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TRIASSIC TERRESTRIAL PHASE RECORDED IN THE CARBONATE PLATFORM SUCCESSION OF THE KARST DINARIDES (CROATIA)

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The Triassic carbonate platform succession of the Karst Dinarides was deposited at the southern Tethyan realm. The facies analysis and distant correlation suggests that a regional terrestrial phase occurred in that area during the Triassic. Due to its regional extent, this terrestrial phase has been viewed as a product of tectonically induced uplift of the huge platform area, causing an extensive emersion and distinct disruption in depositional regime when disconformity and/or various types of terrestrial depositional intervals were formed. Two geodynamic scenarios are presented; a) regional, contemporaneous tectonic uplift scenario; and b) diachronous and differential tectonic uplift scenario. During Norian, the uplifted, exposed platform area was flooded and covered by tidal flat-dominated shallow-water carbonates, marking the beginning of wide and long-lasting isolated platform regime.

Key words: Triassic, Tethys, terrestrial phase, Karst Dinarides, Croatia

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Trijaski karbonatni slijed Krških Dinarida istaložen je na prostranstvu južnog Tetisa. Facijesna analiza i prostorna korelacija tog slijeda naslaga upućuje na regionalnu kopnenu fazu koja je tijekom Trijasa zahvatila ovaj prostor. Svojim regionalnim pružanjem, ova kopnena faza se sagledava kao posljedica tektonski izazvanog izdizanja prostranog platformnog područja, a što je uzrokovalo izrazito okopnjavanje i izrazit prekid dotadašnjeg taložnog režima, čime su nastali taložni diskonformiteti i/ili različiti tipovi kopnenih taložnih slijedova. Predstavljena su dva geodinamska scenarija; a) scenarij regionalnog, istovremenog izdizanja prostranog platformnog područja; i b) scenarij vremenom i intenzitetom različitog izdizanja prostranog platformnog područja. Tijekom Norika, to dotad izdignuto i izloženo platformno područje bilo je preplavljeno i prekriveno plitkovodnim karbonatima plimne zone, označavajući početak prostranog i dugotrajnog taložnog režima izolirane karbonatne platforme.

Ključne riječi: trijas, Tetis, kopnena faza, krški Dinaridi, Hrvatska

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INTRODUCTION

Karst Dinaridic area contains sedimentary signature of four depositional megasequences. These are: 1) carbonate/clastic megasequence ranging from the Lower Carboniferous to the Early Permian, 2) clastic/carbonate megasequence ranging from the late Middle Permian to the Middle Triassic; 3) carbonate megasequence ranging from the Late Triassic to the Late Cretaceous; and 4) carbonate/clastic megasequence ranging from the Paleocene to the Middle Eocene. These megasequences are separated by the significant terrestrial phase, marking regionally important emersion event (VELIĆ *et al.*, 2002).

This paper focuses on the terrestrial phase between the second and the third depositional megasequence. Deposition of the second megasequence occurred contemporaneously along the northern Gondwana margin (southern Tethyan realm) (RAMOVŠ *et al.*, 1990; KRAINER, 1993; JURKOVIĆ & PAMIĆ, 2001; KIESSLING *et al.*, 2003; SREMAC, 2005). From the late Middle Permian to the end of the Permian, the continuous shallow-water platform sedimentation on the epeiric platform area produced a carbonate sequence a several hundred meters thick (KOCHANSKY-DEVIDÉ, 1965; SOKAČ *et al.*, 1976). During the Early Scyhtian the carbonate production was choked up by intensive inputs of terrestrial material derived by fresh water flows from the Gondwana hinterland. Partly during the Late Scyhtian and during the Anisian/Ladinian, the shallow-water carbonate platform sedimentation was restored, but soon it was interrupted with a tectonically induced regional emersion, separating the second and the third megasequence of today's Karst Dinarides. During that emersion, a terrestrial phase came into being throughout the Karst Dinarides. Therefore, this paper presents and interprets this phase. For that purpose, four typical Triassic sections from Karst Dinarides were chosen for correlation.

DESCRIPTION OF THE STUDIED SECTIONS

Within the Triassic sediments of the studied Karst Dinaridic sections, significant terrestrial intervals can be distinguished, marking the long-lasting break in shallow-water platform deposition. These are: a significant disconformity between the Upper Scythian and Lower Norian at Gorski kotar section; an Anisian – Lower Norian tuffaceous interval at Velebit W section; an Upper Ladinian/Carnian – Upper Norian brecciated interval at Svilaja section; and an (Upper?) Ladinian – Lower Norian claystone/bauxitic interval at Velebit E section.

a) The Gorski kotar section

Along the Zagreb-Rijeka road a 40 m thick exposure of Lower Triassic deposits occurs (Figs. 1a and 2a). They are represented by weathered, yellowish grey, reddish and/or olive grey platy beds (0.01–0.1 m) composed of thin-bedded, silty and/or sandy dolopelmicrites that irregularly alternate with grey, medium bedded (0.1–0.5 m) dolomicrites and/or dolomitic oosparites (Fig. 3a). Silty and/or sandy dolopelmicrites are composed of dolomitized peloids with various proportions of mica and/or quartz grains. These beds commonly reveal horizontal lamination with platy mica grains, oriented parallel to bedding. Ooid »ghosts« in dolomitic

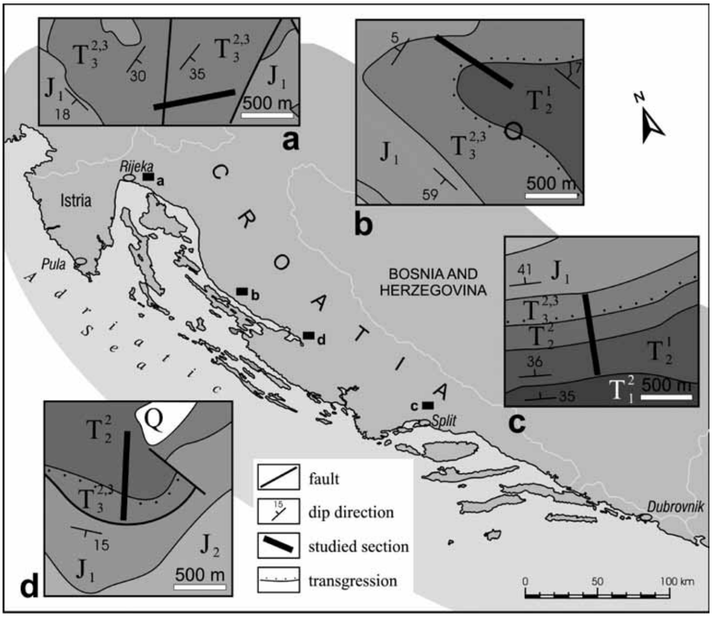

Fig. 1. Geographical positions of the studied sections: a – Gorski kotar (45°21’23 N, 14°38’06 E); b – Velebit W (44°32’14 N, 15°08’49 E); c – Svilaja (43°42’57 N, 16°32’44 E); d – Velebit E (44°16’14 N, 15°48’29 E). Geological sketches a-d according to Basic Geological Map 1:100000, sheets: a – Delnice (SAVIĆ & DOZET, 1984); b – Gospić (SOKAČ *et al.*, 1974); c – Sinj (PAPEŠ *et a*l., 1982); d – Obrovac (IVANOVIĆ *et al.*, 1976) (all modified). Legend: T_1^2 – upper Lower Triassic; T_2^1 – lower Middle Triassic; T_2^2 – upper Middle Triassic; $T_3^{2,3}$ – Upper Triassic; J_1 – Lower Jurassic; J_2 – Middle Jurassic; Q – Quaternary.

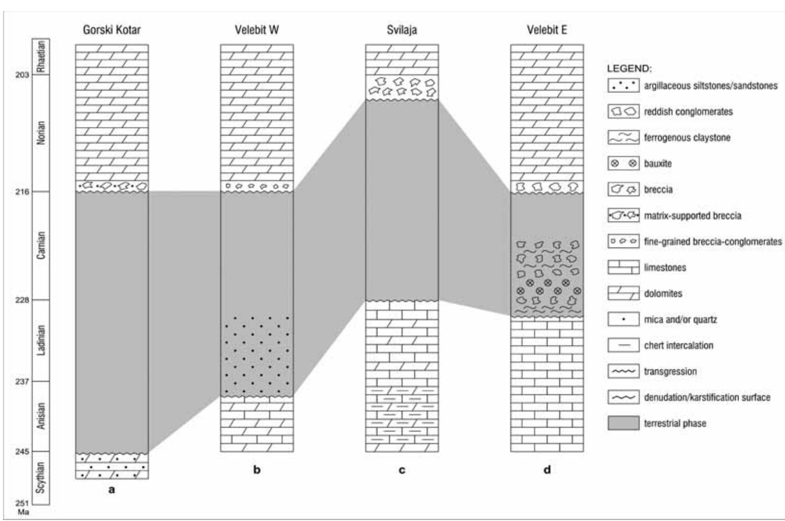

Fig. 2. Correlation of terrestrial phase depositional intervals perceived within the studied sections.

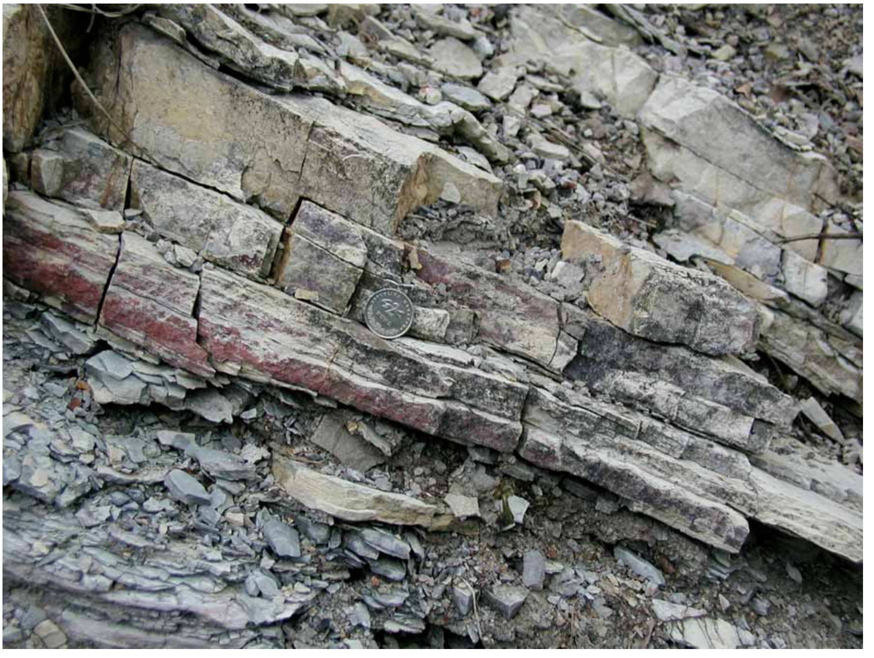

Fig. 3a. Gorski kotar section. Upper Scythian thin-bedded sandy dolopelmicrites.

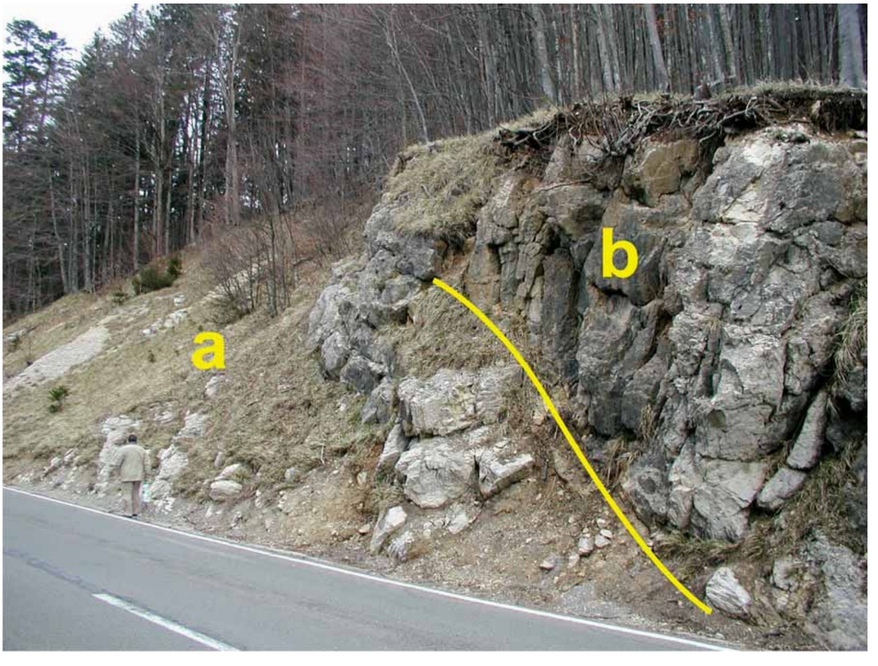

Fig. 3b. Gorski kotar section. Line marks the contact (disconformity surface) between Upper Scythian dolomicrites (a) and Lower Norian matrix-supported breccia (b)

oosparites range in size from 0.2 mm to 1.0 mm. The relicts from the ooid inner fabric are rarely preserved in cryptocrystalline replacive dolomite crystals or pseudosparitic mosaics. In dolomitic oosparites, the Upper Scythian foraminifer *Meandrospira pussila* (Ho) has been identified (ĐURĐANOVIĆ, 1967). Coarser, recrystallized molluscan fragments in these deposits are only sporadically present. Above a sharp

Fig. 3c. Gorski kotar section. Lower Norian matrix-supported breccia.

and uneven contact, the topmost Upper Scythian dolomicritic interval is overlain by a 4.5 m thick matrix-supported breccia (Fig. 3b). It is composed of yellowish grey and reddish silty and/or sandy dolopelmicritic and dolomicritic pebbles, ranging in size from 0.01–0.05 m (Fig. 3c). The color and litological characteristics of these pebbles fully correspond to the rocks from the underlying Upper Scythian beds. The pebbles are poorly sorted, with slight or no apparent grading in a dolomitic groundmass that commonly contains late-diagenetic, eu- to sub-hedral dolomitic microcrystals. This is then the predominant structural characteristic in the overlying ca. 250 m thick succession of Norian-Rhaetian dolomite. Thus, it can be assumed that this matrix-supported breccia belongs to the Early Norian. The Norian-Rhaetian dolomite is thin to medium bedded (0.1–0.4 m), moderate grey and/or, in places, yellowish grey in color due to weathering and limonitization of pyrite grains. Early-diagenetic dolomitic varieties, dolomitic limestone as well as dedolomite, respectively, occur sporadically. The late-diagenetic dolomitic beds are monotonous, composed of predominantly subhedral and to a lesser extent euhedral dolomite crystals, ranging in size from 0.1–0.4 mm, so the primary structures are not visible. In places, it shows even a sandy appearance. The early-diagenetic dolomitic beds show a heterogeneous microfacies composition, with numerous lithological varieties such as dolosparite, dolointrasparite, dolomicrite, dolopelmicrite and/or stromatolitic dolomite. Desiccation and erosion processes ripped up the stromatolitic laminae, forming an intraformational dolomite breccia locally. Abundant, irregular fenestrae and sporadic undeterminable algal fragments, molluscs and ostracodes also occur. The irregular fenestrae frequently show geopetal characteristics. In dolopelmicrites, *Triasina hantkeni* Majzon and *Aulotortus sinuosus* Weynschenk can be sporadically found.

b) The Velebit W section

The succession in the wider area of Velebit W section (Fig. 1b) provides evidence of shallow-marine deposition from the Middle Permian (Kungurian) to the Oligocene. However, attention was given to Middle-to-Upper Triassic strata (Fig. 2b).

The Anisian beds, medium to thick bedded (0.3–1.1 m), are characterized by lateral and vertical alternation of dolomites and limestones that conformably overlie Lower Triassic dolomites. The Anisian dolomites are mostly medium to light grey with yellowish, rusty brown color on weathered surfaces. Two main types of dolomites can be observed; late-diagenetic, micro- to macro-crystalline, composed of anhedral to euhedral dolomite crystals without any preserved sedimentary texture, and early-diagenetic varieties that include dolomicrites, fenestral dolomicrites and dolomitic stromatolites with very fine undulating laminations. Dolomitic stromatolites are sporadically fragmented, forming intraformational breccia intervals a few cm thick. The strata with the Anisian microfauna are represented by mostly recrystallized peloidal-bioclastic wackestones-packstones, frequently interlayered by dolomitized limestones. Among the pellets, peloids and undeterminable molluscan fragments occurring in the recrystalized groundmass, the microfossil content is very poor. The upper part of the Anisian succession contains sporadic findings of Anisian species *Meandrospira dinarica* Kochansky-Devidé & Pantić (Fig. 4a).

The topmost bed of ca. 80 m thick Anisian succession is characterized by a discrete, 0.1 m thick, karstified surface (Fig. 4b), intersected by numerous dissolution-enlarged fractures, thus forming its brecciated appearance with fragments up to 0.1 m in diameter. The fractures are entirely filled up with sparry calcite enriched with reddish bauxitic clayey material.

Above the karstified surface lays a several meters thick succession of fine-grained reddish argillaceous siltstones/sandstones, representing the terrestrial interval. Similar deposits also occur at a few other places of Karst Dinarides. After Sokač *et al.* (1976), these are usually tuffaceous, forming sporadic lense-shaped bodies of various thicknesses. At Velebit W section, these deposits are usually covered, preventing the detailed observation. However, in a few places small outcrops occur, which clearly reveal typical characteristics of these beds. Individual beds are 0.1–0.4 m thick, revealing, in places, horizontal lamination. They typically contain moderate to well sorted quartz grains; feldspars and fragments of basic effusive rocks occur only sporadically. The grains are inserted in an altered matrix composed of illite, kaolinite and chlorite. The reddish color of these deposits indicates the presence of hematite. The uppermost part of these deposits is represented by a 2 m thick, fine-grained, reddish, breccia-conglomerates interval. It is composed of unsorted subangular to rounded tuffitic pebbles, mostly 2 to 8 mm in size. They are quite uncon-

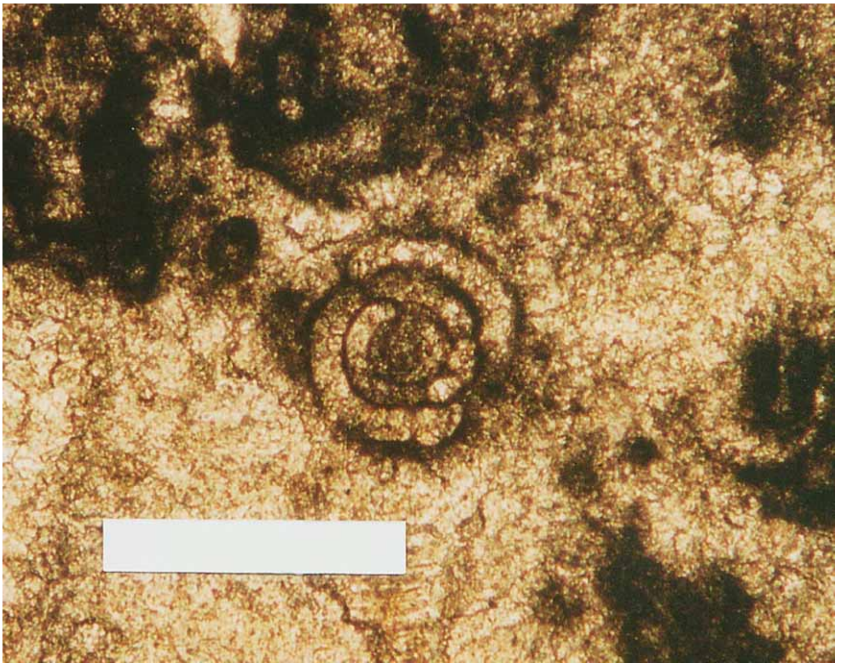

Fig. 4a. Velebit W section. Recrystallized peloidal-bioclastic wackestone with *Meandrospira dinarica* Kochansky-Devide & Pantic. Anisian. Scale bar 0.4 mm.

Fig. 4b. Velebit W section. Karstified surface at the topmost Anisian bed.

solidated, showing a sandy appearance (Fig. 4c). This breccia interval is followed with a succession of Norian-Rhaetian dolomite, ca. 220 m thick. Its structural characteristics fully correspond to those from the Gorski kotar section.

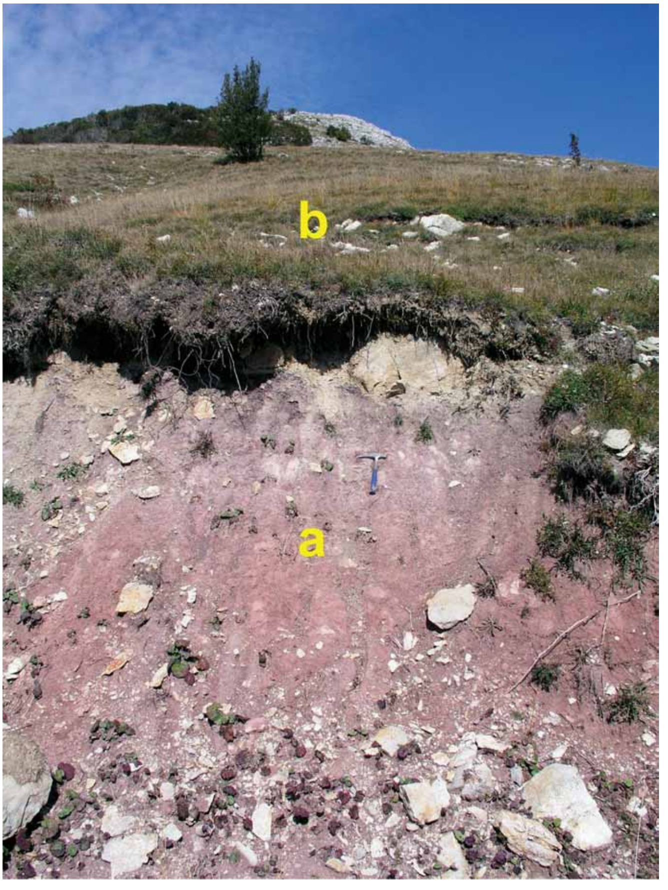

Fig. 4c. Velebit W section. Lower Norian fine-grained, reddish breccia-conglomerates of a sandy appearance (a) followed with a Norian-Rhaetian dolomite (b)

c) The Svilaja section

The surrounding of the Svilaja section (Fig. 1c) is a well-known locality (e.g. JELASKA *et al.*, 2003; BALINI *et al.*, 2006; GRGASOVIĆ *et al.*, 2007), comprising a thick succession of the Middle Triassic strata (Fig. 2c). In the thickness of 55 m, the Anisian carbonates contain more or less clear traces of volcanism; limestone and dolomite beds are punctuated by numerous cm-to-dm thick tuff intercalations, a few mm thick chert intercalations, and frequent pervasive silicification.

The Ladinian interval is composed of 80 m thick interval of bioclastic wackestones-floatsones and dolomites in alteration. The wackestones-floatstones, only sporadically intercalated with chert, frequently contain recrystalized *Diplopora annulata* Schafhäutl fragments, oncoids, crinoidal detritus and stromatolitic intraclasts. Silicification of limestone beds is quite rare. These carbonates represent the termination of the Upper Ladinian/Carnian at the foothills of Mt. Svilaja (Jelaska *et al.*, 2003). Their topmost surface is intensely brecciated.

The breccia interval is 4 m thick. It is composed of angular and subangular limestone and dolomite fragments that vary in size from a few millimeters to a few centimeters (Fig. 5a). Larger fragments occur only sporadically. Some fragments contain calcite and/or dolomite veins. At places, the breccia contains rounded fragments thus passing into a conglomerate. Packing of breccia fragments is dense, while their sorting is poor, without grading or bedding. Predominate type of fragments is white, bioclastic wackestone/floatstone containing *Diplopora annulata* Schafhäutl (Figs. 5b and c). Other wackestone/floatstone fragments contain rare undeterminable mollusc remains, rounded intraclasts, and rare oncoids. Dolomite fragments consist of subhedral to euhedral dolomite crystals with only sporadically preserved original sedimentary structures, such as stromatolitic lamination. The matrix of breccias consists of fine-grained limestone and/or dolomite particles, enriched with reddish bauxitic clayey material. Some larger carbonate particles, incorporated in the matrix, are completely recrystallized. In spots, coarser sparry crystals occur. Sporadic larger cavities are partly matrix-filled or in part spar-filled, revealing geopetal fabrics.

The breccia horizon is overlain by an 8 m thick interval of grain-supported, oolitic-foraminiferal packstone, with Late Norian to Rhaetian foraminifers *Triasina hantkeni* Majzon and *Aulotortus* sp. (Bucković *et al.*, 2003). This is, in turn, followed by a 60 m thick succession of Norian-Rhaetian dolomite.

Fig. 5a. Svilaja section. Upper Norian breccia interval composed of Upper Ladinian fragments.

Fig. 5b. Svilaja section. The breccia fragment. Arrows point at oblique sections of *Diplopora annulata* Schafhäutl.

Fig. 5c. Svilaja section. Recrystallized bioclastic floatsone with *Diplopora annulata* Schafhäutl. Scale bar 0.8 mm.

d) The Velebit E section

The Triassic carbonates of the Velebit E section (Figs. 1d and 2d) are ca. 180 m thick. Both Anisian and Ladinian successions are composed of thick bedded (0.4–1.5 m) bioclastic wackestones/floatstones, sporadically rich with dasyclad algae. In Anisan beds, these are *Macroporella alpina* Pia, *Diplopora hexaster* Pia and *Diplopora proba* Pia, whereas Ladinian deposits predominantly contain *Diplopora annulata* Schafhäutl and *Teutloporella herculea* (Stoppani) (IVANOVIĆ *et al.*, 1976). Variable amounts of peloids, molluscan and ostracod fragments also occur. Foraminifers are very rare. The matrix is clotted micrite with sporadically abundant irregular fenestrae, filled with fibrose and drusy calcite.

Fig. 6a. Velebit E section. Ladinian/Carnian bauxite horizon.

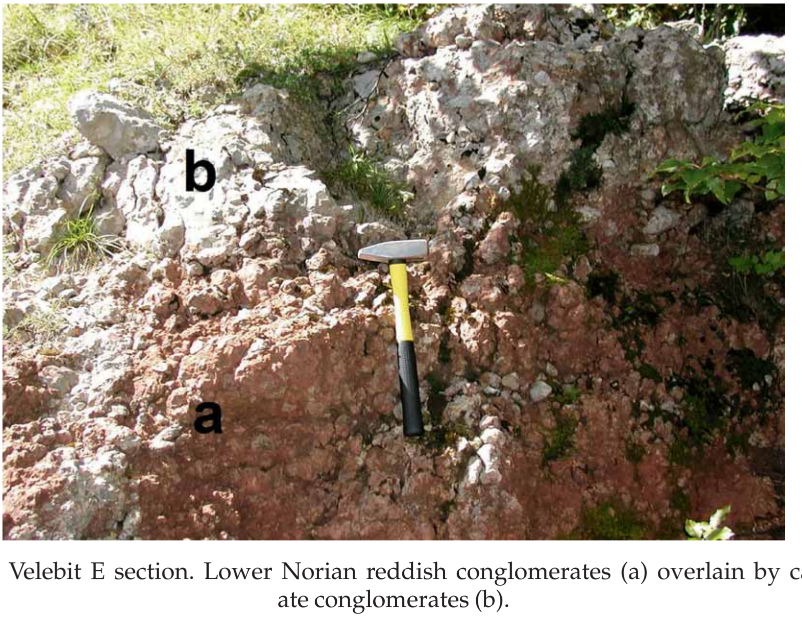

Fig. 6b. Velebit E section. Lower Norian reddish conglomerates (a) overlain by carbonate conglomerates (b).

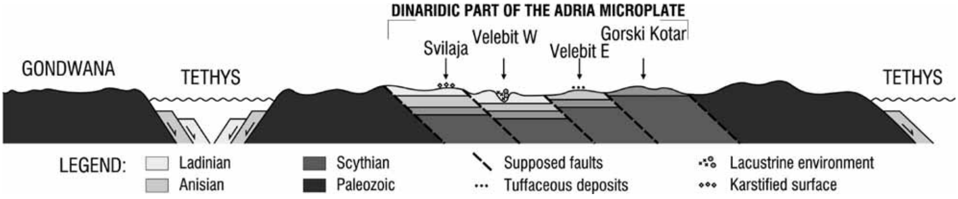

Fig. 7. Schematic sketch showing simplified paleogeography of the Dinaridic part of the Adria Microplate during the time span Late Ladinian – Carnian. Supposed faults stand for a diachronous and differential tectonic uplifts scenario (not to scale).

The upper part of Ladinian bioclastic wackestones/floatstones are overlain by ferruginous chlorite-kaolinite claystones, bauxites and reddish conglomerates, representing the terrestrial interval (Fig. 6a). According to ŠINKOVEC (1970) and TIŠLJAR *et al.* (1991), the bauxite horizon is 18 m thick, revealing an oolitic-crystalline granular and/or peleitic to pseudoporphyric texture. The main mineral is diaspore, while hematite, kaolinite, boehmite and chlorite are subordinated. The bauxite horizon is separated into two layers by an approximately 2 meter thick bed of reddish conglomerates. This bed contains resedimented claystone pebbles and sporadical pebbles of Ladinian bioclastic wackestones-packstones, 0.05–0.2 m in diameter. Overlying the bauxite horizon, there is a 22 m thick, purple colored ferruginous claystone and reddish conglomerate in iregular alteration. These deposits are overlain by carbonate conglomerates, extending about 200 m laterally. It abruptly changes in thickness from few decimeters to 1 meter, overlying, in places, ferruginous claystones and/or reddish conglomerates (Fig. 6b). Packing of conglomerate limestone pebbles is dense and sorting is good, without grading. Within this conglomerate interval two parts can be distinguished. In the lower part, subrounded to rounded pebbles of Ladinian bioclastic wackestones-floatstones, 0.01–0.05 m in diameter, contain a relatively high percentage of ferruginous matrix, while in its upper parts, in contrast, the ferruginous content of the matrix either decreases or disappears (TIŠLJAR *et al.*, 1991). These carbonate conglomerates are followed by 140 m thick succession of Norian-Rhaetian dolomite.

DISCUSSION

As it has been already mentioned, the terrestrial phase between the second and the third megasequence of the Karst Dinarides indicates a break in shallow-marine carbonate sedimentation regime, when deposition and/or denudation processes under subaerial exposure took place. Commonly, the eustatic sea level fall was assumed to be responsible for development of subaerially exposed sequence boundary in ancient carbonate successions, which resulted in paleokarsts beneath the sequence boundary (KERANS, 1988; SARG, 1988; FRITZ *et al.*, 1993; MONTAFIEZ & OSLEGER, 1993; ELRICK, 1996). However, Doglioni *et al.* (1990) suggested that the tectonic »enhancement« could be important factor leading to subaerial exposure. Applying this suggestion, one can notice that tectonic activity, i.e. rifting processes and rift-related volcanism were important events in the northern Gondwana margin since the Late Permian

(ZIEGLER, 1990, PAMIĆ *et al.*, 1998). Thus, during the Middle Triassic, these rifting processes produced discrete zones of igneous rocks, transecting the Palaeozoic basement (CHANNELL *et al.*, 1979; PAMIĆ *et al.*, 1998), and isolated, narrow basins in which deep-water cherts, pelites and limestones were deposited (PAMIĆ *et al.*, 1998). These Middle Triassic tectonic events in the southern Tethyan realm ripped off one large lithospheric fragment called the Adria Microplate (e.g. CHANNELL *et al.*, 1979; VELIĆ *et al.*, 2003; etc.). The large portion of that isolated lithospheric area was soon afterwards subjected to tectonically induced uplift(s), superimposed on overall eustatic variations, resulting in regional emersion phase (Fig. 7). By that, two geodynamic scenarios can be envisaged for the Dinaridic part of the Adria Microplate; a) regional, contemporaneous tectonic uplift scenario; and b) diachronous and differential tectonic uplift scenario. In both cases, disconformity and/or terrestrial depositional intervals should have been formed. However, in some parts of the Dinarides (e.g. in W Slovenia, vicinity of Karlovac in Central Croatia, or W and Central Bosnia and Herzegovina, or N and S Montenegro – VLAHOVIĆ *et al.*, 2005), there are no evidences of such a regionally significant event, indicating that there existed some different geodynamic scenario which is out of scope of this study.

a) The regional, contemporaneous tectonic uplift scenario

In this scenario it can be supposed that regional, contemporaneous emersion took place at the entire Adria Microplate during Late Ladinian/Carnian, causing strong denudation and/or karstification throughout the exposed area (e.g. BOSELLINI 1991; DE ZANCHE *et al.*, 1993, RÛFER & ZÛHLKE, 1995; D' ARGENIO & MINDSZENTY, 1995; GIANOLLA *et al.*, 1998; ŠMUC & ČAR, 2002; BRACK *et al.*, 2005).

The most intensive denudation process took place in today's Gorski kotar area, producing clear disconformity between the Upper Scythian and Lower Norian. This disconformity was noticed earlier by BABIĆ (1968). The denuded sedimentary signature of the Upper Scythian reveals clear deposition features of the shallow-water Gondwana shelf area during Early Triassic (ALJINOVIĆ, 1995). During the Late Scythian sea level rise (e.g. HAQ *et al.*, 1988), the shoreline was shifted towards the Gondwana hinterland, so deposition took place more distally on the Gondwana shelf area, enabling predominant accumulation of micritic to oolitic carbonates, partly and sporadically intercalated with sand- and/or silt-sized particles, derived from Gondwana land by sea-bottom currents. Transgression on the denuded Upper Scythian surface started during the Early Norian. As matrix-supported breccias and/or conglomerates are common characteristic of mass flow deposits (e.g. AGER, 1993), it can be assumed that during the Early Norian transgression severe floods triggered by hurricanes or tropical storms occurred, carrying fine-grained carbonate mud and ripping up pieces of the Upper Scythian shallow sea floor bottom. Such catastrophic events were very erosive, removing the karstic residual clasts and weathering products (paleosol), and forming a thick bed of the Lower Norian matrix-supported breccia, above the sharp and uneven surface of the underlying Upper Scythian mixed siliciclastic-carbonate beds.

During the middle Triassic, a significant volcanic activity took place (see e.g. LUGOVIĆ, 1983; MARCI *et al.*, 1990), when volcanic ash spread and covered some areas, as it can be clearly noticed at Velebit W section. It can be assumed that this cover of fallen volcanic ash blocked any further pervasive denudation of still exposed Anisian carbonate basement, producing tuffaceous terrestrial interval that overlies the Anisian carbonates. Thus, in Velebit W section, the most Anisian carbonates remain preserved. The Early Norian transgression eroded and reworked the top of that tuffaceous interval, but since the presented transgressive breccia-conglomerates at the investigated area is fine-grained, it can be supposed that the transgression took place in a protected area, with low energy of oncoming sea.

At the Svilaja section, the Upper Ladinian/Carnian carbonates were subjected more to karstification than to denudation, so the terrestrial phase can be recognized in terms of paleokarst-related solution-collapse breccias, as it has been described e.g. by RYU *et al.* (2002). Thus, it can be assumed that overall regression caused dissolution of the exposed Upper Ladinian/Carnian carbonates, resulting in extensive karstification, with solution-enlarged vugs and small caverns beneath the platform surface, producing clast- to matrix-supported chaotic breccias, sharply overlying Upper Ladinian/Carnian beds. Active carbonate dissolution ceased, due to the Norian transgression when sediment loading caused local collapse and fragmentation of karstified surface. Continued burial led to further fracturing and in situ brecciation, resulting in mosaic and fracture breccia horizon. The small thickness of the dolomite interval (only 60 m) that overlies the breccia horizon suggests that here the transgression begun later than in the other Karst Dinaridic areas. This is clearly indicated by much thicker Norian-Rhaetian dolomit successions (regularly exceeding 200 m) in most other Karst Dinaridic areas. Thus, it can be assumed that the transgresion in the Svilaja area did not take place before the Late Norian.

A different scenario is envisaged for the terrestrial phase horizon on the Velebit E section. A wide local karstic depression developed here. The depression was filled by pelitic and colloidal clayey material derived from the Middle Triassic volcanic-sedimentary complex (LUGOVIĆ, 1983; MARCI *et al.*, 1990), affected by chemical weathering under subaerial conditions. Chemical weathering of the volcanic rocks led to decomposition and/or dissolution that resulted in formation of kaolinite, chlorite, illite, etc. By fresh water flows and/or by wind, these residuals were transported and then accumulated in the paleorelief depressions, a situation most alike to shallow-water lacustrine environments. Warm and humid Ladinian-Carnian climate (e.g. MUTTI & WEISSERT, 1995) was very favorable for lateritization processes by which the accumulated material was diagenetically altered, thus forming thick claystone/bauxite deposits. The reddish conglomerates were formed during storm events when both erosion of claystone/bauxitic material in the shallow-water pools and reworking of fragments of the karstified Ladinian rocks that surrounded paleodepression took place. The carbonate conglomerate beds that occur at the top of the claystones/bauxites were formed during the Early Norian marine transgression, when the abrasion of karstified Ladinian rocks that surrounded the paleodepression became predominant. Ferruginous matrix within the lower part of the conglomerate interval was derived from the final resedimenation of underlying claystone/bauxitic material, while its absence in the upper part of the conglomerate interval indicates advanced transgression and beginning of the relatively stable Early Norian shallow-marine conditions.

The Norian and Rhaetian sedimentary signature, overlying all the studied sections, is represented by a more or less thick dolomite succession with subordinately preserved features of early-diagenetic dolomitization. Numerous lithological varieties of early-diagenetic dolomitic beds imply a peritidal, isolated, platform environment, where successive shallowing-upward cycles were produced. Nevertheless, late-diagenetic dolomitization destroyed most of the sedimentary and early-diagenetic features, so their occurrences in the Karst Dinaridic dolomite successions are rather sporadic and irregular.

b) The diachronous and differential tectonic uplift scenario

In this scenario it can be supposed that diachronous, differential tectonic uplifts must have taken place on Gondwana shelf and/or Adria Microplate area during the time span Late Scythian – Late Ladinian.

Thus, during the Late Scythian, movement along the faults on Gondwana shelf area allowed the regional uplift of today's Gorski kotar area, enabling the long lasting exposure of Upper Scythian (Campilian) deposits. During the Early Norian transgression the matrix-supported breccia covered the underlying Upper Scythian mixed siliciclastic-carbonate beds of the Gorski kotar section.

During the Late Anisian, another platform block was lifted at today's Velebit W area and soon covered with fallen volcanic ash, producing tuffaceous terrestrial interval that overlies the exposed Anisian carbonates. The Early Norrian transgression covered this terrestrial interval with Hauptdolomite, producing the Velebit W section.

Differential tectonic uplifts of platform blocks at the Adria Microplate realm continued during the Late Ladinian and Late Ladinian/Carnian, causing the emersion phases at today's Velebit E and Svilaja areas. However, these two distant areas are characterized by differential architecture of terrestrial depositions between the Upper Ladinian and Upper Triassic. It was caused by different terrestrial conditions where Svilaja area was subjected to extensive karstification as opposed to established lacustrine environments at the Velebit E area. Both areas were subjected to Norian transgression clearly marked by transgressive breccias and/or conglomerates, and then covered with Hauptdolomite where the smaller thickness of the Hauptolomite within the Svilaja section points to diachronous transgression on the exposed Adria Microplate area.

CONCLUSION

The Triassic succession of the Karst Dinarides is characterized by a significant terrestrial phase caused by the tectonic uplift(s) of the huge lithospheric area, situated at the southern Tethyan realm. In the regional, contemporaneous tectonic uplift scenario, data collected from Svilaja and Velebit E sections indicate that this comprehensive tectonic uplift occurred most probably during the Late Ladinian/Carnian. Intensive denudation and/or karstification processes affected emergent areas, forming an uneven palaeorelief surface built up of the exposed remnants, ranging in age from the Early to the Middle Triassic and covered, partly, by the terrestrial deposits.

On the contrary, the diachronous and differential tectonic uplift scenario, excludes intensive denudation and/or karstification in favor of few diachronously and differentially uplifted tectonic blocks along the major faults as major trigger for exposed palaeorelief modification.

Regardless of the assumed scenarios, due to an overall, though diachronous Norian transgression, the emergent area was flooded and shallow-water, platform regime was restored over the entire huge isolated platform realm. Thus, in the Gorski kotar section, the terrestrial phase, marked by a disconformity, ranges from the Late Scythian to the Early Norian; in the Velebit W secton, the terrestrial phase, marked with a tuffaceous interval, ranges from the Anisian to the Early Norian; in the Svilaja section, the terrestrial phase, marked with a breccia interval, ranges from the Late Ladinian/Carnian to the Late Norian; and in the Velebit E section, the terrestrial phase, marked with a ferruginous chlorite-kaolinite claystones, bauxites and reddish conglomerates, ranges from the (Late?) Ladinian to the Early Norian.

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