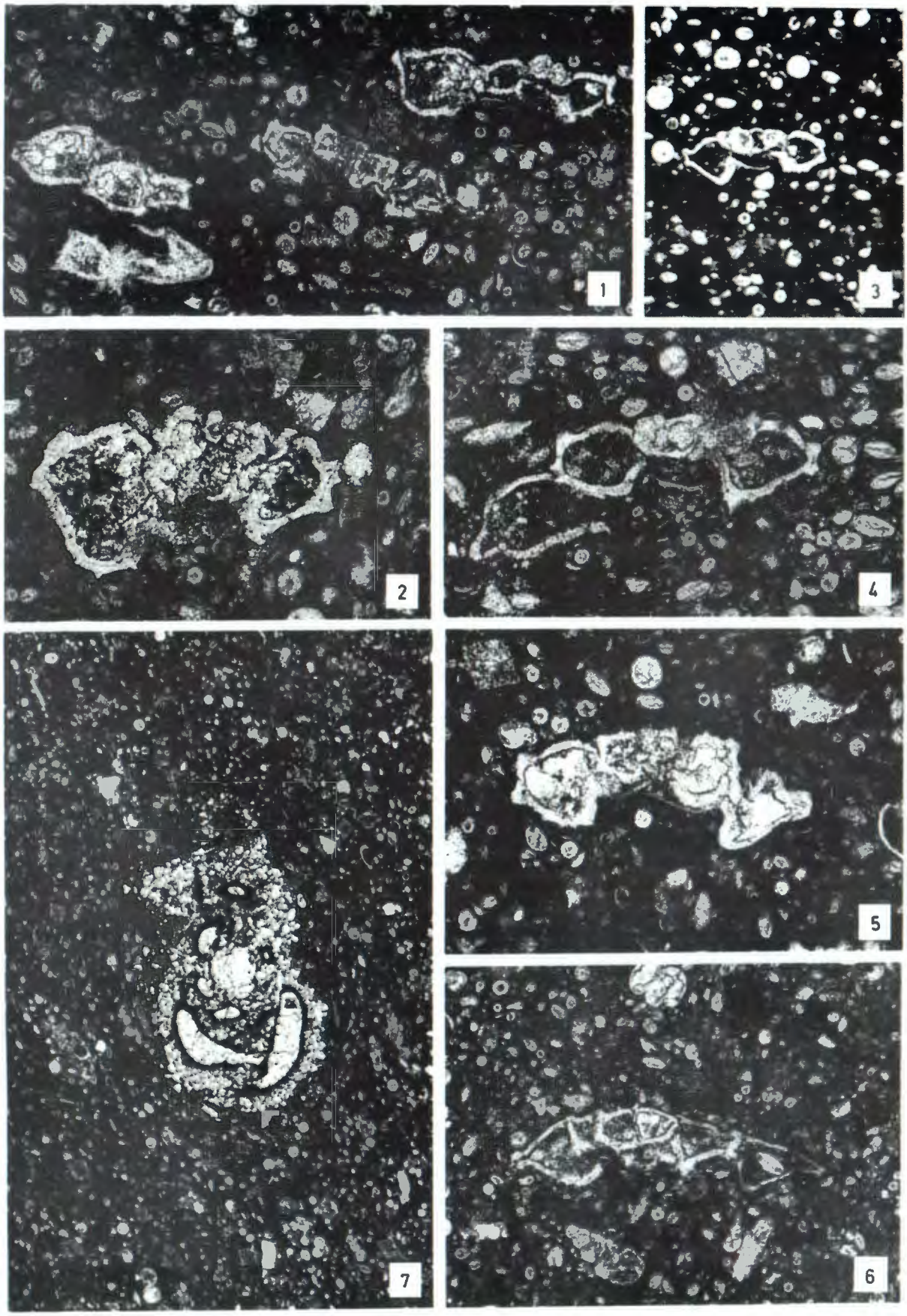
TABLA - PLATE III

1. *Dicarinella* ex gr. *primitiva*, x 80.
2. *Marginotruncana marginata* (REUSS), x 125.
3 - 5. *Dicarinella primitiva* (DALBIEZ); 3=x62, 4,5=x100.
6. *Marginotruncana renzi-primitiva*, x 80.
7. Aglutinirana foraminifera slična ili srodna vrsti *Navarella joaquini* CIRY & RAT .
   (An agglutinated foraminifer, similar to *Navarella joaquini* CIRY & RAT), x 31.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