JAHRBUCH DER GEOLOGISCHEN BUNDESANSTALT
Jb. Geol. B.-A. | ISSN 0016-7800 | Band 151 | Heft 3+4 | S. 199–280 | Wien, Dezember 2011

Triassic Evolution of the Tectonostratigraphic Units of the Circum-Pannonian Region

Sándor Kovács[1], Milan Sudar[2], Eugen Grădinaru[3], Hans-Jürgen Gawlick[4], Stevan Karamata[5], János Haas[1], Csaba Péró[1], Maurizio Gaetani[6], Ján Mello[7], Milan Polák[7], Dunja Aljinović[8], Bojan Ogorelec[9], Tea Kolar-Jurkovšek[9], Bogdan Jurkovšek[9] & Stanko Buser[10]

19 Text-Figures, 7 Plates

Paleoenvironments
Pannonian Basin
Carpathians
Stratigraphy
Neotethys
Dinarides
Triassic
Alps

Contents

1 † Sándor Kovács, János Haas, Csaba Péró: Geological, Geophysical and Space Science Research Group of the Hungarian Academy of Sciences, Department of Geology, Eötvös Loránd University, Pázmány Péter sétány 1/c, 1117 Budapest, Hungary. haas@ludens.elte.hu; perocs@elte.hu
2 Milan Sudar: Department of Paleontology, Faculty of Mining and Geology, University of Belgrade, Kamenička St. 6, P. O. Box 227, 11000 Belgrade, Serbia. sudar@eunet.rs
3 Eugen Grădinaru: Faculty of Geology and Geophysics, University of Bucharest, Bd. Bălcescu Nicolae 1, 010041 Bucharest, Romania. egradin@geo.edu.ro
4 Hans-Jürgen Gawlick: Department of Applied Geosciences and Geophysics University Leoben, Prospection and Applied Sedimentology, University of Leoben, Peter-Tunner Str. 5, 8700 Leoben, Austria. hans-juergen.gawlick@mu-leoben.at
5 Stevan Karamata: Serbian Academy of Sciences and Arts; Knez Mihailova 35, 11000 Belgrade. inga@eunet.rs
6 Maurizio Gaetani: Dipartimento di Scienze della Terra dell'Universita degli Studi di Milano, Via Mangiagalli 34, 20133 Milano, Italy. maurizio.gaetani@unimi.it
7 Ján Mello, Milan Polák: State Geological Institute Dyoníz Štúr, Mlynska dolina 1, 817 04 Bratislava, Slovak Republic. janismello@gmail.com; milan.polak@geology.sk
8 Dunja Aljinović: University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering, Pierottijeva 6, 10000 Zagreb, Croatia. daljin@rgn.hr
9 Bojan Ogorelec, Tea Kolar-Jurkovšek, Bogdan Jurkovšek: Geological Survey of Slovenia, Dimičeva ulica 14, 1000 Ljubljana, Slovenia. bojan.ogorelec@geo-zs.si; tea.kolar@geo-zs.si; bogdan.jurkovsek@geo-zs.si
10 † Stanko Buser: Geological Department, University of Ljubljana, NTF, Aškerčeva 12, 1000 Ljubljana, Slovenia.

Trias-Tektonostratigraphie im Circum-Pannonischen Raum

Zusammenfassung

Nach einer kontinentalen Riftingphase vom Mittel-Perm bis zum Beginn der Mittel-Trias entwickelte sich von der Mittel-Trias an der Neotethys-Ozean und es kam zur Ausbildung eines passiven Kontinentalrandes mit seiner typischen karbonatdominierten Entwicklung. Diese Entwicklung ist in allen unterschiedlichen tektonischen Einheiten im Circum-Pannonischen Raum relativ gleichartig ausgebildet mit geringen regionalen Unterschieden.
Ziel der vorliegenden Arbeit ist es, die Trias-Entwicklungen der verschiedenen Einheiten kurzgefasst darzustellen, ihre fazielle und lithostratigraphische Entwicklung zu dokumentieren und die jeweils erhaltenen Faziespolaritäten für die Diskussion der ursprünglichen Trias-Paläogeographie heranzuziehen. Neben einer textlichen Darstellung erfolgt eine bildliche Klarstellung in Form von vergleichenden stratigraphischen Entwicklungsschemen und photographischer Dokumentation.

Abstract

After a long lasting continental rifting stage from the Middle Permian to the early Middle Triassic, the opening of the Neotethys Ocean commenced during the Middle Triassic in the Circum-Pannonian area. It was followed by spreading of the oceanic basement and typical passive margin evolution during the Late Triassic. The aim of this paper is to summarize the basic characteristics of the Triassic successions of the tectonostratigraphic units, together with interpretation of the paleoenvironments providing data for the facies polarity of the units and through this for the paleoreconstructions. The characterization is supported by lithofacies columns of the units and photos on the typical facies. There is a short summary of the evolutionary history.

Introduction

The Variscan tectogenesis and orogenesis brought about a pattern of Variscan tectonostratigraphic zones (NEUBAUER & RAUMER, 1993; VAI, 1994, 1998, 2003; KOVÁCS, 1998; and EBNER et al., 2008 for latest reviews) which basically influenced the subsequent Neotethyan ("Early Alpine") paleogeography. The assembly of the Pangea supercontinent led to the closure of the western part of the Prototethyan domain. However, from the present Dinaridic domain eastward a huge V-shaped embayment of the Panthalassa Ocean – the "Paleotethys" – remained open (FLÜGEL, 1990; KARAMATA, 2006; STAMPFLI et al., 1998, 2001).

Following a major regression in the late Early Permian or early Middle Permian time (VAI & VENTURINI, 1997), a new significant transgression began in the Middle Permian (FILIPOVIĆ et al., 2003; ALJINOVIĆ et al., 2008) with coastal plain, then sabkha stage, in the eastern part of the former Variscan Carnic–Dinaridic domain. Further transgression led to the development of a wide ramp of mixed siliciclastic-carbonate sedimentation during the Early Triassic that was followed by the prevalence of the carbonate deposition in the early Middle Triassic.

The northwestward propagating Neotethyan oceanic rifting reached the Dinaridic-Carpathian-Alpine region in the middle part of the Middle Triassic leading to the establishment of a young, rifted ocean and its continental margins. On the Adriatic margin the extensional tectonics resulted in the formation of troughs and submarine highs and it was accompanied by volcanism, locally. In the Late Triassic coeval with the spreading of the ocean a thick carbonate succession developed on the subsiding passive margins.

The aim of this paper is to summarize the major facies characteristics of the Triassic formations, and interpret the paleoenvironmental conditions in the Circum-Pannonian region. Where available, the most important biostratigraphic constraints are also given. Sets of colour stratigraphic and facial charts and photos on the typical facies are presented to assist the characterization of the units. Demonstration of the facies polarity of the tectonostratigraphic units is also an important goal of this article because this is crucial for the reconstruction of the original setting of the tectonostratigraphic units (terranes).

Triassic Stratigraphy and Evolution of Tectonostratigraphic Units

ALCAPA MEGAUNIT

Austroalpine – Western Carpathian Units

Eastern Alps (Austroalpine Unit)

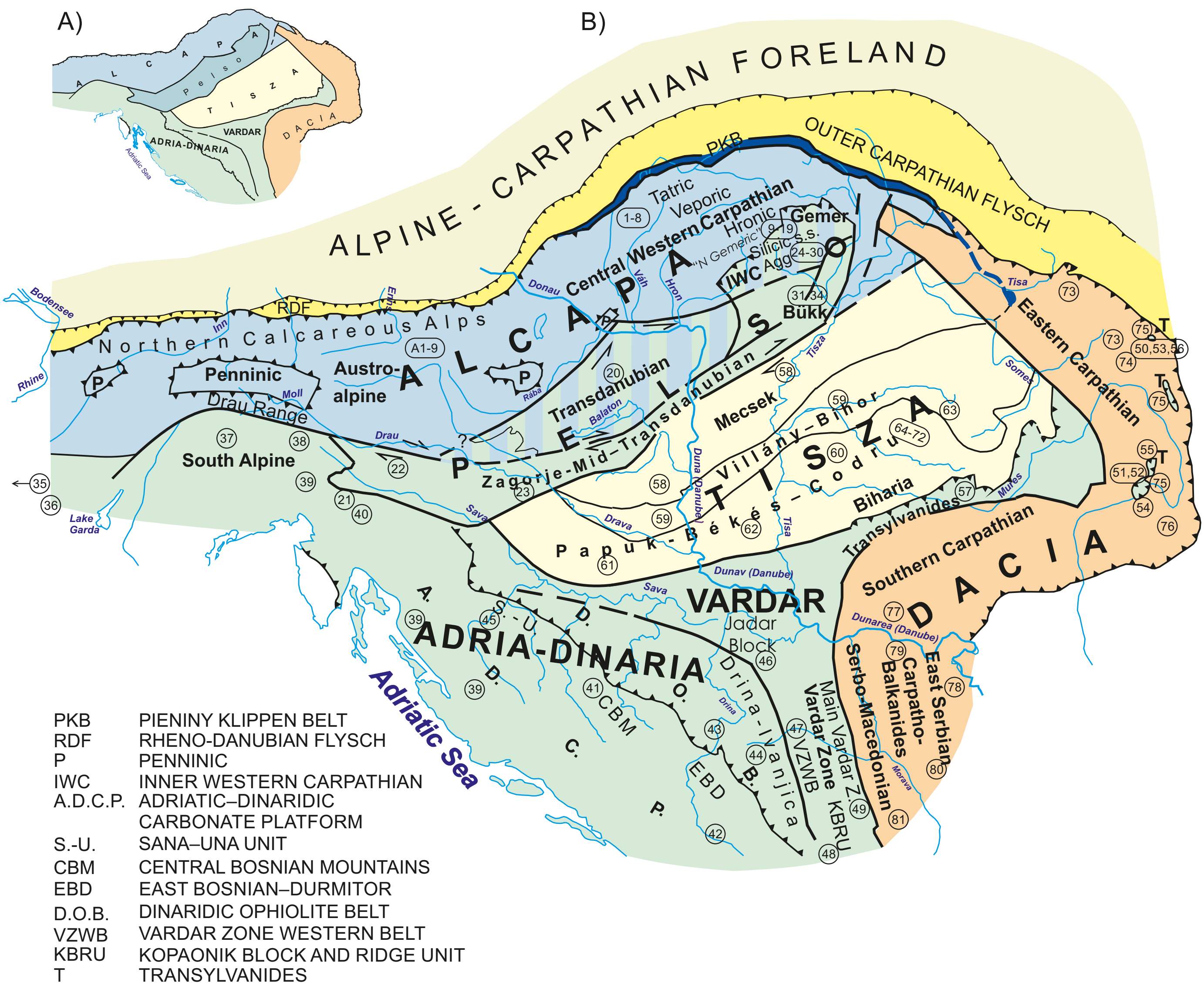
The presented Triassic stratigraphic and facies descriptions for the Eastern Alps resp. the Austroalpine Unit mirror the facies belts from the proximal, Europe-near facies zones to the distal shelf areas in respect to tectonic events in Triassic and Jurassic times (TOLLMANN, 1976, 1985; LEIN, 1987; GAWLICK et al., 1999a, b; KRYSTYN, 1999; MISSONI & GAWLICK, 2011). They follow mostly in their nomenclature the official Stratigraphic Chart of Austria, which was presented by PILLER et al. (2004) in a first version following TOLLMANN (1985), but also with additional changes on the basis of new results (e.g. MANDL, 2000; KRYSTYN, 2008; KRYSTYN et al., 2007, 2009; MISSONI & GAWLICK, 2010, 2011).

Following a major post-Variscan regression and Permian crustal extension (e.g. SCHUSTER & STÜWE, 2008), sedimentation started in Middle/Late Permian with coarse-grained siliciclastics in the north (Alpine Verrucano; compare TOLLMANN, 1976, 1985) and evaporites in the south (Alpine Haselgebirge; TOLLMANN, 1976, 1985) due to early Neotethyan crustal extension (SCHUSTER et al., 2001). In the Early Triassic the siliciclastic sedimentation continued with the deposition of the Alpine Buntsandstein in the north and with deposition of the marine Werfen Beds in the south. Around the Early/Middle Triassic boundary carbonate production started forming carbonate ramps (top Werfen Formation, Gutenstein and Steinalm Formations). A first opening event (Annaberg Formation) with hemipelagic influence is recognized by LEIN et al. (2010) below the Steinalm Formation. Shallow-water carbonate sedimentation with the overlying hemipelagic carbonates (Gallet et al., 1998), which represent a partial drowning event due to the final break-up of the Neotethys Ocean (Lein & Gawlick, 2008), dominated in the entire Eastern Alps in the Middle Triassic. In late Middle to early Late Triassic times the Wetterstein Carbonate Platform was formed. This platform was overlain by the siliciclastics of the Lunz and Northalpine Raibl Formations or by the Reingraben Formation (Halobia Beds) in the Hallstatt realm (Hornung et al., 2007; Krystyn, 2008). On top (Tuvalian) of this siliciclastic event a new carbonate ramp was formed (Opponitz and Waxeneck Formations). During the Norian and Rhaetian optimum climatic and geodynamic conditions produced the classic Late Triassic Hauptdolomit/Dachstein Carbonate Platform.

The present-day N–S alignment of the facies zones has been caused by a complex rotation pattern of the Eastern Alps since the Late Cretaceous (e.g. Haubold et al., 1999; Csontos & Vörös, 2004; Thöny et al., 2006; Pueyo et al., 2007). The Triassic paleogeographic alignment may have been NE–SW.

Northern Calcareous Alps

The Northern Calcareous Alps, part of the complicated Austroalpine Unit, are an elongated fold-and-thrust belt with complex internal structures (Frisch et al., 1998). The classic tectonic subdivision of the Northern Calcareous Alps in a Lower Bavaric, an intermediate Tirolic, and an Upper Juvavic Nappe Group resp. unit (Plöchinger, 1980; Tollmann, 1985; Gawlick, 2000a, b; Mandl, 2000; Frisch & Gawlick, 2003; Missoni & Gawlick, 2010, 2011) was in controversial dispute, and is in contradiction with modern stratigraphic, structural, metamorphic and geochronological data (e.g. Gawlick et al., 1994, 1999a; Frank & Schlager, 2006; Missoni & Gawlick, 2011). Frisch & Gawlick (2003) performed a palinspastic restoration for



Text-Fig. 1.
A: Megaunits in the Circum-Pannonian region.
B: Lower-rank tectonic units and most important nappe systems of the Circum-Pannonian region including the location of the lithofacies columns (in Text-Figs. 3–15).

the time before the Miocene lateral tectonic extrusion, regarding continuity of nappe structures, facies, and diagenetic/metamorphic zones. This new nappe concept, introduced in the central Northern Calcareous Alps, subdivided this part into three subunits: Lower and Upper Bavaric Nappe (= Bavaric Unit), Lower and Upper Tirolic Nappe, separated by the Late Jurassic Trattberg thrust, and the metamorphic Ultra-Tirolic Nappe (FRISCH & GAWLICK, 2003) (= Tirolic Unit). The Hallstatt (Juvavic) Nappe(s) formed the highest unit (GAWLICK et al., 1999b; KRYSTYN, 1999), which was completely destroyed by erosion after nappe stacking in Middle/early Late Jurassic times (GAWLICK et al., 2009a). In the Northern Calcareous Alps only remnants of these Hallstatt nappes exist. These remnants are represented by components up to kilometre-size in Middle to Late Jurassic radiolaritic wildflysch sediments ("Hallstatt Mélange" belonging to the Upper Tirolic Nappe). Destruction of the continental margin started from the oceanic side in late Early Jurassic times (GAWLICK & FRISCH, 2003; GAWLICK et al., 2008; MISSONI & GAWLICK, 2010, 2011), and affected the Tirolic nappes in Middle to Late Jurassic times and should have propagated towards the shelf (Bavaric Unit) until Mid-Cretaceous times (FAUPL, 1997). Internal deformation of central parts of the Northern Calcareous Alps during the subsequent Cretaceous and Tertiary tectonic phases was relatively minor.

According to the classical view (TOLLMANN, 1985), in Valanginian to Aptian times a pulse of thrusting and uplift of the Northern Calcareous Alps should have been associated with siliciclastic flyschoid sedimentation (FAUPL & TOLLMANN, 1979) and probably remobilization of the Juvavic nappes (GAWLICK et al., 1999a). New results show, that the Early Cretaceous basins are foreland (Molasse) basins (GAWLICK et al., 2008), which were simply filled up (MISSONI & GAWLICK, 2011). Only minor tectonic movements in Early Cretaceous (Roßfeld) times can be confirmed in the Tirolic realm (MISSONI & GAWLICK, 2011). Early Cretaceous thrusting movements affected mostly the Bavaric nappes by forming new flyschoid basins (FAUPL, 1997; FAUPL & WAGREICH, 2000). In Late Cretaceous times the Gosauic sedimentary cycle started (e.g. TOLLMANN, 1976; WAGREICH, 1995; FAUPL, 1997), partly with lateral movements of some blocks and extensional tectonics. The Eocene final closure of the Penninic realm resulted in northward thrusting of the entire Northern Calcareous Alps, in reactivation of older thrusts, and the formation of new nappes (e.g. Dachstein and Berchtesgaden Nappes: FRISCH & GAWLICK, 2003; MISSONI & GAWLICK, 2010, 2011). Continued N–S convergence and E–W extension in the Late Tertiary caused the disintegration of the Eastern Alps along strike-slip faults and minor extensional and compressional features (RATSCHBACHER et al., 1991; LINZER et al., 1995; FRISCH et al., 1998).

Bavaric Unit

In the northern Bavaric Nappe Permian and Early Triassic sediments are mostly missing due to younger tectonic movements (TOLLMANN, 1985), except for the western part. The thickness of the Middle and Late Triassic formations can only be roughly estimated due to the polyphase tectonic history, but it could be around 4–5 km (BRANDNER, 1984) (location on Text-Fig. 1; Text-Fig. 3, col. A3).

Carbonate production started around the Early/Middle Triassic boundary with carbonate ramp sediments above the Alpine Buntsandstein (STINGL, 1989) and the evaporitic Reichenhall Formation. The Gutenstein Formation was formed in a restricted, periodically hypersaline lagoonal area. The overlying Steinalm Formation formed under more open marine conditions. Partly small buildups and reefal structures were developed, mostly of calcareous algae and microbial mats. The Gutenstein and Steinalm Formations are named as Virgloria Formation in the Bavaric Unit of the western Northern Calcareous Alps (PILLER et al., 2004). In late Anisian times a large part of this (Steinalm) carbonate ramp was drowned and widespread basinal carbonate sedimentation took place (grey, cherty limestones of the Reifling Formation) (BECHSTÄDT & MOSTLER, 1974, 1976; KRYSTYN, 1991; KRYSTYN & LEIN, 1996). According to GAWLICK (2000a) and MISSONI & GAWLICK (2011) in the Late Ladinian (Longobardian) the hemipelagic carbonatic basins were separated from the open shelf area by the onset of the Wetterstein Carbonate Platforms in the south (compare KRYSTYN & LEIN, 1996). The Reifling sedimentation was interrupted by deposition of the fine-grained siliciclastic Partnach Beds. During Early Carnian, after a regressive/transgressive cycle, the Wetterstein Carbonate Platform (Arlberg and Wetterstein Formations) starts to prograde also above the northern Bavaric realm (BRANDNER & RESCH, 1981; KRYSTYN & LEIN, 1996). South of the rapidly southward (in direction to the Tirolic Unit) prograding platform (the slope deposits are represented by the Raming Formation; LEIN, 1989) a basinal area prevailed in Early Carnian ("Cordevolian") times. The youngest sediments in these basinal areas were the organic-rich grey, cherty limestones of the Göstling Formation. In the Julian the Lunz/Reingraben event (SCHLAGER & SCHÖLLNBERGER, 1974; LEIN et al., 1997) drowned the Wetterstein Carbonate Platform nearly in the whole area and siliciclastic sediments (Lunz and Northalpine Raibl Formations) were deposited (TOLLMANN, 1976, 1985; KRAINER, 1985a). These siliciclastics filled the basinal areas between the Wetterstein Carbonate Platforms and created a uniform topography at the end of the siliciclastic event. In the Late Carnian the siliciclastic input decreased rapidly and a new carbonate ramp was established (Opponitz-Waxeneck carbonate ramp). The transition between the lower Late Carnian "Northalpine Raibl Formation" and the more southernward carbonatic sedimentation is gradual. Around the Carnian/Norian boundary this carbonate ramp progressed into the Late Triassic Hauptdolomit/Dachstein Carbonate Platform (for details see GAWLICK & BÖHM, 2000), represented only by the Hauptdolomit in the Bavaric Unit (Pl. 1, Fig. 1). It was formed from the ?latest Carnian/earliest Norian to the Middle/Late Norian. Intraplatform basin developed during the Middle to Late Norian (Seefeld Formation) (DONOFRIO et al., 2003; compare BECHTEL et al., 2007). In the late Norian the opening of the restricted Hauptdolomit lagoon resulted in the formation of the "Plattenkalk". In the Early Rhaetian the lagoon deepened and the siliciclastic input resulted in mixed terrigenous-carbonatic sedimentation of the Kössen Formation (stratigraphic details in GOLEBIOWSKI, 1990, 1991). The Kössen Formation was partly overlain in the Late Rhaetian by shallow-water, in some areas reefal carbonates (Oberrhät Limestone; FLÜGEL, 1981). These shallow-water carbonates prograded in the Bavaric Unit from north to south.

Tirolic Unit

In the Tirolic Unit the stratigraphic and facies evolution reflect roughly the intermediate passive margin setting between the Bavaric Unit and the Hallstatt Facies Belt (Text-Fig. 3, col. A4–6). Permian and Early Triassic formations are also mostly missing due to later tectonic movements (Tollmann, 1985), especially in the Early Tirolic Nappe. The thickness of the Middle and Upper Triassic formations is similar to that in the Bavaric Unit.

Carbonate production began in the Late Olenekian, slightly earlier as in the Bavaric Unit (Mostler & Rossner, 1984), followed by the evaporitic Reichenhall Formation in both Tirolic nappes around the Olenekian/Anisian boundary. Increased carbonate productivity started also around the Early/Middle Triassic boundary with carbonate ramp sediments (Gutenstein and Steinalm Formations) above the Alpine Buntsandstein/Werfen Formation and the evaporitic Reichenhall Formation. The Gutenstein Formation was partly formed in a restricted shallow-water area. The Steinalm Formation represents carbonates of more open marine conditions; partly forming small build-ups and reefal structures, made up of calcareous algae and microbial mats formed locally. In late Anisian times a large part of this carbonate ramp drowned, and widespread basinal carbonates (mostly dolomitized) were formed (Reifling Formation) (e.g. Missoni et al., 2001: Upper Tirolic Nappe). The siliciclastic influenced Partnach Formation took partly place in the Lower Tirolic Nappe, whereas in the Upper Tirolic Nappe the Wetterstein Carbonate Platform was formed since the Late Ladinian (Krystyn & Lein, 1996). Transitional to the hemipelagic areas the Raming and Grafensteig Formations (Hohenegger & Lein, 1977) were formed. This platform drowned in Julian times due to the Lunz/Reingraben event (Schlager & Schöllnberger, 1974) nearly in the whole area. Siliciclastic (e.g. Raibl Formation, Reingraben Formation) and carbonatic sediments (Cidaris Limestone) were deposited. Just like in the Bavaric Unit, these siliciclastics filled basinal areas between the Wetterstein Carbonate Platforms, which led to a uniform levelled topography at the end of the siliciclastic event. In the Late Carnian the siliciclastic input decreased rapidly and a new carbonate ramp was established. The partly evaporitic Opponitz Formation in the Lower Tirolic Nappe passed gradually into the more open marine Waxeneck Formation in the Upper/Ultra Tirolic nappes. Around the Carnian/Norian boundary this carbonate ramp progressed into the classical Late Triassic Hauptdolomit/Dachstein Carbonate Platform (roughly Hauptdolomit in the Lower Tirolic Nappe and lagoonal to reefal Dachstein Limestone in the Upper Tirolic Nappe). In the Tirolic Unit the Hauptdolomit and Dachstein Limestone ranged from the earliest Norian to the Middle resp. Late Norian, without recognised intraplatform basins in the Middle resp. Late Norian (Pl. 1, Fig. 2). In the latest Norian the opening of the restricted Hauptdolomit lagoon resulted in the formation of the Plattenkalk. In Early Rhaetian the lagoon deepened and the siliciclastic input led to the deposition of mixed terrigenous-carbonatic sediments of the Kössen Formation (Pl. 1, Fig. 3), intercalated by the Lithodendron reef limestone (Golebiowski, 1990, 1991). The Kössen Formation was partly overlain in the Late Rhaetian by shallow-water, partly reefal carbonates (Oberrhät Limestone resp. Rhaetian Dachstein Limestone; Pl. 1, Fig. 5). The Rhaetian Dachstein Carbonate Platform (Flügel, 1981; Schäfer & Senowbari-Daryan, 1981) prograded from the area of the Upper Tirolic Nappe to the north reaching area of the Lower Tirolic Nappe.

The southern part of the Upper Tirolic Nappe and parts of the Ultra Tirolic Nappe represented the transitional area from the lagoon to the open marine shelf (reef rim and transitional zone to the Hallstatt Facies Zone). The Middle Triassic sedimentary succession is similar to those of the other parts of the Tirolic Unit. In the Early Ladinian the transition of the Reifling Formation to the Hallstatt Limestone is partly preserved. The formation of the Wetterstein Carbonate Platform started in the Late Ladinian rapidly prograding to the south (Raming Formation, Lein, 1989). The Lunz/Reingraben event affected these areas only peripherally with thin, fine-grained siliciclastics (Reingraben Beds). In some areas shallow-water organisms survived the event as recorded in the Julian Leckkogel Formation (Dullo & Lein, 1982). The Leckkogel Formation passed gradually into the Late Carnian Waxeneck Formation (Krystyn et al., 1990) and later in the Norian to earliest Rhaetian reefal Dachstein limestone (Zankl, 1969; Flügel, 1981), which drowned in the Early Rhaetian (Krystyn et al., 2009: new introduced Donnerkogel Formation). In fact in this paleogeographic area alternation of basinal sediments, fore reef to back reef sediments, partly lagoonal sediments occurred reflecting sea-level fluctuations and some ?extensional tectonic movements (Lein, 1985; Gawlick, 1998, 2000a; compare Missoni et al., 2008). In the Late Norian in some areas of this belt hemipelagic sequences were deposited in newly formed basins (Mürztal facies, Aflenz facies: Lein, 1982, 1985, 2000; Tollmann, 1985).

The Ultra Tirolic Nappe in the sense of Frisch & Gawlick (2003) represents metamorphosed Triassic to Jurassic successions, including mostly the reef rim and the transitional area to the Hallstatt Facies Belt. But in fact the Ultra Tirolic Nappe is not a single and homogenous nappe, it is built by many slices/nappes of different facies and age range.

Hallstatt Facies Belt (reworked Jurassic Hallstatt Mélange)

The eroded Juvavic nappe stack represented the Jurassic accretionary prism in the Northern Calcareous Alps (Frisch & Gawlick, 2003). Remnants of this nappe complex are only present in the Middle to Late Jurassic radiolaritic trench-like (wildflysch) basin fills (Gawlick & Frisch, 2003) in front of the propagating thrust belt (Neotethyan Belt according to Missoni & Gawlick, 2010). In those radiolaritic wildflysch basins all sedimentary rocks of the Meliata Facies Zone, the Hallstatt Facies Belt and the reefal belt of the Triassic carbonate platform occur. Some blocks show the effect of transported metamorphism (Gawlick & Höpfer, 1999; Missoni & Gawlick, 2010; compare Frank & Schlager, 2006).

The Hallstatt Facies Belt (i.e. Hallstatt Zone) is subdivided into three facies zones:

a) Zlambach/Pötschen Facies Zone (grey Hallstatt facies, Zlambach/Pötschen facies with shallow-water allodapic limestone intercalations)

b) Hallstatt Limestone Facies Zone (red or various colored Hallstatt facies or Hallstatt Salzberg facies) (for newest review see Krystyn, 2008) and

c) Meliata Facies Zone (Lein, 1987; Gawlick et al., 1999a), including the Pötschen Limestone sensu stricto (compare Mostler, 1978).

Recently the depositional area of the Pötschen Limestones without redeposited shallow-water carbonates (Pötschen Formation sensu stricto) was interpreted as transitional facies from the Meliata facies belt (continental slope) to the oceanic realm (Missoni & Gawlick, 2010, 2011; compare Gawlick et al., 2008).

Zlambach/Pötschen Facies Zone

Early Triassic as well as Early and Middle Anisian sediments of this facies belt are not preserved in continuous sections. Clasts of fine-grained siliciclastic sediments of the Werfen Formation occur as components together with components of the Gutenstein and Steinalm Formations and the complete reconstructable hemipelagic Late Anisian to Early Jurassic succession of this facies belt (Gawlick, 1996). Late Anisian to Ladinian Reifling Limestone is also proven in small clasts within upper Middle Jurassic mass-flow deposits (Gawlick, 1996, 2000b). The continuously preserved sections start in the earliest Carnian (Text-Fig. 3, col. A7) with well bedded, chert-rich limestones or hemipelagic dolomites (Gawlick, 1998). The Julian Halobia Beds are partly preserved in some sections but they do not form a definite horizon in this facies belt (Mandl, 1984). In Late Carnian to Middle Norian times mostly well-bedded cherty hemipelagic limestone of the Pötschen Formation with allodapic limestone intercalations of shallow-marine origin were deposited (Lein, 1985; Gawlick, 1998; Missoni & Gawlick, 2011; Pl. 1, Fig. 4) in more distal shelf areas, probably transitional to the red or various coloured Hallstatt Facies Zone (Lein, 1981; Lein & Gawlick, 1999). Hemipelagic dolomites (Pötschen Dolomite similar to the Bača Dolomite of the Slovenian Trough and equivalents in the Cukali area of Albania) and bedded cherty limestones occur more proximally near the transitional area of the carbonate platforms and ramps. Here the sedimentological features of the carbonatic basinal facies reflect the evolution of the neighbouring carbonate platform (Reijmer & Everaas, 1991). Due to sea-level fluctuations partly shallow-water carbonates were deposited as well (Gawlick, 1998). In Late Sevatian to Early Rhaetian times due to terrigenous input and synsedimentary tectonics (strike-slip related movements according to Missoni et al., 2008) the sedimentary facies became complex, and different lithologies of the Pedata Formation were formed: e.g. Pedata Plattenkalk, Pedata Dolomite, Pedata Limestone (Mandl, 1984; Gawlick, 1998, 2000a). Also the basinal areas of the Mürzalpen facies and Aflenz facies deepened during this time interval (Lobitzer, 1974; Lein, 1982). Since Middle Rhaetian times (Krystyn, 1987, 2008) the marly Zlambach Formation was deposited (Pl. 2, Fig. 1), which gradually passed into the Early Jurassic Dürrnberg Formation (Gawlick et al., 2001, 2009a). The youngest known sediments in the Hallstatt Facies Zone are thick cherty to marly successions of the Toarcian to Aalenian Birkenfeld Formation (Gawlick et al., 2009a; Missoni & Gawlick, 2011).

Hallstatt Limestone Facies Zone

As a distal continuation of the grey Hallstatt facies the red or various coloured Hallstatt facies (Lein, 1987; Krystyn, 2008) started with the drowning of the Steinalm carbonate ramp in Anisian (late Pelsonian) times (Text-Fig. 3, col. A8). The existence of the Early Triassic Werfen Beds is only proven by clasts in the Late Triassic Hallstatt Limestone (Lein, 1981). The Steinalm Formation followed stratigraphically the Early Anisian Gutenstein Formation. Deposition of hemipelagic sedimentary successions started in the late Middle Anisian with the condensed red Schreyeralm Limestone (e.g. Krystyn et al., 1971; Tollmann, 1985), that is followed by the Grauvioletter-Graugelber Bankkalk (Ladinian), the Hellkalk (Late Ladinian to Early Carnian), Halobia Beds (Julian), the Roter Bankkalk (Tuvalian), the Massiger Hellkalk (Lacian), the Hangendrotkalk (Alaunian to Sevatian; (Pl. 2, Fig. 2), the Hangendgraukalk (Early Rhaetian) (Krystyn, 1980, 2008) and the Zlambach Marls (Middle to Late Rhaetian: Krystyn, 1987, 2008), which gradually passed into the Early Jurassic Dürrnberg Formation and later into the Birkenfeld Formation (see above).

Meliata Facies Zone

The Meliata Facies Zone (Text-Fig. 3, col. A9) represented the most distal part of the shelf area and the continental slope as well as the transition to the Neotethys Ocean. Rare remnants of this facies belt are described from the eastern (Mandl & Ondrejičková, 1991, 1993; Kozur & Mostler, 1992) and from the central Northern Calcareous Alps (Gawlick, 1993). These remnants occur partly as metamorphosed isolated slides (Florianikogel area) or as breccia components. In a general stratigraphic, reconstructed succession the Middle Triassic radiolarites and partly cherty marls were followed by Early Carnian Halobia Beds and Late Carnian to Early Rhaetian Hallstatt Limestone (red and grey). Younger sediments are not proven so far, but a similar sedimentary succession as in the Hallstatt Limestone Facies Zone can be expected. The Meliata Facies Zone is thought to be the first facies belt with continental crust, which is incorporated in the accretionary prism formed during the closure of the western part of the Neotethys Ocean in this area (late Early Jurassic as mentioned by Gawlick & Frisch, 2003; Gawlick et al., 2009a; Missoni & Gawlick, 2010, 2011). Recently also sequences of the Pötschen Limestone sensu stricto are interpreted to derive from the transitional area of the Meliata Facies Zone to the Neotethys Ocean (Missoni & Gawlick, 2010, 2011; compare Gawlick et al., 2008).

Lower Austroalpine and Central Alpine Mesozoic

In the Triassic the Lower Austroalpine and Central Alpine Mesozoic (Text-Fig. 3, col. A1) represented the most proximal facies zone in the Eastern Alps, i.e. the transition to the facies belts of the Germanic Triassic (Tollmann, 1977). Therefore the facies evolution is rather similar to those of the Lienz Dolomites and Gailtal Alps (see there). Due to intense tectonic movements the occurrences show incomplete sequences and metamorphic overprint (like the Brenner Mesozoic; Lein & Gawlick, 2003 with references). Lein & Gawlick (2003) presented data, which show clearly, that all former reconstructions of the sedimentary successions must be revised. The sedimentary succession in these nearshore zones started in Early Triassic with siliciclasts (quartzites – Alpine Buntsandstein). It was followed by carbonate deposition in a restricted lagoonal area (Gutenstein Formation). The Steinalm Formation can not be separated from the Gutenstein Formation in respect to similar depositional conditions. Upsection the clay-rich and partly dolomitic Reifling Formation follows, overlain by Partnach Beds and later by the Wetterstein Formation. In the Middle Carnian, the Wetterstein Carbonate Platform was drowned and overlain by the siliciclastics of the Northalpine Raibl Formation. In the Late Carnian the siliciclastic influence decreased and the ?Opponitz Formation with some siliciclastic layers was formed. Partly the Opponitz Formation is included in the Northalpine Raibl Formation. In the Late Triassic in the western Eastern Alps the Hauptdolomit, overlain by the Kössen Formation and the "Oberrhät Limestone", is dominant, whereas in the eastern Eastern Alps the Carpathian Keuper facies occurs (as in the Semmering Triassic; see Lein, 2001 for latest review).

Drau Range

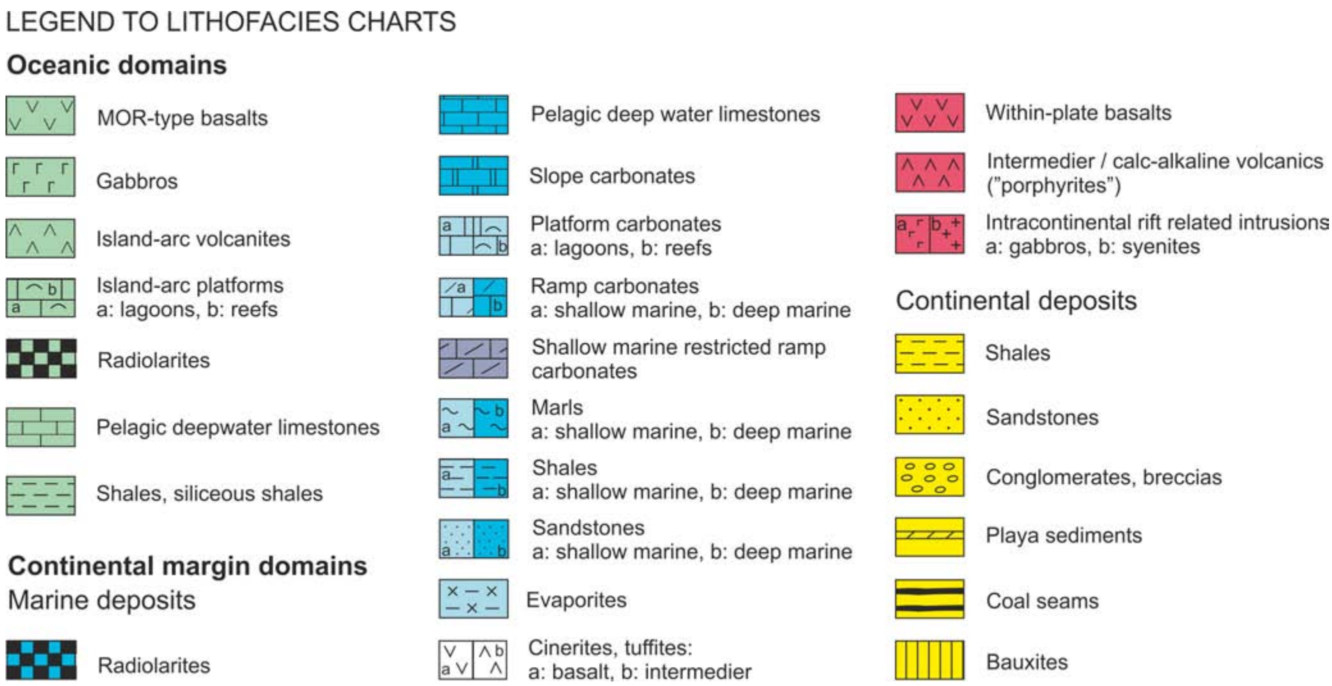
The Drau Range consists of four different tectonic units originating from a facies belt, which is comparable to the western Northern Calcareous Alps to proximal shelf areas of western Lombardy (Bechstädt, 1978; Lein et al., 1997). The sedimentary sequence of the Lienz Dolomites (Text-Fig. 3, col. A2) can be correlated with those of western Lombardy, that of the Gailtal Alps with the transitional area between western Lombardy and Vorarlberg p.p., meaning the Lower Bavaric Nappe, whereas the Northern Karavanks can be correlated with the Upper Bavaric Nappe of the western Northern Calcareous Alps (Lechtal Nappe). The Dobratsch Unit can be correlated with the (Lower) Tirolic Inntal Nappe of the western Northern Calcareous Alps (for details of these correlations, Lein et al., 1997). The sedimentary sequence of the Dobratsch Unit is described by Colins & Nachtmann (1974).

The units of the Drau Range form together with other dismembered units in the south (e.g. Steiner/Kamnik Alps, Koschuta and Hahnkogel Units with exotic basinal sediments: Krystyn et al., 1994; in total "Juvavicum p.p.", Gawlick et al., 1999b) a mega shear-zone formed as a result of polyphase lateral movements along the Periadriatic Lineament and its precursor (Lein et al., 1997; Gawlick et al., 2006). This "Juvavicum p.p." should belong according to the most recent tectonic divisions to the Southern Alps (i.e. Adria-Dinaria Megaunit), but shows facies evolution transitional to the Eastern Alps.

Lienz Dolomites and Gailtal Alps

In the Lienz Dolomites and Gailtal Alps (Text-Fig. 3, col. A2–3) carbonate sediments following the Alpine Buntsandstein (Krainer, 1985b). The evaporitic Reichenhall Formation started to form around the Early/Middle Triassic boundary with the Virgloria and Alplspitz Formations (Brandner, 1972; Piller et al., 2004) equivalent to the Gutenstein and Steinalm Formations, respectively. These sediments were deposited in a restricted, periodically hypersaline shallow-water area. The following organic-rich and partly hemipelagic Fellbach Formation (Late Anisian to Late Ladinian: Lienz Dolomites, Late Anisian to Early Carnian: Gailtal Alps) is a time equivalent of the Reifling Formation and the Partnach Formation. In the Late Ladinian (Longobardian) this area was separated from the open shelf area by the onset of the Wetterstein Carbonate Platform to the south, and sediments of a partly restricted shallow-marine facies were deposited (Abfaltersbach and Arlberg Formations), in part with evaporites (Abfaltersbach Formation). These formations represent the restricted lagoonal areas of the Wetterstein Carbonate Platform (Zeeh et al., 1988).

In the Julian the Lunz/Raibl event drowned the Wetterstein Carbonate Platform in the whole area and the siliciclastic Northalpine Raibl Formation was deposited (e.g. Cerny, 1982). In the Late Carnian the siliciclastic input decreased rapidly and a new carbonate ramp was established. The Opponitz Formation is replaced by the (partly evaporitic) Raibl Formation representing a proximal carbonate ramp. Around the Carnian/Norian boundary this carbonate ramp passed gradually into the Hauptdolomit. In the Lienz Do-

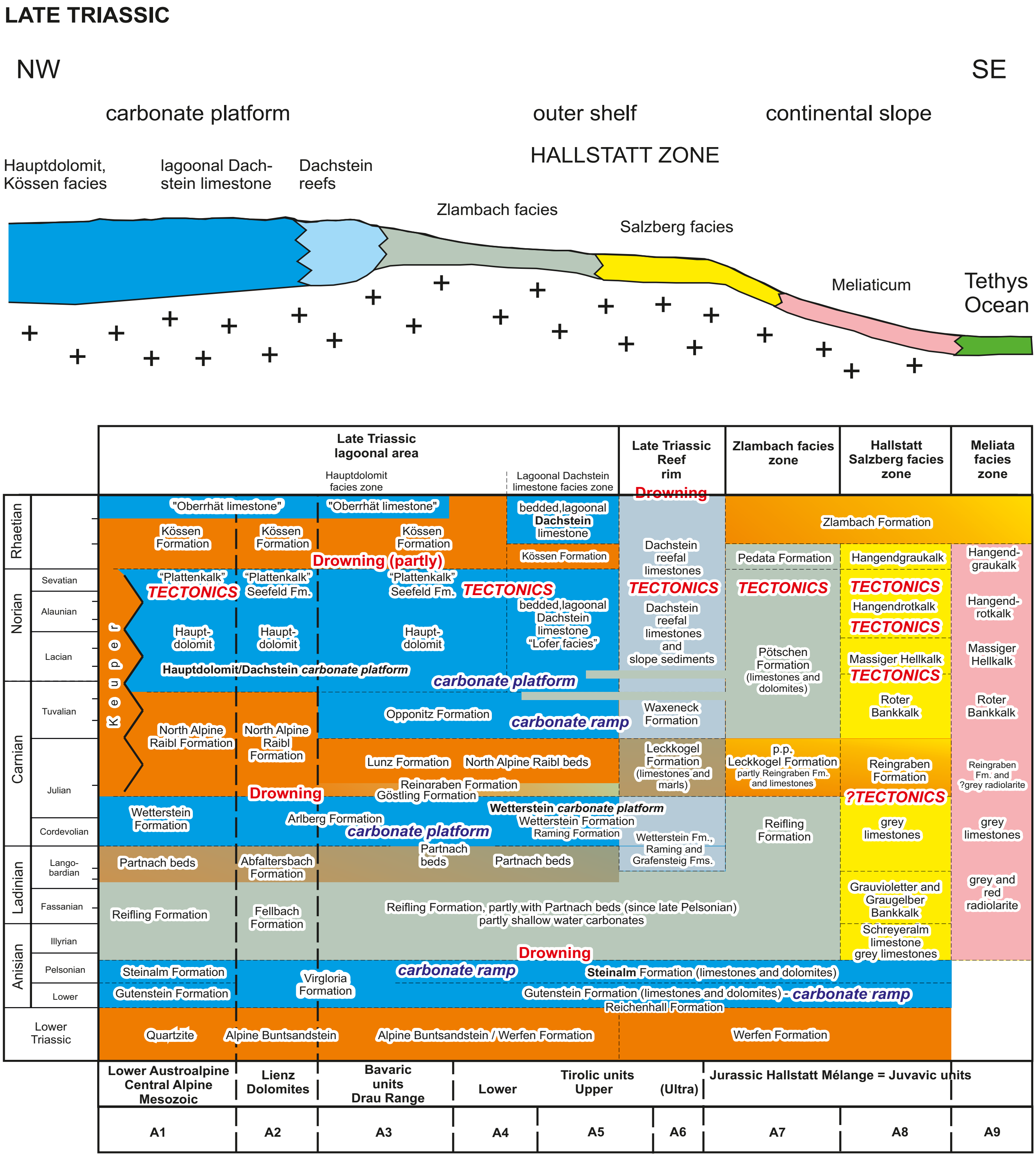


Text-Fig. 2.
Legend to lithofacies charts (Text-Figs. 4–15).

lomites and Gailtal Alps the Hauptdolomit ranges from the ?latest Carnian/earliest Norian to the Middle to Late Norian (Tichy, 1975), with intraplatform basins in the Middle to Late Norian (Seefeld Formation) (Czurda, 1973). In the latest Norian an opening of the restricted Hauptdolomit resulted in the formation of the Plattenkalk. In the Early Rhaetian the lagoon deepened, and the siliciclastic input led to mixed terrigenous-carbonatic sedimentation of the Kössen Formation. In the Late Rhaetian the Kössen Formation was partly overlain by shallow-water carbonates (Oberrhät Limestone).

Northern Karavanks

In the Northern Karavanks the Triassic succession starts with the Alpine Buntsandstein, the Werfen and the evaporitic Reichenhall Formations (Štrucl, 1971; Krainer, 1985b). Carbonate production increased around the Early/Middle Triassic boundary leading to carbonate ramp development, named Virgloria Formation in this area (equivalent to the Gutenstein and Steinalm Formations) (Piller et al., 2004), partly with Pb-Zn ore mineralisations (e.g. Topla ore deposit: Štrucl, 1974). These sediments were formed in a restricted, periodically hypersaline lagoonal area. Drowning of this



Text-Fig. 3.
Lithofacies chart of the Eastern Alpine Units (A1–9) (ALCAPA I) (below). Above: Late Triassic palinspastic section across the Northern Calcareous Alps.

shallow-water carbonate ramp in the Northern Karavanks took place in the Late Anisian. The following Reifling Formation (Late Anisian to Late Ladinian) and Partnach Formation (Late Ladinian to Early Carnian) (LEIN et al., 1997) were in parts overlain by shallow-water carbonates of the Wetterstein Carbonate Platform in the Early Carnian (Ladinian: ŠTRUCL, 1971; BOLE, 2002; ?Late Ladinian to Early Carnian: CERNY, 1989; compare LEIN et al., 1997) partly with Pb-Zn ore deposits (e.g. Bleiberg ore deposit: CERNY, 1989; SCHROLL et al., 2006), that evolves in this area in a classical shallowing upward manner: the basinal Partnach Formation was overlain by allodapic limestones, equivalent to the Raming Formation, followed by reefal limestones and later by the lagoonal carbonates of the Wetterstein Carbonate Platform (LEIN et al., 1997). In the Julian the Lunz/Raibl event drowned the Wetterstein Carbonate Platform in the whole area. The siliciclastic Northalpine Raibl Formation (e.g. ŠTRUCL, 1971; JURKOVŠEK, 1978; JELEN & KUŠEJ, 1982; KAIM et al., 2006; KOLAR-JURKOVŠEK & JURKOVŠEK 1997, 2010) was partly formed under freshwater conditions. In the Late Carnian the siliciclastic input decreased rapidly, and a new carbonate ramp was established. The Opponitz Formation is replaced by the (partly evaporitic) Northalpine Raibl Formation representing a proximal carbonate ramp (HAGEMEISTER, 1988). Around the Carnian/Norian boundary this carbonate ramp progressed gradually into the Hauptdolomit. In the Northern Karavanks the Hauptdolomit ranges from the earliest Norian to the Middle to Late Norian. In the latest Norian an opening of the restricted Hauptdolomit resulted in the formation of the Plattenkalk. In Early Rhaetian the lagoon deepened, and the siliciclastic input led to mixed terrigenous-carbonatic sedimentation of the Kössen Formation. The Oberrhät Limestone is very rare in the Northern Karavanks.

Central Western Carpathian (Tatro-Veporic) Unit

The Triassic stratigraphic and facial patterns of the Central Western Carpathians are very similar to that of the Eastern Alps. It is, in fact, the eastern (NE) continuation of the same facial zones from Europe-near facies zones to the distal shelf. Only names and the definitions of the individual zones or units – (Tatric, Veporic-Fatric, Hronic and Silicic Units) are different. The position of the Zemplinic Unit is ambiguous, and the Pieniny Klippen Belt has special setting in between the Central and Outer Western Carpathians.

Moreover, there exist in the Central Western Carpathians (in comparison to the Eastern Alps) some "special" facies – for example variegated Carpathian Keuper in the Norian of the Tatric, Fatric and Veporic zones.

Integration of the Pieniny Klippen Belt into the Central Western Carpathians is questionable. Pieninian sedimentary zones opened only in the Jurassic time. Triassic rocks in the Pieniny Klippen Belt are known mainly in a form of small detritus, pebbles or blocks in younger sediments. These were derived often from "exotic" sources. Triassic (mainly Upper Triassic) formations are present to a larger extent only in the Drietoma (Klape), Manín and Haligovce sequences, which are included in the Pieniny Klippen Belt, but they are considered as being of Central Carpathian origin.

Pieniny Klippen Belt

The Pieniny Klippen Belt is the most complicated unit of the Western Carpathians (ANDRUSOV, 1959, 1968, 1974; BIRKENMAJER, 1986; PLAŠIENKA et al., 1997a; GOLONKA, 2007; GOLONKA et al., 2008; GOLONKA & PICHA, 2008). It did not yet exist in the Triassic time. Klippen in which Triassic rocks are present originated in the Central Western Carpathians and became part of the Pieniny Klippen Belt tectonically only later.

Anisian–Ladinian ramp carbonates are present only in a limited area of the Haligovce outliers. The Norian is represented by the Carpathian Keuper Formation with characteristic lagoonal sedimentation only in the Drietoma sequence. The Rhaetian is represented by black organodetritic and coral limestone and shales (location on Text-Fig. 1; Text-Fig. 2; Text-Fig. 4, col. 1). Triassic formations are not known in other klippen sequences.

Tatric Unit

The Tatric Unit, which is the deepest tectonic unit of the Central Western Carpathians, is composed of a crystalline core and its sedimentary cover, consisting of Upper Paleozoic and mainly Mesozoic sequences.

The Tatric depositional area probably lied in the continuation of the Lower Austroalpine domains.

Lower Triassic sediments in the Tatric Unit are the most completely developed in the area of the "core mountains" of the Western Carpathians. Lower Triassic siliciclastic sediments lay discordantly on crystalline rocks. They are represented by the Lúžna Formation, consisting of variegated siliciclastic rocks: conglomerates, silicified sandstones, quartzites and shales with a thickness up to 100 m. Early Triassic sedimentation was typified by fluvial sediments, which were gradually changed to coastal and shallow-marine deposition.

At the beginning of the Anisian restricted carbonate ramp sedimentation began, that was extended almost over the whole Tatric area and characterized by grey to black Gutenstein Limestone of various types. Deposition of ramp carbonates continued in the Ladinian, represented by the Ramsau Dolomite. In the upper part of this cycle, in a limited area (Veľká Fatra Mts) slates alternating with dolomites (Došnianske Formation; PLANDEROVÁ & POLÁK, 1976) were formed, continuing in the Carnian. This interval corresponds probably to the Lunz Formation, which is not present in most part of the Tatric area.

The Norian in the Tatric Unit is represented by the "Carpathian Keuper" Formation (Text-Fig. 4, col. 2), which consists of siliciclastic sediments, composed of basal conglomerates, coarse-grained quartzites and variegated shales in the upper part. Thin layers of dolomites occur only rarely.

The uppermost Rhaetian is missing in the Šiprún trough, there is a stratigraphic hiatus. On the contrary, on the North-Tatric ridge in the Tatra Mts remnants of continental sedimentation (Tomanová Formation) are present (MICHALÍK et al., 1976). Rhaetian in Tríbeč Mts and Strážovská hornatina Mts is developed only rudimentary as crinoidal and bioclastic coquina limestone.

Fatro-Veporic Unit

This unit includes elements of a crystalline complex, as well its Upper Paleozoic and Mesozoic cover. Two Mesozoic units are present in the Northern Veporic Unit: the Veľký Bok sequence (metamorphosed) and the Krížna Nappe. ANDRUSOV et al. (1973) described the Fatric tectonic unit

(Text-Fig. 4, col. 3), which includes a group of the Sub-Tatric nappes: Krížna, Beliansky and Vysocký Nappes. The Mesozoic of the Southern Veporic Unit is represented by the metamorphosed Föderata Series.

The Lower Triassic formations of the ***Northern Veporic Unit*** (Text-Fig. 4, col. 3 and 5) directly overlie the Permian siliciclastics. Their character is almost identical to that of the Tatric Unit. They consist of light silicified sandstones and arkoses. Variegated shales prevail in the upper part. The maximum thickness reaches approx. 80 m.

At the beginning of the Anisian, the peritidal platform sedimentation of the Gutenstein Limestone started, accompanied by bioturbated limestone ("calcaire vermiculaire"). It continued during the whole Anisian. In the Early Ladinian the formation of Ramsau Dolomite began, often of the stromatolitic type, relatively rich in Dasycladacea, which progresses to a well-ventilated shallow platform facies. In the Longobardian the Podhradcké Limestone occurs sporadically, consisiting of dark-grey to black bioclastic limestone with detritus of crinoids, bivalves and remnants of conodonts. Most part of the sedimentary sequence was subject to slight metamorphosis in the Northern Veporic.

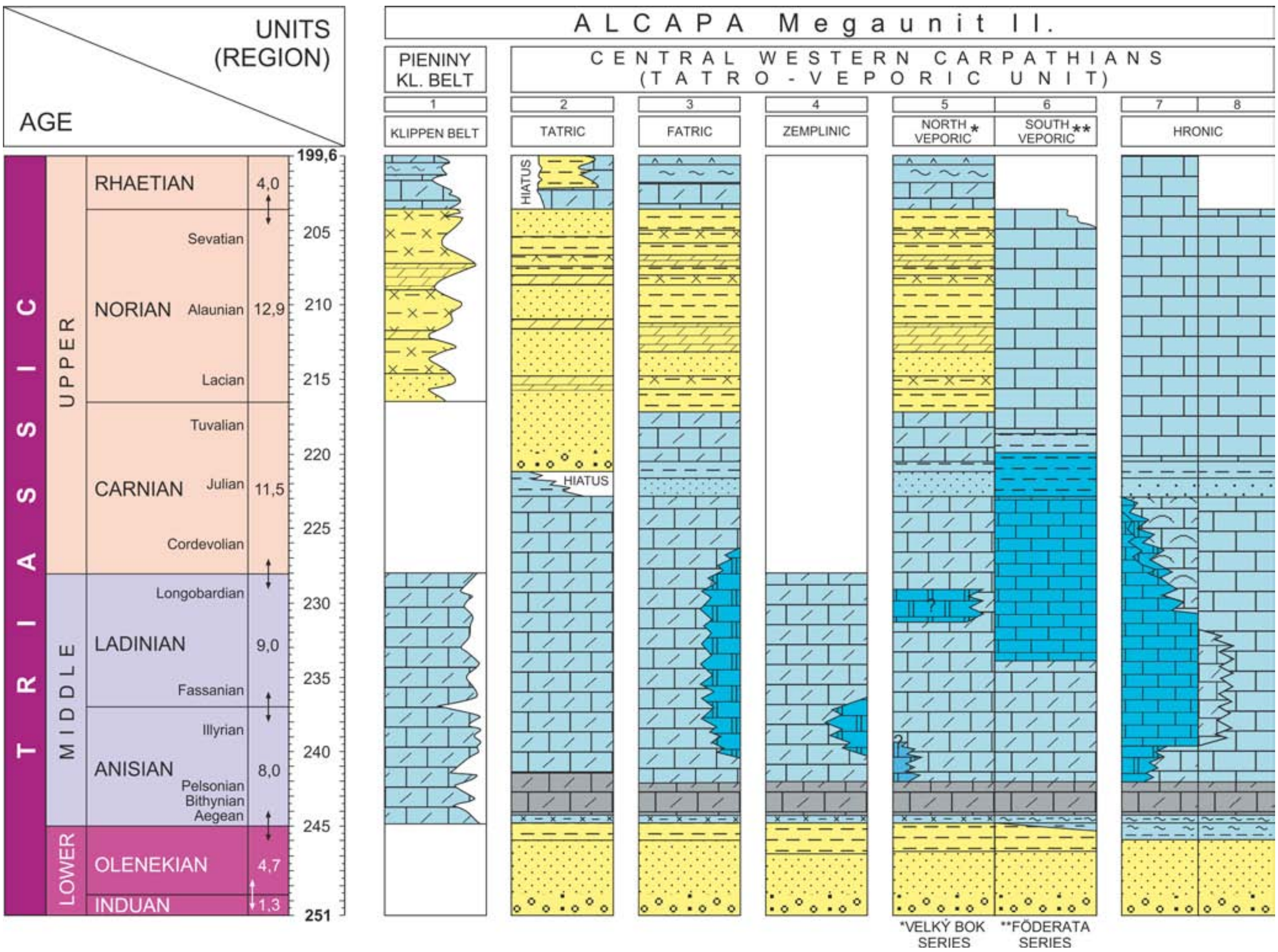
Siliciclastic Lunz Beds deposited in the Carnian, which are only rudimentary in the Veporic Unit. Their maximum thickness reaches up to 20 m. The Upper Carnian is represented by Main Dolomite (Hauptdolomit), which deposited under semiaridic conditions.

The Norian is characterized by the Carpathian Keuper Formation, composed mainly of variegated red, green claystones, shales alternating with platy, grey-yellow dolomites (Pl. 2, Fig. 3). Psammitic and pelitic layers are more common in the lower part of the formation. Thin intercalations of evaporites occur as well. Maximum thickness of the formation does not exceed 100 meters. The Carpathian Keuper Formation developed in lagoonal, significantly aridic environment.

The Rhaetian is characterized mainly by the Kössen Beds, consisting of black, bituminous marly shales, oolitic, crinoidal, mainly bioclastic limestones with shells of bivalves, brachiopods and corals.

The Triassic of the ***Southern Veporic Unit*** (Text-Fig. 4, col. 6) is represented by the low-grade metamorphosed Föderata Group (Rozlozsnik, 1935; Plašienka, 1993; Mello et al., 2000a, b). Lower and Middle Triassic formations are similar to those of the North Veporic Veľký Bok sequence: light and greenish quartzites, at the base sporadically with conglomerates, higher up sericitic shales with beds of platy quartzites or greywackes dominate.

The Middle Triassic carbonate sequence begins usually with rauhwackes and dolomites, followed by dark platy limestones of Gutenstein type, with dark calcareous shales (Anisian). They are gradually replaced upward by light limestones (Anisian–Ladinian).



Text-Fig. 4.
Lithofacies chart of the Pieniny Klippen Belt (1) and Central Western Carpathians (Tatro-Veporic Unit) (2–8). (ALCAPA II).

Deepening of the sedimentation area in the (Ladinian?) – Carnian interval is documented by a sequence of dark to black shaly limestones, cherty limestones and dark marly shales with intercalations of sandstones and layers of dark limestones. From this sequence STRAKA (1981) determined Lower–Middle Carnian conodonts *(Gondolella polygnathiformis, Gladigondolella tethydis*, etc.).

The Uppermost part of the Föderata Group (Upper Carnian – Norian) consists of light massive dolomites ("Hauptdolomit"), in up to 100 m thickness.

The Föderata Group facially reminds basinal sequences of the Hronic Unit (former Biely Váh facies, or Homôlka sequence); therefore no wonder that since SCHÖNENBERG (1946) some geologists have considered it as the root zone of the Hronic nappes.

Zemplinic Unit

The Zemplinic tectonic Unit became amalgamated into the Central Western Carpathian block only during the youngest, Neogene phases of tectonic development. The unit consists of a Variscan crystalline basement and its Upper Paleozoic – Mesozoic cover (BEZÁK et al., 2004b). According to VOZÁROVÁ & VOZÁR (1988), the Zemplinicum represents the continuation of the Veporicum. Its Lower Triassic, developing with continuity from Upper Paleozoic continental siliciclastics, is likewise formed of continental sandstones, shales, sandy conglomerates and yellowish grey dolomitic shales with thin gypsum intercalations (Lúžna Fm.; VOZÁROVÁ & STRAKA, 1989). The evaporitic upper part of the sequence probably belongs to the lowermost Anisian. The upper Lower or Middle Anisian to Lower Ladinian? carbonate succession (Ladmovce Fm.) is represented in its lower part by dark grey, massive or thick bedded, partly bioturbated limestone, whereas in its upper part by light coloured dolomites with intercalations of shales, rauhwackes and breccias. From this upper part a Late Anisian conodont fauna *(Gondolella excelsa, G. cornuta)* was reported (STRAKA in VOZÁROVÁ & STRAKA, 1989). Younger Triassic formations are not preserved (Text-Fig. 4, col. 4).

10–15 km SW of the outcrops of the Zemplinic Unit, in the area of Hungary, Ladinian–Carnian Wetterstein and Norian–Rhaetian Dachstein type platform carbonates were discovered in drill cores near Sárospatak (PENTELÉNYI et al., 2003). Due to the discontinuous record, it is unclear, if they represented the continuation of the Triassic of Zemplinic Unit, or a unit of higher position above that. In the latter case, the situation would resemble that of the Muráň Nappe above the Veporic Unit.

Hronic Unit

The Hronic Unit represents the highest Paleoalpine cover nappe system in the majority of the Central Western Carpathians. Only three tectonic outliers of the Silicic Unit s.l. (the Drienok, Muráň and Vernár Nappes) are lying above (higher) in the central and eastern part of the Central Western Carpathians (see below). The Hronic Nappe System is composed of numerous nappes and duplexes, containing Upper Paleozoic sediments and volcanics, dominantly Triassic carbonates representing various paleoenvironments of the Hronic sedimentation area: carbonate platforms, intraplatform basins and slopes between them. Jurassic and Lower Cretaceous sediments are preserved in much smaller extent.

Some nappes of the Hronic Unit are monofacial (uniform basin facies, so-called "Biely Váh facies"), while the others are polyfacial. The concept to assigne the nappes, or partial nappes derived from carbonate platforms or from the slope areas (typically with the Wetterstein, Raming, Schreyeralm and even Reifling Limestone) to the "higher" (highest) Subtatric or Gemeric (later Silicic) Nappe System, caused long lasting problems of delimitation and classification of the Hronic Unit. This was the case with the Strážov, Veterník, Havranica, Jablonica, Nedzov, Tematín and Tlstá Nappes (and some other small tectonic outliers), which by the majority of the authors were considered as more "southern" elements than the Hronic Unit. The idea about the structure and paleogeography of such a "narrowly" defined Hronic Unit was then very simple (ANDRUSOV et al., 1973, p. 33–34): "The Hronic is the major tectonic unit overthrust on the Veporic and Fatric. Essentially, it is a large nappe which was translated from the south over Veporic and Fatric into the Tatric area". The Choč and Šturec Nappes were considered not only as two different "developments" (basinal Biely Váh and carbonate platform Čierny Váh facies), but as the only subunits of the Hronic Unit, as well.

A different paleogeographical and structural idea of the nappe system of the Hronic Unit (based mainly on the Middle and partly Upper Triassic facies differences) was presented by HAVRILA in several works (HAVRILA & BUČEK, 1992; HAVRILA, 1993; in PLAŠIENKA et al., 1997b; KOVÁČ & HAVRILA, 1998; and mainly in KOHÚT et al., 2008). According to HAVRILA the nappes of the Hronic Unit were derived from two basins and two carbonate platforms belonging exclusively to the Hronic sedimentation area (Text-Fig. 4, col. 7–8).

In the western part of the Central Western Carpathians there are the Dobrá Voda and Homôlka Nappes, derived from the Dobrá Voda Basin, and the Považie Nappe (originally Havranica, Jablonica, Nedzov and Strážov Nappe) derived from the Mojtín-Harmanec Carbonate Platform. The depositional area of the Veterlín and Ostrá Malenica Nappes had an intermediate position between the two paleoenvironments, containing a facially mixed succession.

This new interpretation of the Hronic Unit, with special consideration of the former "Strážov Nappe" plays a critical role in recent paleogeographical interpretations of the Central and Inner Western Carpathians. CSONTOS & VÖRÖS (2004) in their large-scale overview on the Mesozoic plate tectonic evolution of the Carpatho–Pannonian–Dinaridic domain – based on the former "North Gemeride" interpretation of the "Stražov Unit" –, placed the "Meliatic oceanic domain" even to the N of the Stražov domain.

In central and eastern part of the Central Western Carpathians there are disintegrated nappes derived from the Biely Váh Basin – Choč, Svarín and other nappes with local names (Bystrá, Svíbová and Okošená), and nappes derived from the Čierny Váh Carbonate Platform – Boca and Malužiná Nappes. Tlstá and Šturec Nappes are derived from the eastern part of the Mojtín-Harmanec Carbonate Platform and from a transitional area to – Biely Váh Basin, respectively.

The Lower Triassic sedimentary rocks of the Hronic Unit are represented by the siliciclastic Šuňava Formation, consisting of quartzose sandstones, sandstones and shales. The Middle Triassic commences by Lower Anisian Gutenstein dolomites and limestones. The basic architectural element is formed of Ramsau Dolomite of Late Anisian – Early Ladinian age. Typical deep-water deposits are represented by the Middle/Upper Anisian to Ladinian/Lower Carnian Reifling Limestone, and sometimes by the Upper Anisian Schreyeralm Limestone. In some parts the light coloured Wetterstein Limestone represents this time horizon. The middle part of the Carnian mostly consists of the siliciclastic Lunz Formation. The Upper Carnian and Norian is built up by thick and massive Hauptdolomit, which represents the uppermost lithostratigraphic unit of the Hronic Unit in most of the core mountains (Janočko et al., 2006). At several places the sequence terminates with limestones (Dachstein Limestone Fm., Norovica Lmst. Fm.) of Norian–Rhaetian age.

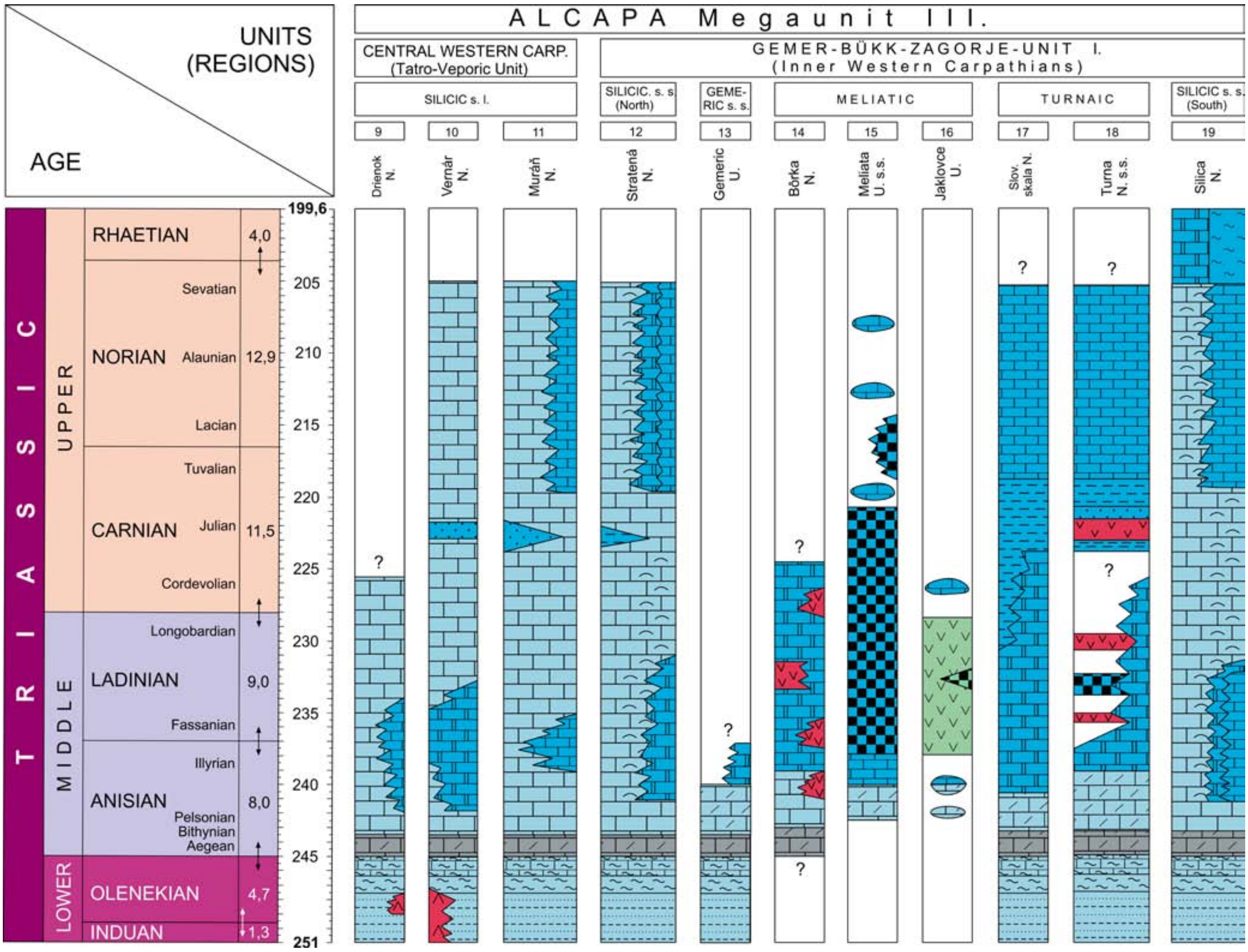
Silicic Unit s.l.

The structurally highest nappes of the Central Western Carpathians (Stratená, Muráň, Stražov, etc.) were previously included into the “Gemericum” (Andrusov et al., 1973; Andrusov, 1975) or the “North Gemeride Units” (Maheľ, 1973). At the same time the Mesozoic of the Slovak Karst area (lying south and above the Gemer Paleozoic; “Gemericum” s.s., a term still applied even nowadays) was classified as “South Gemeride Unit” (Maheľ, 1973). The discovery of the Mesozoic age (Kozur & Mock, 1973) of fragmentarily preserved deep-water sediments (radiolarites, shales) and ophiolites initiated a major challenge in the geotectonic concepts about the southern part of the Western Carpathians, nowadays called “Inner Western Carpathians” (since Mock, 1980b). A decade later Maheľ (1984 and especially 1986, p. 39) classified the former “North Gemeride Units” (after the “Spiš Nappe” of Andrusov, 1968) as “Spišcum” (Spiš Nappe) including the Strážov, Muráň and Besník Nappes.

Recently, however, the distantly lying Strážov Nappe has been included into the Hronic Unit (Havrila, 1993, and other publications, see above), where it is described as well (see above).

On the other hand, the Stratená Nappe, although already thrust onto the Veporic Unit, is described herein as part of the Gemer-Bükk-Zagorje Unit and of the Silicic Unit s.s. within that, since “Meliatic rocks” (radiolarites, etc.) occur below it (Havrila & Ožvoldová, 1996).

The Muráň Nappe lying just west of the “Gemericum” (Gemer Paleozoic) is described herein, as it clearly lies above the Veporic Unit and no oceanic remnants can be found below it (Vojtko, 2000, p. 339, assigned questionably a



Text-Fig. 5.
Lithofacies chart of the Silicic s.l. on the Central Western Carpathians (Tatro-Veporic Unit) (9–11) and of the Gemer-Bükk-Zagorje Unit I (Inner Western Carpathians; SE Slovakia) (12–19). (ALCAPA III).

slightly metamorphosed siliciclastic-evaporitic sequence beneath the Muráň Triassic to the Meliata Unit; however, it contains no trace of ophiolites or deep-water sediments). Except of the Hronic Unit, slices of Carboniferous sediments assigned to the Gemeric Unit were reported from beneath the Muráň Nappe (PLAŠIENKA & SOTÁK, 2001). It is to be added, apart from its well-known Dachstein facies, the Hallstatt facies was recently discovered in the Muráň Nappe (MELLO, unpubl.), which confirms its facial affiliation to Silicic Units.

As mentioned above (in chapter "Hronic Unit"), there exist only three tectonic outliers of the Silicic Unit s.l. (the Muráň, Vernár and Drienok Nappes) in the Central Western Carpathians (compare for example BEZÁK et al., 2004a, b). They are lying above the Hronic Unit or directly above the Veporic Unit in case of the Muráň Nappe, if the Hronic Unit (and Gemeric Unit) is missing.

The problem of these nappes (and especially of the Vernár Nappe) has been discussed by HAVRILA (in MELLO et al., 2000a, b). He accepts assignement of these nappes to the Silicic Unit, but nevertheless speculates about the "transitional" character of the Vernár, Drienok and the "lower" Muráň Nappe (according to him only the "upper" Muráň Nappe belongs to the Silicic Unit).

The ***Vernár Nappe*** (location on Text-Fig. 1; Text-Fig. 5, col. 10) which has a relatively simple structure and the position on the northern margin of former "North Gemeric syncline" was originally assigned to the Gemeric Unit or Choč Nappe (Hronic Unit), by some authors to the Veporic Unit and recently has been ranged to the Silicic Unit (MELLO et al., 2000a, b). The uncertainty with its classification was (and still is) also due to its peculiar facial development – acid volcanics in the Lower Triassic, Middle Triassic sequences similar to the Silicic Unit and Upper Triassic sequences similar to the Hronic Unit.

The ***Muráň Nappe*** (Text-Fig. 5, col. 11) is a distinct nappe outlier about 150 km^2 large which was overthrust from the former "Gemeric" to the Veporic area. Similar to the Silica, Stratená, Drienok and Vernár Nappes, it was recently assigned to the Silicic (and not Gemeric) Unit.

Though in the past it was considered as a coherent nappe body, later it got more and more evident, that the Muráň Nappe (or nappe outlier) consists of several parts or subunits – "lower" and "upper" Muráň Nappe as discussed by HAVRILA (MELLO et al., 2000b), "Turnaicum"(?) of VOJTKO (2000) and Dudlavá skala slice with Hallstatt Limestone (MELLO, unpubl.).

The ***Drienok Nappe*** (Text-Fig. 5, col. 9) is a tectonic outlier of the Silicic Unit in middle Slovakia (SE of Banská Bystrica) lying above the Hronic, or Veporic Unit. It formally was delimited and named by BYSTRICKÝ (1964b), and recently studied and described in POLÁK et al. (2003).

The stratigraphic setting and facies evolution of the three above mentioned nappes are comparable with the nappes of the Silicic Unit s.s. of the Inner Western Carpathians (i.e. the Silica and Stratená Nappes). Nevertheless, there exist some differences or peculiarities, in which they partly differ: the trace of an Early Triassic acid volcanic activity in the Vernár and Drienok Nappes (MELLO et al., 2000b; POLÁK et al., 2003), and the presence of terrigenous sediments in the middle Carnian in the Vernár Nappe (Lunz event). Concerning the final emplacement of these units, PLAŠIENKA (1997) and PLAŠIENKA et al. (1997a) proposed a post-Gosau (latest Cretaceous) final emplacement of at least of the Muráň and Stratená Nappes onto the Veporic Unit.

Pelso Unit

While in the northern part of the ALCAPA Megaunit the strike-ward continuation of Austroalpine units/zones into the Central Western Carpathian (Tatro-Veporic) Unit is well established (HÄUSLER et al., 1993), in its southern part large-scale facies offsets can be recognized both to the Northern Calcareous Alps and to the Southern Alps and Dinarides (KÁZMÉR & KOVÁCS, 1985; SCHMIDT et al., 1991; HAAS et al., 1995a). This part includes predominantly South Alpine and Dinaridic related crustal blocks/fragments, which together form the Pelso Unit ("Pelso Megaunit"; FÜLÖP et al., 1987).

The largest of these blocks is the Transdanubian Range Unit (= Bakonyia Terrane; KOVÁCS et al., 2000), delimited in the NW and N by the Rába and Hurbanovo lines (interpreted as sinistral strike-slip fault; VOZÁR, 1996) and sealed in its most part by Middle Miocene, but in the E by Upper Oligocene sediments (NAGYMAROSY in KOVÁCS et al., 2000), whereas on the S by the Balaton Line, interpreted as dextral strike-slip fault and representing the continuation of the Periadriatic Lineament (FODOR et al., 1998; HAAS et al., 2000b). Although this unit structurally lies in an "Upper Austroalpine" position (HORVÁTH, 1993), its Permo-Mesozoic stratigraphy and facies shows closer affinity to central and western parts of the Southern Alps (HAAS & BUDAI, 1995; VÖRÖS & GALÁCZ, 1998).

More about the facies offsets see chapter "Gemer-Bükk-Zagorje Unit".

Transdanubian Range Unit

The main part of the Transdanubian Range (Keszthely, Bakony, Vértes, Gerecse and Buda Mts) is made up of Triassic formations (location on Text-Fig. 1; Text-Fig. 6, col. 20), showing striking affinity with the corresponding formations in the Southern Alps (HAAS & BUDAI, 1995). The thickness of the Triassic formations may exceed 4 km. Classic exposures of the Lower and Middle Triassic are known in the southern part of the Bakony Mts, i.e. on the Balaton Highland.

In the northeastern part of the Transdanubian Range, above Upper Permian shallow-marine, lagoonal dolomites the Triassic succession begins with shallow subtidal limestones and marls, representing shallow to deeper ramp deposits. Southwestward, these sediments were replaced by marl of mud shoal facies and dolomite of restricted lagoon facies (HAAS et al., 1988; BROGLIO-LORIGA et al., 1990).

These formations are covered by a siltstone-sandstone sequence which indicates an intensified terrigenous input (Campil event in the Southern Alps). Deposition occurred in a subtidal ramp setting. This evolutionary stage was completed by a sea-level fall and a coeval decrease of terrigenous input, resulting in the formation of peritidal-lagoonal dolomites. During the next sea-level rise a marl succession was deposited on the outer ramp below the wave base.

In the Early Anisian the termination of terrigenous input led to deposition of pure carbonates on the ramp (HAAS & BUDAI, 1995), and dolomite was formed in a restricted, periodically hypersaline inner ramp lagoon. It is overlain by laminated and thick-bedded, strongly bioturbated limestone. The dolostones above it probably reflect an increasing restriction and dryer climatic conditions.

In the Middle Anisian, in connection with the Neotethys rifting, extensional tectonic movements began (BUDAI & VÖRÖS, 1992). This phase was followed by an onset of volcaniclastic deposition from distant volcanic centres during the Late Anisian.

In the southwestern part of the Transdanubian Range (Balaton Highland), intrashelf basins began to form during Pelsonian times *(Balatonites balatonicus* zone). Peritidal-subtidal carbonates were deposited on the most elevated blocks, whereas in the basins the dolomite progressed into the cherty Felsőörs Limestone of basin facies (Pl. 2, Fig. 5; VÖRÖS, 2003).

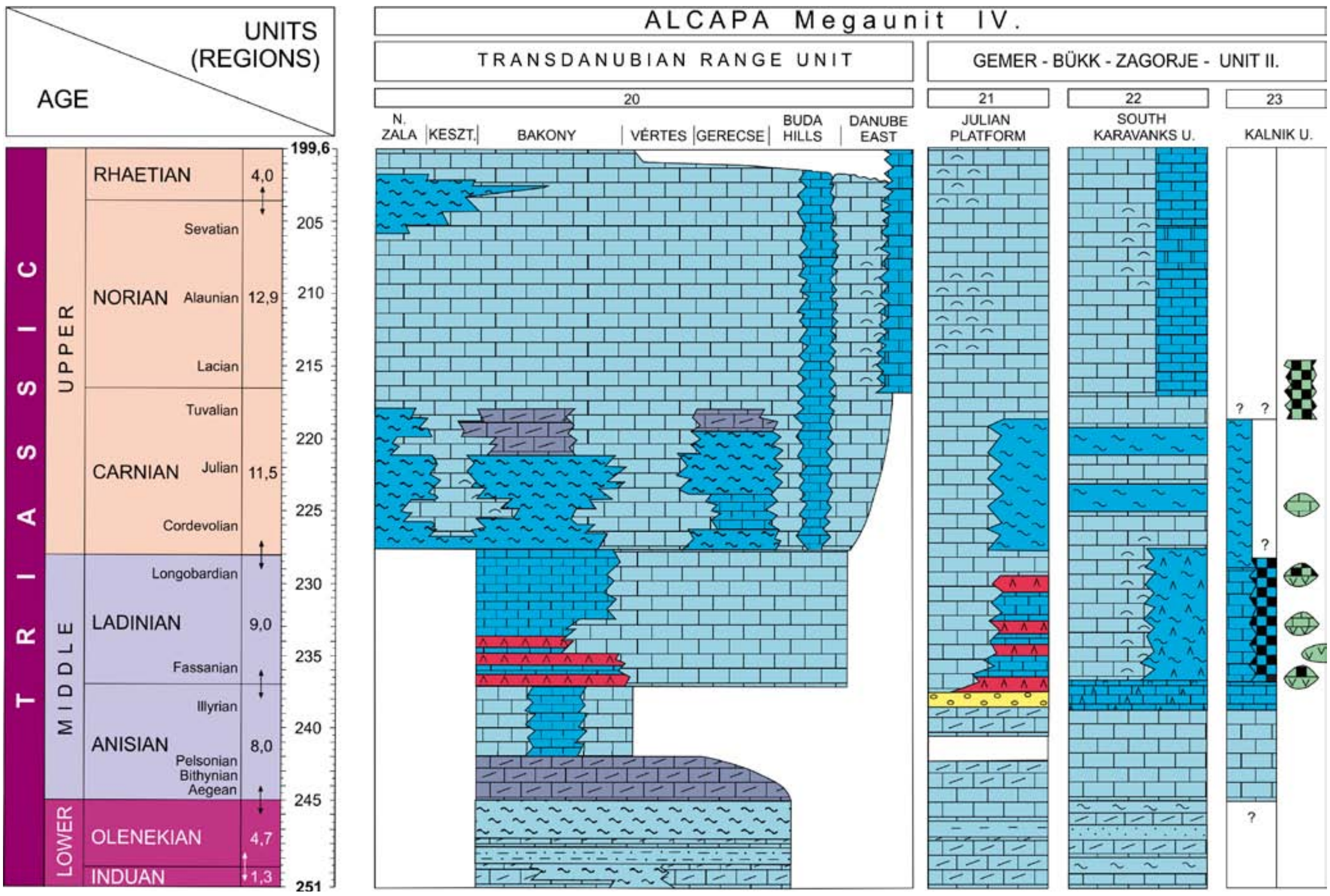
The Anisian/Ladinian boundary interval is characterized by pelagic limestones. The limestones are intercalated by volcanic tuff layers. It is followed by red cherty limestone, and tuffaceous limestone (Buchenstein Formation). Products of the Middle Triassic volcanism are mainly rhyodacite-trachyte pyroclastics, predominantly crystal tuffs (HARANGI et al., 1996). Until the earliest Carnian, deposition of pelagic cherty limestone continued in the Balaton Highland area (Pl. 3, Fig. 1). In the northeastern part of the Transdanubian Range the volcanic activity is indicated only by very thin tuff horizons. During the Ladinian to earliest Carnian, platform dolomite with dasycladacean algae (Budaörs Dolomite) was formed in that area (Pl. 2, Fig. 4).

In the Early Carnian (Julian) the input of a great amount of clay and silt from distal source areas and carbonate mud from the ambient shallow banks resulted in the deposition of a thick marl succession in the basins (HAAS, 1994). Rising sea-level in the late Early Carnian led to drowning of significant parts of the platforms. It was followed by a significant platform progradation in the middle part of the Carnian. In the late Early to early Late Carnian the remnant intraplatform basins were filled up with carbonates and shales.

In the latest Carnian large carbonate platforms began to form (BALOG et al., 1997). In the early stage of the platform evolution cyclic dolomite (Fődolomit Formation, an equivalent of the Hauptdolomit – Dachstein Dolomite or Dolomia Principale) was formed under semiarid conditions.

In small outcrops east of the Danube and in the Buda Hills in the easternmost part of the Transdanubian Range, in addition to the platform carbonates cherty limestone and dolomite of slope and intraplatform basin facies also appear in the Carnian and continue in the Norian–Rhaetian (Mátyáshegy Formation) and locally even into the Early Jurassic (Csővár Limestone) (Pl. 3, Fig. 3) (HAAS et al., 1997, 2000a).

At the end of the Middle Norian, in the southwestern part of the Transdanubian Range extensional basins began to form leading to stabilisation of the restricted subtidal conditions in this area. Thin-bedded dolomite was formed in



Text-Fig. 6.
Lithofacies chart of the Transdanubian Range Unit (20) and of the SW part (Slovenia and NW Croatia) of the Gemer-Bükk-Zagorje Unit I (21–23) (ALCAPA IV).

this environment in the area of the Southern Bakony and the Keszthely Hills. In the Late Norian, a significant climatic change led to enhanced influx of fine terrigenous material and deposition of organic-rich marl in the restricted basin (Kössen Formation; HAAS, 2002).

In the central part of the Transdanubian Range the carbonate platform evolution continued until the end of the Triassic or locally even in the earliest Jurassic. However, the more humid climatic conditions led to cessation of the dolomitization, therefore the Fődolomit Formation was followed by the Dachstein Limestone (HAAS & DEMÉNY, 2002) (Pl. 3, Fig. 2).

Gemer-Bükk-Zagorje Unit

To the ENE of the block of the Transdanubian Range Unit crustal blocks of more complex affinity (mostly Dinaridic–Hellenidic, but in the north also Upper Austroalpine) are in contact with the Central Western Carpathian (Tatro-Veporic) Unit. This region is referred to as “Gemer-Bükk area” (LESS et al., 2004). Units (Text-Fig. 5, col. 12–19; Text-Fig. 7, col. 24–34) building up this area show northern (Austroalpine) structural vergency in the north (“Gemeric Nappe System” – or “Inner Western Carpathians”), whereas in the south they show southern (Dinaridic) vergency (“Bükk Nappe System”). However, in the middle, vergencies are alternating (HAAS & KOVÁCS, 2001, Fig. 4).

In the area of the “Gemer-Bükk units” the northwesternmost occurrences of some typical Neotethyan formations can be found, characteristic for the Hellenides–Dinarides: Upper Permian marine “Bellerophon Limestone” in the Bükk Mts, Middle Triassic early rift-type basalt volcanism with peperitic facies (Darnó Hill) and calc-alkaline, andesitic ones (Bükk Mts), Bódvalenke-type limestones (transition between Hallstatt Limestone and red radiolarite) in the Bódva Unit of Rudabánya Hills, Jurassic redeposited, platform-derived carbonates (western Bükk Mts and Darnó Hill region).

To explain the Dinaridic connections of the Late Paleozoic and Early Mesozoic of the Bükk Mts, proven at that time already by deep-drilling evidences, WEIN (1969) introduced the term “Igal-Bükk Zone”. FÜLÖP et al. (1987) introduced the term “Mid-Transdanubian Zone” for the Transdanubian (e.g. lying W of the Danube River) part of this zone. Later PAMIĆ & TOMLJENOVIĆ (1998) introduced the term “Zagorje-Mid-Transdanubian Zone”. To express the connections to the surface outcrops until the Bükk Mts and further to the whole Gemer-Bükk area (especially because of the Mesozoic Neotethyan ophiolites), PAMIĆ et al. (2002, 2004) and PAMIĆ (2003) proposed the term “Zagorje-Bükk-Meliata Zone / Composite Terrane”. As ophiolites make up only part of the units incorporated into the “Gemer-Bükk area”, many of them reflecting the Paleozoic and Mesozoic facies offsets discussed above, we use herein the term “Gemer-Bükk-Zagorje Unit”, forming the southeasternmost part of the large ALCAPA Megaunit.

Following former paleogeographic considerations KOVÁCS (1983,1984) supposed a common origin for the Bükkian and Gemeric ophiolitic units (“Meliaticum”), an idea which occurred in many subsequent works. However, altough both originated from the Neotethys Ocean (but from its different parts), they clearly differ in their structural settings and partly also in composition.

Different surface and borehole geological data on the Slovakian and, respectively, Hungarian sides of the Slovak Karst – Aggtelek Karst area (LESS et al., 2004) led to different interpretations on the architecture and structural orientation of tectonostratigraphic units building up this terrain. It should be noted, that already ROTH (1939) and BALOGH & PANTÓ (1953) recognized the opposite structural vergencies at the northern and southern, respectively, margins of the karst area, confirmed by recent studies (MELLO & REICHWALDER, 1979; PLAŠIENKA et al., 1997a; PÉRÓ et al., 2003). In the Slovakian territory the superposition of ophiolite-bearing units *(**Meliatic Unit**)* – very low to low-grade metamorphosed unit *(**Turnaic Unit**)* – non-metamorphosed unit *(**Silicic Unit*** s.s.) can be recognized from below upward (like in the Brusník area: VOZÁROVÁ & VOZÁR, 1992; MELLO et al., 1997, and references therein). On the contrary, on the Hungarian side (Aggtelek Karst) the metamorphosed unit of intermediate position is missing and ophiolite slabs *(**Tornakápolna Unit**)* are incorporated in the Upper Permian evaporitic sole of the non-metamorphosed ***Aggtelek Unit*** (RÉTI, 1985; KOVÁCS et al., 2004, and references therein).

Inner Western Carpathian (Gemeric s.l.) Unit

The Inner Western Carpathians means the innermost part of the Western Carpathians that is situated south of the Lubeník-Margecany line (Text-Fig. 1). They differ not only facially from the Central and Outer Western Carpathians.

The structure of the Inner Western Carpathians is composed (from its base upwards) of four main tectonic units, the Gemeric, Meliatic, Turnaic and Silicic s.s. The Inner Western Carpathians represent a segment of the Western Carpathians, in which the remnants of the oceanic zone (Meliatic Unit), of the adjacent continental slope (Gemeric and Turnaic Units) and the shelf (Silicic Unit s.s.) are preserved (MELLO et al., 1998).

Gemeric Unit (s.s.)

The Gemeric (s.s.) Unit is the lowermost tectonic unit in the nappe pile of the Inner Western Carpathians (MOCK, 1980a). In tectonic superposition the Meliatic, Turnaic and Silicic s.s. tectonic units are lying above it.

The Gemeric Unit (Text-Fig. 5, col. 13) consists mainly of Paleozoic slightly metamorphosed sedimentary and volcanic rocks (EBNER et al., 2008; VOZÁROVÁ et al., 2009a, b). The Mesozoic (exclusively Lower and Middle Triassic) cover is preserved only in several places (mainly around Petrovo and Kobeliarovo villages and around Krompachy) underneath of the Bôrka Nappe of the Meliatic Unit.

The Lower Triassic deposits of the Gemeric Unit are very similar to those of other Inner Western Carpathian units; formations of the Werfen Group are present: at the base variegated sandstones and shales with bodies of evaporites (Nová Ves and Kobeliarovo Formations), higher up marlstones and limestones. The Middle Triassic is represented mainly by Gutenstein-type dolomites and limestones, partly light (recrystallised) limestones. Locally (in Petrovo village) cherty (?Reifling) limestones occur.

Meliatic Unit

The Meliatic Unit derived from the oceanic domain of the northwesternmost part of the Neotethys (KOZUR, 1991), including the deepest part of its continental slope (cf. its interpretation in the chapter Northern Calcareous Alps). The unit occurs prevailingly in form of a mélange consisting of slices. The mélange fringes the southern margin of the Gemeric Unit, or appears in a form of tectonic inliers beneath the Turna or Silica Nappes. Several occurrences are also known in the northern part of the Gemeric Unit (Danková, Galmus, Jaklovce and Murovaná skala). The Meliata Unit is usually represented by smaller or larger (often of km-sized) blocks incorporated within Upper Permian (evaporites) or Lower Triassic (marls) ductile rocks that form the base of the overlying Silicic and ?Turnaic Units (Hovorka, 1985); the earliest interpretations of the "Meliata Series" (Čekalová, 1954; Bystrický, 1964a; see in Mello et al., 1997) were based on these observations. According to several researchers (Mock, 1980a; Mello, 1996, and others) two subunits can be distinguished: the Meliata Group s.s. and the Bôrka Nappe.

The Meliata Group s.s. (occurring at the localities Držkovce, Honce, Meliata, Jaklovce, etc.) is a relict of sediments and volcanics originated in a basin with oceanic crust. The Meliata Group s.s. was defined as a complex of dark argillaceous shales of Jurassic age, up to several hundred metres thick, with thin beds of dark and greenish-red radiolarites (Bathonian–Callovian) and spotted marlstones with intercalation of sandstones, which are considered as Liassic. The olistostrome bodies in a shaly complex contain clasts and blocks, mainly of Triassic age, attaining the size of up to several hundred metres in diameter. Petrology and stratigraphy of the Meliatic Unit at the Meliata and Jaklovce localities were described in details by Mock et al. (1998) and Aubrecht et al. (2010).

However, the Triassic blocks represent two depositional settings: the distal (deepest) part of the continental slope and the ocean floor (Ivan & Mello, 2001; Kronome, 2002). The former is represented by the Meliata type section itself (Mock et al., 1998), where light coloured crystalline limestone (of "meta-Steinalm" type), containing neptunian dykes of similarly metamorphosed Pelsonian red, pelagic limestones (the age is proven by conodonts; Kozur & Mock, 1973) and Middle Triassic red radiolarites, occurs. In accordance with the interpretation of the Meliata Facies Zone in the Northern Calcareous Alps (see above), we retain the term ***Meliata Unit s.s.*** (Text-Fig. 5, col. 15) for this setting. Dumitrică & Mello (1982) demonstrated the presence of the Late Illyrian radiolarian zone *(Oertlispongus inaequispinosus* zone) in the area of Slovak Karst from a red radiolarite block near Držkovce. The northwesternmost occurrence of the Meliatic Unit was proven by Ladinian red radiolarites found beneath the Stratená Nappe (Havrila & Ožvoldová, 1996), that is thrust already onto Veporic basement.

The true ocean floor setting is represented by the Jaklovce locality, where MOR-type basalt (Ivan, 2002) occurs in association with red radiolarite in an outcrop along the railway. From here Mello et al. (1995) reported Illyrian to Longobardian conodonts and radiolarians *(Gondolella excelsa, Eptingium manfredi).* For this setting the term ***Jaklovce Unit*** is used herein (Text-Fig. 5, col. 16).

The second subunit, occurs tectonically directly above the Gemer Paleozoic and partly also the Mesozoic sequences, represents a remnant of the Jurassic accretional complex, which is designated as the ***Bôrka Nappe*** (Leško & Varga, 1980; redefined by Mello et al., 1996, 1997, 1998). The occurrences of Late Paleozoic – Mesozoic metamorphosed sequences (types Dúbrava and Hačava) are classed to this subunit, which occurs along the northern margin of the Slovak Karst between Jasov and Sirk, as well as in the Nižná Slaná depression. A characteristic feature of these rocks is the Late Jurassic medium to high pressure metamorphism with low thermal gradient (Mazzoli et al., 1992; Mello et al., 1998). In this type of metamorphism the Bôrka Nappe differs from the underlying Gemeric, as well as overlying Turnaic or Silicic s.s. Units. Its lithological composition is variable. The abundant metabasites (predominantly glaucophanites and light-coloured crystalline limestones with volcanic material) are assigned to the Triassic (Text-Fig. 5, col. 14), whereas the slates are probably of Jurassic age.

Based on the study of protoliths and geochemical characteristics of metabasites (glaucophanites) of the Bôrka Nappe, Ivan & Kronome (1996) concluded that they are very complex and inhomogenous, and accordingly cannot be classed to a coherent group.

Tectonic slices with amphibolite facies assemblages were reported as a further member of the Meliata Unit, besides the above mentioned metamorphosed rocks. Their metamorphic characteristics indicate, that they represent fragments of an older basement unit, which was involved into a subduction zone (Faryad, 2000).

Turnaic Unit

Nappes of the anchimetamorphosed to epimetamorphosed Turnaic Unit *(**Turna Nappe*** and ***Slovenská skala Nappe***; Text-Fig. 5, col. 17–18) occur in the wider region of the Slovak Karst, as a rule above the Meliatic and below the Silicic s.s. Unit. They are represented by rocks of Middle Carboniferous to Late Triassic and/or Jurassic age (Mello et al., 1996). A series of more or less similar lithology is also known in the Rudabánya Hills, Hungary ("Torna Series": Grill et al., 1984; Kovács et al., 1989; Less, 2000); see Martonyi Unit below after Grill (1988), however, in different setting; and of different interpretation.

The Lower Triassic is represented by the Werfen Group similar to that in the Silica Nappe, but metamorphosed. Carbonate ramp facies (Gutenstein and Steinalm Formations) characterize the Lower and partly the Middle Anisian. In the Pelsonian due to the onset of the extensional tectonics the ramp was drowned (in contrast to the Silicic Unit). Therefore in the higher Middle and Upper Triassic, basinal and slope facies (grey, bedded cherty limestones – Reifling and Pötschen Limestones) are predominant. In the Carnian traces of basic volcanic activity (Dvorník Member) occur.

Silicic Unit s.s. (incl. Aggtelek Unit)

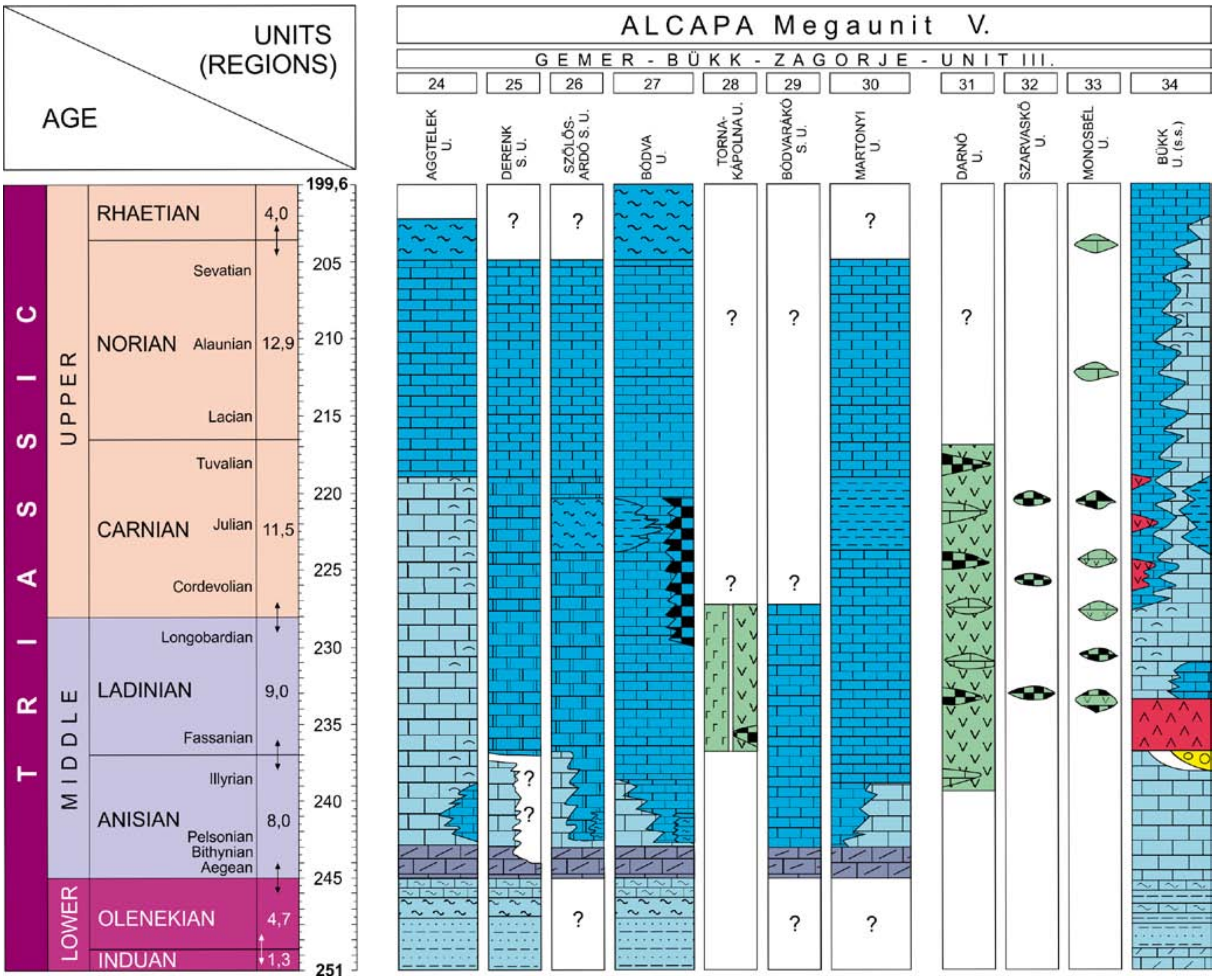
It is the uppermost and innermost unit of the Inner Western Carpathians, thrust over the Turnaic and Meliatic Units and more northerly also over the Gemeric Unit. Several tectonic outliers of the Silicic Unit s.l. (Muráň, Vernár and Drienok Nappes) can be found also over the Veporic and Hronic Units (see the chapter "Central Western Carpathians").

The **Silicic Unit s.s.** is represented in Slovakia by the Stratená Nappe (in the north; Text-Fig. 5, col. 12) and the Silica Nappe in the south (Text-Fig. 5, col. 19). In Hungary the Aggtelek Unit is actually the continuation of the latter (see below). Although the Stratená Nappe is thrust already onto the Central Western Carpathian basement (Veporic Unit), it is classified to this unit herein, since Meliatic rocks (proven by Ladinian red radiolarites: HAVRILA & OŽVOLDOVÁ, 1996) still occur below. Their stratigraphic successions range from the (?Middle-)Late Permian to the Late Jurassic. The oldest formation, the Permian to earliest Triassic Perkupa Evaporite Formation, on which the Silica Nappe was overthrust (or slid down) to its present-day position. The Lower Triassic formations are predominantly siliciclastic in the lower part, consisting of variegated sandstones and shales (Bódvaszilas Formation), higher up the carbonate constituent increases (marlstones and limestones of the Szin Formation).

The Middle and Upper Triassic is made up of carbonates, in places attaining a thickness of nearly 2 km. The Carbonate ramp and platform facies (the latter being dissected into reefs and lagoons) are represented by limestones and dolomites of the Gutenstein, Steinalm, Wetterstein and Dachstein Formations, whereas rocks deposited on the adjacent slopes and in basinal environments by the Reifling, Nádaska, Schreyeralm, Raming, Hallstatt, Pötschen and Aflenz Limestones and Zlambach Marl.

The pre-rift stage (Early to Middle Anisian) of the carbonate ramp facies is represented by the restricted lagoonal Gutenstein Formation, and then by the open lagoonal Steinalm Formation with rich dasycladacean algae association (BYSTRICKÝ, 1964a, 1986).

As a result of rifting processes taking part in the Meliatic domain, the uniform Steinalm carbonate ramp was dissected and extensional intrashelf basins were formed during the Middle and Late Anisian, in which reddish Schreyeralm-type or grey Reifling-type limestones, whereas on their slopes varicoloured limestones (Nádaska Limestone) were deposited. In other areas, however, development of carbonate platforms continued, as indicated by a continuous succession of dasycladacean algae zones *(Physoporella pauciforata* + *Oligoporella pilosa* – *Diplopora annulatissima* – *D. annulata* zones) (BYSTRICKÝ, 1964a, 1986). In most of these areas (the northern or northwestern parts of the present Stratená and Silica Nappes) carbonate platform building (rimmed with reefs) was continuous till the end of the Norian (Wetterstein, Tisovec: see KRYSTYN et al., 1990 / and Dachstein Limestones: MELLO, 1974, 1975a). The intrashelf basins were overlain by the prograding Wetterstein reefs in the Late Ladinian (MELLO, 1975b). No siliciclastic event is recognizable in the Carnian. The presence



Text-Fig. 7.
Lithofacies chart of the Aggtelek Karst (24–25), Rudabánya Hills (26–30) and Bükk Mts (31–34) (NE Hungary) (Gemer-Bükk-Zagorje Unit III) (ALCAPA V).

of horizons with large oncoids (up to 2 cm) in the uppermost part of the Wetterstein Limestone indicate shallowing in the late Julian.

The southern respectively southwestern parts of the present Silica and Stratená Nappes were broken down in the Late Carnian, and pelagic, red or pinkish Hallstatt and grey Pötschen Limestones were deposited till the Late Norian (Mišík & Borza, 1976; Mello et al., 1997, 2000a, b) all summarized in Haas et al. (2004).

Both the Stratená Nappe in the north and the Silica Nappe in the south show a more or less obvious southern facies polarity concerning their Middle (Wetterstein Limestone lagoonal facies – reefal facies – Nádaska Limestone of slope facies in the former) and Upper Triassic (Dachstein Limestone – Hallstatt Limestone in both) formations (Mello et al., 1996, 2000a, b). However, they both show definite N-vergent structures bearing evidence of thrusting over the Gemer Paleozoic (and other underlying) units (Plašienka et al., 1997a). The duplication of the Silicic s.s. Unit both in the N and in the S and likely the opposing structural vergencies recognized on the Slovakian and Hungarian territories can be best explained by the pre-Late Cretaceous (likely intra-Jurassic) sinistral strike-slip duplex proposed by Lein et al. (1997) and Frank & Schlager (2006) with the example of the Eastern Alps.

The **Aggtelek Unit** in NE Hungary forms a direct continuation of the Silica Nappe of SE Slovakia, with southerly deepening facies polarity (Grill et al., 1984; Kovács et al., 1989; Less, 2000) and predominantly S-vergent structural polarity (see below).

As a result of re-mapping of the Aggtelek Karst and Rudabánya Hills, Grill et al. (1984) and Grill (1989) elaborated a three-fold nappe structure of the area. Accordingly, the non-metamorphosed Aggtelek and Bódva Units in highest position, showing definite southward deepening polarity, were attributed to the Silicic Unit in its original sense (as introduced by Kozur & Mock, 1973). Oceanic remnants of the Tornakápolna Unit are found only as blocks in the evaporitic sole of the former units, and were attributed to the Meliatic Unit (Réti, 1985). The metamorphosed Torna (Grill et al., 1984) or Martonyi (Grill, 1989) Unit was considered to occur in the deepest position. The latest review of this period on the structural investigations of the area was presented by Less (2000). Recent structural studies (Fodor & Koroknai, 2000; Hips, 2001; Péró et al., 2002, 2003; Kövér et al., 2008) confirmed the predominantly S-vergent structures of the area, known already since Balogh & Pantó (1953).

In the ***pre-rift stage*** (from ?Middle–Late Permian to Middle Anisian; Kovács, 1984) these units were not yet facially separated, therefore their evolution in this time interval can be characterized together.

Following a probably Middle Permian continental redbed stage, represented only by a small outcrop (Kovács & Hips, 1998; after pers. comm. by A. Vozárová), Neotethyan transgression began with the sabkha stage (Perkupa Evaporite Formation) in the Late Permian, under arid climatic conditions. According to bivalve-biostratigraphic data (the oldest *Claraia* zone is missing), the Permian/Triassic boundary lies within the uppermost part of the formation (Hips, 1996).

Fully marine conditions were established in the Early Triassic from the *Claraia clarai* zone onward (shallow-marine "Werfen Group"). At first a pure siliciclastic inner ramp environment formed, represented by the red Bódvaszilas Sandstone Formation, containing shallow-marine fossils (bivalves) and sedimentary features (ripple marks). In the higher part of the Early Triassic, due to the transgression, the area shifted to the deeper outer ramp domain, with mixed carbonate-siliciclastic sedimentation (Szin Marl Formation, containing the ammonoid guide form *Tirolites cassianus*). By the end of the Early Triassic, the input of fine-grained siliciclastics was strongly reduced and carbonate deposition became predominant. The inner ramp became restricted, where bioturbated ("vermicular") limestone and marls (Szinpetri Limestone Formation) accumulated under disaerobic conditions, but containing in its lower part still some ammonoids and bivalves (Hips, 1996, 1998).

Following the cessation of siliclastic input, a fully restricted, euxinic environment came into existence on the inner ramp, with deposition of dark grey to black carbonates (Gutenstein Formation; mostly limestones in the Aggtelek Unit, and mostly dolomites in the Bódva Unit) in the early part of the Early Anisian. In the later part of the Early Anisian, the area became part of a well-oxygenated and wave-agitated ramp, typified by accumulation of dasycladacean in the subtidal zone *(Physoporella pauciforata*, *Diplopora hexaster*, etc.) and stromatolitic limestones in the peritidal zone (Steinalm Limestone, partly dolomitized).

In the Middle Anisian (in some places probably even in the late Early Anisian), due to onset of the Neotethyan rifting, the disrupture of the Steinalm carbonate ramp began *(**synrift stage**)*, leading to differentiation of the future tectonostratigraphic units. This is indicated by the onset of pelagic (Bódva Unit s.s.) and slope (Szőlősardó Subunit) sedimentation, whereas more to the north the carbonate platform building continued (Aggtelek Unit; location on Text-Fig. 1; Text-Fig. 7, col. 24).

Carbonate platform building in the outer shelf and shelf margin setting continued. In the Late Anisian the first true, rimmed platform developed (Aggtelek reef, Velledits et al., 2011) facing southeastward towards the Szőlősardó–Bódva domains. This pre-Wetterstein-type reef can be considered as the reefal facies of the Steinalm lagoon lying to the north.

Development of the carbonate platform (Wetterstein Formation) continued throughout the Ladinian *(Diplopora annulata* dasycladacean zone) and Carnian *(Poikiloporella duplicata* dasycladacean zone), till the early part of the Late Carnian. In the Carnian the elongated Alsóhegy Carbonate Platform (Alsóhegy Subunit) was built with a reef facies in the south, facing towards the Bódva pelagic domain, and a lagoon northward (Kovács, 1979; Péró et al., 2003). According to the relevant literature, the building of the carbonate platform was not interrupted in the middle part of the Carnian by any siliciclastic event; instead, it continued *(Physoporella heraki* dasycladacean subzone; Kovács, 1979; Piros, 2002). Recently a hardground formation was found between the Lower Carnian reef and the overlying Upper Carnian basinal formations (Gawlick, pers. comm.). In front of the western part of this platform a characteristic slope facies developed coevally (Derenk Limestone, **Derenk Subunit**; Text-Fig. 7, col. 25).

The break-down of the Wetterstein shelf margin took place in the early part of the Late Carnian and deposition of the pelagic Hallstatt Limestone commenced till the Late Norian, where it was followed by the deposition of the Zlambach Marl (Kovács et al., 1989; Kovács, 1997; Less, 2000).

Bódva Unit s.l.

As a result of the disrupture and breakdown of the former Steinalm carbonate ramp, a slope environment (Szőlősardó Facies Unit) and a deep-water pelagic domain (Bódva Facies Unit) formed on attenuated continental crust, came into existence (Grill et al., 1984; Kovács, 1984). As they interfinger with each other, they represent the same structural unit (Bódva Unit s.l. of the Rudabánya Hills), however we distinguish a Szőlősardó and a Bódva s.s. Facies Unit.

Szőlősardó Facies Unit

Following the break-down of the outer part of the Steinalm carbonate ramp during the Middle and Late Anisian, a distally steepened slope environment developed, characterized by a varicoloured limestone formation (Nádaska Limestone Formation), with signs of sediment gravity movements. It ranges maximally from the Middle Anisian *(Gondolella bulgarica* conodont dominance zone) to the early part of the Middle Carnian *(Gondolella auriformis* conodont range zone), and may interfinger with the grey, partly cherty Reifling Limestone. A remarkable, several 10 m thick, marly-shaly succession of the Szőlősardó Marl Formation in the middle part of the Carnian represents the siliciclastic "Reingraben event" (with the characteristic bivalve *Halobia rugosa).* The slope setting of the Szőlősardó Subunit ceased after the break-down of the Aggtelek shelf margin (early part of the Late Carnian) and grey, cherty pelagic limestone (Pötschen Limestone) was deposited during the rest of the Carnian and the Early Norian (Text-Fig. 7, col. 26).

Bódva Facies Unit s s.

In the most distal part of the down-breaking Steinalm ramp, nearest to the rift zone, a deep-water sedimentary domain formed during the Middle and Late Anisian, where the characteristic Bódvalenke Limestone representing a transitional facies between the Hallstatt facies and the Middle Triassic red radiolarite was deposited. In some places, the break-down could happen even in the late Early Anisian (Bithynian), as indicated by an uncertain ammonoid fauna, containing *Nicomedites*? sp. determined by Krystyn (Kovács et al., 1989). The typical version of the Bódvalenke Limestone, which follows the Steinalm Limestone with some transitional facies, is formed by alternation of purplish red or pinkish, micritic limestone beds and red chert beds, with mm-thick purplish-red shale intercalations, and with interbedded whitish calciturbidites consisting of juvenile pelecypod *(Posidonia)* coquinas with their recrystallized matrix (Pl. 3, Fig. 4–5). In some places (e.g. the Szárhegy-East section; Kovács et al., 1989) the Bódvalenke Limestone passes upward into radiolarite. Deposition of the Bódvalenke Limestone continued also up to the early part of the Late Carnian *(Gondolella polygnathiformis* conodont interval zone) and then (with a remarkable hiatus in some sections) was followed by the Hallstatt Limestone (Text-Fig. 7, col. 27), indicating continuation of the oxydative environment, but also, as opposed to that of the Aggtelek Unit, an uneven, highly dissected sea-floor topography, as witnessed by frequent "intraconglomerates" related to sediment gravity movements. Variegated marls (green to purplish red) of the Telekes-Völgy Group (Kövér et al., 2009) may represent some kind of the uppermost Triassic Zlambach Marl (Grill, 1988). The Bódvalenke-type limestones represent a transitional facies between coeval red, Hallstatt-type limestones and red radiolarites; similar facies are common constituents of inner Dinaridic – inner Hellenidic ophiolite mélanges, however, associated with basalts. This association occurs also in the Darnó Unit (see below) (Skourtsis-Coroneou et al., 1995; Kovács, 2011; Kovács et al., 2011).

Tornakápolna Unit

Remnants of a Neotethyan oceanic assemblage, tectonically incorporated as slices or blocks into Upper Permian evaporites at the sole thrust of the Aggtelek and (?)Bódva Units are classed to this unit that does not represent an independent structural unit. These include mostly serpentinites, gabbros and basalts of MOR-affinity (Réti, 1985; Horváth, 2000). The drill-core section of the borehole Tornakápolna 3 is considered as the type section of the "complex" (Réti, 1985; Józsa et al., 1996) in which some sedimentary rocks do occur as well: Upper Anisian – Lower Ladinian red pelagic mudstones and radiolarites in one horizon within pillow basalts, containing radiolarians of the *Oertlispongus inaequispinosus* radiolarian zone (Kozur & Réti, 1986; Dosztály & Józsa, 1992), as well as black siliceous shales and sandy shales in one tectonic slice within serpentinites (Text-Fig. 7, col. 28). The latter proved to be barren of radiolarians, but being lithologically similar to that encountered in the Darnó drill core sections, can be considered as Jurassic (Haas et al., 2004; Kovács et al., 2008a, b, and 2011). In some shear zones (but not overall) ophiolites and evaporites form true "autoclastic mélange" (Dimitrijević et al., 2003). The continuous transition from the Upper Permian evaporites embracing these ophiolite blocks into the shallow-marine Lower Triassic formations is documented by Hips (1996; including also the above mentioned drill core sections).

The geological setting of the Bódva Valley Ophiolite Complex (blocks incorporated into Upper Permian evaporites after obduction) clearly differs from the Darnó Ophiolite Complex of the Bükk Unit s.l. and may correspond to the Gemeric Meliata ophiolites, if they are defined by the Šankovce borehole (Bystrický, 1964a; Gaál in Vass et al., 1986) or by the Jaklovce occurrence (Mock et al., 1998). However, current structural interpretations (Plašienka et al., 1997a; Less, 2000; for latest discussion see Dosztály et al., 2002) are still differing widely, implying the necessity of further joint correlational works.

Martonyi (Torna) Unit

This unit was first distinguished by Less (Grill et al., 1984) as "Torna Series"; it was named by Grill (1989), as "Martonyi Unit". It includes anchizonal to epizonal metamorphosed (Árkai & Kovács, 1986) Triassic series, which occur in the NE part of the Rudabánya Hills, enclosed by the Darnó fault zone. Its known sequence (Text-Fig. 7, col. 30) begins with Lower to Middle Anisian Gutenstein Dolomite and Steinalm Limestone, similarly to those of the Aggtelek and Bódva Units. The Steinalm ramp disrupted and broke down in Middle to Late Anisian, and deposition of grey limestone of basinal facies, lacking chert ***(Becskeháza Subunit)*** or having chert only in the upper part of the section ***(Esztramos Subunit)*** took place under quiet conditions (practically without any trace of sediment gravity movements) till the end of Ladinian or beginning of the Carnian. Carbonate sedimentation was interrupted in the middle part of the Carnian by a fine siliciclastic input representing the "Reingraben event", resulting in a few 10 m thick shale sequence. Basinal carbonate sedimentation renewed in the early part of the Late Carnian, then grey, cherty limestone (Pötschen Limestone s.l.) was deposited till the end of Early Norian, followed by variegated limestones with red chert in the Middle to Late Norian.

A specific, more deep-water development is represented by the ***Bódvarákó Subunit,*** in which the open-lagoonal Steinalm ramp stage was missing and the Gutenstein Dolomite (Text-Fig. 7, col. 29) was immediately followed by the anoxic deep-water Bódvarákó Formation: dark grey to black, cherty limestone alternating with claystones or marls in the Middle to Upper Anisian, and dark grey, strongly silicified limestone and black cherts up to the Upper Ladinian. The continuation of the sequence, although tectonically separated, in the Carnian and Norian was likely the same, as above (FODOR & KOROKNAI, 2000).

Bükk Unit s.l.

Bükk Unit s.s.

The Upper Permian shallow-marine carbonates are overlain by lowermost Triassic oolithic limestone (in more than 100 m thickness; Pl. 4, Fig. 1). Until the end of the Early Triassic, carbonate and siliciclastic dominated ramp sedimentation alternated. The succession shows a deepening upward trend. A bioturbated limestone unit appears at the top of the Lower Triassic (HIPS & PELIKÁN, 2002).

In the Anisian a dolomite ramp was formed. It is capped locally by dolomite conglomerates or breccias with red, terrestrial clay intercalations (VELLEDITS, 1999, 2004). Updoming can be considered as a sign of the initiation of rifting and related volcanic activity in connection with the Neotethyan opening (VELLEDITS, 2006).

In the Early Ladinian, intense calc-alkaline volcanic activity took place. A volcanic complex, hundreds of metres thick (Szentistvánhegy Metaandesite or "porphyrite") was accumulated, consisting of lava rocks, agglomerates, tuffs, ignimbrites and various volcanoclastic sediments (KUBOVICS et al., 1990; SZOLDÁN, 1990; HARANGI et al., 1996).

The rifting manifested also in facies differentiation, platform and intraplatform basin environments were established in the Late Ladinian. A larger part of the mountains is built up of an anchizonal to epizonal metamorphosed (ÁRKAI et al., 1995) carbonate platform sequence, which includes both the Wetterstein and Dachstein evolutionary stages encompassing a range from the Ladinian to the Rhaetian (RIEDEL et al., 1988; FLÜGEL et al., 1992; VELLEDITS, 2000). In the coeval basins grey cherty limestones were accumulated, which extend according to conodont biostratigraphic data from the latest Ladinian to the Rhaetian (VELLEDITS, 2000). A second volcanic activity represented by within-plate basalts (SZOLDÁN, 1990; HARANGI et al., 1996) took place in the basin environments, mostly in the Late Ladinian, but manifesting in places up to the Late Carnian (VELLEDITS et al., 2004; PELIKÁN, 2005).

The platforms were drowned by the latest Triassic, and variegated limestones were deposited locally, which may extend into the Jurassic (Text-Fig. 7, col. 34).

Mónosbél Unit

Within the Middle–Late Jurassic fine siliciclastic-carbonate turbiditic Mónosbél complex slide blocks of up to several 10 m in size occur in the area of Darnó Hill. The blocks consist of reddish, cherty, Bódvalenke-type limestone and chert, and reddish, amygdaloidal basalt. Radiolarian data (DOSZTÁLY & JÓZSA, 1992; DOSZTÁLY, 1994) constrain the age of these blocks as Ladinian–Carnian. The easternmost occurrence of such blocks on the surface is known in the central part of the southern Bükk Mts (basalt, red chert, Upper Carnian Hallstatt-type limestone; DIMITRIJEVIĆ et al., 2003, Pl. II, Fig. 4), which is quite exotic to the Triassic sequence of the Bükk Unit s.s. (Text-Fig. 7, col. 33).

Szarvaskő Unit

In an olistostrome horizon of this Jurassic complex (HAAS et al., 2001) Ladinian to Carnian red radiolarite blocks occur (DOSZTÁLY & JÓZSA, 1992; DOSZTÁLY, 1994; Text-Fig. 7, col. 32). Rare occurrences of Norian, conodont-bearing grey limestone blocks are also known.

Darnó Unit

In a Jurassic accretionary complex (KOVÁCS et al., 2008a, b; HAAS et al., 2011, in this volume), as documented by drill-core sections, abyssal sediments (red pelagic mudstones and radiolarites) in less amount alternate with basalts in larger amount. Part of the radiolarites is of Ladinian–Carnian age (DOSZTÁLY & JÓZSA, 1992; DOSZTÁLY, 1994; JÓZSA et al., 1996; HAAS et al., 2004; KOVÁCS et al., 2008a; Pl. 4, Fig. 3). The basalts are of two types: the early rift-type is reddish or greenish and rich in calcite amygdales, and contains contact metamorphosed Bódvalenke-type limestone inclusions. The latter are reddish, recrystallized limestone blocks of a few cm to a few 10 cm in diameter, with red chert. Some radiolarian data (DOSZTÁLY, 1994; JÓZSA et al., 1996) point also to their Ladinian–Carnian age (Text-Fig. 7, col. 31). This mixture of basalt with red micritic limestone, formed due to the interaction of hot lava flow with cold lime mud on the sea floor, represents a typical peperitic facies (Pl. 4, Fig. 2) and is compared with those occurring in the Kalnik Mt, NW Croatia (KISS et al., 2008), where they are known to a much larger extent (PALINKAŠ et al., 2008; KOVÁCS et al., 2011). The other type of basalt lacks signs of mixing with calcareous lime mud and reminds of the Jurassic Szarvaskő type (HAAS et al., 2011, in this volume).

Zagorje-Mid-Transdanubian Unit

This unit represents the southwestern part of the Gemer-Bükk-Zagorje Unit and crops out on the surface in the Zagorje region (Medvednica, Ivanščica and Kalnik Mts) in NW Croatia. Their subsurface extension, also to Hungary ("Mid-Transdanubian Unit"; FÜLÖP et al., 1987) is quite well known due to plenty of deep-drilling data (BÉRCZI-MAKK et al., 1993; PAMIĆ & TOMLJENOVIĆ, 1998; HAAS et al., 2000b). Structurally, the Julian Alps – South Karavanks and Sava folds (MIOČ, 1981), thrust during the Oligocene? – Miocene southward onto the northwestern part of the Dinarides, are also considered as the western extension of this zone (HAAS et al., 2011, in this volume), therefore they are included (Text-Fig. 1) and described herein. Details on the borehole data of the subsurface continuation of these units into Hungary ("Mid-Transdanubian Unit" of FÜLÖP et al., 1987) can be found in the publications of BÉRCZI-MAKK et al. (1993) and HAAS et al. (2000b), which are summarized below.

Mid-Transdanubian Unit

In the northern part of the Mid-Transdanubian Unit non-metamorphosed Permian and Triassic formations form the pre-Tertiary basement, whereas slightly metamorphosed Permian, Triassic and Jurassic formations occur in the southwestern part of the unit. Ophiolite mélange was encountered in a few wells in a narrow strip along the southern structural contact of the unit (BÉRCZI-MAKK et al., 1993; HAAS et al., 2000b).

South Karavanks Unit

The Triassic sequence of the South Karavanks is typified by Werfen-type Lower Triassic, shallow-marine Anisian dolomite, coeval platform carbonates (Schlern and Conzen Dolomite) and basin facies consisting of marl with volcanic tuff (Wengen Fm.) in the Ladinian, marl, limestone and sandstone (Raibl Group) in the Carnian (Pl. 4, Fig. 5), and Hauptdolomit and Dachstein Limestone in the Norian to Rhaetian (GIANOLLA et al., 1998; COZZI, 2000), that is very similar to what was encountered in the wells south of the Balaton Line.

A great number of wells encountered Triassic formations in the same zone, making it possible to compile a generalised succession. The Lower Triassic is made up of lilac-coloured variegated shale that is overlain by an interval of alternating limestone, dolomite and shale, representing shallow ramp and lagoon facies. Shallow-marine dolomite typifies the Anisian. Coeval platform and basin facies characterises the Ladinian to Carnian interval. Wetterstein-type limestone represents the platform facies. The basin facies is typified by gray cherty limestone, marl and volcanic tuff in several horizons in the Ladinian, and marl and siltstone in the Carnian. The Norian to Rhaetian is represented by Dachstein-type platform carbonates (BÉRCZI-MAKK et al., 1993).

Julian-Savinja Unit

South of the above-described narrow strip there is a relatively wide zone where, beneath a Tertiary cover, predominantly non-metamorphosed Triassic platform carbonates were encountered. The Middle and Upper Triassic is characterised by a typical shallow-ramp platform facies, namely Steinalm-Wetterstein-type and Dachstein-type facies, respectively (BÉRCZI-MAKK et al., 1993).

South Zala Unit

In the Mid-Transdanubian area the South Zala Unit, located south of the above described non-metamorphic units consists of Upper Permian evaporitic carbonates, Triassic carbonates of basin and slope facies and Middle Jurassic hemipelagic shale and volcanoclastics affected by low-grade metamorphism. Possibly, the Medvednica and the South Zala Units are part of one tectonostratigraphic unit.

Julian Carbonate Platform

The Julian Carbonate Platform (Text-Fig. 6, col. 21) was formed after disintegration of the Slovenian Carbonate Platform during the Anisian (BUSER, 1989; BUSER et al., 2008). From then it acted as a distinguished paleogeographic unit up to the Early Jurassic.

Accordingly, Scythian and Anisian beds are similar to those in southern and central Slovenia. In the Scythian shallow-water carbonate and siliciclastic deposits alternate in a succession up to 300 m thick. Frequent oolitic beds and in places evaporites are very characteristic (DOLENEC et al., 1981; RAMOVŠ, 1989b; KOLAR-JURKOVŠEK & JURKOVŠEK, 1996; LUCAS et al., 2008).

The Anisian stage is represented mostly by bedded dolomites. However, in Bled and locally in the Western Karavanks massive and bedded algal-reef limestones occur as well (RAMOVŠ, 1987a; FLÜGEL et al., 1993). These beds are up to 600 m thick. In some places massive limestone beds continue upwards into the Ladinian stage.

The Ladinian stage is characterized by sandstones, marls, shales, limestone with cherts, and also volcanic, mostly tuffaceous rocks (RAMOVŠ, 1989a). Among volcanic rocks, quartz keratophyre, porphyry, and tuffs of ignimbritic character occur. In the Western Karavanks (Text-Fig. 6, col. 22) and in places in the Julian Alps a horizon of breccia-conglomerate some tens of metres thick – Uggowitz (Ugovica) Beds – occurs under the Lower Carnian ("Cordevolian") dolomite.

Lowermost Carnian ("Cordevolian") is represented by a succession up to 1000 m thick of light coloured massive and bedded limestones with diplopore algae and rarely corals and hydrozoans (RAMOVŠ & TURNŠEK, 1984; RAMOVŠ, 1987b; RAMOVŠ & ŠRIBAR, 1992). The Julian and Tuvalian beds, known as Tamar Formation (= "Raibl Beds"), are up to 200 m thick (Pl. 4, Fig. 4; Pl. 5, Fig. 3). They were deposited in a shallow restricted shelf. Dark argillaceous limestone with marl intercalations is predominating over dolomite (RAMOVŠ, 1987b; OGORELEC et al., 1984). In places, the limestone beds contain megalodonts and algal flora with *Clypeina besici* (DOBRUSKINA et al., 2001; KOLAR-JURKOVŠEK & JURKOVŠEK, 2003; KOLAR-JURKOVŠEK et al., 2005). The limestone beds are locally overlain by pelitic tuff. Formation of the Main Dolomite (Hauptdolomit) started in the latest Tuvalian (BUSER, 1979). In the deeper environments of the Julian Platform towards the Slovenian Basin, micritic limestones with abundant fauna (JURKOVŠEK & KOLAR-JURKOVŠEK 1986, 1997; KOLAR-JURKOVŠEK, 1991; CELARC & KOLAR-JURKOVŠEK, 2008, etc.) dolomites, and limestones with chert nodules were deposited (JURKOVŠEK et al., 1984).

In the Norian and Rhaetian the Dachstein Limestone in Lofer facies predominates, reaching a thickness of 1500 m (Pl. 5, Fig. 1; BUSER, 1979; OGORELEC & ROTHE, 1993). In the northern part of Triglav widely extended coral-reefs occur (TURNŠEK, 1997).

Kalnik Unit

The ophiolitic mélange of the Kalnik Unit (Text-Fig. 6, col. 23) crops out in the Kalnik, Medvednica and Ivanščica Mts, in Croatia, but its subsurface extension to the territory of Hungary is also proven by borehole data (HAAS et al., 2000b). Its matrix is composed of fine-grained siliciclastics (mostly dark grey to black shales), the age of which is Middle Jurassic based on intercalated radiolarites (Halamić et al., 1999). The m to km-sized blocks in this matrix include ultramafics, basalts, gabbros and deep-water sediments (radiolarites, silicified limestones) (Pamić, 1997; Pamić & Tomljenović, 1998). Triassic red radiolarites, interlayered with basalts or lying on top of them, range in age from the Late Anisian *(Oertlispongus inaequispinosus, Falcispongus calcaneum,* etc.) to Late Carnian – Middle Norian (several *Capnuchosphaera* species, *Capnodoce* sp*.,* etc.; Halamić & Goričan, 1995; Goričan et al., 2005). Triassic basalts are frequently amygdaloidal and represent peperitic facies with red, micritic limestone inclusions (Pl. 5, Fig. 2), from which conodonts were reported in the Kalnik Mt (Palinkaš et al., 2008). In the NW part of the Medvednica Mt (Orešje quarry) well-preserved Late Anisian conodonts (platformless forms of *Gondolella excelsa*, figured as "*Paragondolella* cf. *excelsa")* were found in red limestone inclusions in MOR-type basalt (Halamić et al., 1999). Triassic early rift type basalts are considered to be related to sea-floor spreading in back-arc basin setting, initiated around the Anisian/Ladinian boundary (Goričan et al., 2005). A whole submarine volcanic complex with abundant peperitic facies was reconstructed in the Kalnik Mt, having equivalents in NW Bosnia (Vareš region, Dinaridic Ophiolite Belt) and in NE Hungary (Darnó Unit) (Kiss et al., 2008; Palinkaš et al., 2008). A suddenly broken down shelf margin setting is represented by the Belski dol section in the eastern part of Ivanšćica Mt, where Anisian light coloured platform limestone is directly overlain by red radiolarite of the Late Anisian *Oertlispongus inaequispinosus* zone (Halamić & Goričan, 1995; Goričan et al., 2005). In Mt. Ivanšćica Grgasović & Sokač (2003) reported also blocks of Anisian reef limestones suggesting shallow-marine carbonate sedimentation.

Medvednica Unit

The metamorphosed "Medvednica Complex" (Pamić & Tomljenović, 1998), besides Devonian and Carboniferous ones, includes also Triassic conodont-bearing limestones (reported as Ladinian to Carnian, but figured also typical Norian "metapolygnathoids"; Djurdjanović, 1973).

ADRIA-DINARIA MEGAUNIT

South Alpine Unit

In the area of the Southern Alps (location on Text-Fig. 1; Text-Fig. 8, col. 35–38) the Alpine (Neotethyan) cycle begins with a westward Late Permian transgression. Accordingly, the continental, predominantly fluvial Gröden (Val Gardena) Sandstone was step by step overlain by sabkha and shallow lagoon facies of the Bellerophon Formation in the eastern part of the Southern Alps (Dolomites, Carnic Alps). This trend continued after the Permian/Triassic boundary event led to the inundation of Eastern Lombardy and formation of shallow ramp deposits of the Werfen Formation, 300–400 m in thickness, that transgressively overlies continental and marine Upper Permian formations (Gaetani, 1979; Gaetani et al., 1998).

The Lower Triassic sequence was deposited in a shallow ramp setting that was characterised by mixed siliciclastic and carbonate deposition. The sea-floor was usually located below the fair-weather wave base but it was frequently subjected to storm currents. The succession is made up of transgressional-regressional cycles. The first transgressional cycle starts at the Permian/Triassic boundary with a characteristic oolite horizon that is overlain by marl and mudstone. This basal member pinches out westward in Lombardy (Assereto et al., 1973; Brandner & Mostler, 1982; Broglio-Loriga et al., 1990). Predominantly shallow subtidal carbonates with storm interlayers were formed during the second cycle in the Dolomites that also pinch out westward. Siliciclastics prevail in the next cycle (Campil Member) all over the South Alpine domain probably as a result of a significant climatic change. The fourth transgressional cycle led to formation of a deeper ramp facies (Val Badia Member), containing a rich ammonite fauna *(Tirolites cassianus)* in the area of the Dolomites. It progresses into shallow inner ramp facies westward and southward (Broglio-Loriga et al., 1990). The area of the westernmost Southern Alps (Ticino) was not yet reached by the transgression, and the whole Lower Triassic is represented by continental, Buntsandstein-type siliciclastics ("Servino"; Pisa, 1974; Gaetani et al., 1987; Sciunnach et al., 1999).

The Werfen Formation is comformably overlain by Lower Anisian cyclic peritidal, shallow subtidal dolomites (Lower Serla Dolomite). In the Western Dolomites and in NE Carnia it is covered by Upper Anisian conglomerates – Richthofen Conglomerate, Uggowitz (Ugovizza) Breccia – indicating uplift in the Late Anisian that resulted in an intense erosion. As a consequence, in these areas the Werfen Formation became deeply eroded or it is lacking completely.

As a result of the next relative sea-level rise in the later part of the Late Anisian platform carbonates (Contrin Formation) began forming on the structural highs and basinal carbonates in the intraplatform basins. The tectonic activity reached its maximum intensity in the Ladinian when a platform carbonate succession was deposited, several km thick (Bosellini, 1984, 1991; Doglioni, 1988) whereas deposition of pelagic carbonates (Buchenstein Formation) with pyroclastic intercalations ("pietra verde") continued in the basins. Predominantly in the Dolomites, intense mafic volcanism (shoshonites) took place coevally which was accompanied by the formation of magmatic intrusions (Castellarin et al., 1980). In the Late Ladinian to Early Carnian the Ladinian intraplatform basins progressively filled up with volcanics (pillow lavas, hyaloclastics) and volcanoclastics (Wengen Formation). Parallel to the filling-up, the platforms (Cassian Dolomite) prograded onto the basin deposits (San Cassian Formation). A volcanic chain was situated also south of the area of the present Southern Alps, in the basement of the Po Basin, as revealed by AGIP wells (Brusca et al., 1982).

In the Late Carnian, large areas of the South Alpine domain became subaerially exposed (Gnaccolini & Jadoul, 1990) and then covered by fine siliciclastics with humid paleosols (lower part of the Travenanzes Formation; Stefani et al., 2010). Then evaporites and caliche soils indicate arid climatic conditions (upper part of the Travenanzes Formation; Stefani et al., 2010). In Lombardy a delta complex developed contemporaneously.

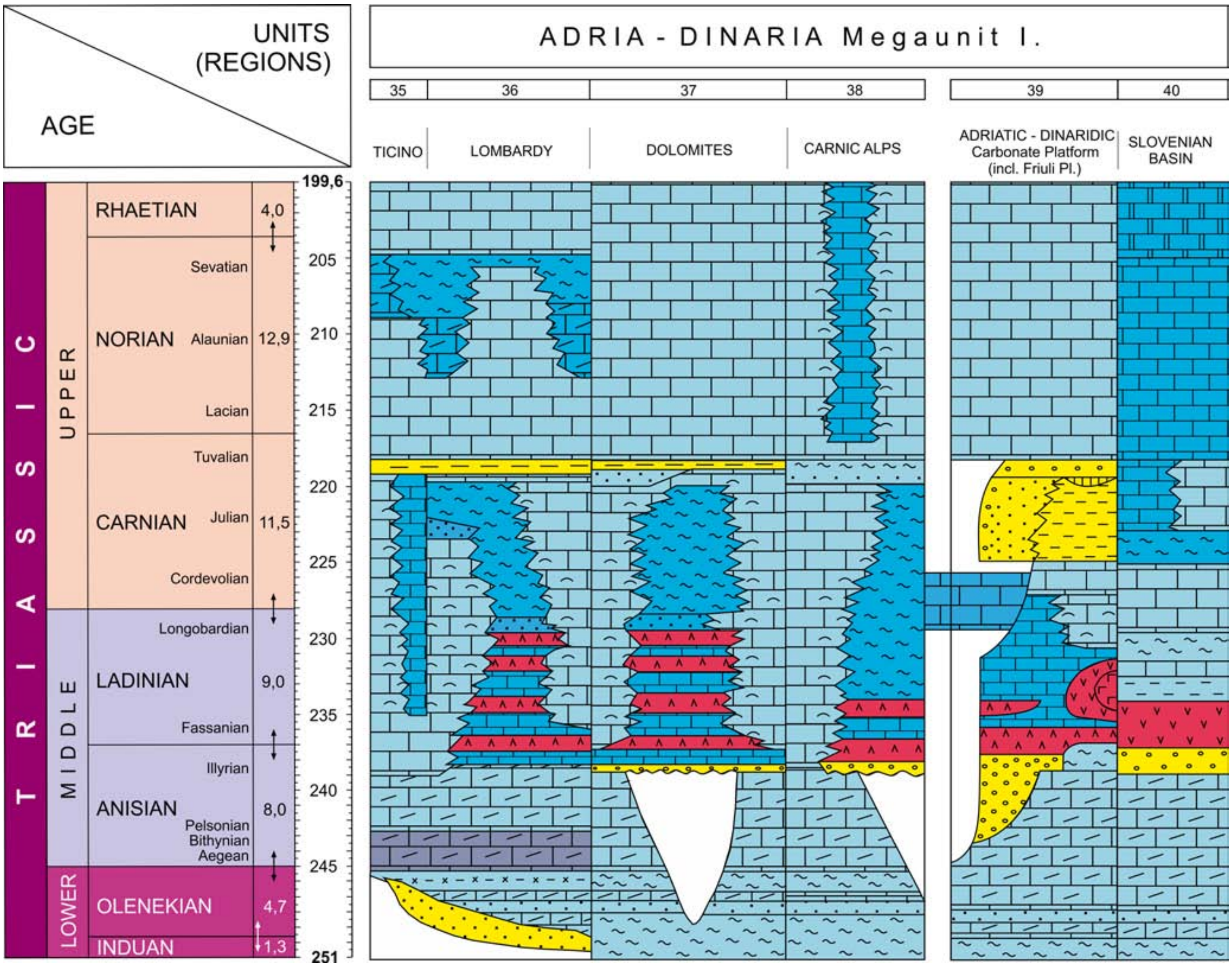
The following cyclic peritidal-subtidal dolomites (Dolomia Principale) formed also under an arid climate. It is of overall extension in the South Alpine realm in a thickness at km-scale (Bosellini & Hardie, 1988; Jadoul et al., 1992). In the Norian incipient stage of the opening of the Piemont-Penninic ocean branch led to disintegration of the platform and formation of fast subsiding basins and structural highs in Lombardy (Jadoul et al., 2004). As a result the thickness of the Upper Triassic succession is extremely variable (from 0.5 to 4 km). First basinal carbonates were deposited in the basins coeval with the formation of the Dolomia Principale (Aralalta Group; Jadoul, 1985). During the Late Norian to Hettangian, a cyclic shale-carbonate succession was formed (Riva di Solto Shale and Zu Limestone; Jadoul et al., 1992). In the Dolomites the development of carbonate platforms continued till the end of the Triassic. In the Carnic Fore-Alps, in the eastern part of the Southern Alps, among carbonate platforms made up of Norian Dolomia Principale and Rhaetian Dachstein Limestone, small intraplatform basins occur (Carulli et al., 1998; Cozzi & Podda, 1998). In the basins Norian cherty dolomite and Rhaetian to Liassic limestones were formed. The platforms are bounded by N–S and NE–SW trending synsedimentary listric faults (Cozzi, 2000). The development of these basins was related to the Neotethys opening.

Adria Unit

Adriatic-Dinaridic Carbonate Platform

The Mesozoic Adriatic-Dinaridic Carbonate Platform (ADCP; Text-Fig. 8, col. 39) of Pamić et al. (1998) or Adriatic Carbonate Platform (AdCP) of Velić et al. (2004) was built on a large part of the Variscan "Carnic-Dinaridic microplate" (in the sense of Vai, 1994, 1998, 2003) or southern part of the "Noric-Bosnian Terrane" (in the sense of Flügel, 1990; Neubauer & Raumer, 1993; Ebner et al., 2007), characterized by mostly marine Late Carboniferous and Permian sedimentation (Vozárová et al., 2009a, b). Building of a coherent, immense carbonate platform (one of the largest in the Tethys domain) began in the Late Triassic (Norian–Rhaetian) and continued (with local differentiations: short-lived basins or emersions, the latter being indicated by bauxite horizons) until the end of the Cretaceous.

The area of **Slovenia** since the Late Permian to the end of the Anisian was an integrated part of an extensive and shallow carbonate platform (the Slovenian Carbonate Platform; Buser, 1989; Buser et al., 2008). At the end of the Anisian the Slovenian Carbonate Platform was disintegrated into the Adriatic-Dinaridic Carbonate Platform in the south and the Julian Carbonate Platform in the north,



Text-Fig. 8.
Lithofacies chart of the Southern Alps (35–38), Adriatic-Dinaridic Carbonate Platform (39) and Slovenian Basin (40) (ADRIA-DINARIA I).

separated by the Slovenian Basin (Cousin, 1973; Buser, 1989). This basin extended from Tolmin, through Ljubljana and Zagreb to Bosnia (e.g. into the Bosnian Zone).

Sediments of the Adriatic-Dinaridic Platform (Slovenian part) are lying on the carbonate-clastic succession of the uniform Slovenian Carbonate Platform (Buser, 1989), that existed until the end of the Anisian.

The transition from the Permian to the Lower Triassic is continuous and consists of limestone and dolomite (Pl. 5, Fig. 4). The P/T boundary is characterized by the extinction of the Permian fossils and defined by the first appearance datum (FAD) of the conodont species *Hindeodus parvus* (Kolar-Jurkovšek & Jurkovšek, 2007; Kolar-Jurkovšek et al. 2011). The boundary is marked also by a strong enrichment of the light $\partial^{13}C$ in carbonate rocks (Dolenec et al., 2004). The Tesero horizon occurs at the P/T boundary interval and reaches a thickness of 0.5 m to a few meters.

Scythian beds south of the Periadriatic lineament are relatively uniform. Their thickness varies strongly from 40 to 600 m. Alternation of siliciclastic and carbonate rocks, particularly limestone with admixtures of silicate detritic grains is noticed in the lower part of the succession. Red oolitic limestones or dolomites are characteristic lithotypes (Grad & Ogorelec, 1980; Ramovš, 1989b; Dozet, 2000). Echinoderms, gastropods *(Natiria costata)* and the foraminifera *Meandrospira pusilla* are frequent fossils (Aničić & Dozet, 2000). The oolitic lithofacies contains a conodont association of the Smithian Obliqua Zone represented by shallow-water genera (Kolar-Jurkovšek & Jurkovšek, 1996).

At some places beds and lenses of evaporitic minerals, gypsum and anhydrite occur (Čar et al., 1980). In the Scythian succession the amount of siliciclastic component shows an upward decreasing trend. Dark biomicritic and marly limestone is prevailing over dolomite, with rare stromatolitic laminae.

The Anisian succession is rather uniform, represented mostly by bedded dolomite, often showing signs of peritidal sedimentation (Grad & Ogorelec, 1980). Subordinately biomicritic limestone also occurs, containing the foraminifera *Meandrospira dinarica* and *Glomospira densa*. The Anisian deposits reach a thickness up to 600 m.

The previously uniform Slovenian Carbonate Platform disintegrated into two parts: the Julian Carbonate Platform in the north, and the Adriatic-Dinaridic Carbonate Platform in the south. In connection with this significant facies differences can be observed already in the Anisian, especially on the slope zones of both carbonate platforms to the Slovenian Basin.

In the lower part of the Ladinian succession basinal facies prevail: micritic limestone and cherty limestone, which may be partly dolomitized. They are overlain by shallow-water carbonates characterized by a *Diplopora* association, sandstones and tuffs of the spilite-keratophyre association.

The lower part of the Carnian is represented mostly by dolomitized platform carbonates, rich in Dasycladaceae, some hundreds of metres thick. The Julian and Tuvalian beds were deposited in a shallow restricted lagoonal environment and are up to 400 m thick. They are represented by dark, marly limestones, intercalated by siliciclastics (marly siltstones and sandstones) and also by tuff and tuffitic beds and coal (Cigale, 1978; Buser, 1979). Southern Slovenia was partly subaerially exposed in the Tuvalian, where bauxites and siliciclastics of the Borovnica Formation were deposited (Buser, 1996). On the northern margin of the Adriatic Carbonate Platform and towards the Slovenian Basin, deposition of black, marly limestone, rich in a thick-shelled mollusc fauna, took place (Buser, 1979; Jelen, 1990; Jurkovšek & Jelen 1989; Jurkovšek 1993).

The Norian and Rhaetian stages are represented by the Main Dolomite (Hauptdolomit), up to 1200 m thick and characterised by Lofer facies (Ogorelec & Rothe, 1993). Above it 200 m of Dachstein Limestone are preserved locally. Megalodontids are the most characteristic fossils. Both the Main Dolomite (Hauptdolomit) and the Dachstein Limestone show in places clear evidence of paleokarstification.

In the area of **Croatia** due to extensional tectonic movements in the Middle Permian, the uniform shallow epeiric platform disintegrated, and horst and grabens developed (Velić et al., 2003). Some of the Permian highs (horsts) (e.g. Velebit Mts) were probably isolated from the main carbonate platforms in the Southern Alps and possibly experienced continuous carbonate sedimentation from the Permian to the Early Triassic (Tišljar et al., 1991). Some Permian interplatform areas (grabens) were filled with clastics prior to the Early Triassic shallow-marine carbonate-dominated deposition (for example the Gorski Kotar region).

The AdCP platform evolution can be divided into three megasequences:

1) Middle Permian – Upper Ladinian or Carnian

2) Norian – Upper Cretaceous and

3) Paleocene – Middle Eocene (Velić et al., 2001, 2003).

The first megasequence began with platform carbonate deposition in the Middle to Late Permian that was conformably overlain by Lower Triassic strata in some places (Velebit Mts). The oldest Lower Triassic deposits in Croatia were documented (by means of conodonts) in the Gorski Kotar Region but the P/T boundary interval is not exposed (Aljinović et al., 2006).

The Lower Triassic successions are usually devided into two lithostratigraphic units: mainly red shales, sandstones and oolitic grainstones containing representatives of the characteristic bivalve genus *Claraia* are considered as the Lower Scythian "Seis (= Siusi) beds"; dominantly grey clayey/silty limestones and marls as Upper Scythian "Campil beds". According to the similar lithologic characteristic of the Lower Triassic (Scythian) deposits in the wide Dinaridic area, deposition in a wide shallow epeiric sea was suggested especially due to the presence of oolitic grainstones and shallow-water structures (Aljinović, 1995; Marjanac, 2000; Jelaska et al., 2003).

In the Middle Triassic, the area of the future Adriatic Carbonate Platform proceeded to disintegrate due to rift related tectonic movements, forming the huge isolated platform – the Adria Microplate (Velić et al., 2003) or Southern Tethyan Megaplatform (STM) (Vlahović et al., 2005). This carbonate platform represents the fundament of the future Adriatic Carbonate Platform.

The Middle Triassic rifting disintegrated the area; highs (horsts) and grabens were developed. Some rift-related highs experienced continuous shallow-marine carbonate deposition usually with algal limestones (Herak, 1974;

Grgasović & Sokač, 2003), while between the uplifted blocks the influence of a deeper environment has been recognised mostly by the presence of ammonoids or pelagic microorganisms in grey, cherty limestones (Sakač, 1992; Balini et al., 2006). Recently Missoni et al. (2010) distinguished four independent platform stages for the Late Anisian to Early Carnian interrupted by basinal sequences (Velebit Mountains). As a consequence of the rift related tectonic movements, resedimented intraformational breccia facies (analogous to the Richthofen Conglomerate of the Southern Alps) occur in many places (for example the "Otarnik breccia" at the base of the intraplatform succession at the Svilaja Mt; Marjanac, 2000; Jelaska et al., 2003).

Widespread volcanic and volcaniclastic rocks (basalts, andesites and dacites, which were largely transformed into metabasalt – mainly spilite, metaandesite, mainly keratophyre and metadacite, mainly quartzkeratophyre; e.g. Pamić, 1982, 1984) are also interpreted as consequences of the rifting. The magmatic activity reached its paroxism during the Ladinian. In S Bosnia, along the NE margin of the Adriatic-Dinaridic Carbonate Platform plutonic rocks, among which intermediate ones predominate over basic and acidic ones, are represented by varieties of gabbro, diorite, granodiorite, granite, albite-syenite and albite-granite. The largest Triassic plutonic body is the Jablanica gabbro-norite pluton occurring SW of the Bosnian Schist Mountains in an area of 20 km^2 (Pamić, 2000; Trubelja et al., 2004; Robertson et al., 2009).

In the Svilaja Mt volcaniclastic deposits – ignimbrites and tuffs (called "pietra verde") – occur in deeper marine successions. They are conformably overlain by bioclastic, grey cherty limestones and dolomites with calcareous algal skeletons, foraminifers, radiolarians, gastropods, bivalves and brachiopods (Marjanac, 2000; Jelaska et al., 2003; Balini et al., 2006).

The Middle/Late Triassic boundary is mostly characterised by a relatively long emersion phase, which is indicated by bauxite occurrences (Vlahović et al., 2005) marking the end of the first megasequence (Velić et al., 2001, 2003; Vlahović et al., 2005). In the Carnian terrestrial red conglomerates, sandstones and shales occur locally (Vlahović et al., 2005), probably on the uplifted blocks. However in some places shallow-marine conditions prevailed during the whole Middle to Late Triassic period (Central Croatia; Vlahović et al., 2005).

Transgression at the end of the Carnian led to the establishment of shallow carbonate platform conditions over a huge area called "Southern Tethyan Megaplatform" including the later Adriatic Carbonate Platform. Development of the Dachstein-type platform can be considered as the beginning of the second megacycle that is characterized by carbonate platform evolution which was continuous over large areas until the Late Cretaceous in the territory of the Adriatic-Dinaridic Carbonate Platform (Velić et al., 2003).

The Upper Triassic platform carbonates are exposed almost continuously along the NE margin of the Adriatic-Dinaridic Carbonate Platform from Slovenia to southern Montenegro and northern Albania (Dragičević & Velić, 2002). Two typical lithofacies of these platform carbonates are distinguished. There are predominantly dolomite successions corresponding to the Hauptdolomit or Dolomia Principale, and there are limestones only subordinately dolomitized corresponding to the Dachstein Limestone. Generally the lower part of the Upper Triassic platform carbonates are dolomitic whereas the upper part is usually limestone containing a typical megalodontid and foraminifera assemblage of the Dachstein Limestone. This thick carbonate sequence represents typical deposits of the isolated carbonate platform but it should not be ascribed to the Adriatic Carbonate Platform s.s. During that period the entire area of the Southern Tethyan Megaplatform was still united (Vlahović et al., 2005). The Upper Triassic platform carbonates are directly overlain by Lower Jurassic platform carbonates (usually fossiliferous limestones) or their dolomitized equivalents.

The huge Southern Tethyan Megaplatform was partly disintegrated during the Late Liassic, resulting in the formation of several basins and platforms, among them the Adriatic Carbonate Platform (AdCP; Velić et al., 2003; Vlahović et al., 2005).

In **Montenegro,** at the SW part of the Adriatic-Dinaridic Carbonate Platform, due to the neighbourhood of the Budva Zone (not extending to the area of our map) which later evolved into a Mesozoic deep-water seaway, Early Anisian siliciclastic flysch/wildflysch-type sediments (cf. Dimitrijević, M.N., 1967; Radoičić, 1987) were reported, too.

Central Bosnian Mountains Unit

The Upper Permian shallow-water, fossiliferous Bellerophon limestone, cavernous limestones and locally evaporites (gypsum, anhydrite) grade into the siliciclastic and rarely cavernous limestone of the Travnik Formation, of the Permian/Triassic boundary interval (Karamata et al., 1997; Hrvatović, 1999). Gradually developing from this formation or directly lying over the Paleozoic basement Lower Triassic sandstones and siltstones follow (location on Text-Fig. 1; Text-Fig. 9, col. 41). The Anisian is represented by massive ramp-type limestone. In the Ladinian the "volcanogenic-sedimentary formation" (shales, cherts, and with the volcanic members of "within-plate" character as spilites, rare keratophyres and pyroclastic rocks) was formed in basin areas. The gabbro-diorite-albite-granite body of Radovan Mt is related to this Triassic magmatic activity. During the Ladinian and in the whole Upper Triassic, monotonous reefal, platform-type limestones and dolomites were deposited (Karamata et al., 1997).

Slovenian Basin and Bosnian Zone

In the Late Permian in the region of Slovenia the wide Slovenian Carbonate Platform established, and remained stable till the Late Anisian. In the Late Anisian the platform started to disintegrate along regional faults (Buser, 1989; Buser et al., 2008). However, carbonates still kept depositing on elevated blocks. In the basins the deposition of deeper marine reddish and light grey nodular limestone of Han Bulog-type took place. This event was the beginning of later total destruction of the carbonate platform.

Due to the "Idrija tectonic phase", in the Ladinian a complete tectonic disintegration of the Slovenian Carbonate Platform took place. Certain areas became submerged deep below the sea, and others became land. Only at rare localities smaller remains of the former carbonate platform persisted. The region in central Slovenia was submerged deepest and this signifies the beginning of the later Slovenian Basin (Text-Fig. 8, col. 40). In deeper parts the Pseudogailtal beds were deposited, which consist of alternation of shaly mudstones, greywackes and tuffs with rare beds of dark grey limestone. Dark grey layered and platy limestones often accompanied by green tuffaceous beds of "pietra verde"-type contain Ladinian conodonts, as well as radiolarians, ammonoids and bivalves (Kolar-Jurkovšek, 1991; Goričan & Buser, 1990; Placer & Kolar-Jurkovšek, 1990; Jurkovšek 1983, 1984).

On the uplifted terrestrial areas variegated conglomerates were accumulated. During Ladinian, in a horst-bounded graben, at Idrija a world famous hydrothermal-volcanogenic synsedimentary mercury deposit was formed.

During the Late Ladinian or Early Carnian a compressional phase commenced. The area of central Slovenia still remained a deep basin, and that was defined as the Slovenian Basin. The volcanism ceased completely. North of the deeper sea region the stable Julian Carbonate Platform was formed, comprising the present South Karavanks, Julian and Kamnik-Savinja Alps. South of the Slovenian Basin the Adriatic-Dinaridic Carbonate Platform came into being, comprising the actual External Dinarides. In the western part of the Slovenian Basin, dark grey platy limestones with chert and the "Amphiclina Beds" were deposited (Buser et al., 2008). At the basin margin dark grey massive reef limestones, rich in sponges and corals occur (Turnšek, 1997). In the upper part of the basin successions siliciclastics alternate with bedded limestones. The limestones contain Late Carnian to Early Norian conodonts (Krivic & Buser, 1979; Kolar-Jurkovšek, 1991; Ramovš, 1998).

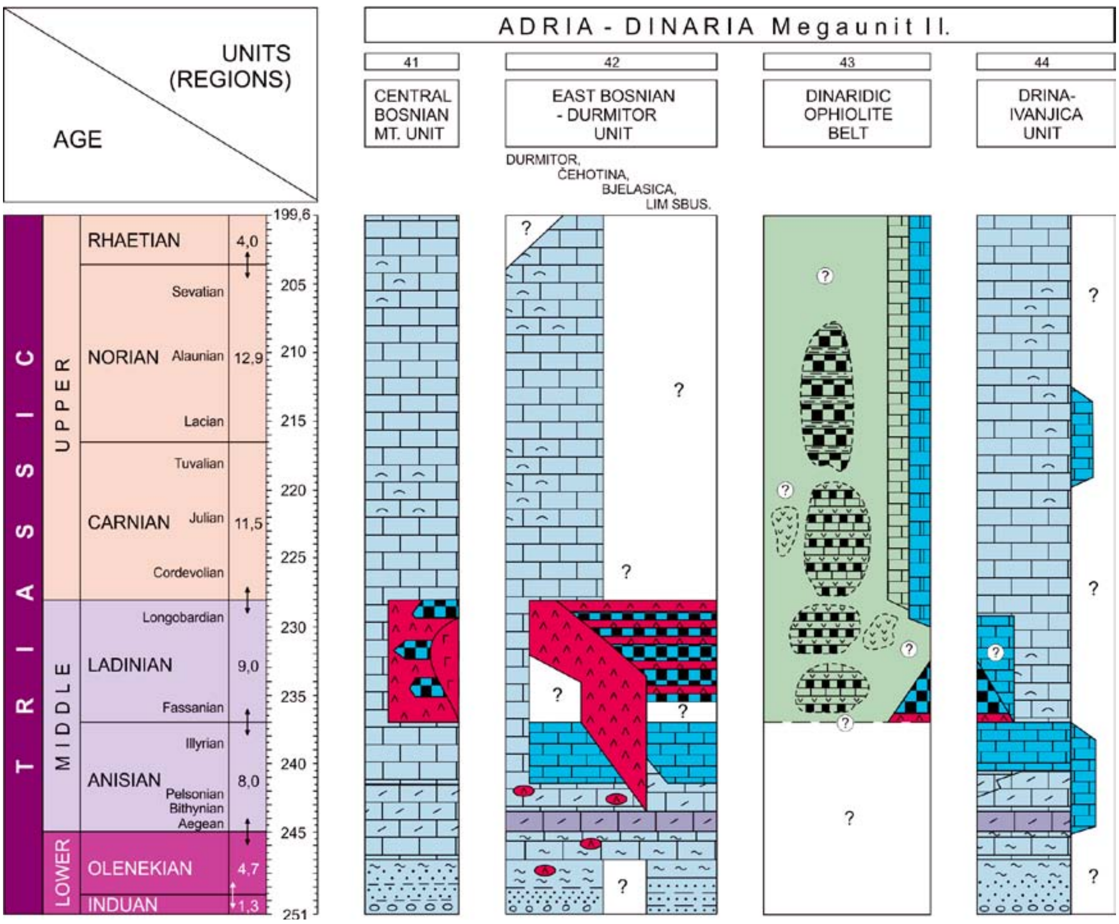
In the central and eastern Slovenian parts of the Slovenian Basin, dark grey bedded micritic limestones occur, intercalated by thin marl layers, wich contain Carnian conodonts (Kolar-Jurkovšek, 1991), and rarely ammonoids.

During the Norian and Rhaetian, deep-sea conditions established all over the basin (Buser et al., 2008; Rožič et al., 2009). Platy and layered limestones with chert nodules and lenses were deposited, which were subject to pervasive dolomitization; Bača Dolomite is the most typical rock of the Slovenian Basin containing Late Triassic conodonts of the genus *Misikella* (Ogorelec & Dozet, 1997; Rožič et al. 2009; Kolar-Jurkovšek 2011). Intraplatform troughs stretched from the basin into the Julian Carbonate Platform also during the Norian and Rhaetian, in which white micritic limestone with chert nodules containing monotids and conodonts were deposited (Kolar-Jurkovšek et al., 1983).

The Bosnian Zone s.s. (in Bosnia) embraces units that were deposited at the northern slope of the Adriatic-Dinaridic Carbonate Platform and of terranes accreted before the Permian/Triassic (i.e. the Bosnian Schist Mountains). Sedimentation is dated from Middle Jurassic to Late Cretaceous; the presence of Upper Triassic formations is questionable (Pamić et al., 1998; Karamata et al., 2004).

Dinaridic Unit

The eastern margin of Adria, i.e. the base of the Dalmatian-Herzegovian Unit (= the Adriatic-Dinaridic Carbonate Platform) and amalgamated units (the Central Bosnian Mountains and the Drina-Ivanjica), together with the Dinaridic Ophiolite Belt and the East Bosnian-Durmitor Unit, form the Dinarides. The Triassic sequences (as well as the



Text-Fig. 9.
Lithofacies chart of the Dinaridic Unit (41–44). (ADRIA-DINARIA II).

overlying Jurassic ones) of the first group (Dalmatian-Herzegovian Composite Unit, Central Bosnian Mountains and Drina-Ivanjica Units) were affected by the subduction processes of the oceanic lithosphere in the Vardar Ocean.

Triassic successions occur in practically all different units and nappes of the Dinarides. Also, they form the underlying strata in these nappe complexes, which consist near the surface only of Jurassic or Cretaceous sequences. The description of the different units starts with the westernmost units and ends with the easternmost ones.

East Bosnian-Durmitor Unit

Principal subunits of this unit are the Durmitor, Ćehotina and Bjelasica Subunits (Text-Fig. 9, col. 42); the Lim Subunit will also be described here, although it could represent a possible part of the Dinaridic Ophiolite Belt thrust over the East Bosnian-Durmitor Unit (Dimitrijević, 1997). The Lim Subunit is not equivalent to the Lim Zone of Andjelković (1982) and Sudar (1986). Triassic sequences in these subunits do not show much difference, so they will be described together, highlighting the differences.

In the **Bjelasica Subunit** the Lower Triassic beds are the oldest, and Ladinian ones are the youngest on the surface; Anisian–Ladinian volcanic rocks of rhyolitic to andesite-basaltic composition and calc-alkaline affinity are associated with polymetallic ore deposits (e.g. Brskovo, Žuta Prla, etc., Dimitrijević, 1997).

In the **Lim Subunit** clastic beds older than Early Triassic are absent. Upper Triassic deposits above the Anisian and Ladinian pelagic carbonate and volcanic succession are not known (Dimitrijević, 1997).

The Upper Permian “Bellerophon limestones” are overlain by red Lower Scythian siliciclastics, often with carbonate matrix, and varicoloured marlstones. The upper part of the Lower Triassic shallow-marine carbonate-terrigenous deposits are composed of sandy and marly “bioturbated” limestones, with oolites and occasionally siltstones and claystones. The thickness of Lower Triassic deposits is 250–500 m.

Shallow-water carbonate deposits are typical for the Anisian. It commonly began with sandy limestones and dolomites equivalent to the Gutenstein-type limestone/dolomite sequence, formed in a restricted, periodically hypersaline intertidal area. They are overlain by different types of massive, light grey limestones, equivalent to the Steinalm Limestones of the Eastern Alps / Western Carpathians, and are characteristic for environments of more open marine conditions. In the Late Anisian red Bulog Limestone (Dimitrijević, 1997), which indicates the drowning of this Steinalm carbonate ramp, were deposited in some places. The Anisian deposits reach a thickness of about 300 m, but only 5–10 m are of Bulog Limestone.

Submarine volcanism began in places at the end of the Early Triassic (Visitor Mt) or before, during or after the deposition of the Bulog Limestone in other places (Dimitrijević, 1997). Calc-alkaline volcanic rocks are scarce in the west, but they form km-long flows in the north and northeast domains. They are more numerous in the southeast and the first generations occur as typical submarine flows interlayered with volcanic breccias, tuffs, tuffites, limestones, and marly sediments. The succession mostly ends with red limestones and cherts, but in some places the volcanic rocks are directly overlain by Ladinian red limestones. To the northwest, large masses of dacites with andesites and rhyolites occur.

The pelagic Ladinian sediments are exposed over large areas in the northwestern part of the unit. They begin with dark red chert, sporadically interbedded with shales, tuffs and marlstones. Overlying them or directly over the Anisian beds red limestones with varicoloured cherty nodules and intercalations follow. The basinal succession is topped by the Wetterstein Limestone with massive reefal limestone and dolomite lenses, rich in fauna and flora (Dimitrijević, 1997).

The transition to the Upper Triassic is everywhere gradual, without change in the platform depositional regime. The Upper Ladinian to Lower Carnian deposits are analogous to the Wetterstein Limestone. Then Upper Carnian – Norian Dachstein platform-type carbonates follow with reef and lagoonal Loferite facies (Dimitrijević, 1997). Rhaetian has not been proven. The Upper Triassic limestones are 500–700 m thick.

Dinaridic Ophiolite Belt

The Early–Middle Triassic rifting, which is interpreted as a result from continuous subduction of the oceanic lithosphere of the main Vardar Ocean (Karamata, 2006) was intensified in the late Middle Triassic and should be followed according to Karamata (2006) by the formation of a marginal sea between the main part of the Adria and the Central Bosnian Mountains Unit in the southwest and the Drina-Ivanjica Unit in the northeast. Therefore, the Dinaridic Ophiolite Belt should be a remnant of an autochthonous ocean between these two units. This basin evolved during the late Middle – Late Triassic – Early Jurassic into the Dinaride Ocean (Robertson et al., 2009; Text-Fig. 9, col. 43) and its continuation to the south, represented by the ophiolite complexes of Mirdita Zone in Albania, and the ophiolite complexes of northern Pindos Mts and western Othrys Mts in Northern Greece. The boundary between these ophiolite complexes is a younger strike-slip fault now covered by the Neogene deposits of the Metohija depression. This view of an autochthonous position (Karamata, 2006) of the Dinaridic Ophiolite Belt was recently discussed controversially. Schmid et al. (2008) and Gawlick et al. (2008, 2009b) found several arguments for a westward Jurassic obduction of the ophiolite nappes. According to these authors the Dinaridic Ophiolite Belt represents a far-travelled nappe stack from the Neotethys Ocean. According to Missoni & Gawlick (2010, 2011) the Dinaridic Ophiolite Belt is part of the orogenic Neotethyan Belt, formed in the Middle to early Late Jurassic, striking from the West Carpathians to the Hellenides.

The Triassic formations (limestones, terrigenous, siliceous and oceanic crust rocks, etc.) in that basin are not preserved and exposed on their original places. They are found only as blocks, olistoliths and slide blocks (= olistoplakae in the sense of Dimitrijević, 1997), in the olistostrome/mélange of this basin (e.g. Dimitrijević et al., 2003; Karamata, 2006). Several Middle to Late Jurassic carbonate-clastic trench-like basin fills were recently distinguished by Sudar et al. (2010), Gawlick et al. (2010a, 2010b, 2010c) and Richard L. (= Lein, R.) et al. (2010). These authors interpret also the Middle–Late Triassic basinal sequences, similar to the Hallstatt Limestone successions of the Eastern Alps or the Albanides/Hellenides as derived from the outer shelf region facing the Neotethys Ocean to the east.

Another type of Triassic rocks derived from the Drina-Ivanjica Unit, from the area marked now as the eastern boundary of the Dinaridic Ophiolite Belt (in the Zlatibor and Zlatar Mts, etc.). In this area the special and controversially discussed Triassic carbonate rocks of the Grivska Formation occur together with limestones of different Hallstatt facies zones, as yet not defined in detail (Sudar et al., 2010; Gawlick et al., 2010a, b; Missoni et al., 2012). Both formations were deposited, according to former interpretations, from the Late Triassic onwards, on the margin/slope of the Drina-Ivanjica carbonate platform facing the Dinaride Ocean to the west. According to Sudar et al. (2010) and Gawlick et al. (2010a, b) they derive from the Hallstatt Facies Belt facing the Neotethys Ocean to the east and represent far-travelled remnants of this shelf further east of Drina-Ivanjica. This view is confirmed by the occurrence of blocks with a complete Late Ladinian to Early Carnian carbonate platform evolution (Wetterstein Carbonate Platform), and the drowning sequence beside other carbonate blocks in the carbonate-clastic mélange west of the Drina-Ivanjica Unit (Sirogojno area) (Missoni et al., 2012). These blocks derive from the Drina-Ivanjica Unit or further east and document in that area the transition to the outer shelf region, represented by the grey Hallstatt facies zone (e.g. Kopaonik Formation; Schefer et al., 2010) and the various coloured Hallstatt facies zone further east (Sudar et al., 2010; Gawlick et al., 2010a, b).

The first type, i.e. the Grivska Formation is quite specific (compare the new definition as Grivska Group by Missoni et al., 2012), it is everywhere in tectonic relationship with its surroundings (blocks/slides in a argillaceous-radiolaritic matrix), and is known from olistoliths and km-sized slide blocks (olistoplakae) inside the olistostrome/mélange below the ophiolites of the Dinaridic Ophiolite Belt; rarely Grivska Formation blocks were also found mixed with the Drina-Ivanjica carbonate platform succession (Dimitrijević, 1997). The Grivska Formation consists of platy to thin-bedded mostly turbiditic grey limestones. It is characterized by grey, brownish to black chert nodules and interbeds, silicification, structures of submarine slides, some cross-lamination, and thin siltstone beds, etc. (Pl. 6, Fig. 3). This formation is interpreted as the product of the hemipelagic deposition on the proximal slope environments of the Drina-Ivanjica Carbonate Platform toward the present southwest, to the oceanic tract of the Dinaridic Ophiolite Belt (Dimitrijević, 1997). According to the available data, we suppose the age of the formation in a very wide stratigraphic range, from the latest Middle Triassic to the Middle (?Late) Jurassic (compare Missoni et al., 2012). Its Triassic part was documented by conodonts ranging from latest Ladinian to Middle Norian (Andjelković & Sudar, 1990; Sudar, 1996; Sudar, unpubl. data).

The second type, the Upper Triassic red, light grey to yellowish limestones of the various coloured Hallstatt facies are present in the wide region of Zlatar Mt (Pl. 5, Fig. 5), and in the surroundings of Sarajevo (Trebević Mt), etc. The age of these rocks was established by Sudar (1986), Sudar et al. (2010) and Gawlick et al. (2010a), in the Lim Zone of Andjelković (1982), but their mentioned regions of deposition according to Serbian literature (e.g. Karamata et al., 1997, etc.) belong to the Dinaridic Ophiolite Belt. These pelagic carbonate deposits should represent, according to the in-situ view of the Dinaride Ocean, products of deep-water deposition on the more distal parts of the continental slope of the Drina-Ivanjica Carbonate Platform, or on its toe towards the deep-sea or oceanic realm of the Dinaridic Ophiolite Belt basin. They represent transitional deposits between the hemipelagic limestone of the Grivska Formation, and the different types of siliceous rocks deposited on the oceanic crust of this basin. From these limestones in the Trebević Mt and Zlatar Mt all conodont zones of the Carnian and Norian were documented (Sudar, 1986 and unpubl. data).

Except for the mentioned carbonate rocks from the outer shelf, the more internal outer shelf (Grivska Formation), and the reef/platform depositional domains, in the area of the Zlatibor and Zlatar Mts also various types of Triassic siliceous rocks, which were deposited in different parts of this oceanic basin, are present. These rocks also belong to the Dinaridic Ophiolite Belt. The age determinations of these mostly radiolaritic deposits connected with basalts of the ophiolite sequence confirm, that remnants of a Ladinian and Late Triassic deep-sea are preserved in the Dinaridic Ophiolite Belt (Obradović & Goričan, 1988; Gawlick et al., 2010a; etc.).

Beside the mentioned data, in the ophiolite-related basalt-radiolarite locality near Visoka village (basin of rivers Mali Rzav and Ljubišnja, Zlatibor Mt), a Late Ladinian radiolarian assemblage of the *Muelleritortis cochleata* zone was reported by Vishnevskaya & Djerić (2006) and Vishnevskaya et al. (2009).

In the locality Potpeć, along the road Bistrica–Priboj, a slide block of red cherty limestone overlying amygdaloidal basalt, and with intercalations of red chert and violet-red shales, appears in the olistostrome/mélange (Pl. 6, Fig. 1). It was first reported by Popević (1970) as part of the Jurassic "Diabase-Chert Formation". But after finding Late Anisian (previously Early Ladinian, before the new GSSP at the base of the Curionii Zone) radiolarians of the *Oertlispongus inaequispinosus* zone, this block was described as "another olistolith from the porphyrite-chert assemblage occurs also in the Diabase-Chert Formation" (Obradović & Goričan 1988, p. 54), because of its Triassic age. At the western side of the road Gostilje–Sirogojno descending to the Katušnica River (Zlatibor Mt) a similar olistolith is exposed. On that locality basaltic pillow lavas are associated with red cherty limestone, intercalations of violet to red shales, and with red cherts (Pl. 6, Fig. 5), which yielded Carnian radiolarians (Dosztály, unpubl. data). Such blocks are known in the Hungarian geological literature (Haas et al., 2004; Kovács, 2011) as "Bódvalenke-type olistoliths". It is interesting to note, that this kind of olistoliths has a much wider distribution at the surface on the Othrys and North Pindos ophiolite complexes of Greece (Palinkaš et al., 2010).

Three kilometres west of Sjenica a ten metres-sized chert olistolith is exposed, slightly sheared at the margins. It occurs in a Jurassic argillaceous-silty-radiolaritic matrix, together with other olistostrome components, such as an albite-granite olistolith, olistoliths of basalts and different carbonate blocks. The radiolarite chert olistoliths in a Middle Jurassic matrix (radiolaritic-ophiolitic mélange according to Gawlick et al., 2009b) are bedded, reddish to green, locally with thin interlayers of siliceous shale. They contain latest Carnian to late Middle Norian radiolarians (Goričan et al., 1999). A similar radiolaritic-ophiolithic mélange was recently dated in the Ljubiš area in the Zlatibor mélange (Gawlick et al., 2010b): here several Triassic radiolarite slides occur together with ophiolite blocks in a late Middle Jurassic matrix. These occurrences of mélange with Triassic blocks of the sedimentary cover of the ocean floor occur below the ophiolite nappes of the Dinaridic Ophiolite Belt. They form in this case a classical sub-ophiolite mélange (age and component composition), on which the ophiolite nappes where transported to the west (compare Gawlick et al., 2008, for Mirdita ophiolites).

Drina-Ivanjica Unit

A Triassic succession, probably deriving from the the Drina-Ivanjica Unit or from further east (Missoni et al., 2012) can only be reconstructed from different blocks. Two different types of blocks can be recognized: an older one (Early Triassic to the end of the Middle Anisian), which belongs to the pre-platform continental and ramp deposition, and a younger second (Late Anisian/Ladinian to the end of the Triassic), which belongs to a carbonate platform depositional system (Dimitrijević & Dimitrijević, 1991; Text-Fig. 9, col. 44).

On the low to very low metamorphosed Paleozoic rocks, the deposition of the succession began with Triassic Kladnica Clastics, deposited prevailingly in braided river systems and with the greatest known thickness of about 250 m. They are, most probably unconformably, overlain by “Seisian” Clastics up to 180 m thick (Dimitrijević & Dimitrijević, 1991) or Žunići Clastics (Radovanović, 2000) which represent products of a siliciclastic inner ramp environment. Both of these deposits were largely eroded or reduced during the younger thrusting processes.

The late Early Triassic is represented by the deposits of the “Bioturbate Formation”, in which micrites (bioturbated almost everywhere) and marlstones are predominant, but siliciclastic sediments, dolomites and locally oolites are present as well. Later, the depositional area deepened and a mixed siliciclastic-carbonate sedimentation prevailed. By the end of the Early Triassic or the Early/Middle Triassic boundary respectively, the input of fine-grained siliciclastics decreased and carbonate deposition in a restricted environment took place.

In the area of Sirogojno village there is an enigmatic volcanogenic-sedimentary formation (Sirogojno Formation) of about 350 m in thickness. It is an olistoplaka which consists of different pinkish tuffaceous and coarse-grained siliciclastics, tuffs, volcanic breccias, and andesites. Original position and stratigraphic age of these rocks are unknown and their extension in the adjoining areas is also not known. It has been regarded as Early Triassic by Dimitrijević (1997). Both below and above these rocks the “Bioturbate Formation”occurs, but both contacts are clearly tectonic.

The Anisian Ravni Formation equivalent to the Gutenstein and Steinalm Limestone succession in other areas lies over the upper Lower Triassic limestone with a thickness of about 400 m. It consists of three members: The Utrina Micrite of Gutenstein-type (deposited in a subtidal, fully restricted, oxygen-depleted environment), Dedovići Biosparite (Steinalm-type limestone deposited in the shallow subtidal to intertidal environment with open circulation and with well oxygenated and, in parts, high water energy conditions), and Lučići Oncosparite (Steinalm-type limestone formed in subtidal and intertidal environments, respectively). In the last two members conodonts of the *Paragondolella bulgarica* zone of Pelsonian age were found (Sudar, 1996).

In the Late Anisian the Steinalm-type carbonate ramp was drowned and the hemipelagic red nodular Bulog Limestone Formation was deposited, in parts with a hardground and normally with shallow-water clasts. In the Klisura quarry near Sirogojno the formation reaches 17–19 m thickness. Its deposition started on top of the Dedovići Biosparite with neptunian dykes and a hardground. It includes several horizons rich in ammonoids of the Late Anisian *Paraceratites trinodosus* zone (Mudrenović, 1995). Conodonts of the Late Anisian, Early Illyrian *Paragondolella bifurcata* and *Pridaella cornuta* zones are abundant (Sudar, 1996). The formation is terminated by a decollement surface in the quarry, interpreted as a low-angle normal fault by Sudar et al. (2008). The overlying succession starts with the bentonite shear horizon of the Late Ladinian Klisura Member (slope facies of the prograding Wetterstein-type platform of the Trnava Formation) (Missoni et al., 2012). In other places the basal Bulog Limestone is split into irregular interbeds or fissures in the uppermost parts of the Lučići Oncosparites and in the Dedovići Biosparite (Ravni Formation).

The first carbonate platform evolution stage represented by the Wetterstein Formation is latest Ladinian or Early Carnian in age. The formation consists of remains of destroyed reef flats and skeletons of patch reefs, back-reef sands and deposits of inter-reef lagoons. The thick bedded transitional facies in the Klisura Quarry section contains rare conodonts of the *Paragondolella foliata* zone (lowermost Carnian, “Early Cordevolian”; Sudar, 1996). The deposition of the Wetterstein Carbonate Platform ended in the Early Carnian (? in the early Middle Carnian) by uplift and emersion. In the early Late Carnian a new wave of subsidence led to inundations of the platform (Stopića Formation) (Missoni et al., 2012).

Late Triassic Dachstein-type platform carbonates are exposed in a wide area around Zlatibor Mt. It consists of the following members or formations according to Dimitrijević & Dimitrijević (1991): Dachstein Formation or Dachstein Reef Complex (high-energy marginal domain with grains mainly of patch-reef origin; inside it is possible to distinguish patch-reefs, reef sand, inter-reef lagoon, reef flat, reef framework, and reef slope facies), Ilidža (Vapa) Formation (limestone with abundant black pebbles and infilled cavities originated in the back-reef depositional environment), and Lofer Formation (?Carnian to Rhaetian peritidal-lagoonal Lofer cyclothems formed in a low-energy inner platform domain) (Hips et al., 2010).

Triassic formations originated from this unit extend over the southwestern border of the Drina-Ivanjica Unit, as the northeastern part of Adria-Dinaria, as well as on top of parts of the Dinaridic Ophiolite Belt, e.g. in the Zlatibor and Zlatar Mts area. They have probably deposited onto the Paleozoic basement originally, but during the Late Jurassic thrusting and closing of the Dinaridic Ophiolite trough, they should have slid into it as blocks, olistoliths and huge olistoplakae (Dimitrijević & Dimitrijević, 1991; Dimitrijević, 1997, etc.). For a different view see Missoni et al. (2012).

In the area SE of Zvornik, on both sides of the Drina River, strongly recrystallized pelagic grey to dark grey limestones of the Zvornik Limestone Formation occurs, with conodonts of the *Paragondolella regale, Paragondolella bulgarica* and *Neogondolella cornuta* zones, documenting the Early to Late Anisian age (Sudar 1986). In the same narrow zone, but on the eastern side of Drina River, metamorphosed grey cherty limestones of Late Carnian *(Paragondolella polygnathiformis* and *Paragondolella nodosa* zones) and Early Norian age *(Epigondolella abneptis* zone) are exposed (Sudar, 1986). These metacarbonates do not show any sedimentological and paleontological similarities with the other carbonate deposits of the Drina-Ivanjica Unit. Probably they are not in original position either, and may represent the relics of the NE margin/slope of the original Dinaridic microcontinent (Drina-Ivanjica Unit), towards the Vardar Zone Western Belt.

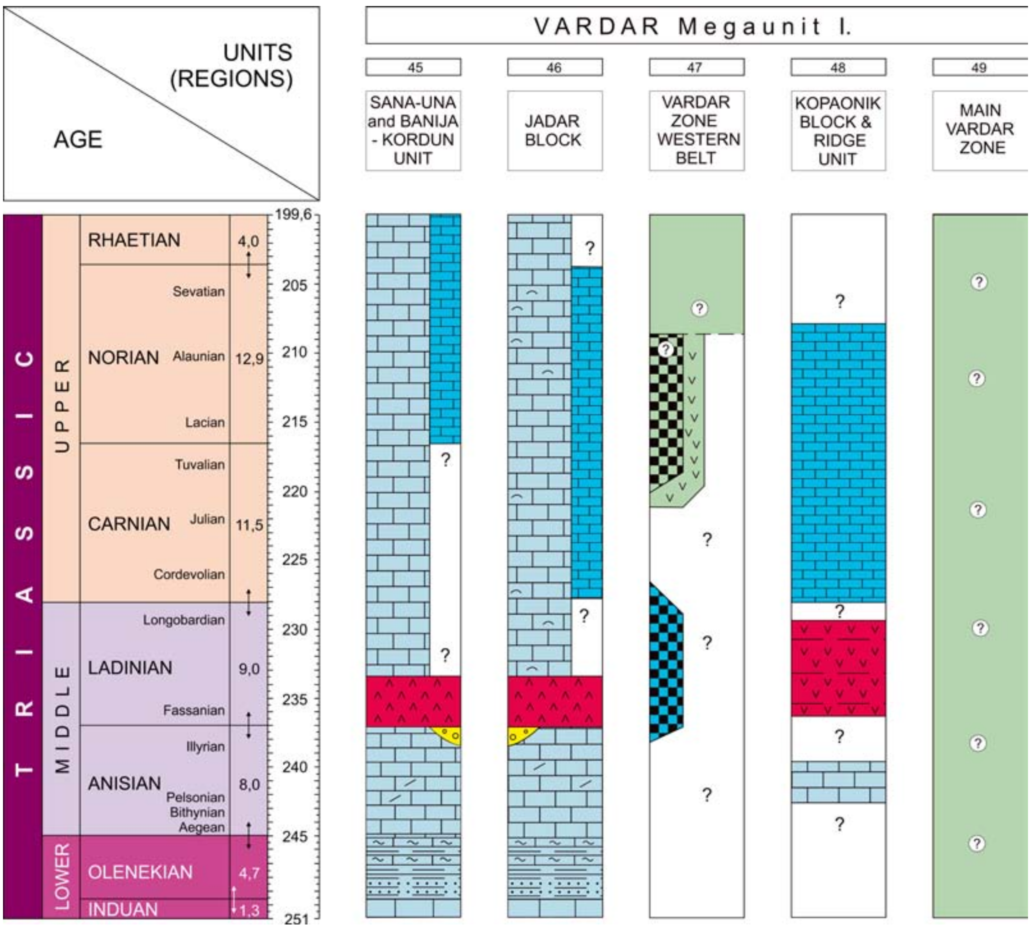
VARDAR MEGAUNIT

The Vardar Megaunit (or Zone) includes the following units from west to east: Vardar Zone Western Belt, Kopaonik Block and Ridge Unit and the Main Vardar Zone. During the Triassic and Jurassic they occupied large areas, but in the latest Cretaceous and Tertiary they were compressed to narrow belts (Karamata, 2006; Robertson et al., 2009). Besides these, at present within the Vardar Zone Western Belt the isolated geotectonic units of Sana-Una and Banija-Kordun, and of the Jadar Block are comprised. They both represent fragments with a very similar or practically equivalent Late Paleozoic and Early Mesozoic geologic evolution. Their present geologic position (as wedges stuck into geologically different surroundings) was achieved by (Late Cretaceous –) Tertiary strike-slip movements. According to Schmid et al. (2008), the Jadar and Kopaonik Units represent tectonic windows below the Vardar ophiolites.

Sana-Una and Banija-Kordun Units

The succession (Protić et al., 2000) starts with the Middle Permian Tomašica Formation (different siliciclastics with dolomites, rauhwackes and gypsum) on top of the older (Paleozoic) strata. According to the present data, Upper Permian formations are not known in this unit.

The Radomirovac Formation of Early Triassic age is made up of shallow ramp siliciclastic and carbonate alternations, with sporadic appearance of ooidal limestones in different horizons and of bioturbated limestones in the uppermost level (Derviš Kula Member). Stratified light grey to grey coloured dolomites and dolomitic limestones dominate in the Anisian Japra Formation. Alternation of cherts, tuffs (“pietra verde”), marlstones, cherty limestones and limestones with *Daonella* and *Posidonia* build up the Donji Volar Formation of Ladinian age. The Upper Triassic consists mostly of shallow-water dolomites and limestones with megalodontids (Podvidača Formation; Protić et al., 2000), but Norian and Rhaetian dolomites with cherts are present as well (Hrvatović, 1999; location on Text-Fig. 1; Text-Fig. 10, col. 45).



Text-Fig. 10.
Lithofacies chart of the Vardar Megaunit (45–49) (VARDAR I).

Jadar Block Unit

The Early Alpine succession of the Jadar Block encloses formations from Middle Permian to Early Jurassic times. The depositional history was unique over the whole area of the Jadar Block and very similar to that of the Bükk series in Northern Hungary (FILIPOVIĆ et al., 2003), and also, of the Sana-Una (PROTIĆ et al., 2000) and of the Banija-Kordun Units.

The shallow-marine "Bituminous Limestone" of Late Permian age passes mostly without break in sedimentation into the Early Triassic oolitic limestones (Svileuva Formation). However, according to the latest investigations a tectonic contact between these two formations has been established (SUDAR et al., 2007). No indications of the "boundary clay" have been found as yet.

The overlying Obnica Formation begins with siliciclastic or shallow-marine carbonate sedimentation and with a deepening upwards trend. Besides an abundant mollusc fauna these sediments contain the conodonts of the *Parachirognathodus – Furnishius* and *Neospathodus triangularis – Neospathodus homeri* zones of Smithian and Early Spathian age (BUDUROV & PANTIĆ, 1974; SUDAR, 1986). The formation ends with thin bedded dark grey limestones, rich in bioturbations, sporadically dolomitic, silty or clayey, with ooids in some beds (Bioturbate Limestone Member).

These rocks pass gradually into grey coloured, brecciated, massive or bedded dolomites and dolomitic limestones of Anisian age (Jablanica Formation equivalent to Gutenstein and Steinalm Formations). Locally, on their top conglomerates consisting predominantly of dolomite pebbles with terrestrial clay intercalations are present. They indicate a local uplift (Podbukovi Conglomerate Member).

During the Early Ladinian, an intense calc-alkaline volcanic activity in connection with the rift volcanism took place, with effusions of andesites ("porphyrite") and its pyroclastics (Tronoša Formation; Text-Fig. 10, col. 46).

In the Late Triassic time different environments existed. Platform limestones of the Lelić Formation that gradually developed from the Ladinian formation were subject to karstification and overlain by reefal limestones. Grey cherty limestones of the Gučevo Limestone Formation were deposited in basinal environments coevally. They are abundant in "filaments" and conodonts of Carnian and Norian age *(Paragondolella foliata, Paragondolella polygnathiformis, Paragondolella nodosa, Metapolygnathus abneptis*, and *Epigondolella postera* zones; SUDAR, 1986).

Vardar Zone Western Belt

Because of the widening of the back-arc Dinaride Ocean (in the sense of KARAMATA, 2006; ROBERTSON et al., 2009) as a result of the continuous southwestwards subduction of the Vardar Ocean lithosphere in the Carnian(?)–Norian, another new oceanic realm was formed behind the Kopaonik Block and Ridge Unit (i.e. SW of that). The basin probably opened during the Early Norian (KARAMATA et al., 1999, 2000; KARAMATA, 2006). For a different view see SCHMID et al. (2008). Identical continental slope formations composed mainly of fine-grained and rare coarse-grained terrigenous rocks, with some limestone intercalations, marbles and basaltic lava flows on the western flank of the Kopaonik Block and at the eastern flank of the Studenica slice (the margin of the Drina-Ivanjica Unit), occur also on both sides of the basin.

In the western basin of the Vardar Zone (the precursor of the Vardar Zone Western Belt) different Triassic pelagic deposits ranging from the continental slope to the deep sea or oceanic realm occur (Text-Fig. 10, col. 47).

In the Ovčar-Kablar Gorge, after Ovčar Banja in the direction to Požega, an olistolith of the volcanogenic-sedimentary formation (formerly known as "Porphyrite-Chert Formation"; OBRADOVIĆ & GORIČAN, 1988, and others) is present. It is in tectonic contact with the Triassic (?Ladinian, Carnian) massive shallow-water limestones. The olistolith is made up of folded, purple to grey platy limestones, red radiolarites, tuffs, siliceous shales and green tuffaceous cherts ("pietra verde"-type). The age, based on radiolarians, – *Oertlispongus inaequispinosus* zone (OBRADOVIĆ et al., 1986, 1987/1988; OBRADOVIĆ & GORIČAN, 1988) – from cherts of this locality, is latest Illyrian to Longobardian. In one of the recent papers the authors mentioned also a Late Carnian – Early Norian age of the chert and radiolarite from this section (DJERIĆ & GERZINA, 2008).

MOR-type pillow lavas in the Ovčar-Kablar Gorge (after Čačak, near the first dam) (Pl. 6, Fig. 2) and in the locality Bukovi (Maljen Mt), are interlayered and covered by deep-water red cherts and/or siliceous shales with radiolarians of Carnian and Late Carnian to Middle Norian age (OBRADOVIĆ et al., 1986, 1987/1988; OBRADOVIĆ & GORIČAN, 1988; VISHNEVSKAYA & DJERIĆ, 2006; VISHNEVSKAYA et al., 2009).

Kopaonik Block and Ridge Unit

This unit (Text-Fig. 10, col. 48) was formed at the beginning of the Late Triassic when it was detached from the continental units or continental slope units west of it, probably from the eastern parts of the Drina-Ivanjica Unit. In the unit a dismembered and accreted sedimentary succession is recognized. Its sedimentary succession can only be reconstructed from different slices. Hemipelagic sedimentation starts on top of metamorphosed grey limestones (equivalent to the Steinalm Limestone of other units). Drowning of the Steinalm ramp was dated by SCHEFER et al. (2010) as Late Anisian. Upsection, a hemipelagic series of a terrigenous continental slope formation follows, the so-called "Central Kopaonik Series", which comprises (?) Middle Triassic marbles, basaltic volcanics (MEMOVIĆ et al., 2004) and in middle and in higher levels limestone interlayers. Upward, this formation grades into cherty limestones (best exposed at the eastern slopes of Kopaonik Mt. and in vicinity of Trepča). The specific "Central Kopaonik Series" occurs all around the Kopaonik granodiorite massif of Oligocene age, which intruded it, and is composed of phyllitoids (dominantly sericite-chlorite schists), chlorite-epidote-actinolite schists, and thin-bedded grey, cherty crystalline limestones.

The mentioned "series" was previously considered to be Paleozoic. After the first discovery of Late Triassic conodonts in the northern (MIĆIĆ et al., 1972) and southern Kopaonik Mt (KLISIĆ et al., 1972), SUDAR (1986) confirmed the Carnian age of the "Central Kopaonik Series" *(Paragondolella polygnathiformis* zone – middle "Cordevolian" – Early Tuvalian and *Paragondolella nodosa* zone – Middle and Late Tuvalian), and pointed out the presence of the Norian stage (Lacian *Metapolygnathus abneptis* and Alaunian *Epigondolella postera* zones) in the metamorphics of the "Metamorphic Trepča Series".

The determined conodonts from these Late Triassic cherty metalimestones occur both in the "Central Kopaonik Series" and "Metamorphic Trepča Series", overthrust by ophiolite complexes. They are strongly recrystallized and ductilely deformed, with CAI values 5.0–7.0 (Sudar & Kovács, 2006; Schefer et al., 2010). These limestones show also strong, rather xenotopic recrystallization with well expressed preferred orientation (foliation/S_1 schistosity) in thin sections and they correspond to a higher degree of type C metasparites/marbles which forms at temperatures above 300 °C. Nevertheless, by comparing the published data about limestone textural alteration and with previously published metamorphic petrological data from NE Hungary, at least a Szendrő-type (min. 400 °C, but less then 500 °C, temperature and 300 MPa pressure) can be assumed for the regional metamorphism of the Triassic conodont-bearing cherty limestone series of Kopaonik Mt (Sudar & Kovács, 2006).

The regions of the Studenica Valley and Kopaonik area in southern Serbia represent the easternmost occurrences of Triassic sediments in the Dinarides (Schefer et al., 2010). In these areas, the most characteristic rocks are strongly deformed and metamorphosed sediments are defined by Schefer et al. (2010) as Kopaonik Formation. These "hemipelagic and distal turbiditic, cherty metalimestones indicate a Late Anisian drowning of the former shallow-water carbonate shelf. Sedimentation of the Kopaonik Formation was contemporaneous with shallow-water carbonate production on nearby carbonate platforms that were the source areas of diluted turbidity currents reaching the depositional area of this formation. The Kopaonik Formation was dated by conodont faunas as Late Anisian to Norian and possibly extends into the Early Jurassic. It is therefore considered an equivalent of the grey Hallstatt facies of the Eastern Alps, the Western Carpathians, and the Albanides-Hellenides." (Schefer et al., 2010, p. 89).

In the Fruška Gora Mt, besides members of the ophiolite complex, a thick series of variously metamorphosed rocks is exposed (Čanović & Kemenci, 1999). These sedimentary rocks, metamorphosed under zeolite to greenschist facies conditions, originated in deep-water environments, showing identical features like the Triassic "schistes lustrés" identified in the broad Kopaonik Mt region (Grubić & Protić, 2000). The series occur mostly on the main ridge and the southern slopes. It comprises different types of schists (sericite-chlorite, sericite, albite, actinolite types, etc.), phyllites, metasandstones, metasiltstones, metacherts, bedded to schistose marbly limestones and dolomites, "calcschists", and siliceous (cherty) microcrystalline limestones. According to findings of the microfauna (Djurdjanović, 1971) i.e. conodonts, foraminifera, radiolarians in the metamorphosed cherty limestones, Middle? and Late Triassic age (Carnian, Norian) has been determined.

The characteristics of the metamorphosed series of the Fruška Gora Mt are described herein, in the Kopaonik Block and Ridge Unit, because of obvious similarities with the conodont-bearing cherty limestones, i.e. Triassic "schistes lustrés" in the broad area of Kopaonik Mt. (Central Kopaonik, near Trepča, vicinity of the Studenica Monastery, etc.; Grubić, 1995). However, it is necessary to point to the fact that the Fruška Gora Mountain, as "block or ridge", is in a geological sense part of the Vardar Zone Western Belt today.

Main Vardar Zone

The main basin of the Vardar Ocean is – according to Karamata (2006) – the remnant of the westernmost part of the Prototethys and later Paleotethys. A different view is presented by other authors (e.g. Gawlick et al., 2008; Schmid et al., 2008; Missoni & Gawlick, 2010, 2011; Kilias et al., 2010; beside others), who see the Vardar oceanic crust as relic of the Neotethys Ocean floor. The Main Vardar Zone is squeezed and deeply eroded, finally also covered by Tithonian reef limestone (far to the south, close to Lojane, southernmost Serbia, and the Demir Kapija, southern Macedonia; Karamata, 2006) and Lower Cretaceous "paraflysch". There are only indications (Text-Fig. 10, col. 49) that this oceanic domain existed during Triassic times (the lense of the Devonian – Early Carboniferous Veleš series and the early Middle Jurassic age of the metamorphic sole of ophiolitic rocks south of Razbojna).

The relicts of the Main Vardar Ocean are exposed as a narrow discontinuous belt along the boundary of the Serbian-Macedonian Unit (Carpatho-Balkanides in the sense of other authors; compare Schmid et al., 2008) and in much wider areas in the west on the eastern and even western slopes and in the sagged parts of the Kopaonik Block and Ridge Unit, as well as parts of this unit in the north and south. In the east ultramafic rocks are exposed, with rare amphibolites at their base, and westward gabbros, sheeted dyke complex and basalts follow. In the west, mainly to the east of the Kopaonik Block and Ridge Unit, but locally also west of that, there are large masses of mostly serpentinized ultramafics with rare gabbro. The serpentinized ultramafics overthrust the (?Paleozoic–)Triassic of the "Central Kopaonik Series". Their emplacement was probably due to a younger compression when they were squeezed out and thrust westward. By this processes these serpentinized ultramafics from the Main Vardar Zone were brought close (or even together) to the serpentinized ultramafics from the Vardar Zone Western Belt. In general, now it is impossible to distinguish the ultramafics according to their provenance, only in some places they can be differentiated. For example, the ultramafics at Troglav (Bogutovačka Banja, central Serbia) and close to Banjska (near Kosovska Mitrovica, southern Serbia) are considered to be younger (see Haas et al., 2011, in this volume), since the amphibolites at their metamorphic soles belong to the Vardar Zone Western Belt.

Transylvanides

The Transylvanides (Transylvanian Dacides; Săndulescu, 1984) are the highest overthrust units both in the Southern Apuseni Mts and in the Eastern Carpathians. They are typical obducted nappes or nappe outliers with oceanic crust and/or Mesozoic sedimentary rocks (Săndulescu, 1984, 1994; Patrulius et al., 1996; Patrulius, 1996). The Transylvanides include two distinct groups of units, i.e. the ***Simic Metaliferi Mts Nappe System*** located in the Southern Apuseni Mts and the unrooted ***Transylvanian Nappe System*** from the inner zones of the Eastern Carpathians (Săndulescu & Dimitrescu, 2004).

The Southern Apuseni ophiolitic suture zone represents a complex tectonic collage of mainly obducted nappes, which are made up of sedimentary Jurassic and Cretaceous formations, at the sole of which Jurassic – Lower Cretaceous magmatic complexes of ophiolitic or island arc character were conserved (IANOVICI et al., 1976; SAVU, 1980, 1983; BLEAHU et al., 1981; LUPU, 1983; SĂNDULESCU, 1984). The Meso-Cretaceous and Laramian tectogeneses accomplished the structural framework of the Simic Metaliferi Mts Nappe System, which is overthrust on the Inner Dacides (including the Northern Apusenides and Sialic Metaliferi Mts), part of the "Tisia Block" (SĂNDULESCU, 1984).

The Southern Apuseni ophiolitic suture zone (or Mureş Zone) can be followed eastwards in the basement of the Transylvanian Basin (RĂDULESCU et al., 1976; SĂNDULESCU & VISARION, 1978; IONESCU et al., 2009). Farther to the west the continuation of the suture zone, although dissected by the huge South Transylvanian (Mureş) dextral strike-slip zone (SĂNDULESCU, 1984, 1988; BALLA, 1984; RATSCHBACHER et al., 1993; SCHMID et al., 2008) is structurally connected to the Vardar Zone, first recognized by ANDJELKOVIĆ & LUPU (1967). Continuation in the pre-Tertiary basement of Vojvodina into the eastern part of the Vardar Zone (Main Vardar Zone) is proven by borehole data (KEMENCI & ČANOVIĆ, 1997).

As documented in the Eastern Carpathians, the rifting of the Transylvanide oceanic domain started in the Middle Triassic.

Simic Metaliferi Mts Nappe System
(Southern Apuseni Mts)

Proper Triassic sedimentary series, including remnants of the oceanic basement, are absent in the Southern Apuseni ophiolitic suture zone. Only a few Triassic olistoliths were encountered in the Barremian – Lower Aptian Bejan Wildflysch in the Bejan Unit by LUPU et al. (1983) and LUPU & LUPU (1985). They consist of Upper Triassic pelagic, light grey, micritic limestone with halobiids (location on Text-Fig. 1; Text-Fig. 11, col. 57). In view of the occurrence of Triassic olistoliths, SĂNDULESCU (1984) assumed that the Bejan Unit had a paleogeographic position near the Bucovinian domain.

Transylvanian Nappe System
(Perşani, Olt and Hăghimaş Nappes in the Eastern Carpathians)

The main units of the unrooted Transylvanian Nappe System in the East Carpathians, which were obducted during the Meso-Cretaceous tectogenesis, are the Perşani, Olt and Hăghimaş Nappes (SĂNDULESCU, 1975b, 1984; SĂNDULESCU et al., 1981; PATRULIUS, 1996; PATRULIUS et al., 1979, 1996). They have different stratigraphic successions and ophiolitic complexes in their basal part, except the Perşani Nappe where an ophiolitic complex is lacking. The Perşani and Olt Nappes include only rocks of Triassic and Early Jurassic age, whereas the Hăghimaş Nappe is made up exclusively of a Middle and Upper Jurassic to Lower Cretaceous succession.

SĂNDULESCU & RUSSO-SĂNDULESCU (1981), RUSSO-SĂNDULESCU et al. (1981, 1983) and HOECK et al. (2009) discussed the structural position, age, petrological and geochemical features of the allochthonous basic and ultrabasic rocks belonging to the Transylvanian nappes or to the olistoplakae and olistoliths included in the Lower Cretaceous wildflysch of the Bucovinian Nappe. For most of them, the Triassic age is well constrained by their close relationships with the Triassic sedimentary rocks. To others, e.g. for pillow basalts at Lacu Roşu, interpreted as a thrust slice underneath the Hăghimaş Nappe, or for the serpentinites in Rarău Mt, a Callovian–Oxfordian age is assigned by SĂNDULESCU (1984).

PATRULIUS (1996) – based on the facies features of the Triassic and Lower Jurassic formations of the Transylvanian nappes, also of the olistoliths and olistoplakae embedded in the Bucovinian Lower Cretaceous Wildflysch Formation – defined several "independent" sedimentary series, as follows: the Zimbru, the Olt, the Lupşa and the Hăghiniş "Series".

In the ***Zimbru "Series"***, outcropping in the Piatra Zimbrului klippe in the Rarău Mt (Text-Fig. 11, col. 50), Ladinian red radiolarian cherts and variegated radiolarites with thin beds of limestones (13 m thick) are overlain by variegated cherty limestone shales, 7 m thick. The rich radiolarian fauna shows a Late Illyrian – Fassanian age (DUMITRICĂ, 1991). Upsection, the Lower Carnian Zimbru Limestone, 80 m thick, consists of light grey micritic limestones with some pink layers, with conodonts and *Halobia* lumachelles, and bioclastic reef detritus in the upper part (Pl. 6, Fig. 4). The Upper Carnian – Norian Popi Limestone, at least 60 m thick, is represented by dark-coloured bioclastic-biomicritic limestones with chert nodules, which interfingers with light-grey, pinkish and glauconitic nodular limestones (Pl. 7, Fig. 1). Its age is proved by conodonts, halobiids, ammonoids and brachiopods (PATRULIUS et al., 1971; MUTIHAC, 1966, 1968; IORDAN, 1978; MIRĂUŢĂ & GHEORGHIAN, 1978; TURCULEŢ, 2004, and references therein). The Upper Norian is present in small olistoliths of "Salinaria Marls" with *Monotis salinaria*. The dark grey to black Rhaetian ("Kössen") limestones contain a rich fauna (e.g. *Rhaetina gregaria;* PATRULIUS et al., 1971; IORDAN, 1978; TURCULEŢ, 2004). Outside the Rarău Syncline, scarce and minor remnants of the Zimbru "Series" are represented by: Upper Norian grey sandy limestone with *"Monotis"substriata* and Rhaetian grey limestone with *Rhaetina gregaria* in the Hăghimaş Syncline, Middle Norian dark grey shales and thin-bedded limestones with *Halobia fallax*, as well as Rhaetian black limestones with large megalodonts in the Perşani Mts (Text-Fig. 11, col. 51).

The ***Olt "Series"***, occurring mainly in the ***Olt Nappe*** (Perşani Mts; Text-Fig. 11, col. 52), some 200 m thick, starts with an ophiolitic complex, which includes blocks of serpentinites (emplaced probably in the Jurassic), gabbros, dolerites and basalts, mainly as variolitic pillow lavas associated with volcanoclastics, radiolarian chert, argillaceous shales and red or grey nodular limestones. In the Pârâul Rotund klippe the pillow-lava sequence includes red limestone with Anisian conodonts: *G. bulgarica, G. bifurcata*, and foraminifera: *Pilammina densa, Trochammina alpina,* etc., pointing to a Pelsonian age (MIRĂUŢĂ in PATRULIUS et al., 1996). The ophiolitic complex is capped by island-arc volcanics, with bostonitic porphyries and andesites (CIOFLICĂ et al., 1965; PATRULIUS, 1996; PATRULIUS et al., 1996; HOECK et al., 2009). The white, massive limestones, overlying the volcanics, contain a conodont assemblage near their base with *Gondolella trammeri* (Ladinian). In some klippen the Hallstatt Limestone covers the whole Early Carnian – Late Norian range, in others it underlies white massive carbonates, is interbedded with them, or lies on top of them (PATRULIUS, 1967, 1996; PATRULIUS et al., 1966, 1971, 1996). Other klippen have red encrinitic limestone and white-grey encrinitic calcarenites (“Drnava facies”) with abundant brachiopod faunas of Rhaetian age.

In the ***Hăghimaş Syncline*** the Olt “Series” includes only small olistoliths and boulders consisting of serpentinites (emplaced probably in the Jurassic), variolitic pillow lavas, Upper Carnian and Middle Norian Hallstatt Limestone and marly limestones with *Monotis haueri* (GRASU, 1971, and references therein).

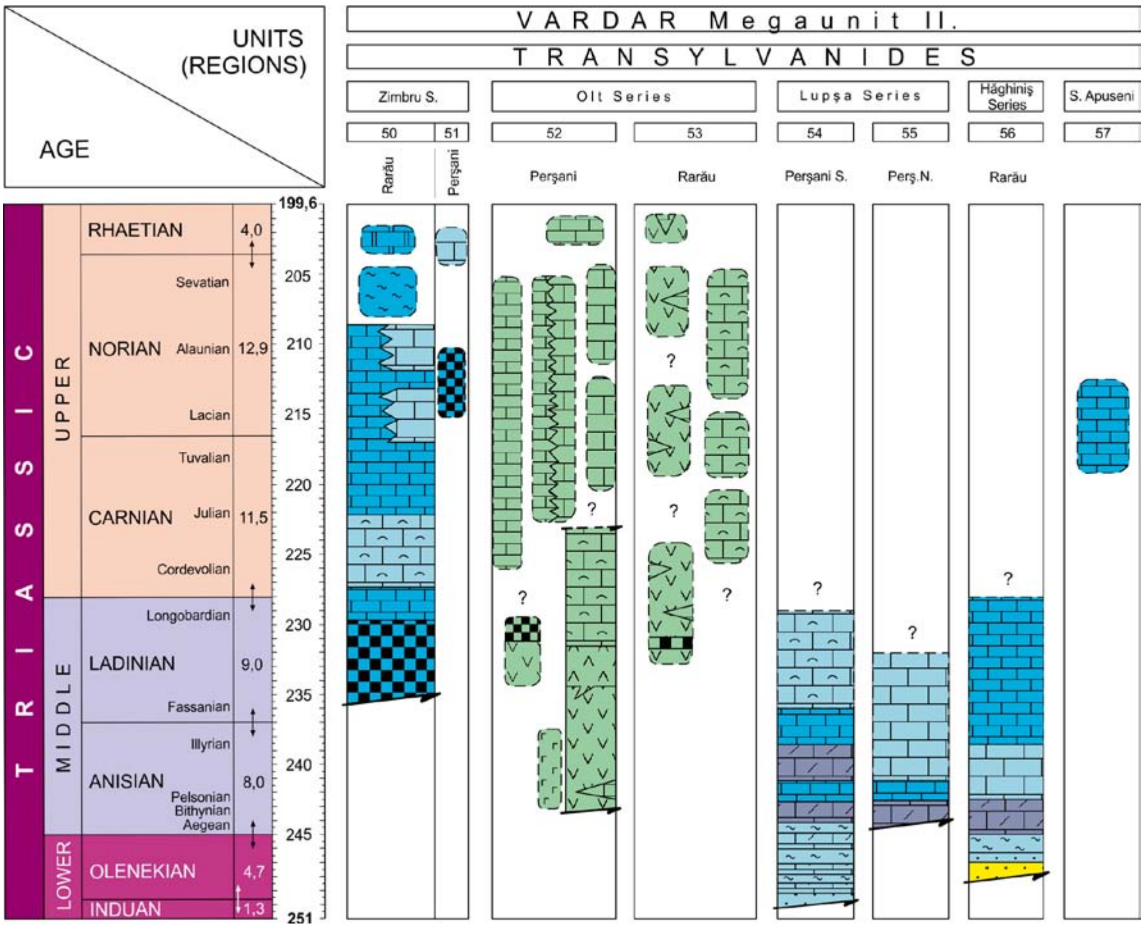
Upper Ladinian – Norian Hallstatt-type olistoliths with very rich faunas (TURCULEŢ, 2004, and references therein) and Carnian–Norian light-coloured reefoid limestone olistoliths were found in the Lower Cretaceous Bucovinian Wildflysch in the Rarău Syncline.

In the ***Rarău Syncline*** (Text-Fig. 11, col. 53), apart from the large ***Breaza Outlier*** consisting of serpentinites (emplaced probably in the Jurassic), there are also other outliers and numerous olistoliths composed of mafic and ultramafic rocks (SĂNDULESCU, 1973; RUSSO-SĂNDULESCU et al., 1981, 1983; SĂNDULESCU & RUSSO-SĂNDULESCU, 1981). In the Măcieş stream, the pillow basalts include blocks of limestones ranging in age from Ladinian to Norian (MUTIHAC, 1968; IORDAN, 1978; GHEORGHIAN, 1978; TURCULEŢ, 1991a; POPESCU, 2008), and even Middle Liassic (TURCULEŢ, 1991b). There are biostratigraphic constraints to assume that in the area in which the Olt Nappe has its origin, the volcanic activity lasted at least till the Early Jurassic (TURCULEŢ, 1991b).

In the outer-shelf zone the ***Lupşa “Series”*** of the ***Perşani Nappe***, at least 500 m thick, the Triassic succession of the Lupşa Outlier (Text-Fig. 11, col. 54), starts with the Spathian Werfen beds, that consist of grey argillaceous to marly silty shales and siltstones with interbedded silty and sandy limestones with *Costatoria costata* and scarce *Tirolites* sp., and a palynologic assemblage belonging to the *Densoisporites nejburgii* zone (ANTONESCU et al., 1976). The Middle Triassic starts with grey vermicular, and dark-grey argillaceous, Gutenstein/Annaberg-type limestones (Lower Anisian), and is followed by the Lower Schreyeralm Limestone with red cherts, sometimes nodular, with *Balatonites* sp. (Pelsonian). Upsection, the dark-grey to almost black limestone (Pelsonian) is followed by the Upper Schreyeralm Limestone (Illyrian–Fassanian), which may contain cherty nodules and bands too. The succession is capped by Ladinian light-coloured, massive limestone followed by bedded grey limestone.

In the Colţii Nadaşului klippe (Text-Fig. 11, col. 55), the black limestone is followed by the Schreyeralm Limestone (Pelsonian), with a thin basal breccia horizon, and the sequence is closed by the dasycladacean Steinalm Limestone (Pelsonian and maybe also Illyrian; PATRULIUS et al., 1971, 1979, 1996).

In the ***Hăghiniş “Series”*** (Text-Fig. 11, col. 56) some 200 m thick, Upper Scythian(?) yellowish quartzitic microconglomerates are followed by red fine siliciclastics; then Anisian dolomite, grey-black limestone, and massive, light-coloured, Steinalm-like limestones follow. Upwards, the thin,



Text-Fig. 11.
Lithofacies chart of the Transylvanides of the Eastern Carpathians (50–56) and of the Southern Apuseni Mts (57) (VARDAR II).

pink-grey micritic limestone with abundant juvenile specimens of halobiids, assumed to be Ladinian in age, is unconformably overlain by Upper Hettangian red limestones.

As stated by PATRULIUS (1996), the Triassic to Lower Jurassic rock sequence of the Hăghiniş "Series" has close affinities to the corresponding one of the Bucovinian Nappe, and it was assumed that among the Transylvanian units the Hăghiniş Nappe was closest to the area, from which the Bucovinian Nappe was derived. On the other hand the Zimbru "Series" with its Wetterstein-like Zimbru Limestone, its Norian rocks with terrigenous materials and especially its black Rhaetian limestones with Kössen fauna can be best compared to the rock-sequences of the Lower Codru Nappes (Northern Apuseni Mts). In consequence, PATRULIUS (1996) assumed that the original position of the Olt and Lupşa "Series" was between the western Zimbru "Series" and the eastern Hăghiniş "Series".

TISZA MEGAUNIT

The most part of this microcontinent-sized megaunit forms the pre-Tertiary basement of the southeastern part of the Pannonian Basin in Hungary, Croatia and Serbia, continuing to Romania, where it crops out in the Apuseni Mountains on a large surface extension. Isolated outcrops in the SW part of the megaunit can be found in the Mecsek and Villány Mts of southern Hungary, just W of the Danube River, and in the Papuk and Psunj Mts of NE Croatia.

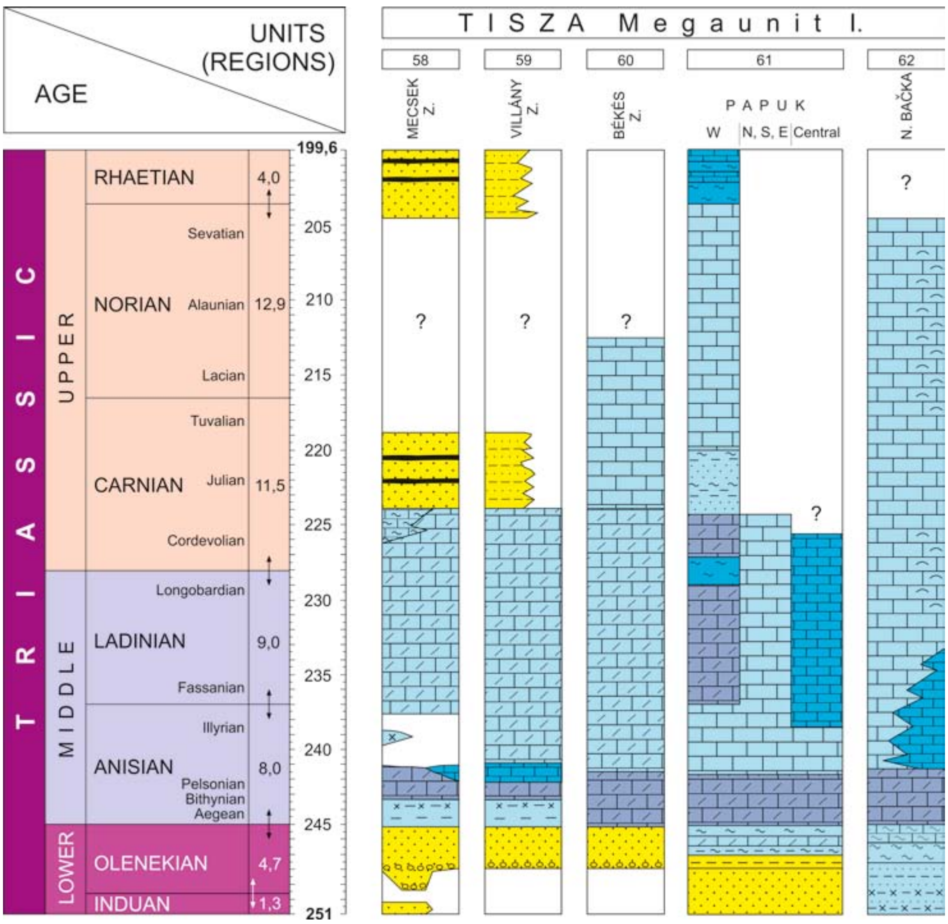
Based on the types of Mesozoic development of the whole megaunit and on the structure of the Northern Apuseni Mts (BLEAHU et al., 1981), the following WSW–ENE striking tectono-facial zones can be distinguished within (from the NW to SE; BLEAHU et al., 1994; HAAS & PÉRÓ, 2004):

- Mecsek Zone;
- Villány-Bihor Zone;
- Papuk-Békés-Lower Codru Zone;
- Northern Bačka-Upper Codru Zone;
- Biharia Zone

Thrusting of the pre-Alpine basement of the Villány-Bihor Zone (e.g. of the so-called "Bihor Autochthonous") onto the metamorphosed continuation of the Mesozoic of the Mecsek Zone is proven by the Sáránd 1 borehole in Hungary, near the Romanian border (ÁRKAI et al., 1998), with mean metamorphic ages of 91.5 and 81.1 Ma.

A significant Late Cretaceous (95–82 Ma) tectonometamorphic event reaching up to amphibolite facies conditions was recorded in the Szeged Basin (HORVÁTH & ÁRKAI, 2002; LELKES-FELVÁRI et al., 2003); it was presumably related to the overthrust of the Codru Nappe System onto the Villány-Bihor Zone.

The Romanian part of the megaunit was called Northern Apuseni Unit (BLEAHU, 1976a, b), Western Dacides (SĂNDULESCU, 1980), but actually named Inner Dacides (SĂNDULESCU, 1984). It is divided into the lowermost Bihor Parautochthonous with thick pre-Alpine crystalline basement and Permian – Upper Cretaceous sedimentary cover, the Codru Nappe System that usually includes N to NW vergent detached (cover) nappes with Permian – Lower Cretaceous sedimentary sequences, and the highest Biharia Nappe System that includes pre-Alpine basement



Text-Fig. 12.
Lithofacies chart of the western and middle parts of the Tisza Megaunit in Southern Hungary (58–60), Northeastern Croatia (61) and Northern Serbia (62) (TISZA I).

nappes with scarce low-grade metamorphic Permo-Triassic cover.

The common post-nappe sedimentary cover of the Northern Apuseni Unit is the Coniacian–Maastrichtian Gosau Formation which is overthrust by the N–NW vergent non-metamorphic Simic Metaliferi Mts Nappe System in the southern part of the Apuseni Mountains. It is to be expected, that certain parts of the Codru Nappe System were detached from the Biharia Nappe System basement (PATRULIUS et al., 1971). The Arieşeni Nappe (which is identical with the Biharia Nappe), can be correlated to the Dieva and perhaps Moma(?) Nappes. At least the Triassic of the Vaşcău and Coleşti Nappes has a more external shelf facies than the Lower Codru Nappes. This review was made mainly after the detailed correlational work by BLEAHU et al. (1994).

Mecsek and Villány-Bihor Units

Mecsek and Villány Units

Facies characteristics of the Triassic formations in the Mecsek (location on Text-Fig. 1; Text-Fig. 12, col. 58) and Villány (Text-Fig. 12, col. 59) Facies Zones in Hungary are similar, thus allowing a common description for them. The outcropping areas in the Mecsek Mountain and Villány Hills provided a predominant part of the data however hydrocarbon exploratory wells proved the continuation of both facies units in the basement of the Great Plain (BLEAHU et al., 1971, 1994; BÉRCZI-MAKK, 1986, 1998).

During the Triassic times, the Tisza Megaunit was located at the northern Tethyan shelf margin east of the dry lands of the Bohemian Massive and Vindelician High.

The Lower Triassic sequence is a continuation of Late Permian fluvial sedimentation. The lowermost Triassic siliciclastic sediments (Jakabhegy Sandstone; comparable with the Germanic Buntsandstein) are divided into three lithologic units (BARABÁS-STUHL, 1993; KONRÁD, 1998; BARABÁS & BARABÁS-STUHL, 2005). The basal unit is built by coarse conglomerates with pebbles of quartzite, rhyolite, granite and shales (Pl. 7, Fig. 4). Based on various sedimentological characteristics, fluvial transport from NE (according to the present-day co-ordinates) can be interpreted (KONRÁD, 1998). The second lithologic unit ("pale sandstone") consists of fining-upward cycles: thin conglomerates, cross-bedded sandstones, capped by siltstones. The topmost unit of the Jakabhegy Sandstone consists of siltstones and fine-grained sandstones with paleosol horizons, representing a series of facies from terrestrial to alluvial and coastal plain environments (KONRÁD, 1998). Intercalations of aeolian dune sands have also been recognized. Based on sporomorphs the topmost part of the formation is of earliest Anisian age (BARABÁS-STUHL, 1993). Lower Triassic siliciclastic sediments have also been explored in the drillings of the Great Hungarian Plane (BÉRCZI-MAKK, 1986, 1998).

Rising sea-level led to the gradual flooding of the whole Tisza Megaunit and the development of a mixed siliciclastic-carbonate ramp system in the Early Anisian (TÖRÖK, 1998). Three large-scale sedimentary cycles have been recognized within the Middle Triassic sequences (TÖRÖK, 2000). The earliest sediments of the first sedimentary cycle are greenish-red siltstones. Gypsum to anhydrite pseudomorphs, desiccation pores and cracks indicate a peritidal origin of the sandstone-siltstone-dolomite cycles (TÖRÖK, 2000). Sporomorphs indicate Early Anisian deposition (BARABÁS-STUHL, 1993). The covering anhydrite and gypsum layers are coastal plain to sabkha deposits (TÖRÖK, 1998), that are overlain by dolomitized peritidal carbonates. This formation is considered as the "Hungarian Röt", corresponding to the Röt in the Germanic Basin (TÖRÖK, 2000).

The second cycle consists of Anisian mid and outer ramp deposits. Flaser-bedded limestone and marlstones with numerous tempestites indicate frequent storm activity (Wellenkalk; Pl. 7, Fig. 6). The Bithynian–Pelsonian age of these beds is based on crinoids (HAGDORN et al., 1997) and palynomorphs (GÖTZ et al., 2003).

In Mecsek Mts and Villány Hills the deepest facies is characterized by crinoidal-brachiopod beds, representing outer ramp deposits (TÖRÖK, 1993). Increased connection to the open sea is indicated by ammonoids of the Binodosus Subzone, and abundant conodonts containing still *Gondolella bulgarica*, i.e. indicating Late Pelsonian. However, eupelagic elements are missing from the conodont fauna (KOVÁCS & RÁLISCH-FELGENHAUER, 2005).

In the Late Anisian (Illyrian) significant spatial differences occur in the grade of dolomitization and facies development. The evaporitic "Middle Muschelkalk" event seems to be represented by a hiatus in the Mecsek Mts, however, gypsum pseudomorphs were reported from the dolomites (KONRÁD, 1998).

The uppermost Muschelkalk (Ladinian) is characterized by bituminous oncoidal packstones and bivalve shell beds of backshoal origin (TÖRÖK, 1993). These are overlain by laminated organic carbon-rich calcareous marls. The succession contains an abundant ostracod and gastropod fauna, but with very low diversity, as well as characeans and plant fragments (MONOSTORI, 1996), indicating freshwater conditions probably due to a climate change that is also reflected in the gradually enhanced terrestrial input (HAAS et al., 1995b).

The Late Triassic, representing the third major sedimentary cycle, is characterized by a differentiation of facies units within the Tisza Megaunit. A rapidly subsiding half-graben structure developed in the Eastern Mecsek Mts, resulting in the formation of several hundred metres (up to 500 m) of arkosic sandstones and siltstones (Karolinavölgy Sandstone). Continuation of these half-graben structures in the basement of the Great Plain is proven by deep drilling evidences (BÉRCZI-MAKK et al., 1996). Various depositional environments include lacustrine, fluvial and deltaic settings (NAGY, 1968). The upward transition of these beds to the Jurassic Gresten-type sequence is continuous. Subsequent strongly differing burial depths in the Mecsek half-graben and on the Villány ridge can be shown by the sharply changing Colour Alteration Indexes (CAI) of Anisian conodonts in the two zones (KOVÁCS et al., 2006).

The Villány Unit is characterised by a thin, coastal-continental Upper Triassic succession akin to the "Carpathian Keuper" facies of the European shelf of the Tethys. In the Villány Hills, Ladinian dolomite is conformably overlain by a formation made up of an alternation of yellowish-grey dolomitic marl and dolomite, brownish or greenish-grey sandy siltstone, and greyish-white quartzarenite. In the upper part of the 15–40 m-thick formation, the dolomite layers disappear and greenish-reddish variegated siltstone becomes predominant. Marine fossils are completely absent from these layers. Above the Middle Triassic carbonates a few wells also encountered similar sequences in the basement of the Great Plain (BÉRCZI-MAKK et al., 1996).

Bihor Unit

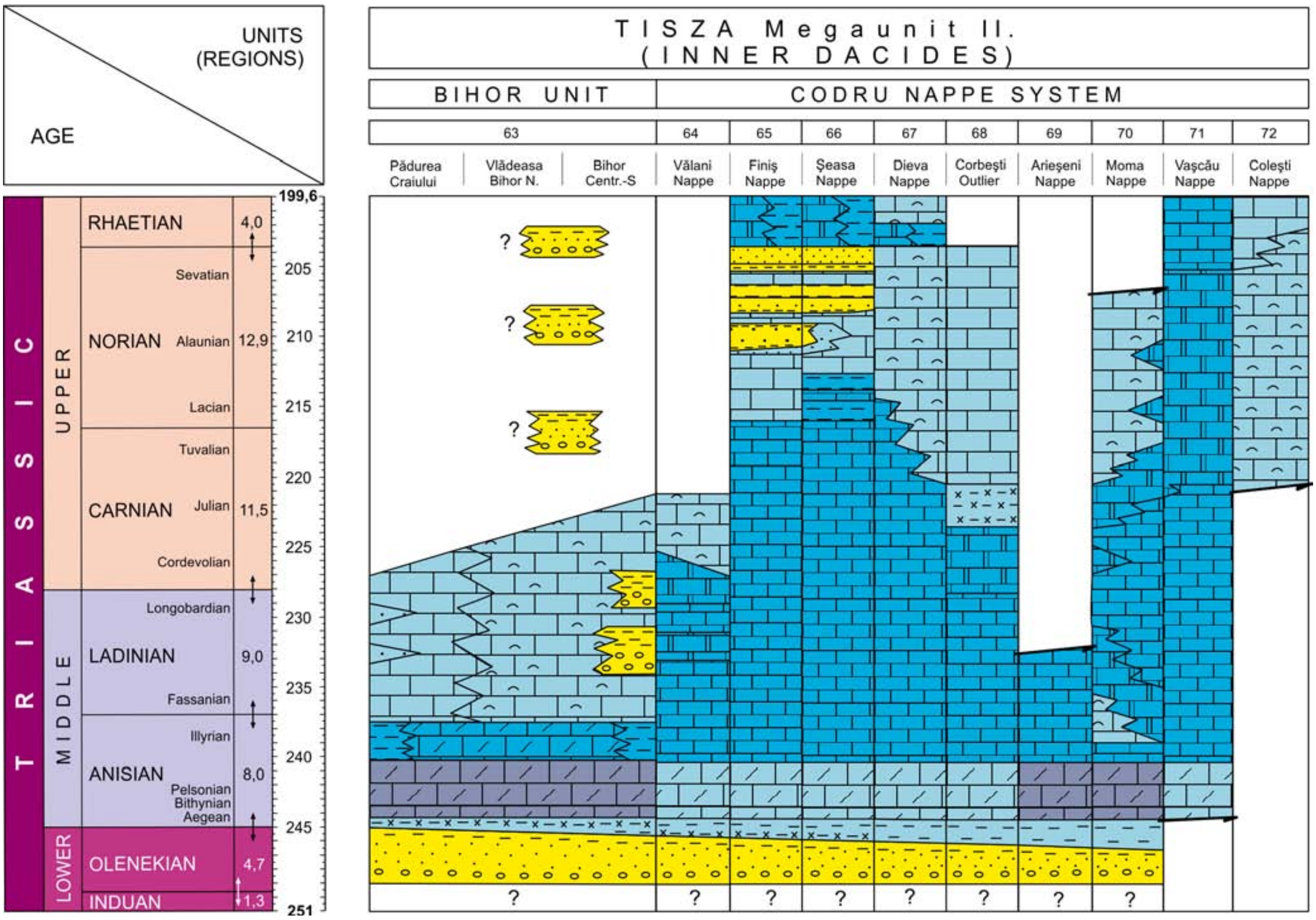
The Triassic sequence of the Bihor Unit in Romania (location on Text-Fig. 1; Text-Fig. 13, col. 63) has a typical tripartite development with mixed Germanic and Neotethyan character: continental Lower Triassic, shallow-marine carbonatic Middle Triassic to Lower Carnian and continental Upper Triassic. The Triassic formations are usually underlain by pre-Alpine crystalline schists, but different Permian formations appear in between them, southward.

The Scythian is made up of fluvial and deltaic, partly limnic siliciclastics (continental redbeds or "Buntsandstein" stage). There is a typical coarse basal conglomerate member. Sediment transport directions are usually from NE to SW. Red, sometimes green shales of tidal flat and shallow-marine facies characterize the lowermost Anisian, with rich *Triadispora crassa* assemblage (ANTONESCU et al., 1976). It is overlain by evaporitic dolomite, akin to the Röt in the Germanic facies.

The Lower Anisian is characterised by a mixed shallow ramp facies (DIACONU & DRAGASTAN, 1969; DRAGASTAN et al., 1982) while the Lower–Middle Anisian is represented by a lower and an upper dolomite sequence with thick dark, vermicular limestones and dolomites (Bucea and Padiş-Călineasa Formations) in between (IANOVICI et al., 1976; PATRULIUS, 1976). These formations (<800 m) were deposited on a deeper, restricted ramp, and are equivalent to the Germanic "Wellenkalk".

The Illyrian shows maximum deepening with basinal limestones, with calcarenitic and coquina storm-beds, slumps and mud-flows (brachiopods, crinoids, daonellids, conodonts and ammonoids) and siliciclastic sediments (Lugaş Formation). The Upper Illyrian displays strong affinities with the Germanic Triassic, with the occurrence of reptiles of poor swimming capacity (*Nothosaurus*, *Tanystropheus*; JURCSÁK, 1978, and the references therein), also known from the Germanic Basin ("insular extension of the Vindelician Land"; PATRULIUS in IANOVICI et al., 1976; PATRULIUS et al., 1979).

Wetterstein-type platform carbonates can be considered as a Neotethyan feature, wich corresponds to the Late Illyrian *(Diplopora annulata, D. annulatissima)* to earliest Carnian interval. They are thicker in the south, with reef buildups, and thinner (usually dolomitized) in the north with dasycladacean back-reef lagoon facies (MANTEA, 1969, 1985; POPA & DRAGASTAN, 1973; POPA, 1981). In the marginal Central Bihor the platform building "was interrupted by three coarse continental sequences", Zugăi, Ordâncuşa, Scăriţa (BALTREŞ & MANTEA, 1995), which are interpreted as signs of proximity of the continental hinterland, the "Bihor Land" (BLEAHU et al., 1994). Although the Zugăi Formation can also be interpreted as a paleokarsti-



Text-Fig. 13.
Lithofacies chart of the eastern part of the Tisza Megaunit (Apuseni Mts, Romania) (63–72) (TISZA II).

fied horizon upon Wetterstein Formation, underlying the Gresten sandstones.

The carbonate platform development was followed by a long subaerial erosional interval (paleokarst) in the Late Triassic. However, the Upper Triassic is represented locally by a less than 100 m thick fine-grained siliciclastic continental – shallow marine(?) succession (the Carpathian Keuper-type Scăriţa Formation; PATRULIUS & BLEAHU, 1967).

Papuk-Békés-Codru Unit

Papuk Unit

The Lower Triassic in the Papuk Mts in Croatia is bipartite (Text-Fig. 12, col. 61). The lower unit consists of lilac and white continental quartzites directly overlying Variscan granites and metamorphic rocks. The upper unit is made up of the shallow-marine "Werfen Shales", with a characteristic Late Scythian bivalve fauna *(Unionites fassaensis, Eomorphotis* cf. *hinnitidea*, etc.; ŠIKIĆ & BRKIĆ, 1975; names revised by K. HIPS, pers. comm.), providing biostratigraphic evidence, that here a marine transgression took place earlier than in the Villány and Mecsek areas further north. Carbonate ramp conditions were established in the Anisian: first dark grey Gutenstein-type dolomites, then light coloured Steinalm-type dolomites were formed. Facies differentiation took place in the following part of the Middle Triassic: Reifling-type grey cherty limestones were deposited in the central part of the mountains, whereas in other parts light coloured, Wetterstein-type dolomites containing locally dasycladacean algae *(Diplopora annulata)* were found. Grey shale intercalations (up to a few meters thick) with the bivalve *Daonella lommeli* may correspond to the Partnach beds of the Northern Calcareous Alps. The following part of the Triassic sequence is exposed only in the westernmost part of the mountains, in the valley of the Pakra Creek, where grey sandstones and shales of a few 10 m thickness may correspond to the Carnian Lunz Formation, and the overlying black, stromatolitic dolomites (in ca. 200 m thickness) to a special type of the Alpine Hauptdolomit. The uppermost part of the Triassic sequence consists of black shales (in the lower part) and black, marly limestones (in the upper part), representing the Alpine Kössen Formation, with the same, rich fauna, as in the equivalents in the Northern Calcareous Alps and in the Western Carpathians (ŠIKIĆ et al., 1975; ŠIKIĆ in BLEAHU et al., 1994).

Békés Unit

Lower and Middle Triassic rocks were explored southeast to the Codru overthrust in the Békés(-Codru) Unit (Text-Fig. 12, col. 60), in the basement of the Great Plain in Hungary. The basement of the Szeged Basin and the Békés Basin belongs to this unit.

In the Békés Basin the Lower Triassic is represented by grey and lilac continental sandstones (Jakabhegy Formation). Lower Anisian "Werfen-type" variegated or red shales were encountered in both basins. In the Szeged Basin, the higher part of the Anisian and the Ladinian is represented by shallow-marine, lagoonal dolomites. In the Békés Basin similar dolomites are covered by grey shallow-marine marls and limestones with calcareous algae of Late Ladinian age and light grey dolomites of Carnian to Norian age.

Northern Bačka Unit

In the SSE part of the Tisza Megaunit, in Serbia, hydrocarbon-prospecting boreholes explored a marine Triassic succession representing outer shelf and shelf margin settings, comparable with the Tirolic nappes in the Northern Calcareous Alps (ČANOVIĆ & KEMENCI, 1988; KEMENCI & ČANOVIĆ, 1997) and with the higher Codru nappes of the Apuseni Mts (BLEAHU et al., 1994).

Sporadically reported evaporites may be either Late Permian or earliest Triassic in age. The (?Permo-)Scythian succession begins with a quartz conglomerate – quartz sandstone formation, without fossils, followed by a shallow-marine mixed carbonate-siliciclastic deposition consisting of shales, marls, marly limestones and dolomites. The latter contains a foraminifera association characteristic for the higher Scythian *(Meandrospira pusilla, M. cheni,* etc.) and *Myophoria*-type bivalve shells. The Anisian is represented by Steinalm-type ramp carbonates with dasycladaceans *(Physoporella pauciforata)* and foraminifera. At the Anisian/Ladinian transition dark grey, Reifling-type marly limestones were deposited. The Ladinian to Norian (?Rhaetian) is made up of thick Wetterstein, then Dachstein-type platform carbonates, with both reefal (calcareous sponges, hydrozoans, corals) and lagoonal (dasycladaceans *Teutloporella herculea* in the former, *Diplopora muranica* in the latter) facies (ČANOVIĆ & KEMENCI, 1988; KEMENCI & ČANOVIĆ, 1997; Text-Fig. 12, col. 62).

Codru Nappe System

In the Codru Nappe System in Romania, the Lower Triassic is represented by continental redbeds, with marine influences in the upper part. After an Early–Middle Anisian outer and middle shelf period, a huge Reifling-type intrashelf basin developed (Roşia and Izbuc Formations; PATRULIUS et al., 1976) which was infilled from the earliest Carnian ("Cordevolian") to the Lacian. Starting from Tuvalian–Alaunian the coeval Carpathian Keuper, Hauptdolomit, Dachstein Limestone and "Wand" Limestone (PATRULIUS & BLEAHU, 1967; PATRULIUS et al., 1971, 1979) appear passing on from the lower nappes to the higher ones (Text-Fig. 13, col. 64–72). The traces of the Kössen event appear only in the Lower Codru Nappes.

Red sandstones of fluvial-deltaic facies represent the Lower Triassic, the basal conglomerate member is less developped, as in the Bihor Unit. However, in the Finiş Nappe (Highiş Mts) and the Dieva Nappe (Codru Mts) a grey shallow-marine succession occurs in the upper part of the Scythian with bivalves, and *Tirolites* sp. too (PATRULIUS et al., 1979).

Shallow-marine mixed ramp facies characterise the Lower Anisian. In the Middle Anisian a large carbonate ramp developed and predominantly monotonous grey dolomite (Sohodol Formation) or dark grey anoxic dolomites (Bulz Formation) were formed. Only in the south (Vaşcău Nappe) the well-oxygenated outer shelf facies appears, with Steinalm Limestone, around 500 m thick (PATRULIUS et al., 1979; BUCUR, 2001).

The platform drowned in the Early Illyrian *(Gondolella constricta cornuta* zone in the sense of KOVÁCS, 1994) (Reifling event), and a large basin came into being (Roşia Limestone). This resulted in an extreme narrowing of the platform facies zones, and their shifting towards the continental hinterland. The basinal, frequently cherty grey limestones with shales contain pelagic elements, such as radiolarians, "filaments", conodonts, ammonoids, daonellids. The basin evolution continued in the Ladinian – Early Carnian with the appearance of slope deposits (Raming-type) and allodapic carbonates originated from the neighbouring Wetterstein Platform (Moma Nappe). It was followed by progradation of the Wetterstein Platform (Vălani Nappe, Arieşeni Nappe/Corbeşti Outlier). In the most distal, hemipelagic basin (Vaşcău Nappe) the succession starts with Illyrian–Julian (the latter is indicated by *G. auriformis)* red "Schreyeralm" Limestone (PATRULIUS et al., 1971, 1979; BLEAHU et al., 1970, 1972, 1994); on top of it Roşia Limestone appears too.

The top of Roşia Limestone reaches the Alaunian as indicated by *Gondolella steinbergensis*, *Metapolygnathus abneptis abneptis*, etc. (PATRULIUS et al., 1979; PANIN et al., 1982). The last remnants of the Roşia Basin were filled up by the grey, siliciclastic-marly Codru Formation after the Early Lacian in the north (Şeasa Nappe), or was followed by the "Wand Limestone" in the south (Vaşcău Nappe). The Middle Lacian – Early Alaunian Codru Formation (GRĂDINARU, 2005) in the Apuseni Mts significantly differs chronostratigraphically from the Middle Carnian Lunz-Reingraben infillings of East Alpine – Western Carpathian Reifling Basins.

Development of large carbonate platforms resumed in the Late Carnian when reefal (Dachstein Reef Limestone) and reef-slope facies ("Wand" Limestone; PATRULIUS & BLEAHU, 1967; PATRULIUS et al., 1971, 1979) were formed on the outer shelf, with Late Rhaetian lagoon facies (loferitic cycles) on top, as documented in the Coleşti Nappe (PANIN & TOMESCU, 1974; PATRULIUS et al., 1979; BLEAHU et al., 1994; BALTREŞ, 1998; BUCUR & SĂSĂRAN, 2001). In some places, the Dachstein Limestone shows an irregular network of paleocarst cavities filled with variegated, from mauve to brick-red and ochreous-brown, ferruginous limestones, sometimes bearing Late Norian *Halorella* coquinas. It proves that during the Late Norian the carbonate platform emerged, with evolving carstification and lateritic weathering processes (Grădinaru, unpubl. data).

The latest Norian – Rhaetian is represented by Carpathian Keuper and Kössen Formation in the Finiş-Gârda Nappe and Următ Outlier, and by limestones with *Involutina* in the Vaşcău Nappe.

Due to the extreme narrowing of the inner shelf facies zone, because of enhanced terrigenous influx from the proximal continental hinterland (Bihor Land), the typical Hauptdolomit is almost absent (restricted only to the Arieşeni Nappe/Corbeşti Outlier and Vetre Nappe). A special transitional facies from the Dachstein Limestone to the Carpathian Keuper in the Upper Alaunian – Sevatian has been documented (Şeasa-Ferice Nappe; BORDEA et al., 1978; BLEAHU et al., 1984; ŞTEFĂNESCU et al., 1985).

In the Lower Codru Nappes typical Carpathian Keuper is common, with red-purplish, sometimes grey or greenish continental siliciclastic sedimentation, with interbedded evaporites and light coloured micritic dolomites-limestones. Its age is Tuvalian–Rhaetian (Vălani Nappe) or restricted to the Late Alaunian – Sevatian (Finiş, Şeasa-Ferice, Următ Nappes).

In the Finiş, Şeasa-Ferice, Următ and Dieva Nappes Kössen-type restricted basin facies represents the Rhaetian, that is overlain after a probable gap by sandstone and dark grey Gryphaea shale (Sinemurian). "Oberrhätkalk" appears only in the Dieva Nappe (BORDEA & BORDEA, 1973; BORDEA et al., 1975).

Biharia Unit

Biharia Nappe System

The Arieşeni Nappe was assigned to the Biharia Nappe System by BALINTONI (1994), who proved the correspondence of the Biharia and the Arieşeni Series. As it was discussed above, the Arieşeni/Corbeşti Outlier belongs to the Hauptdolomit Facies Belt.

The Vulturese-Belioara Series, which was traditionally interpreted as low-grade metamorphosed Middle Paleozoic cover of the medium-grade Upper Precambrian – Lower Paleozoic crystalline basement, has possible interpretations as Triassic sequence too (BORCOŞ & BORCOŞ, 1962; PATRULIUS et al., 1971; BALINTONI, 1994). It starts with pink quartzitic conglomerates, sandstones and sericitic schists (Scythian?), followed by well-bedded, black, graphitic dolomite and massive pinkish-yellowish dolomite (Upper Scythian? or Anisian?). The third formation is a thick-bedded light marble, partly dolomitic (Middle Triassic, or even younger?). Its Variscan basement was subject to a Mesozoic rejuvenation (100.6 Ma; DALLMEYER et al., 1994). Based on this interpretation DIMITRESCU (in IANOVICI et al., 1976) suggested that the Vulturese-Belioara Series might be compared to the Föderata-Struženik Series of the Western Carpathians.

DACIA MEGAUNIT

The Dacia Megaunit, which includes only some of the Dacidian units (Median, Outer and Marginal Dacides; SĂNDULESCU, 1984) within the Eastern and Southern Carpathians, generally has a more external character than the ALCAPA or Tisza Megaunits. Triassic successions are found only in the Median Dacides. In the Eastern Carpathians, the Median Dacides are represented by the Central Eastern Carpathian Nappe System (Bucovinian Nappe, Subbucovinian Nappe and the Infrabucovinian Units; SĂNDULESCU et al., 1981), whereas in the Southern Carpathians they include the Getic Nappe and the Supragetic Units (SĂNDULESCU 1976b, 1988).

Generally, the Triassic sedimentary series are stratigraphically incomplete, punctuated by discontinuities and have reduced thicknesses, that prove swell-type sedimentary environments during the Triassic (PATRULIUS, 1967; SĂNDULESCU, 1984). Their present day scattered occurrences, mostly in the Southern Carpathians, are the result of the extensive pre-Jurassic erosion that affected the areas of the Median Dacides.

Within the Dacia Megaunit, in the region of the East Serbian Carpatho-Balkanides, Triassic successions can be recognized in the following units from east to west: (1) Danubian-Stara Planina-Vrška Čuka (-Prebalkan) Unit Stara Planina-Poreč Unit (Upper Danubian), (2) Bucovinian-Getic-Kučaj (-Sredno Gora) Unit within it Kučaj Unit (Getic), and (3) Kraishte Unit within it Lužnica Unit (West Kraishte). All these units behaved during the Triassic as a single megaunit, made up of former Variscan terranes, which amalgamated and docked to Moesia in Carboniferous times (KARAMATA, 2006) and became again separated in the Middle–Late Jurassic by the opening of the Severin–Krajina oceanic domain between them (see: HAAS et al., 2011, in this volume).

Danubian-Vrška Čuka-Stara Planina (-Prebalkan) Unit

Southern Carpathians

Lower Danubian and Upper Danubian Units

In the Danubian Units from Romania (Marginal Dacides in the sense of SĂNDULESCU, 1984), having the most external position and lying on the European continental margin, the Triassic formations are completely missing. The lacking of Triassic sedimentary series is due either to non-deposition or to erosion. The oldest Mesozoic deposits, overstepping the crystalline rocks, are Hettangian–Sinemurian continental "Gresten Beds".

East Serbian Carpatho-Balkanides

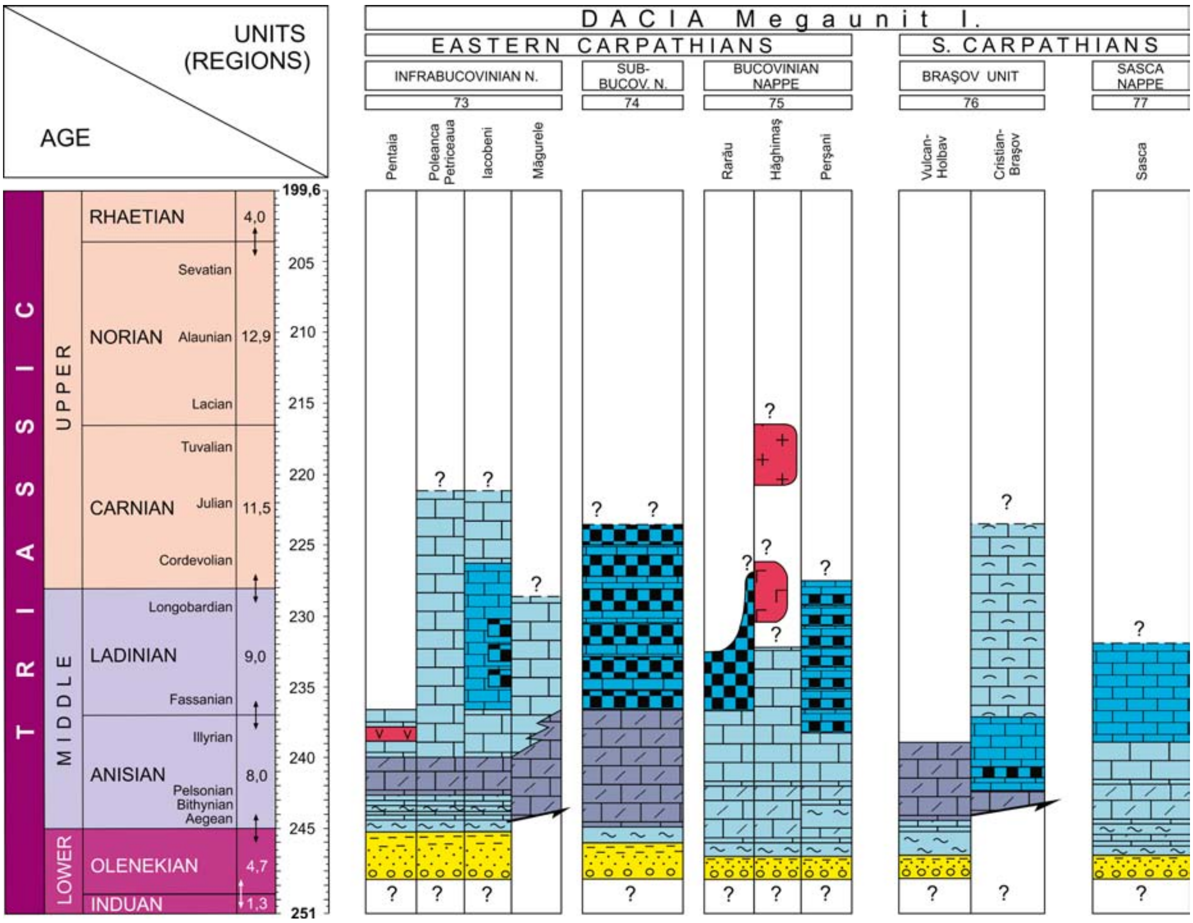
Stara Planina-Poreč Unit (Upper Danubian)

Whereas in the northern, Poreč part of the Stara Planina-Poreč Unit (location on Text-Fig. 1; Text-Fig. 15, col. 78), the Triassic sediments are absent (MASLAREVIĆ & KRSTIĆ, 2001), in the Stara Planina region (Jelovica-Visočka Ržana section) the Lower Triassic overlies various parts of the Topli Dol Formation (Permian red clastics; MASLAREVIĆ & ČENDIĆ, 1994) or Riphean–Cambrian schists.

These lowermost Lower Triassic siliciclastic sediments, named as Temska Formation (MASLAREVIĆ & ČENDIĆ, 1994) mark the beginning of a new megasequence that is characterized by fluvial sedimentation deposited in semi-arid or arid climate with storm episodes (Pl. 7, Fig. 2). These are deposits of braided rivers, the middle part is an alluvial fan and others are related to that of meandering rivers. The major facies are channels with bars (longitudinal and transversal), and interchannel fine-grained facies (flood plain, natural levee, crevasse, and crevasse splay) (MASLAREVIĆ & KRSTIĆ, 2001). This formation, 300–400 m in thickness, is overlain by the marine siliciclastic Zavoj Formation deposited on tidal flats and contains an Early Scythian flora (UROŠEVIĆ in MASLAREVIĆ & ČENDIĆ, 1994).

The Zavoj Formation is overlain by micaceous sandstones, partly clayey, and dolomitic limestones representing the upper part of the Lower Triassic. The carbonate deposition took place on a ramp. These "shelly limestones" (also known as "myophorian" or "gervilleian limestones") in most cases are strongly bioturbated; coquina beds are common.

The following carbonate deposits consist of lowermost Anisian platy, "folded limestones" with bivalves, Pelsonian thick-bedded "brachiopod limestones" with numerous brachiopods and conodonts of the *Paragondolella bulgarica zone* (SUDAR, unpubl. data); the uppermost part of the exposed section is made up of "crinoidal limestones" with crinoid calyces and stems, and calcareous algae, Illyrian in age.



Text-Fig. 14.
Lithofacies chart of the Eastern Carpathians (except Transylvanides) (73–75) and the Southern Carpathians (76–77) (DACIA I).

The crinoidal limestones are followed by massive, slightly dolomitic limestones with gastropods, bivalves and brachiopods of Ladinian age. These rocks represent the end of the Triassic sequence in this part of the Stara Planina Mts region. The thickness of the Middle Triassic is about 250 m, only about 15 m are Ladinian.

More eastwards in the Stara Planina Mts, the very condensed Upper Triassic has been preserved only in the Senokos area. On the basis of the different lithofacies and associations of bivalves, brachiopods and foraminifera, the following lithologic units can be separated: Carnian siltstones, sandstones, and sandy and dolomitic limestones, Norian dolomites, dolomitic limestones and limestones, and Rhaetian biosparites, oolite and dolomitic limestones, and algal limestones. This succession is overlain by Rhaetian–Liassic terrigenous siliciclastics of various lithology (“red series”; Urošević & Andjelković, 1970; Senokos Formation; Urošević & Radulović, 1990), deposited in alluvial, lacustrine, or marshy environments. The thickness of the unit is from 30 to 350 m.

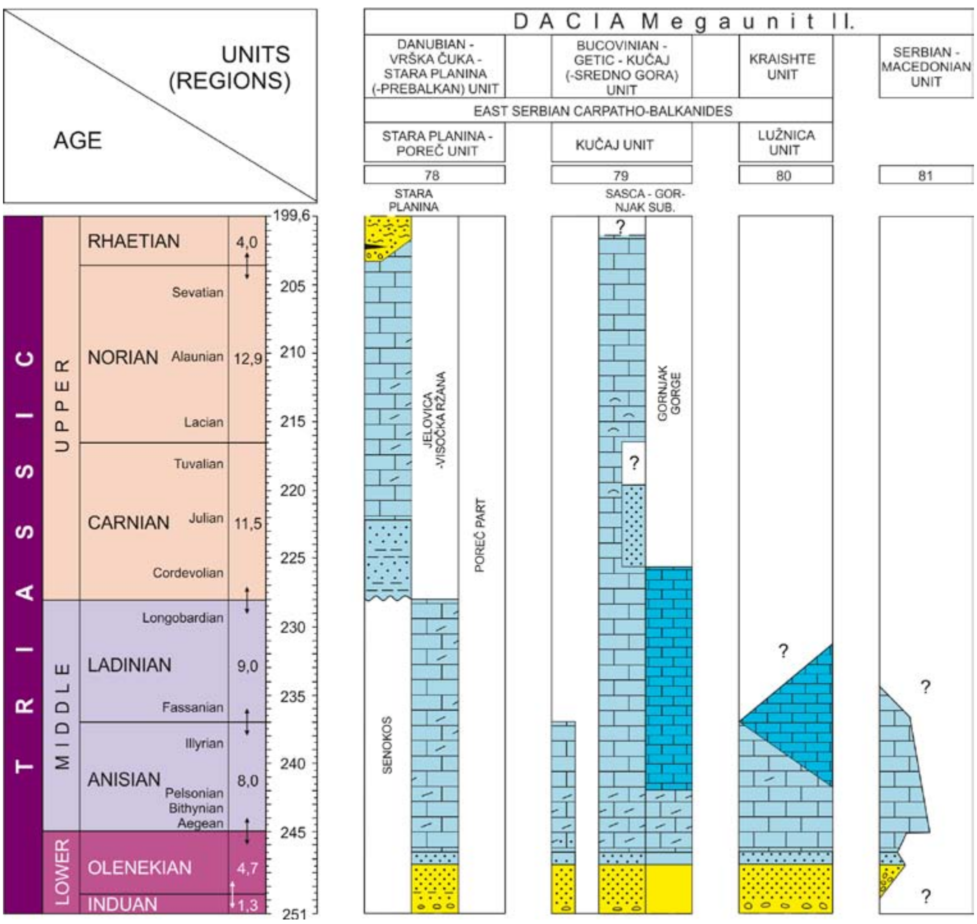
Bucovinian-Getic-Kučaj (-Sredno Gora) Unit

Eastern Carpathians

Bucovinian, Subbucovinian and several Infrabucovinian Units are distinguished. They form a pile of thrust nappes stacked during the Meso-Cretaceous tectogenesis, assigned to the Central Eastern Carpathian Nappe System (Săndulescu, 1984). Having the most extended occurrences in the Bucovinian Nappe, the Triassic series are generally incomplete in all units. The diversity of facies demonstrates a complex paleogeography of the Bucovinian realm during the Triassic (Patrulius et al., 1971; Săndulescu, 1984).

Infrabucovinian Units

The Infrabucovinian Units (location on Text-Fig. 1; Text-Fig. 14, col. 73), the lowest in the Central Eastern Carpathian Nappe System, are represented in the Maramureş Mts by the following units (starting from the outside): Vaser-Belopotok, Pentaia (Ştevioara), Petriceaua, Poleanca and Stânişoara (Săndulescu, 1984, 1985). In the ***Vaser-Belopotok Unit*****,** the Triassic sequences are missing. In the ***Pentaia Unit*** the Triassic succession starts with continental Scythian quartzose sandstones (“Buntsandstein”-like) succeeded by Middle Triassic dolomites and bituminous limestones with sills of basalts and tuffites. The ***Poleanca Unit*** has Scythian light-coloured quartzose sandstones and Middle Triassic well-bedded grey bituminous and massive dolomites. The ***Petriceaua Unit*** has Scythian light-coloured quartzose sandstones and variegated shales, followed by Middle to Upper(?) Triassic massive dolomites, bituminous limestones and dolomites, grey bedded limestones, red limestones and massive limestones locally dolomitized. In the ***Stânişoara Outlier*** Scythian(?) quartzose sandstones are followed by Middle Triassic massive dolomites and limestones. In the ***Iacobeni Unit*** the Triassic succession starts with continental Scythian conglomerates and quartzose sandstones followed by red shales with platy limestones and then by Gutenstein-type grey bedded bituminous dolomites with yellowish massive dolomites in the middle part (Pl. 7, Fig. 3). The succession continues with Ladinian variegated limestones, sometimes



Text-Fig. 15.
Lithofacies chart of the East Serbian Carpatho-Balkanides (78–80) and the Serbian-Macedonian Unit (81) (DACIA II).

nodular, and chloritic shales, with dolomite lenses in the upper part (Pl. 7, Fig. 5), and ends with Upper Triassic(?) light, slightly metamorphosed limestones (Săndulescu, 1976a; Popescu & Popescu, 2005a; Popescu, 2008).

The Triassic succession from the ***Măgurele Scales*** includes a basal Anisian sequence with dark-coloured limestones and dolomitic limestones. Upsection, the succession is made up of dark-coloured bituminous dolomites and limestones, platy grey limestones with hydrozoans and solenoporacean algae, and grey dolomitic limestones with halobiids, the whole sequence being assigned to the Ladinian (Săndulescu, 1976a; Popescu & Popescu, 2005a; Popescu, 2008). The Upper Triassic is generally missing.

Subbucovinian Unit

In the Subbucovinian Nappe (Săndulescu, 1976a, 1985; Text-Fig. 14, col. 74), the Triassic succession starts with a thin sequence of Scythian whitish quartzose sandstones (“Buntsandstein”-like), either overlying Permian continental red siliciclastics or directly the crystalline basement. The Middle Triassic is represented by Anisian massive grey dolomites which are covered by Ladinian red siltstones with radiolaritic cherts, and grey platy limestones. The Upper Triassic is usually absent.

In the Tomeşti tectonic window, the succesion starts with a thin siliciclastic sequence of redbeds followed by a sequence, around 200 m thick, of Middle Triassic massive dolomites (Grasu, 1976). A sequence of variegated radiolarites and shales, around 100 m thick, unconformably overlies the older Triassic succession. The radiolarites used to be assigned to the Ladinian, but Callovian–Oxfordian radiolarians were identified by Dumitrică (unpubl. data).

Bucovinian Unit

The Triassic series of the Bucovinian Nappe is largely occurring in the Rarău and Hăghimaş Synclines, and also in the Perşani Mts (Text-Fig. 14, col. 75).

The Bucovinian Triassic series in the ***Rarău Syncline*** (Mutihac, 1968; Turculeţ, 1971, 2004, and the references therein; Săndulescu, 1973, 1974, 1976a; Tomescu & Săndulescu, 1978; Grasu et al., 1995; Popescu, 2004, 2008) starts with continental redbeds grading upwards to marine shallow-water carbonates. The first sequence, with a variable thickness from 5 to 25 m, has basal conglomerates and quartzose sandstones with intercalations of red shales more frequent towards the upper part. The first carbonate sequence, 50 to 150 m thick, is made up of Lower Anisian massive dolomites (Pl. 7, Fig. 7), locally platy and fossiliferous in the basal part *(Costatoria costata, Entolium discites)*. In some places, the dolomites directly cover the crystalline basement. The carbonate sedimentation continued with Steinalm-type algal limestones, up to 100 m thick, only locally preserved, which delivered dasycladacean algae *(Physoporella-Oligoporella* group, *Diplopora annulatissima*, *D. annulata)*, foraminifera indicative for the Pelsonian–Ladinian interval. The presence of some Ladinian radiolarites is very controversial. Upper Triassic successions are missing, mostly due to erosion before the deposition of the Middle Jurassic Tătarca Breccia.

The Bucovinian Triassic series in the ***Hăghimaş Syncline*** (Pelin, 1969; Patrulius, 1967; Patrulius et al., 1969, 1971, 1979; Săndulescu, 1974, 1975a; Grasu, 1971; Baltreş, 1975, 1976; Popescu & Popescu, 2005b; Popescu, 2008; Grasu et al., 2010) is similar to the Triassic series in the other regions within the Bucovinian Nappe. It starts with a continental siliciclastic sequence of variable thickness, 5 to 30 m, and includes quartzose conglomerates and sandstones, variegated siltstones and shales, but commonly conglomerates and sandstones. The following sequence, reaching up to 250 m in thickness in the region of Lacu Roşu, and reduced only to some tens of meters in thickness on the eastern margin of the Hăghimaş Syncline, is made up of grey to white-yellowish, massive dolomites. Locally this sequence is transgressive and rests directly on the crystalline basement. In some places there is a gradual transition from the siliciclastic sequence to the massive dolomites by a package, 10 to 20 m thick, including platy limestones with intercalations of micaceous siltstones, platy dolomitic limestones and dolomites. The faunas from this transitional package (Pelin, 1969; Grasu, 1971) include *Costatoria costata*, *Unionites fassaensis*, etc. The palynological investigations done by Antonescu et al. (1976) pointed out components of the *Triadispora crassa* zone (latest Spathian(?) – Aegean). The microfacies investigations (Dragastan & Grădinaru, 1975; Popescu & Popescu, 2005b; Popescu, 2008) provided a rich latest Spathian – Aegean foraminifer assemblage. In the platy dolomites underlying the massive dolomites *Beneckeia tenuis* (under *Ceratites semipartitus*; Pelin, 1969) indicative of the Aegean lower part of the Röt Formation of the Germanic Triassic (Kozur, 1999), was found. It is followed by Steinalm-type, white massive limestones, locally dolomitized (Baltreş, 1975). The sequence ends with Upper Triassic(?) light-coloured carbonates with frequent halobiid “filaments” and dasycladacean algae (Săndulescu, 1975a).

The Bucovinian crystalline basement in the western limb of the Hăghimaş Syncline is intruded by the well-known ***Ditrău alkaline intrusive complex***, wich includes two rock assemblages. The older one (231–227 Ma, Late Ladinian to Early Carnian) consists of mantle derived gabbrodioritic magma with mantle xenoliths. The younger one (216–212 Ma, Late Norian) shows mixing and mingling with crustal syenite magma due to rising of the older magma (Dallmeyer et al., 1997; Kräutner & Bindea, 1998).

The Pelsonian–Norian white limestones from the Rarău Syncline (Piatra Şoimului) assigned formerly to the Bucovinian Unit (e.g. Patrulius, 1967; Grasu et al., 1995; Turculeţ, 2004), are actually olistoliths, slid on Callovian–Oxfordian radiolarites of the Bucovinian Nappe, and thus belong to the Transylvanian Unit (Patrulius, 1996; Popescu & Popescu, 2004; Popescu, 2008).

In the ***Perşani Mountains*** the Bucovinian Triassic series overlies the crystalline basement. On the eastern part of the Gârbova Massif, the succession starts either with a thin siliciclastic sequence or directly with a dolomite sequence, up to 200 m thick, displaying stromatolitic and loferitic structures (Grădinaru & Dragastan, unpubl. data). They are of Early Anisian – Pelsonian age, locally including also the latest Scythian. On the western side of the Gârbova Massif the succession has a basal siliciclastic sequence of redbeds, 10 to 15 m thick, followed by a sequence, 20 to 40 m thick, with thin-bedded, grey-bluish, silty or micritic limestones and silty shales. A rich sporomorph assemblage of the *Triadispora crassa* zone was inventoried by ANTONESCU et al. (1976) as of latest Scythian(?) to Early Anisian age, correlative with the Röt palynoflora from the Germanic Triassic). The occurrence of the ammonoid *Beneckeia tenuis* fully supports the Early Anisian age (GRĂDINARU, unpubl. data). The upper part of the platy limestone sequence grades laterally and vertically to dolomites which alternate or are interfingering with massive Steinalm-type limestones, up to 100 m thick. The dasycladacean algae are diagnostic for the Pelsonian – Early Illyrian (GRĂDINARU & DRAGASTAN, unpubl. data). The succession ends with a sequence of variegated, nodular limestones with cherts up to 50 m thick, containing radiolarians, sponge spicules and halobiids. The biofacies (GRĂDINARU & DRAGASTAN, unpubl. data), together with the conodonts, holothurian sclerites and foraminifera (MIRĂUȚĂ & GHEORGHIAN, 1978) indicate a latest Anisian to Ladinian age. Comparing the successions on both sides of the Gârbova Massif, the eastward progression of the dolomite sequence on the crystalline basement, and also a deepening trend in the sedimentation are plausible.

Southern Carpathians

The Triassic formations are restricted to the Sasca-Gornjak Nappe (continuing in Eastern Serbia; SĂNDULESCU, 1984), which is a narrow unit stretched between the Supragetic and the Getic Units in the western Banat region, and are better developed in the easternmost part of the Getic Nappe, i. e. in the Braşov region (SĂNDULESCU, 1964, 1966; PATRULIUS, 1969). They are included in two distinct sedimentary series, the "Braşov Series" and "Sasca Series", respectively. The Triassic sedimentary series of these two units are very different in their lithostratigraphy and also in their paleobiogeographic affinities. Small occurrences of Triassic deposits, ascribed to the "Făgăraş Series" are also found in the Supragetic Unit in Romania.

Getic-Supragetic Units

The ***"Braşov Series"*** occurs in the easternmost part of the Getic Nappe, in the Vulcan–Holbav and Cristian–Râşnov regions (Text-Fig. 14, col. 76). Isolated patches of this series are found in the southern regions of the Leaota and Bucegi Mts and also in the Lotru Mts. These rocks also appear in olistoliths and are embedded in the Albian Bucegi Conglomerate (PATRULIUS, 1963) on the eastern slope of the Bucegi Mts. The Hettangian–Sinemurian continental "Gresten Beds" overlap the Triassic terrains from the easternmost part of the Getic Nappe.

In the ***Vulcan-Holbav region***, the succession starts with Scythian redbed-type siliciclastics, around 300 m thick, having a basal coarse-grained sequence, 25–100 m thick, and ending with grey-yellowish to blackish shales and interlayers of quartzose sandstones and red clays (SĂNDULESCU, 1966). The terminal part contains a palynological assemblage characteristic for the *Triadispora crassa* zone (topmost Spathian(?) – Early Anisian; ANTONESCU et al., 1976). The succession continues upwards with a Plattenkalk-type sequence, around 25 m thick, made up of brown-yellowish marls and platy marly limestones, upsection alternating with platy bituminous limestones. This sequence yielded *Costatoria costata praegoldfussi*, and is correlated with the Lower Anisian Germanic Röt (PATRULIUS, unpubl. data). The sequence ends with Anisian Gutenstein-type medium to thick-bedded dark grey limestones.

In the ***Cristian–Râşnov region***, the Scythian siliciclastic sequence is not known. The "Braşov Series" is represented only by a carbonatic succession which includes the following units (GRĂDINARU, unpubl. data):

1) the lower sequence, around 150 m thick, including light grey bedded bituminous limestones, with tiny cherty spherules in the upper part;
2) the second sequence, 25 m thick, with light grey, bedded, sometimes laminated, bituminous limestones, bearing thin layers of dark grey cherts;
3) the third sequence, about 40 m thick, dark grey bedded limestones alternating with marly shales;
4) the fourth sequence, nodular limestones, more than 50 m thick, with thin layers of marly shales;
5) the fifth sequence, at least 100 m thick, Wetterstein-type, light-grey to whitish reefal-lagoonal massive bioclastic limestones (Braşov Limestone; JEKELIUS, 1936).

The second unit delivered *Balatonites stenodiscus*, *Acrochordiceras undatum*, etc., whereas the third unit delivered *B. balatonicus*, *Bulogites reiflingensis*, *Acrochordiceras carolinae*, etc. These two assemblages are indicative of the Pelsonian Balatonicus and Binodosus Subzones (in the sense of MIETTO & MANFRIN, 1995). From the first and second units rich Pelsonian radiolarian faunas are described by DUMITRICĂ (1982, 1991). A rich Pelsonian sporopollenic assemblage together with acritarch species was described by ANTONESCU (1970), which is comparable to that of the Wellenkalk in the Germanic Triassic. The fourth unit, which may be correlated with the Reifling Limestone, includes rich ammonoid assemblages of the Illyrian Trinodosus Subzone *(Paraceratites trinodosus,* etc.) and Avisianum Subzone *(Aplococeras avisianum*, etc.). Rich assemblages with conodonts, foraminifera and holothurian sclerites are described by MIRĂUȚĂ & GHEORGHIAN (1978). The fifth unit occurs mainly in the Dealul Melcilor Hill in Braşov town, but only in the Cristian region the Wetterstein-type limestone conformably overlies the Reifling-type nodular limestone (GRĂDINARU, unpubl. data). A very rich Ladinian (– ?Lower Carnian) fauna, with Sphinctozoa, corals, gastropods, bivalves (e.g. *Daonella lommeli)*, crinoids, echinoids, brachiopods, and only scarse cephalopods, was described by JEKELIUS (1936) and KÜHN (1936). Dasycladacean algae (e.g. ?*Diplopora annulata, Teutloporella infundibuliformis)* have also been recorded. Later investigations (DRAGASTAN & GRĂDINARU, 1975) yielded further fauna, e.g. *Dictyocoelia manon* and *Colospongia catenulata*. The higher part of the Triassic, as almost everywhere in the whole Bucovinian domain, is lacking here.

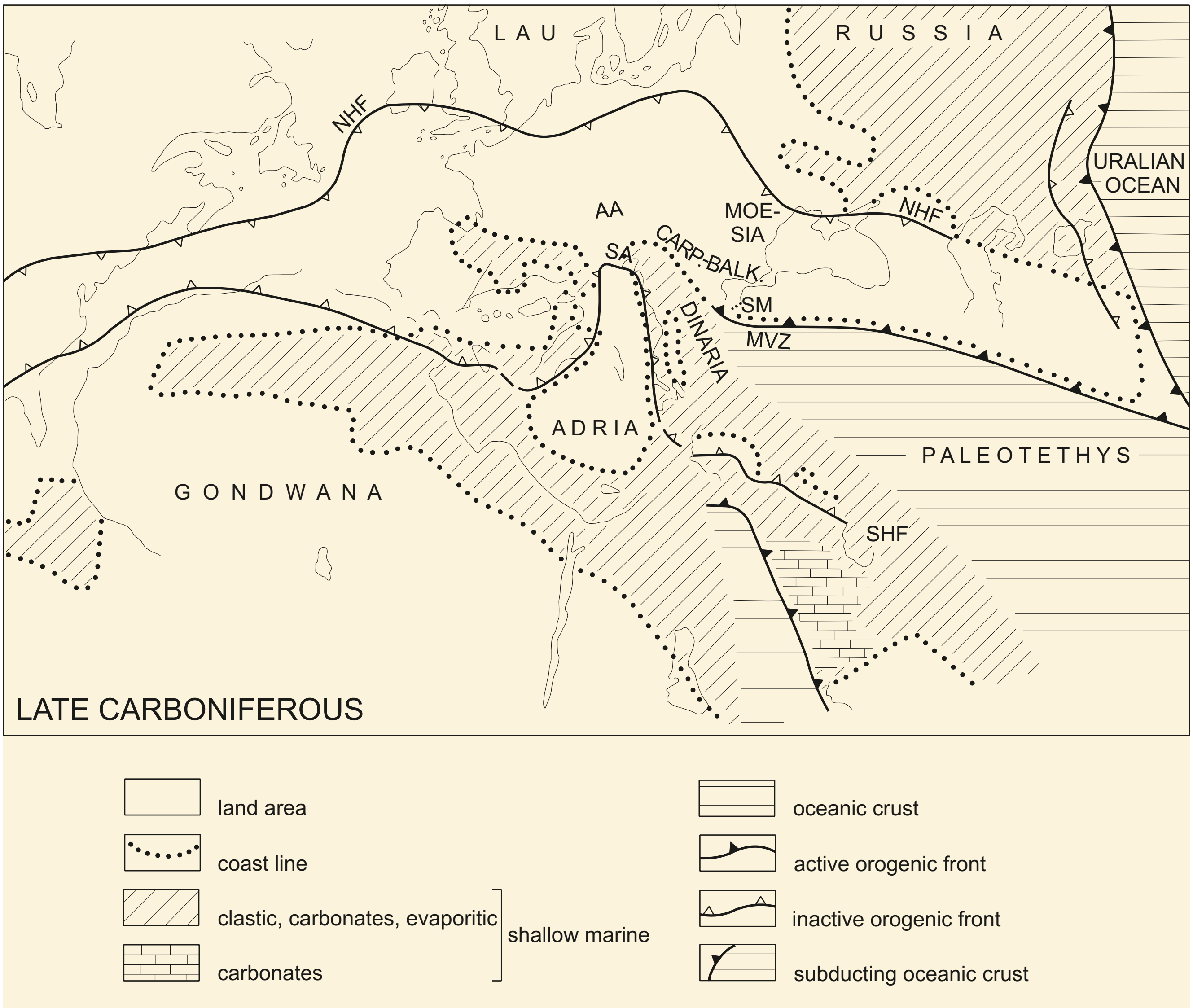
The two Triassic successions from the Vulcan–Holbav and Cristian–Râşnov regions developed in different depositional environments, an inner shelf with high terrigenous influx in the Vulcan–Holbav region, and a much deeper open marine basinal environment for the Cristian–Râşnov region during the Middle and Late Anisian, shallowing-upward to a reefal-lagoonal environment.

In the southern region of the ***Leaota Mts*** the crystalline basement is covered by a small patch of "Werfen Limestone". The olistolith from Gâlma Ialomiței *(**Bucegi Mts**)*, having platy limestones with *Costatoria costata*, *Unionites fassaensis,* etc. In the ***Lotru Mts*** (LUPU & LUPU, 1967), the lower redbed-type siliciclastic sequence ("Werfen Quartzite"), more than 100 m thick, of Permian(?)–Scythian age is followed by a "Werfen Limestone" *(Costatoria costata praegoldfussi*, *Hoernesia socialis*, and the palynological flora with *Triadispora crassa* and *Perotrilites minor)* Early Anisian in age (ANTONESCU et al., 1976; PATRULIUS, unpubl. data). The recognition that the "Werfen Limestone" auct. in the Getic Nappe is of Early Anisian age, and thus is correlatable with the Lower Röt from the Germanic Triassic, is proved by the presence of the *Triadispora crassa* zone.

Small scattered patches of Triassic sedimentary sequences are also found in the **Supragetic domain** in the easternmost ***Făgăraş Mts*** and in ***Poiana Mărului tectonic scale*** (SĂNDULESCU, 1966).

The actual very scattered occurrences of Triassic sedimentary successions, extending from the Lotru Mts, in the central part of the Southern Carpathians, to the Braşov region in the easternmost part of the Getic Nappe, demonstrate the originally large extension of the Triassic deposition area in the central and eastern part of the Getic domain. The same conclusion can also be drawn for the eastern Supragetic domain.

The ***"Sasca Series"*** in the Sasca-Gornjak Nappe (Text-Fig. 14, col. 77) overlaps Verrucano-type Permian deposits. Data on the lithology and biostratigraphy are found in publications of MIRĂUŢĂ & GHEORGHIAN (1993), BUCUR et al. (1994, 1997) and BUCUR (1997). The Triassic succession begins with Lower Scythian coarse-grained continental siliciclastics, around 150 m thick. They are followed by a deepening-upward marine carbonatic sequence, around 100 m thick. It starts with the Dealul Redut Dolomite Member made up of light-coloured dolomitic limestones with thin encrinitic layers. The foraminifer *Meandrospira pusilla* and the dasycladacean algae indicate a Spathian – Early Anisian age. The following Valea Susara Limestone Member, made up of Steinalm-type dasycladacean limestones, is dated as Pelsonian – Early Illyrian by a rich foraminifer assemblage *(Meandrospi-*



Text-Fig. 16.
Paleogeography of the western end of the Paleotethys domain during the Late Variscan stage (latest Carboniferous) (slightly modified after VAI, 1998).
The Southern Alps – Adria-Dinaria together formed the Carnic-Dinaridic microplate.
Abbreviations:
NHF: Northern Hercynian Front; SHF: Southern Hercynian Front; AA: Austroalpine domain; CARP.-BALK.: Carpatho-Balkanides; MVZ: Main Vardar Zone; SA: Southern Alps; SM: Serbo-Macedonian Zone.

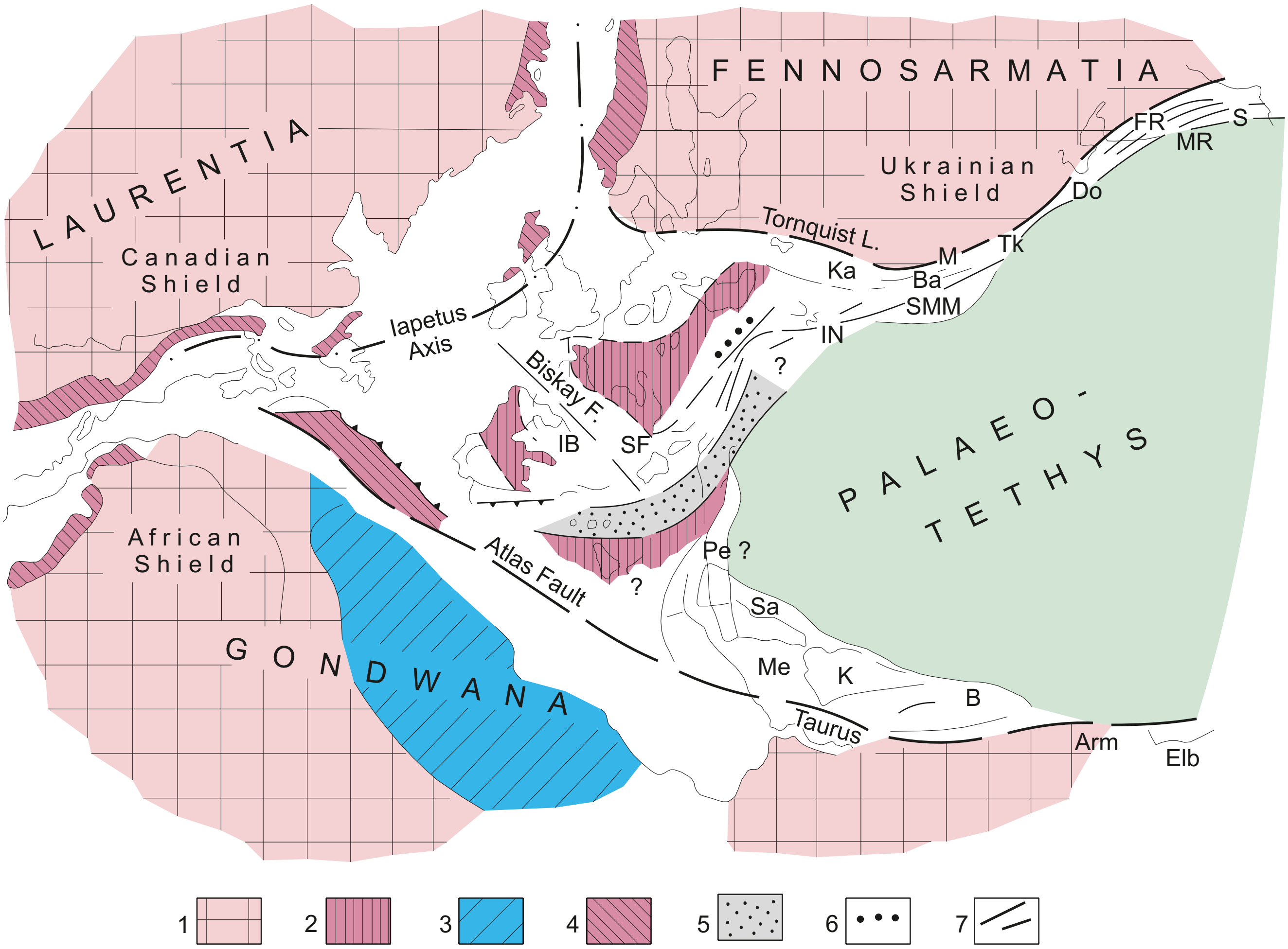
ra dinarica, *Pilammina densa*, etc.) and algae (*Diplopora subtilis*, *Oligoporella pilosa*, etc.). The succession is ended by the Valea Cerbului Limestone Member made up of dark black to weathered bluish-grey, "filament"-bearing bituminous limestones. Conodonts (*Gondolella bakalovi, G. transita,* etc.), foraminifera (*Turriglomina mesotriasica*) and holothurian sclerites prove the Late Illyrian – Early Ladinian age. The ammonoid fauna includes *Latemarites* sp., *Parakellnerites* cf. *loczyi*, *?Kellnerites* sp. (Vörös, pers. comm.), and *Aplococeras avisianum*, etc. and *Daonella* sp. (Bădăluţă, unpubl. data). The ammonoid assemblage is characteristic for the Illyrian Reitzi and Avisianum Subzones.

East Serbian Carpatho-Balkanides

Kučaj Unit (Getic)

The lowermost Triassic continental siliciclastic sediments in the Kučaj Unit (Text-Fig. 15, col. 79) are not uniformly overlying the Permian terrestrial rocks. In many places, the overlapping deposits are of Middle Jurassic age.

In the Sasca-Gornjak Subunit on the westernmost part of the Kučaj Unit, lowermost Scythian rocks resembling the Temska Formation of the Stara Planina region mentioned above are represented by basal quartz conglomerates and white or pink sandstones that pass upwards into subarkosic rocks (Maslarević & Krstić, 2001). The sequence has features characteristic for gravel and sand dominated braided rivers. The continental siliciclastics are overlain by shallow-marine deposits (sandstones of greywacke and subgreywacke types), which contain fossil macroflora (Sumorovac Formation; Urošević & Gabre, 1986). The overlying upper part of the Scythian is represented by the Krepoljin Formation made of sandy dolomites or dolomites and limestones, sometimes with bioturbations. These rocks were deposited in a subtidal or at the boundary to



Text-Fig. 17.
The starting point of the Neotethyan evolution: Paleogeography of the western end of the Paleotethys domain during the Late Variscan stage (Early–Middle Permian). (After Flügel, H.W., 1990, modified after Karamata, 2006 concerning the position of the Serbo-Macedonian Zone).

Legend and abbreviations:
1. Gondwana (Arm Armenia; Elb Elburz), Laurentia, Fennosarmatia.
2. Metamorphic zones.
3. Marine Carboniferous on Gondwana.
4. Circum-Atlantic pre-Mesozoic zones.
5. Betic-Serbian Zone.
6. Nötsch-Ochtina Zone (Carboniferous).
7. Mediterranean zones (IB Iberia; SF Southern France; IN Istambul Nappe; Ka Eastern and Southern Carpathians; SMM Serbo-Macedonian Zone; Ba Balkanides; Do North Dobrogea; M Moesian Platform; Tk Trans-Caucasus; Caucasus: FR Fore Range; MR Main Range; S Svanetian Zone; Pelagonian – Anatolian microplate: Pe Pelagonian units (?); Sa Sakaryan microcontinent; Me Menderes – Cyclades "massif"; K Kirsehir "massif"; B Bitlis "massif").

an intertidal ramp setting, partly in a restricted lagoon environment.

The most characteristic and well-preserved Middle Triassic and partly Carnian succession of the mentioned subunit can be seen in the Ždrelo section of the Gornjak Gorge (vicinity of Žagubica), with a thickness of about 200 m (UROŠEVIĆ & SUDAR, 1991a, b).

The Anisian Ždrelo Formation, deposited in shallow subtidal regions on a carbonate ramp with periodical deepening, is made of:

1) lowermost Anisian light coloured dolomitic limestones with crinoid calyces and stems,
2) grey, bedded, nodular Pelsonian limestones and shale with brachiopods, bivalves, foraminifera and conodonts of the upper part of *Paragondolella bulgarica* zone,
3) white limestones containing Upper Pelsonian calcareous algae and foraminifera, and
4) Illyrian black, bedded micrites, and sparites with ammonites, foraminifera and conodonts *(Neogondolella cornuta* zone) (UROŠEVIĆ & GABRE, 1986).

The overlying Ladinian and Lower Carnian rocks are included in the Lomnica Formation (UROŠEVIĆ & GABRE, 1986). They were deposited in restricted shallow subtidal conditions connected to the basin. The formation can be divided into the following members of different ages: (1) earliest Ladinian (Lower Fassanian *Neogondolella excentrica* and Late Fassanian *Neogondolella transita* conodont zones) dark-grey to black micrite, microsparite and platy (mm-thick) dark marlstone; fine-grained dolomites, ferruginous platy, dark-grey to black marlstones, and dark marly limestones (biomicrites and biosparites with many filaments and foraminifera, e.g. *Nodobacularia vujisici)*, and (3) micrites and microsparites with an abundant foraminiferal fauna and conodonts of the earliest Carnian *Paragondolella foliata* zone (UROŠEVIĆ & SUDAR, 1991a, b) with *Pg. foliata, Pg. polygnathiformis, Sephardiella mungoensis.* It is interesting to note, that the fauna contains no components of the eupelagic *Gladigondolella*-apparatus, recalling the Balkanide province of BUDUROV et al. (1985). Carnian strata in this section have a thickness of about ten metres. They are apparently conformably and transgressively overlain by Bajocian (Middle Jurassic) oolitic limestones which mark a new depositional cycle.

According to UROŠEVIĆ & GABRE (1986), in other parts of the Sasca-Gornjak Subunit of the Kučaj Unit, the following lithological units are present over the above mentioned Lower and Middle Triassic deposits: Wetterstein Formation (platform limestones of Ladinian – lowermost Carnian, "Cordevolian", age, lateral equivalent of the Lomnica Formation, deposited in a back-reef lagoon), Rapatna Formation (Lower Carnian to Norian quartz sandstones deposited in shallow subtidal environment), Golubac Formation (Carnian limestones, sporadically sandy and dolomitic with oncoids; deposited in shallow-water basin with low energy and open circulation; they are lateral equivalents of the Rapatna Formation), and Dachstein Formation (shallow-water platform Carnian–Norian and partly Rhaetian limestones and dolomites with Lofer facies).

In the eastern parts of the Kučaj Unit, Lower Triassic and Anisian deposits with the same characteristics as in other parts, are developed only on the Vidlič Mt (near Pirot) and on the Vlaška and Greben Mts (vicinity of Zvonačka Banja).

Kraishte Unit

East Serbian Carpatho-Balkanides

Lužnica Unit (West Kraishte)

In this unit (Text-Fig. 15, col. 80), exposed only on Ruj Mt and on its northeastern extension, Lower Triassic rocks (conglomerates, sandstones and limestones) overlie Permian red siliciclastics. Anisian nodular and massive limestones with indeterminable pelagic bivalves and foraminifera are exposed only in the core of the Talambas anticline (DIMITRIJEVIĆ, 1997).

Along the Serbian-Bulgarian border, on the Ploče Hill, separated from the (?)Devonian by a Neogene belt, low-grade metamorphic conglomeratic sandstone and sericite-chlorite schist, interstratified with calcschist occur, considered as Upper Scythian. They are overlain by beds of Anisian limestones, locally dolomitic and much crushed, followed by platy to thin-bedded limestones interbedded with chert (?Ladinian) (DIMITRIJEVIĆ, 1997).

Younger Triassic deposits are missing in this unit (DIMITRIJEVIĆ, 1997).

Serbian-Macedonian Unit

In central Serbia, west of the East Serbian Carpatho-Balkanides, the Serbian-Macedonian Unit ranges in a N–S extension, with some Triassic deposits (Text-Fig. 15, col. 81) preserved. It is also included into the Dacia Megaterrane.

Before the Permian, probably in the middle part of the Carboniferous, the Ranovac-Vlasina Unit with all other units on the east (Kučaj, Stara Planina, etc.) were amalgamated and docked with the eastern margin of the Serbian-Macedonian Unit (KARAMATA, 2006). In this unit locally Lower Triassic shallow-water quartz sandstones, claystones etc., as well as Middle Triassic limestones at Poslonska Mt are preserved, representing an overstep sequence on the metamorphic basement (KARAMATA & KRSTIĆ, 1996).

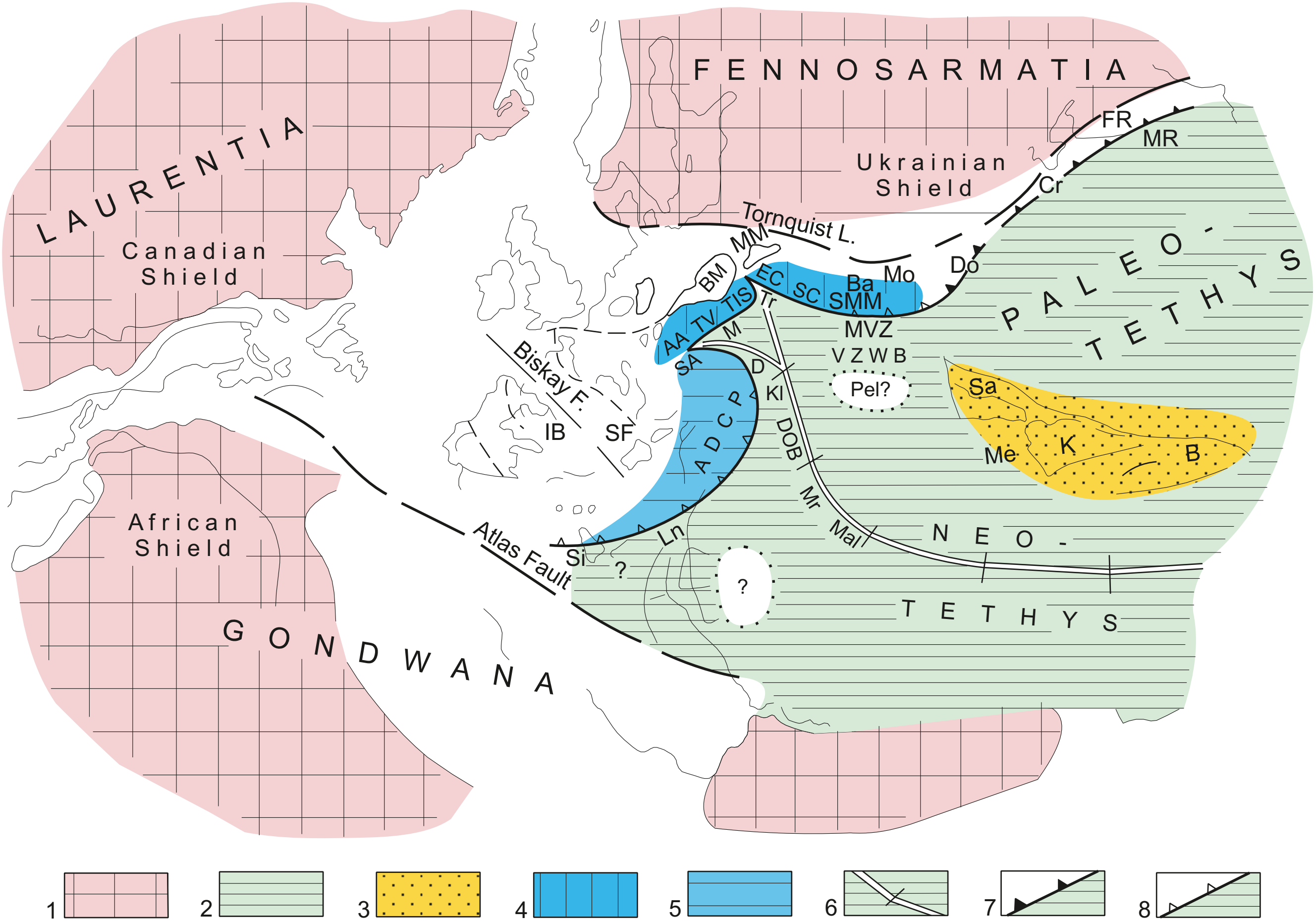
History of Evolution and Notes for Paleogeographic Interpretation

The Late Variscan (Paleotethyan) marine sedimentary cycle ended with a major regression, as recorded in the surface occurrences of the "Carnic-Dinaridic microplate" (in the sense of VAI, 1994, 1998) (Text-Fig. 16). The beginning of the Neotethyan sedimentary cycle is marked by Middle Permian basal conglomerates and breccias, like the Tarvis (Tarvisio) Breccia in the Carnic Alps or the Bobova Breccia in the Jadar Block and its equivalent in the Bükk Unit. These either unconformably (like in the Carnic Alps) or even disconformably (like in the Jadar Block) overlie the marine Late Variscan deposits and are followed by coastal plain sediments, and then sabkha deposits, most likely still in the Middle Permian (Text-Fig. 17). In the late Permian a shallow-marine carbonate ramp developed ("Bellerophon Formation").

Contemporaneously large extensional grabens were formed in the more distant continental areas (continental rifting stage) that filled up with terrestrial sediments and volcanic material. Transgression commencing in the Late Permian led to step-by-step inundation of the former continental basins and the eroded surface of the Variscan basement. The Early to early Middle Triassic sedimentary successions, deposited in the precursor graben of the Neotethys Ocean, began to open in this region during the late Middle to Late Anisian. However, a considerable part of the Dacia Megaunit became inundated only during the Early to Middle Jurassic in connection with the opening of the Piemont/Penninic Ocean. Subsequent to mixed siliciclastic-carbonate ramp sedimentation, the carbonate deposition became prevailing during the late Early Triassic to Early Anisian interval, first under restricted marine and later more open-marine conditions.

The Neotethyan oceanic rifting initiated already in the Middle–Late Permian in the domain east of the Circum-Pannonian region (e.g. it is recorded in the classical Oman ophiolite complexes). Propagating northwestwards the rifting process reached the domain of the Hellenides and probably the Albanides in the late Early Triassic, whereas the Circum-Pannonian region was affected in the early Middle Triassic (Kovács, 1992, 1998). It is best documented in the western ophiolite belt of the Balkan Peninsula, represented in the study area by the Dinaridic Ophiolite Belt and equivalents.

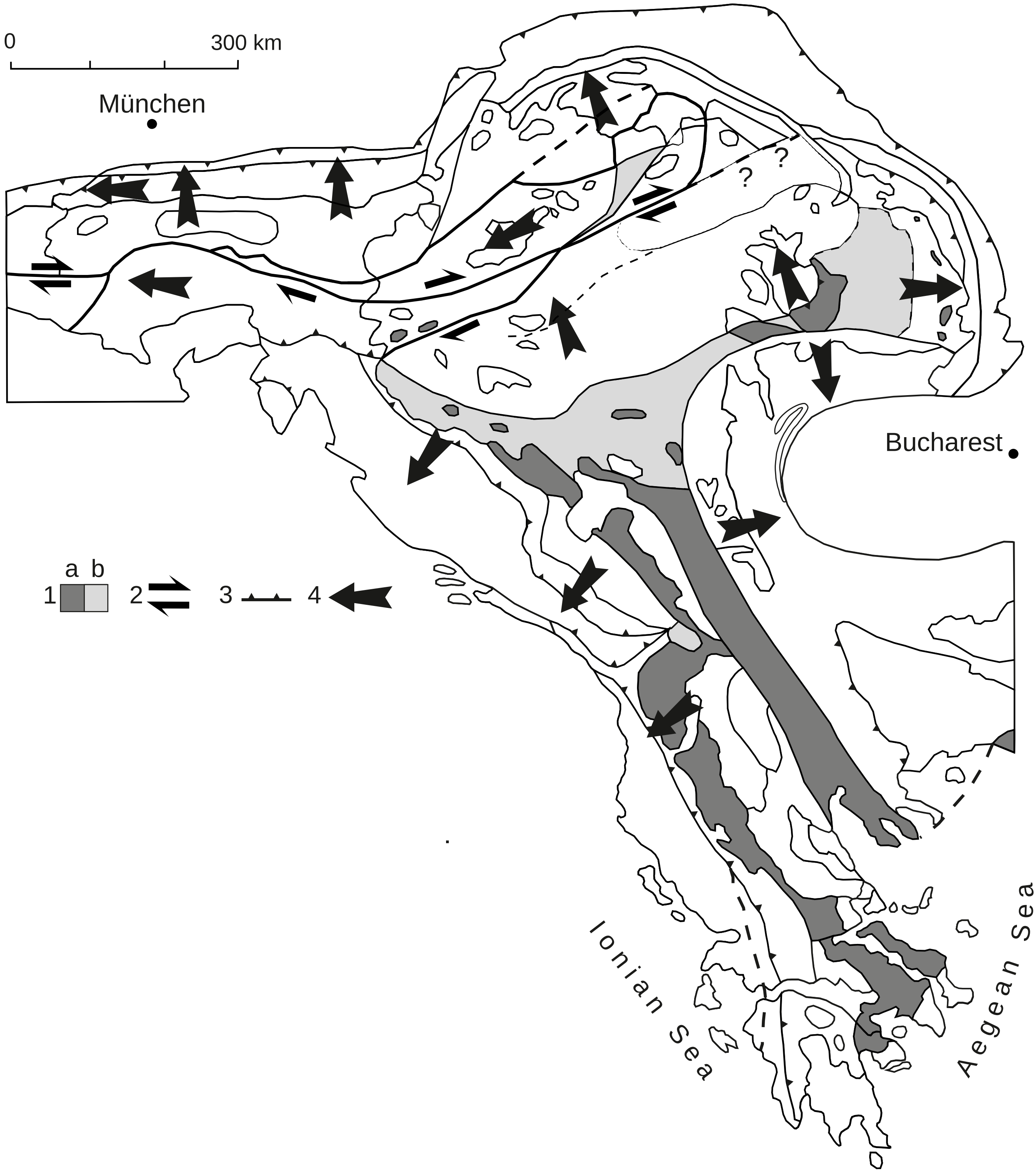
The ocean opening resulted in the disruption of the marginal ramps that is manifested in the partial drowning and partial uplift of the Steinalm ramp and equivalents. This process was accompanied by volcanism, locally. By the Ladinian the Neotethyan passive margin configuration was already fully established (Text-Fig. 18).



Text-Fig. 18.
Late Triassic (Norian) paleogeographic reconstruction of the Neotethys NW-end. Base map (Pangean frame) after Flügel, H.W., 1990 (see Fig. 17 herein).
For an alternative model of opening of DOB (Dinaridic Ophiolite Belt) (by SW-ward subduction in the Main Vardar Zone) see Karamata, 2006.

Legend and abbreviations:
1: Precambrian shields.
2: Tethyan oceanic domains: D Darnó Unit, DOB Dinaridic Ophiolite Belt, Kl Kalnik Unit, Ln Lagonegro Basin, M Meliata Unit, Mal Maliak Zone, Mr Mirdita Zone, MVZ Main Vardar Zone, Si Sicani Basin, Tr Transylvanides, VZWB Vardar Zone Western Belt.
3: Cimmerian continental blocks: B Bitlis, K Kirsehir, Me Menderes, Sa Sakarya; Pel? “Pelagonia” (only Flambouron Nappe).
4: European margin: AA Austroalpine domain, Ba Balkanides, EC Eastern Carpathians, Mo Moesia, SC Southern Carpathians, SMM Serbo-Macedonian “Massif”, TIS Tisza, TV Central Western Carpathians (Tatro-Veporic Unit).
5: Adriatic margin: ADCP Adriatic - Dinaridic Carbonate Platform, SA Southern Alps.
6: Spreading axis.
7: Active Paleotethyan subduction zone: Do North Dobrogea, Cr South Crimea, FR Fore Range of Caucasus, MR Main Range of Caucasus.
8: Inactive (pre-Late Carnian) Paleotethyan subduction zone. Emerged Variscan areas in the European foreland: BM Bohemian Massif, IB Iberia; MM Małopolska Massif; SF Southern France.

A typical passive margin evolution is reflected in the Middle and Late Triassic sequences of the Circum-Pannonian region. However, the local tectonics, sea-level changes, terrigenous input from the hinterland, climate changes, result in slightly different sedimentary evolutions in different regions. In spite of regional differences the overall trend of deposition is well visible on the stratigraphic and lithologic charts presented in the previous chapters. Also the facies



Text-Fig. 19.
Middle – Late Permian – Early Triassic to Early Jurassic facies polarity in the Circum-Pannonian region (from the propagating Neotethys domain towards the continental margins/hinterland) (base map simplified after KOVÁCS et al., 2000).
Legend:
1: Neotethyan oceanic domains; a) on the surface; b) in the pre-Tertiary basement.
2: Major strike-slip faults.
3: Major nappe fronts.
4: Direction (sense) of facies polarity.

polarities are correlatable (Text-Fig. 19): continental influenced sediments near the continental areas, huge carbonate platforms in the central shelf areas and deposition of mostly hemipelagic carbonates on the outer shelf facing the Neotethys Ocean.
The subsequent multistage tectonic movements dismembered the original Triassic shelf arrangement that resulted in the present-day very complex arrangement of the structural units in the Circum-Pannonian realm. Therefore the basic features and trends of the successions form the basis for a correlation of the different tectonic units in the whole region and for paleogeographic reconstructions, still discussed controversially.

Acknowledgements

The research of the authors from Hungary was supported by the National Research Fund, Grants No. T 47121 (SK, KB) and K 61872 (JH, BK), and by the Austrian-Hungarian bilateral Scientific and Technological Programme Project No. AT-8/2007; in Serbia (MS, SK) by the Ministry of Science of the Republic of Serbia, Projects No. 146009 and 146013; in Romania (EG) by the Romanian Academy, grant No. 188, 77/2005-74/2006, and by CNCSIS Project No. 1669/2007-2008; in Austria by the Hungarian-Austrian bilateral Scientific and Technological programme Project No HU 14/2005 and HU 5/2008; in Croatia MZOŠ project 195-0000000-3202; in Slovenia by the Slovenian Research Agency (programme numbers P1-0011, P1-025 and Project No. J1-9465).

The authors are indebted for the photos to D. Jovanović, G. Kiss, Gy. Konrád, Sz. Kövér, D. Milovanović, D.A. & L.G. Popescu and Á. Török.

Reviews of Prof. L. Krystyn and Prof. A.M.C. Şengör improved the manuscript.

References

ALJINOVIĆ, D. (1995): Storm influenced shelf sedimentation – an example from the Lower Triassic (Scythian) siliciclastic and carbonate succession near Knin (southern Croatia and Western Bosnia and Herzegovina). – Geol. Croatica, **48**, 17–32, Zagreb.

ALJINOVIĆ, D., KOLAR-JURKOVŠEK, T. & JURKOVŠEK, B. (2006): The Lower Triassic shallow marine succession in Gorski Kotar region (External Dinarides, Croatia): lithofacies and conodont dating. – Riv. Ital. Paleontol. Stratigr., **112**, 35–53, Milan.

ALJINOVIĆ, D., ISOZAKI, Y. & SREMAC, J. (2008): The occurrence of giant bivalve Alatoconchidae from the *Yabeina* Zone (Upper Guadalupian, Permian) in European Tethys. – Gondwana Research, **13**, 275–287, Kochi (Japan).

ANDJELKOVIĆ, M. (1982): Geology of Yugoslavia – Tectonics (Geologija Jugoslavije – Tectonics). – 692 p. (in Serbian), Belgrade (Rudarsko-geološki Fakultet, Univ. Belgrade).

ANDJELKOVIĆ, M. & SUDAR, M. (1990): The importance of Triassic and Jurassic carbonate rocks for the structural features between Priboj and Sjenica. – 12 Kongr. Geol. Jugosl., **1**., Stratigr., Sedimentol., Paleontol., 33–42 (in Serbian, English summary), Belgrade.

ANDJELKOVIČ, M.Ž. & LUPU, M. (1967): Die Geologie der Šumadija- und Mureş-Zone. – Carpathian-Balkan Geological Association 8th Congress, Geotect., Stratigr., Paleogeogr., Paleontol., **1**, 15–28, Belgrade.

ANDRUSOV, D. (1959): Geology of the Czechoslovak Carpathians. Vol. 2 (Geológia Československých Karpát 2). – 376 p. (in Slovak), Bratislava (Vyd. Slov. Akad. Vied).

ANDRUSOV, D. (1968): Grundriss der Tektonik der Nördlichen Karpaten. – 188 p., Bratislava (Verl. Slow. Akad. Wiss).

ANDRUSOV, D. (1974): The Pieniny Klippen Belt. – In: MAHEĽ, M. (Ed.): Tectonics of the Carpathian-Balkan Regions. – 145–158, Bratislava (Geol. Ústav D. Štúra).

ANDRUSOV, D. (1975): Aperçu bref du bâti des Carpathes occidentales. – General Proceedings Carpathian-Balkan Geological Association 10th Congress, 95–108, Bratislava (Geol. Ústav D. Štúra).

ANDRUSOV, D., BYSTRICKÝ, J. & FUSÁN, O. (1973): Outline of the structure of the West Carpathians. – Carpathian-Balkan Geological Association 10th Congress, Guide-book, 48 p., Bratislava (Geol. Ústav D. Štúra).

ANIČIĆ, B. & DOZET, S. (2000): Younger Paleozoic and Mesozoic rocks in the northern Krško depression borderland, Slovenia. – Geologija, **43**, 13–36 (in Slovenian, English summary), Ljubljana.

ANTONESCU, E. (1970): Étude de la microflore de l'Anisien de la vallée du Cristian (Braşov). – Mém. Inst. Géol., **13**, 1–46, Bucharest.

ANTONESCU, E., PATRULIUS, D. & POPESCU, I. (1976): Corrélation palynologique préliminaire de quelques formations de Roumanie attribuées au Trias inférieur. – Dări de Seamă, Inst. Geol. Geofiz., **62**/5, 3–30, Bucharest.

ÁRKAI, P. & KOVÁCS, S. (1986): Diagenesis and regional metamorphism of the Mesozoic of Aggtelek-Rudabánya Mts. (Northeast Hungary). – Acta Geol. Hung., **29**, 349–373, Budapest.

ÁRKAI, P., BALOGH, K. & DUNKL, I. (1995): Timing of low-temperature metamorphism and cooling of the Paleozoic and Mesozoic formations of the Bükkium, innermost Western Carpathians, Hungary. – Geol. Rdsch., **84**, 334–344, Berlin – Heidelberg

ÁRKAI, P., BÉRCZINÉ MAKK, A. & HAJDÚ, D. (1998): Alpine prograde and retrograde metamorphisms in an overthrusted part of the basement, Great Plain, Pannonian Basin, Eastern Hungary. – Acta Geol. Hung., **41**, 179–210, Budapest.

ASSERETO, R., BOSELLINI, A., FANTINI, SESTINI, N. & SWEET, W.C. (1973): The Permian-Triassic boundary in the Southern Alps. – In: LOGAN, A. & HILLS, V. (Eds.): The Permian and Triassic Systems and their mutual boundary. – Mem. Can. Soc. Petr. Geol., **2**, 176–199, Calgary.

AUBRECHT, R., GAWLICK, H.-J., MISSONI, S., SUZUKI, H., PLAŠIENKA, D., KRONOME, K. & KRONOME, B. (2010): Middle Jurassic matrix radiolarians from the Meliata ophiolitic mélange at the type Meliata sites Meliata and Jaklovce (Western Carpathians): palaeogeographic evidence. – Journal of Alpine Geology, **52**, 82–83, Vienna.

BALINI, M., JURKOVŠEK, B. & KOLAR-JURKOVŠEK, T. (2006): New Ladinian ammonoids from Mt. Svilaja (External Dinarides, Croatia). – Riv. Ital. Paleontol. Stratigr., **112**, 383–395, Milan.

BALINTONI, I. (1994): Structure of the Apuseni Mountains. – ALCAPA II Field Guidebook, Rom. Journ. Tect. Reg. Geol., **75**, Suppl. no. **2**, 51–58, Bucharest.

BALLA, Z. (1984): The Carpathian loop and the Pannonian basin: a kinematic analysis. – Geophys. Trans., **30**, 313–353, Budapest.

BALOG, A., HAAS, J., READ, J.F. & CORUH, C. (1997): Shallow marine record of orbitally forced cyclicity in a Late Triassic carbonate platform, Hungary. – Journ. Sed. Res., **67**, 661–675, Boulder.

BALOGH, K. & PANTÓ, G. (1953): Das ungarische und das angrenzende südslovakische Mesozoikum (Mesozoikum severního Maďarska a přilehlých částí Jihoslovenského krasu). – Sborník Ústř. Ústav Geol., **20**, 613–660 (in Czech, German summary), Praha.

BALTREŞ, A. (1975): Der Obere Anis vom Lacul Roşu (Ostkarpaten): Algen, Foraminiferen, Sedimentologie und Diagenese. – 14th European Micropaleontol. Colloq., Romania, 1975. Micropaleontol. Guide to the Mesozoic and Tertiary of the Romanian Carpathians, 115–121, Bucharest (Inst. Geol. Geophys.).

BALTREŞ, A. (1976): Middle Triassic, supratidal and intertidal dolomites in the Hăghimaş Massif (East Carpathians): carbonate sedimentation and diagenesis. – In: International Colloquium on Carbonate Rocks and Evaporites. – Guidebook ser. **15**, 65–69, Bucharest (Inst. Geol. Geophys.).

BALTREŞ, A. (1998): Rhaetian carbonate cycles in the Northern Apuseni Mountains (the Vaşcău Plateau). – Rev. Roum. Géol., **42**, 125–130, Bucharest.

BALTREŞ, A. & MANTEA, GH. (1995): Sedimentologic evolution of Bihor Carbonate Platform. – Travaux ICSOBA, Acad. Sci., **22–24**, 43–59, Zagreb.

BARABÁS, A. & BARABÁS-STUHL, Á. (2005): Geology of the Lower Triassic Jakabhegy Sandstone Formation, Hungary, SE Transdanubia. – Acta Geol. Hung., **48**, 1–47, Budapest.

BARABÁS-STUHL, Á. (1993): Palynological revaluation of Lower Triassic and Lower Anisian formations of Southeast Transdanubia. – Acta Geol. Hung., **36**, 405–458, Budapest.

BECHSTÄDT, T. (1978): Faziesanalyse permischer und triadischer Sedimente des Drauzuges als Hinweis auf eine großräumige Lateralverschiebung innerhalb des Ostalpins. – Jb. Geol. B.-A., **121**, 1–121, Wien.

BECHSTÄDT, T. & MOSTLER, H. (1974): Mikrofazies und Mikrofauna mitteltriadischer Beckensedimente der Nördlichen Kalkalpen Tirols. – Geol. Paläont. Mitt. Innsbruck, **4**, 1–74, Innsbruck.

BECHSTÄDT, T. & MOSTLER, H. (1976): Riff-Becken-Entwicklung in der Mitteltrias der westlichen Nördlichen Kalkalpen. – Zeitschr. Deutsch. Geol. Ges., **127**, 271–289, Hannover.

Bechtel, A., Gawlick, H.-J., Gratzer, R., Tomaselli, M. & Püttmann, W. (2007): Molecular indicators of paleosalinity and depositional environment of small scale basins within carbonate platforms: The Late Triassic Hauptdolomite section Wiestalstausee near Hallein (Northern Calcareous Alps, Austria). – Organic Geochemistry, **38**, 92–111, Oxford (Elsevier). http://dx.doi.org/10.1016/j.orggeochem.2006.08.016

Bérczi-Makk, A. (1986): Mesozoic formation types of the Great Hungarian Plain. – Acta Geol. Hung*,* **29**, 261–282, Budapest.

Bérczi-Makk, A. (1998): The stratigraphy of the Triassic and Jurassic formations of the Great Hungarian Plain and Tokaj Mts. (Az Alföld és a Tokaji-hegység triász és jura képződményeinek rétegtana). – In: Bérczi, I. & Jámbor, Á. (Eds.): Stratigraphy of the Hungarian Geological Formations (Magyarország geológiai képződményeinek rétegtana). – 281–296 (in Hungarian), Budapest (MOL Rt. – Magyar Áll. Földt. Int.).

Bérczi-Makk, A., Haas, J., Rálisch-Felgenhauer, E. & Oravecz-Scheffer, A. (1993): Upper Paleozoic – Mesozoic formations of the Mid-Transdanubian Unit and their relationships. – Acta Geol. Hung., **36**, 263–296, Budapest.

Bérczi-Makk, A., Császár, G. & Nusszer, A. (1996): Stratigraphy and geological evolution of the Mesozoic basement of the Mecsek Zone in the Central Part of Great Hungarian Plain (East Central Hungary). – Földt. Közl., **126**, 185–207 (in Hungarian, English summary), Budapest.

Birkenmajer, K. (1986): Stages and structural evolution of the Pieniny Klippen Belt, Carpathians. – Stud. Geol. Polon., **88**, 7–32, Warsaw.

Bleahu, M. (1976a): Structural position of the Apuseni Mountains in the Alpine system. – Rev. Roum. Géol. Géophys. Géogr., sér. Géol., **20**, 7–19, Bucharest.

Bleahu, M. (1976b): Structure géologique des Apuseni septentrionaux. – Rev. Roum. Géol. Géophys. Géogr., sér. Géol., **20**, 27–39, Bucharest.

Bleahu, M., Patrulius, D., Tomescu, C., Bordea, J., Panin, Șt. & Rădan, S. (1970): Nouvelles données sur la stratigraphie des dépôts triasiques des Monts Apuseni. – Dări de Seamă, Inst. Geol., **56**/4, 29–41 (in Romanian, French summary), Bucharest.

Bleahu, M., Istocescu, D. & Diaconu, M. (1971): Formations prénéogènes de la partie occidentale des Monts Apuseni et leur position structurale. – Dări de Seamă, Inst. Geol., **57**, 5–12 (in Romanian, French summary), Bucharest.

Bleahu, M., Tomescu, C. & Panin, Șt. (1972): Contribution à la biostratigraphie des dépôts triasiques du Plateau de Vașcău (Monts Apuseni). – Dări de Seamă, Inst. Geol., **58**/3, 5–25 (in Romanian, French summary), Bucharest.

Bleahu, M., Lupu, M., Patrulius, D., Bordea, S., Ştefan, A. & Panin, Şt. (1981): The structure of the Apuseni Mountains. – Carpathian-Balkan Geological Association 12th Congress, Guide to excursion B3, Guidebook ser. **23**, 106 p., Bucharest (Inst. Geol. Geofiz.).

Bleahu, M., Panin, Şt., Ştefănescu, M., Stan, N., Popescu, A., Tomescu, C. & Ştefan, A. (1984): Geological map of R. S. Romania (Harta Geologică Republica Socialistă România), sheet 55a, Dumbrăvița 1:50.000. – Bucharest (Inst. Geol. Geofiz.).

Bleahu, M., Mantea, Gh., Bordea, S., Panin, Şt., Ştefănescu, M., Śikić, K., Haas, J., Kovács, S., Péró, Cs., Bérczi-Makk, A., Konrád, Gy., Nagy, E., Rálisch-Felgenhauer, E. & Török, Á. (1994): Triassic facies types, evolution and paleogeographic relations of the Tisza Megaunit. – Acta Geol. Hung., **37**, 187–234, Budapest.

Bole, B. (2002): Carbonate rocks of Mt. Peca, Slovenia. – Geologija, **45**, 59–69 (in Slovenian, English summary), Ljubljana.

Borcoş, M. & Borcoş, E. (1962): Recherches géologique et pétrographique dans la région Runc-Segagea-V. Ierii-Sat (Bassin de V. Iara, Monts Apuseni). – Dări de Seamă, Com. Geol., Inst. Geol., **47**, 131–148 (in Romanian, French summary), Bucharest.

Bordea, S. & Bordea, J. (1973): Nouvelles données stratigraphiques et structurales au NW des Monts Bihor. – Dări de Seamă, Inst. Geol. Geofiz., **59**/5, 5–12 (in Romanian, French summary), Bucharest.

Bordea, S., Bleahu, M. & Bordea, J. (1975): Nouvelles données stratigraphiques et structurales sur le Bihor de l'Ouest. L'Unité d'Următ et l'Unité de Vetre. – Dări de Seamă, Inst. Geol. Geofiz., **61**/5, 61–83 (in Romanian, French summary), Bucharest.

Bordea, J., Iordan, M., Tomescu, C. & Bordea, S. (1978): Contributions biostratigraphiques sur le Trias supérieur de l'unité de Ferice (Monts Bihor). – Dări de Seamă, Inst. Geol. Geofiz., **64**/4, 63–78 (in Romanian, French summary), Bucharest.

Bosellini, A. (1984): Progradation geometries of carbonate platforms: examples from the Triassic of the Dolomites, Northern Italy. – Sedimentology, **31**, 1–24, Oxford.

Bosellini, A. (1991): Geology of the Dolomites. An introduction. – Dolomieu Conference on Carbonate Platforms and Dolomitization, Guidebook, 41 p., Ortisei/St. Ulrich.

Bosellini A. & Hardie L.A. (1988): Facies e cicli della Dolomia Principale delle Alpi Venete. – Mem. Soc. Geol. Ital., **30** (1985), 245–266, Roma.

Brandner, R. (1972): „Südalpines“ Anis in den Lienzer Dolomiten (Drauzug) – (ein Beitrag zur alpin-dinarischen Grenze). – Mitt. Ges. Geol. Bergbaustud. Österr. **21**, 143–162, Wien.

Brandner, R. (1984): Meeresspiegelschwankungen und Tektonik in der Trias der NW-Tethys. – Jb. Geol. B.-A., **126**, 435–475, Wien.

Brandner, R. & Mostler, H. (1982): Der Geologische Aufbau des Schlerngebietes und seiner weiteren Umgebung. – In: Mostler, H. (Ed.): Excursionführer zur 4. Jahrestag. der Österr. Geol. Ges., Seis am Schlern, Südtirol, 1982. – S. 42, Innsbruck (Österr. Geol. Ges.).

Brandner, R. & Resch, W. (1981): Reef development in the Middle Triassic (Ladinian and Cordevolian) of the Northern Limestone Alps near Innsbruck, Austria. – SEPM Spec. Publ., **30**, 203–231, Tulsa, OK.

Broglio-Loriga, C., Góczán, F., Haas, J., Lenner, K., Neri, C., Oraveczné Scheffer, A., Posenato, R., Szabó, I. & Tóthné Makk, Á. (1990): The Lower Triassic sequences of the Dolomites (Italy), Transdanubian Mid-Mountains (Hungary), their correlation. – Mem. Sci. Geol., **42**, 41–103, Padova.

Brusca, C., Gaetani, M., Jadoul, F. & Viel, G. (1982): Ladinian–Carnian paleogeography and metallogenesis of the Southern Alps (Paleogeografia ladino-carnica e metallogenesi del Sudalpino). – Mem. Soc. Geol. Ital., **22**, 65–82 (in Italian), Rome.

Bucur, I.I. (1997): The Mesozoic deposits from the Reșița-Moldova Nouă zone (Southern Carpathians). – 214 p. (in Romanian, English summary), Cluj-Napoca (Cluj Univ. Press).

Bucur, I.I. (2001): Upper Triassic deposits of Vașcău Plateau. – In: Bucur, I.I., Filipescu, S. & Săsăran, E. (Eds.): Algae and carbonate platforms in western part of Romania. – Field Trip Guidebook, 4th Regional Meeting of IFAA (Cluj-Napoca, Romania, 2001), 19–29, Cluj-Napoca (Cluj Univ. Press).

Bucur, I.I. & Săsăran, E. (2001): Triassic loferites of Colești Nappe (Vașcău). – In: Bucur, I.I., Filipescu, S. & Săsăran, E. (Eds.): Algae and carbonate platforms in western part of Romania. – Field Trip Guidebook, 4th Regional Meeting of IFAA (Cluj-Napoca, Romania, 2001), 129–135, Cluj-Napoca (Cluj Univ. Press).

Bucur, I.I., Strutinski, C. & Pop-Stratila, D. (1994): Middle Triassic carbonate deposits and calcareous algae from the Sasca Zone (Southern Carpathians, Romania). – Facies, **30**, 9–14, Erlangen.

Bucur, I.I., Strutinski, C. & Paica, M. (1997): A new occurrence of Triassic deposits NE of Oravița (Southern Carpathians, Romania) and its paleotectonic significance. – Geol. Carpathica, **48**, 39–48, Bratislava.

Budai, T. & Vörös, A. (1992): Middle Triassic history of the Balaton Highland: extensional tectonics, basin evolution. – Acta Geol. Hung., **35**, 237–250, Budapest.

Budurov, K. & Pantić, S. (1974): Die Conodonten der Campiller Schichten von Brassina (Westserbien). I. Stratigraphie und Conodonten-Zonen. – Bull. Geol. Inst., ser. Paleontol., **23**, 105–113, Sofia.

Budurov, K.J., Gupta, V.J., Sudar, M.N. & Buryi, G.I. (1985): Conodont zonation, biofacies and provinces in the Triassic. – Journ. Geol. Soc. India, **26**/2, 84–94, New Delhi.

Buser, S. (1979): Triassic beds in Slovenia. – In: Drobne, K. (Ed.): Geological Development in Slovenia and Croatia. – 16th European Micropaleontol. Colloq., Zagreb-Bled., Guidebook, 17–26, Ljubljana (Croat. Geol. Soc. & Slov. Geol. Soc.).

Buser, S. (1989): Development of the Dinaric and Julian Carbonate Platforms and of the intermediate Slovenian Basin (NW Yugoslavia). – Mem. Soc. Geol. Ital., **40**, 313–320, Rome.

Buser, S. (1996): Geology of western Slovenia and its paleogeographic evolution. – In: Drobne, K., Goričan, Š. & Kotnik, D. (Eds.): The role of impact processes in the geological and biological evolution of planet Earth. – International Workshop (1996), Postojna/Slovenia, 111–123, Ljubljana (Znanst. SAZU).

Buser, S., Kolar-Jurkovšek, T. & Jurkovšek, B. (2008): The Slovenian Basin during the Triassic in the light of conodont data. – Boll. Soc. Geol. Ital., **127**, 257–263, Rome.

Bystrický, J. (1964a): Slovenský kras. Stratigraphie und Dasycladaceaen des Gebirges Slovenský Kras. – 204 p. (in Slovak, German summary), Bratislava (Ústredny Ústav Geol.).

Bystrický, J. (1964b): Stratigraphy and Triassic development of the Drienok Series (Stratigrafia a vývin triasu série Drienka). – Zpr. Geol. Výsk. R. 1963, **2**, 94–96 (in Slovak), Bratislava.

Bystrický, J. (1986): Stratigraphic ranging and zonation of Dasycladal Algae in the West Carpathians Mts., Triassic. – Miner. Slovaca, **18**, 289–321, Bratislava.

Čanović, M. & Kemenci, R. (1988): The Mesozoic of the Pannonian Basin in Vojvodina (Yugoslavia). – 337 p. (in Serbian, English summary), Novi Sad (Ed. Matica Srpska).

Čanović, M. & Kemenci, R. (1999): Geologic setting of the Pre-Tertiary basement in Vojvodina (Yugoslavia) Part II: The north part of the Vardar zone in the south of Vojvodina. – Acta Geol. Hung., **42**, 427–449, Budapest.

Čar, J., Gregorič, V., Ogorelec, B. & Orehek, S. (1980): Sedimentological development of Scythian beds in the Idrija mercury deposit. – Rud. Met. zb., **27**, 3–20 (in Slovenian, English summary), Ljubljana.

Carulli, G.B., Cozzi, A., Longo Salvador, G., Ponton, M. & Podda, F. (1998): Evidence of synsedimentary tectonic activity during the Norian–Lias (Carnian Prealps, Northern Italy). – Mem. Soc. Geol. Ital., **53**, 403–415, Rome.

Castellarin, A., Lucchini, F., Rossi, P.L., Simboli, G., Bosellini, A. & Sommavilla, E. (1980): Middle Triassic magmatism in the Southern Alps. II.: A geodynamic model. – Riv. Ital. Paleontol. Stratigr., **85**, 1111–1124, Milan.

Čekalová, V. (1954): Geological conditions in western part of the Southslovakian Karst (Geologické pomery západnej časti juhoslovenského krasu). – Geol. Práce, Správy, **1**, 48–49 (in Slovak), Bratislava.

Celarc, B. & Kolar-Jurkovšek, T. (2008): The Carnian-Norian basin-platform system of the Martuljek mountain group (Julian Alps, Slovenia): progradation of the Dachstein carbonate platform. – Geol. Carpathica, **59**, 211–224, Bratislava.

Cerny, I. (1982): Geochemie und Sedimentologie der Raibler Schichten im Raum Förolach (Gailtal, Kärnten). – Carinthia II, **172**/92, 63–76, Klagenfurt.

Cerny, I. (1989): Die karbonatgebundenen Blei-Zink-Lagerstätten des alpinen und außeralpinen Mesozoikums. Die Bedeutung ihrer Geologie, Stratigraphie und Faziesgebundenheit für Prospektion und Bewertung. – Arch. f. Lagerst.forsch. Geol. B.-A., **11**, 5–126, Wien.

Cigale, M. (1978): Carnian beds in the Idrija region. – Geologija, **21**, 61–75 (in Slovenian, English summary), Ljubljana.

Cioflică, G., Patrulius, D., Ionescu, J. & Udubaşa, G.G. (1965): Triassic allochthonous ophiolites from Perşani Mountains. – Stud. Cerc. Geol. Geofiz. Geogr., ser. Geol., **10**, 161–182 (in Romanian), Bucharest.

Colins, E. & Nachtmann, W. (1974): Die permotriadische Schichtfolge der Villacher Alpe (Dobratsch), Kärnten. – Geol. Paläont. Mitt. Innsbruck, **4**/3, 1–43, Innsbruck.

Cousin, M. (1973): Le sillon Slovène: les formations triasiques, jurassiques et néocomiennes au Nord-Est de Tolmin (Slovénie occidentale, Alpes méridionales) et leurs affinités dinariques. – Bull. Soc. Géol. Fr., **7**/15, 327–339, Paris.

Cozzi, A. (2000): Synsedimentary tensional features in Upper Triassic shallow-water platform carbonates of the Carnian Prealps (northern Italy) and their importance as palaeostress indicators. – Basin Research, **12**, 133–146, Oxford.

Cozzi, A. & Podda, F. (1998): A platform to basin transition in the Dolomia Principale of the M. Pramaggiore area, Carnian Prealps, Northern Italy. – Mem. Soc. Geol. Ital., **53**, 387–402, Rome.

Csontos, L. & Vörös, A. (2004): Mesozoic plate tectonic reconstruction of the Carpathian region. – Palaeogeogr., Palaeoclimat., Palaeoecol., **210**, 1–56, Amsterdam.

Czurda, K. (1973): Parameter und Prozesse der Bildung bituminöser Karbonate (Bituminöser Hauptdolomit). – Mitt. Ges. Geol. Bergbaustud. Österr., **21**, 235–250, Wien.

Dallmeyer, R.D., Neubauer, F., Pană, D. & Fritz, H. (1994): Variscan vs. Alpine tectonothermal evolution within the Apuseni Mountains, Romania: evidence from $^{40}Ar/^{39}Ar$ mineral ages. – ALCAPA II. Field Guidebook, Rom. Journ. Tect. Reg. Geol., **75**, Suppl. **2**, 65–76, Bucharest.

Dallmeyer, R.D., Kräutner, H.-G. & Neubauer, F. (1997): Middle-Late Triassic $^{40}Ar/^{39}Ar$ hornblende ages for early intrusions within the Ditrău Alkaline massif, Rumania: implications for Alpine rifting in the Carpathian Orogen. – Geol. Carpathica, **48**, 347–352, Bratislava.

Diaconu, M. & Dragastan, O. (1969): Triassic calcareous algae from the Apuseni Mountains (Rumania). – Rev. Palaeobotan. Palynol., **9**, 63–101, Amsterdam.

Dimitrijević, M.D. (1997): Geology of Yugoslavia. – Geol. Inst. Gemini, Spec. Publ., 187 p., Belgrade (Ed. Barex).

Dimitrijević, M.N. (1967): Sedimentologic problems of Middle Triassic flysch in the terraines between Scutari Lake and the Adriatic Sea. – Geol. Glasn., **5**, 223–310 (in Serbian, English summary), Titograd.

Dimitrijević, M.N. & Dimitrijević, M.D. (1991): Triassic carbonate platform of the Drina-Ivanjica element (Dinarides). – Acta Geol. Hung., **34**, 15–44, Budapest.

Dimitrijević, M.N., Dimitrijević, M.D., Karamata, S., Sudar, M., Gerzina, N., Kovács, S., Dosztály, L., Gulácsi, Z., Pelikán, P. & Less, Gy. (2003): Olistostrome/mélanges – an overview of the problems and preliminary comparison of such formations in Yugoslavia and Hungary. – Slovak Geol. Mag., **9**, 3–21, Bratislava.

Djerić, N. & Gerzina, N. (2008): Late Triassic radiolarians from the Ovčar-Kablar Gorge (SW Serbia). – Geol. an. Balk. poluos., **69**, 39–47, Belgrade.

Djurdjanović, Ž. (1971): Ein Beitrag zur Lithologie und Stratigraphie der Kristallinen Gesteine der Fruška Gora (Sirmien – Jugoslawien). – Bull. Sci., Cons. Acad. Sci. Arts RSF Yugosl., Sect. A, **16**/5-6, 137–138, Belgrad.

DJURDJANOVIĆ, Ž. (1973): About the Paleozoic and the Triassic of Medvednica Mountain and the area near Dvor na Uni on the basis of Conodonts. – Geol. Vjesnik, **25**, 29–49 (in Croatian, English summary), Zagreb.

DOBRUSKINA, I.A., JURKOVŠEK, B. & KOLAR-JURKOVŠEK, T. (2001): Upper Triassic flora from "Raibl beds" of Julian Alps (Italy) and Karavanke Mts. (Slovenia). – Geologija, **44**, 263–290, Ljubljana.

DOGLIONI, C. (1988): Examples of strike-slip tectonics on platform-basin margin. – Tectonophysics, **156**, 293–302, Amsterdam

DOLENEC, T., OGORELEC, B. & PEZDIČ, J. (1981): Upper Permian and Scythian beds in the Tržič area. – Geologija, **24**, 217–238 (in Slovenian, English summary), Ljubljana.

DOLENEC, T., OGORELEC, B., DOLENEC, M. & LOJEN, S. (2004): Carbon isotope variability and sedimentology of the Upper Permian carbonate rocks and changes across the Permian-Triassic boundary in the Masore section (Western Slovenia). – Facies, **50**, 287–299, Berlin – Heidelberg.

DONOFRIO, D.D., BRANDNER, R. & POLESCHINSKI, W. (2003): Conodonten der Seefeld-Formation: ein Beitrag zur Bio- und Lithostratigraphie der Hauptdolomit-Plattform (Obertrias, westliche Nördliche Kalkalpen, Tirol). – Geol. Paläont. Mitt. Innsbruck, **26**, 91–107, Innsbruck.

DOSZTÁLY, L. (1994): Mesozoic radiolarian investigations in Northern Hungary (Mezozoos Radiolaria vizsgálatok Észak-Magyarországon). – Unpubl. thesis, 108 p. (in Hungarian), Budapest (Hung. Geol. Inst).

DOSZTÁLY, L. & JÓZSA, S. (1992): Geochronological evaluation of Mesozoic formations of Darnó Hill at Recsk on the basis of radiolarians and K-Ar age data. – Acta Geol. Hung., **35**, 371–393, Budapest.

DOSZTÁLY, L., JÓZSA, S., KOVÁCS, S., LESS, GY., PELIKÁN, P. & PÉRÓ, CS. (2002): North-East Hungary. – In: VOZÁR, J., VOJTKO, R. & SLIVA, L. (Eds.): Carpatian-Balkan Geological Association 17th Congress, Guide to geological excursions. – 104–117, Bratislava.

DOZET, S. (2000): Višnja gora formation, central Slovenia. – Rud. Met. zb., **47**, 137–154 (in Slovenian, English summary), Ljubljana.

DRAGASTAN, O. & GRĂDINARU, E. (1975): Some Triassic Algae, Foraminiferae, Sphinctozoa and microproblematicae from the Eastern Carpathians and North Dobrogea. – St. Cerc. Geol. Geofiz. Geogr., ser. Geol., **20**, 247–254 (in Romanian, English summary), Bucharest.

DRAGASTAN, O., DIACONU, M., POPA, E. & DAMIAN, R. (1982): Biostratigraphy of the Triassic formations in the east of the Pădurea Craiului Mountains. – Dări de Seamă, Inst. Geol. Geofiz., **67**/4, 29–61, Bucharest.

DRAGIČEVIĆ, I. & VELIĆ, I. (2002): The northeastern margin of the Adriatic Carbonate Platform. – Geol. Croatica, **55**, 185–232, Zagreb.

DULLO, W.-C. & LEIN, R. (1982): Facies and environment of the Leckkogel Beds (Carnian; Alps). – Facies, **6**, 5–36, Erlangen.

DUMITRICĂ, P. (1982): Triassic Oertlisponginae (Radiolaria) from Eastern Carpathians and Southern Alps. – Dări de Seamă, Inst. Geol. Geofiz., **67**/3, 57–74, Bucharest.

DUMITRICĂ, P. (1991): Middle Triassic Tripedurnulidae, n. fam. (Radiolaria) from the Eastern Carpathians (Romania) and Vicentinian Alps (Italy). – Rev. Micropaléontol., **34**/4, 261–278, Paris.

DUMITRICĂ, P. & MELLO, J. (1982): On the age of the Meliata Group and the Silica Nappe radiolarites (localities Držkovce and Bohúňovo). – Geol. Práce, Správy, **77**, 17–28, Bratislava.

EBNER, F., VOZÁROVÁ, A. & KOVÁCS, S. (2007): Die variszische Orogenese im Circum-Pannonischen Raum – reflektiert an Devon-Karbon-Sedimenten. – Jb. Geol. B.-A., **147**, 315–329, Wien.

EBNER, F., VOZÁROVÁ, A., KOVÁCS, S., KRÄUTNER, H.G., KRSTIČ, B., SZEDERKÉNYI, T., JAMČIČ, D., BALEN, D., BELAK, M. & TRAJANOVA, M. (2008): Devonian – Carboniferous pre-flysch and flysch environments in the Circum Pannonian Region. – Geol. Carpathica, **59**, 159–195, Bratislava.

FARYAD, S.W. (2000): Tectonic slices with amphibolite facies assemblages: a further member of the Meliata unit. – Miner. Slovaca, **32**, 173–174, Bratislava.

FAUPL, P. (1997): Austria. – In: MOORES, E.M. & FAIRBRIDGE, R.W. (Eds.): Encyclopedia of European and Asian regional geology. – 51–63, London (Chapman & Hall).

FAUPL, P. & TOLLMANN, A. (1979): Die Roßfeldschichten: Ein Beispiel für Sedimentation im Bereich einer tektonisch aktiven Tiefseerinne aus der kalkalpinen Unterkreide. – Geol. Rdsch., **68**, 93–120, Stuttgart.

FAUPL, P. & WAGREICH, M. (2000): Late Jurassic to Eocene palaeogeography and geodynamic evolution of the Eastern Alps. – Mitt. Österr. Geol. Ges., **92**, 79–94, Vienna.

FILIPOVIĆ, I., JOVANOVIĆ, D., SUDAR, M., PELIKÁN, P., KOVÁCS, S., LESS, GY. & HIPS, K. (2003): Comparison of the Variscan-Early Alpine evolution of the Jadar Block (NW Serbia) and "Bükkium" (NE Hungary) terranes; some paleogeographic implications. – Slovak Geol. Mag., **9**, 23–40, Bratislava.

FLÜGEL, E. (1981): Paleoecology and facies of Upper Triassic reefs in the Northern Calcareous Alps. – SEPM Spec. Publ., **30**, 291–359, Tulsa, OK.

FLÜGEL, E., VELLEDITS, F., SENOWBARI-DARYAN, B. & RIEDEL, P. (1992): Rifforganismen aus "Wettersteinkalken" (Karn?) des Bükk-Gebirges, Ungarn. – Geol. Paläont. Mitt. Innsbruck, **18**, 35–62, Innsbruck.

FLÜGEL, E., RAMOVŠ, A. & BUCUR, I. (1993): Middle Triassic (Anisian) limestones from Bled, Northwestern Slovenia: microfacies and microfossils. – Geologija, **36**, 157–181, Ljubljana.

FLÜGEL, H.W. (1990): Das voralpine Basement im Alpin-Mediterranen Belt. Überblick and Problematik. – Jb. Geol. B.-A., **133**, 181–221, Wien.

FODOR, L. & KOROKNAI, B. (2000): Ductile deformation and revised stratigraphy of the Martonyi Subunit (Torna Unit, Rudabánya Mts.), Northeastern Hungary. – Geol. Carpathica, **51**, 355–369, Bratislava.

FODOR, L., JELEN, B., MÁRTON, E., SKABERNE, D., ČAR, J. & VRABEC, M. (1998): Miocene-Pliocene tectonic evolution of the Slovenian Periadriatic fault: Implications for Alpine-Carpathian extrusion models. – Tectonics, **17**, 690–709, Washington, DC.

FRANK, W. & SCHLAGER, W. (2006): Jurassic strike slip versus subduction in the Eastern Alps. – Int. Journ. Earth Sci., **95**, 431–450, Berlin.

FRISCH, W. & GAWLICK, H.-J. (2003): The nappe structure of the central Northern Calcareous Alps and its disintegration during Miocene tectonic extrusion – a contribution to understanding the orogenic evolution of the Eastern Alps. – Int. Journ. Earth Sci., **92**, 712–727, Berlin.

FRISCH, W., KUHLEMANN, J., DUNKL, I. & BRÜGEL, A. (1998): Palinspastic reconstruction and topographic evolution of the Eastern Alps during late Tertiary tectonic extrusion. – Tectonophysics, **297**, 1–15, Amsterdam.

FÜLÖP, J., BREZSNYÁNSZKY, K. & HAAS, J. (1987): The new map of basin basement of Hungary. – Acta Geol. Hung., **30**, 3–20, Budapest.

GAETANI, M. (Ed.) (1979): Riccardo Assereto and Giulio Pisa Field Symposium on Triassic stratigraphy of the Southern Alps. – Field Guide Book, IGCP Project 4 (Bergamo, 1979), 79 p., Milan.

Gaetani, M., Gianotti, R., Jadoul, F., Ciarapica, G., Cirilli, S., Lualdi, A., Passeri, L.M., Pellegrini, M. & Tannoia, G. (1987): Upper Caboniferous, Permian and Triassic in the Lariana area (Carbonifero superiore, Permiano e Triassico nell' area Lariana). – Mem. Soc. Geol. Ital., **32**, 5–48 (in Italian), Rome.

Gaetani, M., Gnaccolini, M., Jadoul, F. & Garzanti, E. (1998): Multiorder sequence stratigraphy in the Triassic system of the Western Southern Alps. – Mesozoic and Cenozoic sequence stratigraphy of European basins, SEPM Spec. Publ., **60**, 701–717, Tulsa, OK.

Gallet, Y., Krystyn, L. & Besse, J. (1998): Upper Anisian to Lower Carnian magnetostratigraphy from the Northern Calcareous Alps (Austria). – J. Geoph. Res., **103**, 605–621, Washington, DC.

Gawlick, H.-J. (1993): Triassische Tiefwasserfazieskomponenten (Kieselkalke, Radiolarite) in der jurassischen Strubbergbrekzie am Tennengebirgsnordrand (Nördliche Kalkalpen, Austria). – Jb. Geol. B.-A., **136**, 347–350, Wien.

Gawlick, H.-J. (1996): Die früh-oberjurassischen Brekzien der Stubbergschichten im Lammertal – Analyse und tektonische Bedeutung (Nördliche Kalkalpen Österreich). – Mitt. Ges. Geol. Bergbaustud. Österr., **39–40**, 119–186, Wien.

Gawlick, H.-J. (1998): Obertriassische Brekzienbildung und Schollengleitung im Zlambachfaziesraum (Pötschenschichten) – Stratigraphie, Paläogeographie und diagenetische Überprägung des Lammeregg-Schollenkomplexes (Nördliche Kalkalpen, Salzburg). – Jb. Geol. B.-A., **141**, 147–165, Wien.

Gawlick, H.-J. (2000a): Paläogeographie der Ober-Trias-Karbonatplattform in den Nördlichen Kalkalpen. – Mitt. Ges. Geol. Bergbaustud. Österr., **44**, 45–95, Wien.

Gawlick, H.-J. (2000b): Sedimentologie, Fazies und Stratigraphie der obertriassischen Hallstätter Kalke des Holzwehralm-Schollenkomplexes (Nördliche Kalkalpen, Salzburger Land). – Jb. Geol. B.-A., **142**, 11–31, Wien.

Gawlick, H-J. & Böhm, F. (2000): Sequence and Isotope Stratigraphy of Late Triassic Distal Periplatform Limestones – an example from the Northern Calcareous Alps (Kälberstein Quarry, Berchtesgaden Hallstatt Zone). – Intern. Jour. Earth Sciences, **89**, 108–129, Berlin (Springer).

Gawlick, H.-J. & Frisch, W. (2003): The Middle to Late Jurassic carbonate clastic radiolaritic flysch sediments in the Northern Calcareous Alps: sedimentology, basin evolution and tectonics – an overview. – N. Jb. Geol. Paläont. Abh., **230**, 163–213, Stuttgart.

Gawlick, H.-J. & Höpfer, N. (1999): Stratigraphie, Fazies und Hochdruck-Mitteltemperatur-Metamorphose der Hallstätter Kalke der Pailwand (Nördliche Kalkalpen, Österreich). – Zeitschr. Deutsch. Geol. Ges., **150**, 641–671, Hannover.

Gawlick, H.-J., Krystyn, L. & Lein, R. (1994): Conodont colour alteration indices: Paleotemperatures and metamorphism in the Northern Calcareous Alps – a general view. – Geol. Rdsch., **83**, 660–664, Berlin – Heidelberg.

Gawlick, H.-J., Frisch, W., Vecsei, A., Steiger, T. & Böhm, F. (1999a): The change from rifting to thrusting in the Northern Calcareous Alps as recorded in Jurassic sediments. – Geol. Rdsch. **87**, 644–657, Berlin – Heidelberg.

Gawlick, H.-J., Krystyn, L., Lein, R. & Mandl, G.W. (1999b): Tectonostratigraphic concept for the Juvavic Domain. – Tübinger Geowiss. Arbeiten, Reihe A, **52**, 95–99, Tübingen.

Gawlick, H.-J., Suzuki, H. & Missoni, S. (2001): Nachweis von unterliassischen Beckensedimenten in Hallstätter Fazies (Dürrnberg-Formation) im Bereich der Hallein-Berchtesgadener Hallstätter Zone und des Lammer Beckens (Hettangium–Sinemurium). – Mitt. Ges. Geol. Bergbaustud. Österr., **45**, 39–55, Wien.

Gawlick, H.-J., Missoni, S., Auer, M., Schlagintweit, F., Suzuki, H. & Weyer, D. (2006): The mega-imbricate zone south of Maria Elend (Karavank Mountains, Austria) – a contribution for a better understanding of the polyphase tectonic history along the eastern Periadriatic Lineament. – In: Sudar, M., Ercegovac, M. & Grubić, A. (Eds.): Proceedings 18th Congress of Carpathian-Balkan Geological Association. – 163–166, Belgrade (National committee of the Carpathian-Balkan Geological Association; Serbian Geological Society).

Gawlick, H.-J., Frisch, W., Hoxha, L., Dumitrică, P., Krystyn, L., Lein, R., Missoni, S. & Schlagintweit, F. (2008): Mirdita Zone ophiolites and associated sediments in Albania reveal Neotethys Ocean origin. – Int. Journ. Earth. Sci., **97**, 865–881, Berlin (Springer). http://dx.doi.org/10.1007/s00531-007-0193-z

Gawlick, H.-J., Missoni, S., Schlagintweit, F., Suzuki, H., Frisch, W., Krystyn, L., Blau, J. & Lein, R. (2009a): Jurassic Tectonostratigraphy of the Austroalpine domain. – Journal of Alpine Geology, **50**, 1–152, Vienna.

Gawlick, H.-J., Sudar, M., Suzuki, H., Djerić, N., Missoni, S., Lein, R. & Jovanović, D. (2009b): Upper Triassic and Middle Jurassic radiolarians from the ophiolite mélange of the Dinaridic Ophiolite Belt, SW Serbia. – N. Jb. Geol. Paläont. Abh., **253**, 293–311, Stuttgart.

Gawlick, H.-J., Sudar, M., Lein, R., Missoni, S., Jovanovic, D. & Suzuki, H. (2010a): The Hallstatt Mélange occurrence of Vodena Poljana in the Inner Dinarids (Zlatar Mountain, SW Serbia). – Journal of Alpine Geology, **52,** 116–118, Vienna.

Gawlick, H.-J., Sudar, M., Missoni, S., Suzuki, H., Jovanovic, D. & Lein, R. (2010b): Age and provenance of the Dinaridic Ophiolite Belt in the Zlatibor area (SW Serbia). – Journal of Alpine Geology, **52**, 118–119, Vienna.

Gawlick, H.-J., Sudar, M., Missoni, S., Suzuki, H., Jovanovic, D. & Lein, R. (2010c): Jurassic Radiolarians from the Radiolaritic-Ophiolitic Mélange of the Zlatibor Area (Dinaridic Ophiolite Belt, SW Serbia). – In: Banjac, N. (Ed-in-Chief): Proc. 15th. Congr. geol. Serbia intern. partic. – p. 161, Belgrade.

Gheorghian, D. (1978): Inventaire sommaire des debris d'échinodermes contenus par les calcaires triasiques des nappes transylvaines (Carpates Orientales). – Dări de Seamă, Inst. Geol. Geofiz. **64**/3, 55-68, Bucharest.

Gianolla, P., De Zanche, V. & Mietto, P. (1998): Triassic sequence stratigraphy in the Southern Alps (Northern Italy): definition of sequences and basin evolution. – Mesozoic and Cenozoic sequence stratigraphy of European basins, SEPM Spec. Publ., **60**, 719–747, Tulsa, OK.

Gnaccolini, M. & Jadoul, F. (1990): Carbonate platform, lagoon and delta high-frequency cycles from the Carnian of Lombardy (Southern Alps, Italy). – Sed. Geol., **67**, 143–159, Amsterdam.

Golebiowski, R. (1990): The Alpine Kössen Formation, a key for European topmost Triassic correlations. A sequence – and ecostratigraphic contribution to the Norian-Rhaetian discussion. – Albertiana, **8**, 25–35, Utrecht.

Golebiowski, R. (1991): Becken und Riffe der alpinen Obertrias. Lithostratigraphie und Biofazies der Kössener Formation. – In: Nagel, D. & Rabeder, G. (Eds.): Exkursionen im Jungpaläozoikum und Mesozoikum Österreichs. – 79–119, Wien (Österr. Paläont. Ges.).

Golonka, J. (2007): Late Triassic and Early Jurassic paleogeography of the world. – Paleogeogr., Paleoclimat., Paleoecol., **244**, 297–307, Amsterdam.

Golonka, J. & Picha, F.J. (Eds.) (2008): The Carpathians and their foreland: Geology and hydrocarbon resources. – AAPG Memoir, **84**, 600 p., Tulsa, OK.

Golonka, J., Krobicki, M. & Michalík, J. (2008): Western Carpathian basins. – In: McCann, T. (Ed.): The geology of Central Europe, Volume 2: Mesozoic and Cenozoic. – 896–900, London (Geol. Society).

Goričan, Š. & Buser S. (1990): Middle Triassic radiolarians from Slovenia (Yugoslavia). – Geologija, **31–32** (1988/89), 133–197, Ljubljana.

Goričan, Š., Karamata, S. & Batoćanin-Srećković, D. (1999): Upper Triassic (Carnian–Norian) Radiolarians in cherts of Sjenica and the time span of the oceanic realm ancestor of the Dinaridic Ophiolite Belt. – Bulletin T. 119, Serbian Acad. Sci. Arts., Cl. Sci. Math. Nat., Sci. Nat., **39**, 141–149, Belgrade.

Goričan, Š., Halamić, J., Grgasović, T. & Kolar-Jurkovšek, T. (2005): Stratigraphic evolution of Triassic arc-backarc system in northwestern Croatia. – Bull. Soc. Géol. Fr., **176**, 3–22, Paris.

Götz, A.E., Török, Á., Feit-Burkhardt, S. & Konrád, Gy. (2003): Palynofacies patterns of Middle Triassic ramp deposits (Mecsek Mts., S Hungary): a powerful tool for high-resolution sequence stratigraphy. – Mitt. Ges. Geol. Bergbaustud. Österr., **46**, 77–90, Vienna.

Grad, K. & Ogorelec, B. (1980): Upper Permian, Scythian and Anisian rocks in the Žiri area. – Geologija, **23**, 189–220 (in Slovenian, English summary), Ljubljana.

Grădinaru, E. (2005): From the thesaurus of the museum collections. II.: Early Norian ammonoids from Roșia-Sohodol region (Apuseni Mts). – Acta Palaeontol. Rom., **5**, 181–189, Bucharest.

Grasu, C. (1971): Recherches géologiques dans le sedimentaire mésozoïque du bassin supérieur de Bicaz (Carpates Orientales). – Lucr. St. Cerc. Biol. Geol. Geogr. “Stejarul”, **4**, 7–55, Piatra Neamț.

Grasu, C. (1976): Le sédimentaire mésozoïque de la partie méridionale de Izvorul Mureşului. Le problème de nappe sub-bucovinienne. – An. Muz. Șt. Nat. Piatra Neamț, Geol.-Geogr., **3**, 43–53 (in Romanian, French summary), Piatra Neamț.

Grasu, C., Catană, C., Turculeț, I. & Niță, M. (1995): Pétrographie mésozoïque du „Synclinal marginal externe“ (Petrografia mezozoicului din “Sinclinalul marginal extern”). – 192 p. (in Romanian), Bucharest (Ed. Acad. Rom.).

Grasu, C., Miclăuș, C., Brânzilă, M. & Baciu, D.S. (2010): Hășmaș Mountains. Geologic and physical geographic monography (Munții Hășmașului. Monografie geologică și fizico-geografică). – 434 p. (in Romanian), Iaşi (Ed. Univ. “A.I.Cuza” Iaşi).

Grgasović, T. & Sokač, B. (2003): Review on fossil dasycladacean associations in the Triassic of Croatia. – Acta Micropalaeont. Sinica, **20**, 75–79, Beijing.

Grill, J. (1988): Jurassic formations of the Rudabánya Mts. – Ann. Rep. Geol. Inst. Hung., **1986**, 69–103 (in Hungarian, English summary), Budapest.

Grill, J. (1989): Structural evolution of the Aggtelek-Rudabánya Mountains, NE Hungary. – Ann. Rep. Geol. Inst. Hung., **1987**, 411–432 (in Hungarian, English summary), Budapest.

Grill, J., Kovács, S., Less, Gy., Réti, Zs., Róth, L. & Szentpétery, I. (1984): Geology and evolution of the Aggtelek-Rudabánya Mts. – Földtani Kutatás, **24**/4, 49–56 (in Hungarian, English summary), Budapest.

Grubić, A. (1995): Schistes lustrés in the Kopaonik area. – In: Dokmanović, B. & Rakić, B. (Eds.): Geology and metallogeny of the Kopaonik Mt. – Symposium, Kopaonik-Belgrade, 159–168 (in Serbian, English summary), Belgrade (Republ. Društv. Fond Geol. Istr. Srbije).

Grubić, A. & Protić, Lj. (2000): Deep-water Triassic sediments of the Vardar Zone and Fruška Gora Mt. – In: Karamata, S. & Janković, S. (Eds): Proceedings of the International Symposium “Geology and metallogeny of the Dinarides and the Vardar Zone”. – Acad. Sci. Arts Repub. Srpska, Collect. and Monogr., I, Dep. Nat., Math. Tech. Sci., **1**, 87–92, Banja Luka – Srb. Sarajevo.

Haas, J. (1994): Carnian basin evolution in the Transdanubian Central Range, Hungary. – Zentralbl. Geol. Paläont. Teil I., **1994**, 1233–1252, Stuttgart.

Haas, J. (2002): Origin and evolution of Late Triassic backplatform and intraplatform basins in the Transdanubian Range, Hungary. – Geol. Carpathica, **53**, 159–178, Bratislava.

Haas, J. & Budai, T. (1995): Upper Permian-Triassic facies zones in the Transdanubian Range. – Riv. Ital. Paleontol. Stratigr., **101**, 249–266, Milan.

Haas, J. & Demény, A. (2002): Early dolomitisation of Late Triassic platform carbonates in the Transdanubian Range (Hungary). – Sed. Geol., **151**, 225–242, Amsterdam.

Haas, J. & Kovács, S. (2001): The Dinaridic-Alpine connection – as seen from Hungary. – Acta Geol. Hung., **44**, 345–362, Budapest.

Haas, J. & Péró, Cs. (2004): Mesozoic evolution of the Tisza Mega-unit. – Int. Journ. Earth Sci., **93**, 297–313, Berlin.

Haas, J., Tóthné Makk, Á., Góczán, F., Oraveczné Scheffer, A., Oravecz, J. & Szabó, I. (1988): Lower Triassic key sections in the Transdanubian Mid-Mountains. – Ann. Inst. Geol. Hung., **65**/2, 1–356 (in Hungarian, English summary), Budapest.

Haas, J., Kovács, S., Krystyn, L. & Lein, R. (1995a): Significance of Late Permian-Triassic facies zones in terrane reconstructions in the Alpine-North Pannonian domain. – Tectonophysics, **242**, 19–40, Amsterdam.

Haas, J., Kovács, S. & Török, Á. (1995b): Early Alpine shelf evolution in the Hungarian segment of the Tethys margin. – Acta Geol. Hung., **38**, 95–110, Budapest.

Haas, J., Tardiné Filácz, E., Oraveczné Scheffer, A., Góczán, F. & Dosztály, L. (1997): Stratigraphy and sedimentology of an Upper Triassic toe-of-slope and basin succession at Csővár-1, North Hungary. – Acta Geol. Hung., **40**, 111–177, Budapest.

Haas, J., Korpás, L., Török, Á., Dosztály, L., Góczán, F., Hámor-Vidó, M., Oravecz-Scheffer, A. & Tardi-Filácz, E. (2000a): Upper Triassic basin and slope facies in the Buda Mts. based on study of core drilling Vérhalom tér, Budapest. – Földt. Közl., **130**, 371–421 (in Hungarian), Budapest.

Haas, J., Mioč, P., Pamić, J., Tomljenović, B., Árkai, P., Bérczi-Makk, A., Koroknai, B., Kovács, S. & Rálisch-Felgenhauer, E. (2000b): Complex structural pattern of the Alpine-Dinaridic-Pannonian triple junction. – Int. Journ. Earth Sci. Abstr., **89**, 377–389, Berlin.

Haas, J. (Ed.), Bérczi-Makk, A., Budai, T., Harangi, Sz., Hips, K., Józsa, S., Konrád, Gy., Kovács, S., Less, Gy., Pelikán, P., Pentelényi, L., Piros, O., Rálisch-Felgenhauer, E., Török, Á. & Velledits, F. (2004): Geology of Hungary. Triassic (Magyarország geológiája. Triász). – 384 p. (in Hungarian), Budapest (Eötvös Kiadó).

Haas, J., Kovács, S., Gawlick, H.-J., Grădinaru, E., Karamata, S., Sudar, M., Péró, Cs., Mello, J., Polák, M., Ogorelec, B. & Buser, S. (2011): Jurassic evolution of the tectonostratigraphic units of the Circum-Pannonian region. – Jb. Geol. B.-A., **151**/3–4, 281–354, Vienna.

Hagdorn, H., Konrád, Gy. & Török, Á. (1997): Crinoids from the Muschelkalk of the Mecsek Mountains and their stratigraphical significance. – Acta Geol. Hung., **40**, 391–410, Budapest.

Hagemeister, A. (1988): Zyklische Sedimentation auf einer stabilen Karbonatplattform: die Raibler Schichten (Karn) des Drauzuges/Kärnten (Österreich). – Facies, **18,** 83–122, Erlangen.

Halamić, J. & Goričan, Š. (1995): Triassic radiolarites from Mts. Kalnik and Medvednica (Northwestern Croatia). – Geol. Croatica, **48**, 129–146, Zagreb.

Halamić, J., Goričan, Š., Slovenec, D. & Kolar-Jurkovšek, T. (1999): A middle Jurassic radiolarite-clastic succession from the Medvednica (northwestern Croatia). – Geol. Croatica, **52**, 29–57, Zagreb.

Harangi, Sz., Szabó, Cs., Józsa, S., Szoldán, Zs., Árváné Sós, E., Balla, M. & Kubovics, I. (1996): Mesozoic igneous suites in Hungary: implications for genesis and tectonic setting in the nort-western part of Tethys. – Int. Geol. Rev., **38**, 336–360, London.

HAUBOLD, H., SCHOLGER, R., FRISCH, W., SUMMESBERGER, H. & MAURITSCH, H.J. (1999): Reconstruction of the geodynamic evolution of the Northern Calcareous Alps by means of paleomagnetism. – Phys. Chem. Earth., **24**, 697–703, Oxford.

HÄUSLER, H., PLAŠIENKA, D. & POLÁK, M. (1993): Comparison of Mesozoic successions in the Central Eastern Alps and the Central Western Carpathians. – Jb. Geol. B.-A., **136**, 715–739, Vienna.

HAVRILA, M. (1993): Contribution to solution of paleogeography of the Hronicum sedimentation area. – In: ERDÉLYI, G. & VETŐ, I. (Eds.): 8th Meeting of the Association of European Geological Societies, Abstract of papers. – p. 22, Budapest (Hungarian Geological Society).

HAVRILA, M. & BUČEK, S. (1992): Slope detrital sediments of the Hronic unit (Svahové detritické sedimenty hronika. Čiast. záver. Správa). – Manuscript, Archive, 22 p. (in Slovak), Bratislava (Geol. Ústav D. Štúra).

HAVRILA, M. & OŽVOLDOVÁ, L. (1996): Meliaticum in the Stratenská hornatina Hills. – Slovak Geol. Mag., **2**, 335–339, Bratislava.

HERAK, M. (1974): Paläogeographie und Fazies-Entwicklung während der Trias in den Dinariden Kroatiens. – Schriftr. Erdwiss. Komm. Österr. Akad. Wiss., **2**, 101–106, Wien (Springer-Verlag).

HIPS, K. (1996): Stratigraphical and facies evaluation of the Lower Triassic formations in the Aggtelek-Rudabánya Mountains, NE Hungary. – Acta Geol. Hung., **39**, 369–411, Budapest.

HIPS, K. (1998): Lower Triassic storm-dominated ramp sequence in northern Hungary: an example of evolution from homoclinal through distally steepened ramp to Middle Triassic flat-topped platform. – In: WRIGHT, V.P. & BURCHETTE, T.P. (Eds.): Carbonate Ramps. – Geol. Soc. London, Spec. Publ., **149**, 315–338, London.

HIPS, K. (2001): The structural setting of Lower Triassic formations in the Aggtelek-Rudabánya Mountains (Northeastern Hungary) as revealed by geologic mapping. – Geol. Carpathica, **52**, 287–299, Bratislava.

HIPS, K. & PELIKÁN, P. (2002): Lower Triassic shallow marine succession in the Bükk Mountains, NE Hungary. – Geol. Carpathica, **53**, 351–367, Bratislava.

HIPS, K., HAAS, J., VIDÓ, M., BARNA, ZS., JOVANOVIĆ, D., SUDAR, M.N. & SIKLÓSY, Z. (2010): Selective blackening of bioclasts via mixing-zone aragonite neomorphism in Late Triassic Limestone, Zlatibor Mountains, Serbia. – Sedimentology, **58**, 854–877, Oxford. http://dx.doi.org/10.1111/j.1365-3091.2010.01186.x

HOECK, V., IONESCU, C., BALINTONI, I. & KOLLER, F. (2009): The Eastern Carpathians "ophiolites" (Romania): Remnants of a Triassic ocean. – Lithos, **108**, 151–171, Amsterdam.

HOHENEGGER, J. & LEIN, R. (1977): Die Reiflinger Schichten des Schneeberg-Nordostabfalles und ihre Foraminiferenfauna. Teil 1: Geologie, Stratigraphie und Systematik (exklusive Lagenina). – Mitt. Ges. Geol. Bergbaustud. Österr., **24**, 203–261, Wien.

HORNUNG, T., BRANDNER, R., KRYSTYN, L., JOACHIMSKI, M. & KEIM, L. (2007): Multistratigraphic constraints of the NW Tethyan "Carnian Crisis". – In: LUCAS, S.G. & SPIELMANN, J.A. (Eds.): The Global Triassic. – New Mexico Museum Nat. Hist. & Science Bull., **41**, 59–67, Albuquerque, NM.

HORVÁTH, F. (1993): Towards a quantitative model for the Pannonian Basin. – Tectonophysics, **226**, 333–358, Amsterdam.

HORVÁTH, P. (2000): Metamorphic evolution of gabbroic rocks of the Bódva Valley Ophiolite Complex, NE Hungary. – Geol. Carpathica, **51**, 121–129, Bratislava.

HORVÁTH, P. & ÁRKAI, P. (2002): Pressure-temperature path of metapelites from the Algyő-Ferencszállás area, SE Hungary: thermobarometric constraints from coexisting mineral assemblages and garnet zoning. – Acta Geol. Hung., **45**, 1–27, Budapest.

HOVORKA, D. (1985): Ultramafic rocks of the Western Carpathians, Czechoslovakia. – 259 p., Bratislava (Geol. Ústav D. Štúra).

HRVATOVIĆ, H. (1999): Geological guide through Bosnia and Herzegovina (Geološki vodić kroz bosnu i Hercegovinu). – Geol. Glasn., **24**, 1–204 (in Bosnian), Sarajevo (Geol. Surv. Fed. Bosnia & Herzegovina).

IANOVICI, V., BORCOŞ, M., PATRULIUS, D., LUPU, M., DIMITRESCU, R. & SAVU, H. (1976): La géologie des Monts Apuseni. – 631 p. (in Romanian, French summary), Bucharest (Ed. Acad. Rom. Soc. Rep.).

IONESCU, C., HOECK, V., TOMEK, C., KOLLER, F., BALINTONI, I. & BEŞUŢIU, L. (2009): New insights into the basement of the Transylvanian Depression (Romania). – Lithos, **108**, 172–191, Amsterdam.

IORDAN, M. (1978): The Triassic brachiopods from Rarău Syncline and the Perşani Mountains areas. – Dări de Seamă, Inst. Geol. Geofiz., **64**/3, 69–84, Bucharest.

IVAN, P. (2002): Relics of the Meliata ocean crust: geodynamic implications of mineralogical, petrological and geochemical proxies. – Geol. Carpathica, **53**, 245–256, Bratislava.

IVAN, P. & KRONOME, B. (1996): Protolith and geodynamic setting of the HP/LT metamorphosed basic rocks from the northern margin of the Bôrka nappe (Meliatic Unit, Inner Western Carpathians). – Slovak Geol. Mag., **3–4**, 331–334, Bratislava.

IVAN, P. & MELLO, J. (2001): Tectonic subunits in the Bôrka Nappe (Inner Western Carpathians): Their lithostratigraphy and original position in the structure of the ancient Meliata ocean basin. – Geolines, **13**, 64–65, Praha.

JADOUL, F. (1985): Norian stratigraphy and palaeogeography of the Western Bergamo Prealps (Stratigrafia e palaeogeografia del Norico nelle Prealpi Bergamasche occidentali). – Riv. Ital. Paleontol. Stratigr., **91**, 479–511 (in Italian), Milan.

JADOUL, F., BERRA, F. & FRISIA, S. (1992): Stratigraphic and paleontologic evolution of a carbonate platform in an extensional tectonic regime: example of the Dolomia Principale in Lombardy (Italy). – Riv. Ital. Paleontol. Stratigr., **98**, 29–44 (in Italian, English summary), Milan.

JADOUL, F., GALLI, M.T., BERRA, F., CIRILLI, S., RONCHI, P. & PAGANONI, A. (2004): The Late Triassic-Early Jurassic of the Lombardy Basin: stratigraphy, palaeogeography and palaeontology. – Field Trip Guide Book, p. 68, 32nd International Geological Congress (Florence, 2004), **6**, 1–36, Rome.

JANOČKO, J., PERESZLÉNYI, M., VASS, D., BEZÁK, V., JACKO, S.JR., JACKO, S., KOHÚT, M., POLÁK, M. & MELLO, J. (2006): Geology and hydrocarbon resources of the Inner Western Carpathians, Slovakia and Poland. – In: GOLONKA, J. & PICHA, F.J. (Eds.): The Carpathians and their Foreland. Geology and hydrocarbon resources. – AAPG Memoir, **84**, 569–603, Tulsa, OK.

JEKELIUS, E. (1936): Der weisse Triaskalk von Braşov und seine Fauna. – An. Inst. Com. Geol. Rom., **17** (1932), 1–106, Bukarest.

JELASKA, V., KOLAR-JURKOVŠEK, T., JURKOVŠEK, B. & GUŠIĆ, I. (2003): Triassic beds in the basement of the Adriatic-Dinaridic carbonate platform of Mt. Svilaja (Croatia). – Geologija, **46**, 225–230, Ljubljana.

JELEN, B. (1990): The Karnian bivalves (Mollusca) from Lesno brdo, Slovenia, NW Yugoslavia and their paleobiological significance. – Geologija, **31/32**, 11–27 (in Slovenian, English summary), Ljubljana.

JELEN, M. & KUŠEJ, J. (1982): Quantitative palynological analysis of Julian clastic rocks from the lead-zinc deposit of Mežica. – Geologija, **25**, 213–227, Ljubljana.

JÓZSA, S., DOSZTÁLY, L., GULÁCSI, Z. & KOVÁCS, S. (1996): Ophiolites of Szarvaskő, Darnó Hill and Bódva Valley. – In: [org. by] OMFB [et al.]: Workshop "Magmatic Events in Rifted Basins" under the aegis of IGCP. – Project 369 (1996, Budapest, Mecsek, Bükk), p. 16, Budapest (OMFB [Hungarian National Committee for Technological Development]).

JURCSÁK, T. (1978): Des nouveaux résultats dans l'étude des Sauriens fossiles d'Aleşd (départ. Bihor, Roumanie). – Nymphaea, **6**, 15–60 (in Romanian, French summary), Oradea.

JURKOVŠEK, B. (1978): Biostratigraphy of the Carnian beds in the Mežica area. – Geologija, **21**, 173–208 (in Slovenian, English summary), Ljubljana.

JURKOVŠEK, B. (1983): Fassanian beds with daonellas in Slovenia (Fassanske plasti z daonelami v Sloveniji). – Geologija, **26**, 29–70.

JURKOVŠEK, B. (1984): Langobardian beds with daonellas and posidonias in Slovenia (Langobardske plasti z daonelami in pozidonijami v Sloveniji). – Geologija, **27**, 41–95.

JURKOVŠEK, B. (1993): Karnijske plasti s školjkami južno od Rovt. – Geologija, **36**, 195–205.

JURKOVŠEK, B. & JELEN, B. (1989): Fossil lamellibranchs from the Carnian beds at Orle (Fosilne školjke iz karnijskih plasti pri Orlah). – Geologija, **31/32**, 129–132.

JURKOVŠEK, B. & KOLAR-JURKOVŠEK, T. (1986): A Late Triassic (Carnian) fish skeleton (family Birgeriidae) from Slovenia, NW Yugoslavia. – Neues Jb. Geol. Paläontol., Monatsh., **8**, 475–478.

JURKOVŠEK, B. & KOLAR-JURKOVŠEK, T. (1997): Carnian crinoids from the Mežica area (Karnijski krinoidi iz okolice Mežice). – Razpr. Slov. akad. znan. umet., Razr. naravosl. vede, **38**, 33–71.

JURKOVŠEK, B., OGORELEC, B., KOLAR-JURKOVŠEK, T., JELEN, B., ŠRIBAR, L. & STOJANOVIČ, B. (1984): The geological structure of the area south of Vršič with special regard to the development of Carnian beds. – Rud. Met. zb., **31**, 301–334 (in Slovenian, English summary), Ljubljana.

KAIM, A., JURKOVŠEK, B. & KOLAR-JURKOVŠEK, T. (2006): New associations of Carnian gastropods from Mežica region in the Karavanke Mountains of Slovenia. – Facies, **52**, 469–482, Berlin – Heidelberg.

KARAMATA, S. (2006): The geological development of the Balkan Peninsula related to the approach, collision and compression of Gondwanan and Eurasian units. – In: ROBERTSON, A.H.F. & MOUNTRAKIS, D. (Eds.): Tectonic development of the Eastern Mediterranean Region. – Geol. Soc. London, Spec. Publ., **260**, 155–178, London.

KARAMATA, S. & KRSTIĆ, B. (1996): Terranes of Serbia and neighbouring areas. – In: KNEŽEVIĆ, V. & KRSTIĆ, B. (Eds.): Terranes of Serbia: The formation of the geologic framework of Serbia and the adjacent regions. – 25–40, Beograd (Facult. Min. Geol., Univ. Belgrade, Comm. Geod., Serbian Acad. Sci. Arts).

KARAMATA, S., KRSTIĆ, B., DIMITRIJEVIĆ, M.D., DIMITRIJEVIĆ, M.N., KNEŽEVIĆ, V., STOJANOV, R. & FILIPOVIĆ, I. (1997): Terranes between the Moesian plate and the Adriatic Sea. – In: PAPANIKOLAU, D. & SASSI, F.P. (Eds.): IGCP Project 276, Terrane maps and terrane descriptions. – Ann. Géol. Pays Helléniques, 1e Sér., **37**, 429–477, Athens.

KARAMATA, S., DIMITRIJEVIĆ, M.N. & DIMITRIJEVIĆ, M.D. (1999): Oceanic realms in the central part of the Balkan Peninsula during the Mesozoic. – Slovak Geol. Mag., **5**, 173–177, Bratislava.

KARAMATA, S., OLUJIĆ, J., PROTIĆ, LJ., MILOVANOVIĆ, D., VUJNOVIĆ, L., POPEVIĆ, A., MEMOVIĆ, E., RADOVANOVIĆ, Z. & RESIMIĆ-ŠARIĆ, K. (2000): The Western Belt of the Vardar Zone – the remnant of a marginal sea. – In: KARAMATA, S. & JANKOVIĆ, S. (Eds.): Proceedings of the International Symposium “Geology and metallogeny of the Dinarides and the Vardar Zone”. – Acad. Sci. Arts Repub. Srpska, Collect. and Monogr., I, Dep. Nat., Math. Tech. Sci., **1**, 131–135, Banja Luka – Srb. Sarajevo.

KARAMATA, S., VASIĆ, N., OLUJIĆ, J., VISHNEVSKAYA, V., MARCHENKO, T., VUJNOVIĆ, L. & MICIĆ, V. (2004): The bedded chert sequence of Uzlomac (Bosnia) an association formed at the continental slope beneath the Dinaridic Upper Triassic-Jurassic carbonate platform. – Bulletin T. **119**, Serbian Acad. Sci. Arts, Cl. Sci. Math. Nat., Sci. Nat., **42**, 363–378, Belgrade.

KÁZMÉR, M. & KOVÁCS, S. (1985): Permian-Paleogene paleogeography along the eastern part of the Insubric-Periadriatic Lineament system: evidence for continental escape of the Bakony-Drauzug. – Acta Geol. Hung., **28**, 71–84, Budapest.

KEMENCI, R. & ČANOVIĆ, M. (1997): Geologic setting of the Pre-Tertiary basement in Vojvodina. Part I: The Tisza Mega-Unit of North Vojvodina. – Acta Geol. Hung., **40**, 1–36, Budapest.

KILIAS, A., FRISCH, W., AVGERINAS, A., DUNKL, I., FALALAKIS, G. & GAWLICK, H.-J. (2010): Alpine architecture and kinematics of deformation of the northern Pelagonian nappe pile in the Hellenides. – Austrian J. Earth Sci., **103**, 4–28, Vienna.

KISS, G., MOLNÁR, F. & PALINKAŠ, L. (2008): Volcanic facies and hydrothermal processes in Triassic pillow basalts from the Darnó Unit, NE Hungary. – Geol. Croatica, **61**, 385–394, Zagreb.

KLISIĆ, M., MIĆIĆ, I., PAJIĆ, V., SIMIĆ, D. & KANDIĆ, M. (1972): Contribution to the stratigraphy of the Trepča metamorphic series. – Zapisnici Srp. Geol. Druš. za 1968, 1969 i 1970 (Zbor 10. XII. 1968), 105–107 (in Serbian, Cyrillic), Belgrade.

KOHÚT, M., PLAŠIENKA, D., PUTIŠ, M., IVAN, P., MÉRES, Š., HAVRILA, M., UHER, P. & MICHALÍK, J. (2008): Structure of the “core mountains” of western Slovakia (Malé Karpaty and Považský Inovec Mts.). – In: NÉMETH, Z. & PLAŠIENKA, D. (Eds.): Proceedings and Excursion Guide of SlovTec 08. – 6th Meeting of the CETeG & 13th Meet. of the Czech TSG, 2008, Upohlav, PKB, Slovakia, 59–186 (Havrila – Hronicum: 174–178), Bratislava (Štatny Geol. Ústav D. Štúra).

KOLAR-JURKOVŠEK, T. (1991): Microfauna of Middle and Upper Triassic in Slovenia and its biostratigraphic significance. – Geologija, **33**, 21–170 (in Slovenian, English summary), Ljubljana.

KOLAR-JURKOVŠEK, T. (2011): Latest Triassic conodonts of the Slovenian Basin and some remarks on their evolution. – Geologija, **54**/1, 83–92.

KOLAR-JURKOVŠEK, T. & JURKOVŠEK, B. (1996): Contribution to the knowledge of the Lower Triassic conodont fauna in Slovenia. – Razprave IV. razr. SAZU, **37**, 3–21, Ljubljana.

KOLAR-JURKOVŠEK, T. & JURKOVŠEK, B. (1997): *Valvasoria carniolica* n. gen. n. sp., a Triassic Worm from Slovenia. – Geologia Croatica, **50**/1, 1–5.

KOLAR-JURKOVŠEK, T. & JURKOVŠEK, B. (2003): *Clypeina besici* Pantić (Chlorophyta, Dasycladales) from the “Raibl Beds” of the Western Karavanke Mountains (Slovenia). – Geol. Carpathica, **54**, 237–242, Bratislava.

KOLAR-JURKOVŠEK, T. & JURKOVŠEK, B. (2007): First record of Hindeodus-Isarcicella population in Lower Triassic of Slovenia. – Palaeogeogr., Palaeoclimat., Palaeoecol., **252**, 72–81, Amsterdam.

KOLAR-JURKOVŠEK, T. & JURKOVŠEK, B. (2010): New paleontological evidence of the Carnian strata in the Mežica area (Karavanke Mts, Slovenia): conodont data for the Carnian pluvial event. – Palaeogeogr. Palaeoclimatol. Palaeoecol., **290**/1-4, 81–88. http://dx.doi.org/10.1016/j.palaeo.2009.06.015

KOLAR-JURKOVŠEK, T., BUSER, S. & JURKOVŠEK, B. (1983): Upper Triassic Beds of the Western Part of the Pokljuka Plateau (NW Yugoslavia). – Rud. Met. zb., **30**, 151–185 (in Slovenian, English summary), Ljubljana.

KOLAR-JURKOVŠEK, T., GAZDŹICKI, A. & JURKOVŠEK, B. (2005): Conodonts and foraminifera from the “Raibl Beds” (Carnian) of the Karavanke Mountains, Slovenia: stratigraphical and palaeobiological implications. – Geol. Quarterly, **49**, 429–438, Warsaw.

KONRÁD, GY. (1998): Synsedimentary tectonic events in Middle Triassic evolution of the SE Transdanubian part of Tisza Unit. – Acta Geol. Hung., **41**, 327–342, Budapest.

KOVÁČ, P. & HAVRILA, M. (1998): Inner structure of Hronicum. – Slovak Geol. Mag., **4**, 275–280, Bratislava.

KOVÁCS, S. (1979): Geological buildup of the South Gemerian Alsóhegy. – Őslénytani Viták, **24**, 33–58 (in Hungarian, English summary), Budapest.

KOVÁCS, S. (1983): The “Tisia problem” and the plate tectonic concept. Contributions based on the distribution of the early Mesozoic facies zones. – An. Inst. Geol. Geofiz., **60**, 75–83, Bucharest.

Kovács, S. (1984): North Hungarian Triassic facies types: A review. – Acta Geol. Hung., **27**, 251–264, Budapest.

Kovács, S. (1992): Tethys "western ends" during the Late Paleozoic and Triassic and their possible genetic relationships. – Acta Geol. Hung., **35**, 329–369, Budapest.

Kovács, S. (1994): Conodonts of stratigraphical importance from the Anisian/Ladinian boundary interval of the Balaton Highland, Hungary. – Riv. Ital. Paleontol. Stratigr., **99**, 473–514, Milan.

Kovács, S. (1997): Middle Triassic rifting and facies differentiation in Northeast Hungary. – In: Sinha, A.K. (Ed.): Geodynamic domains in the Alpine-Himalayan Tethys. – 375–397, New Delhi – Calcutta (Oxford & IBH Publishing Co. Pvt. Ltd.).

Kovács, S. (1998): Events preceding the opening of the Mesozoic Tethys in the East Mediterranean Region. – In: Papanikolaou, D. & Sassi, F.P. (Eds.): IGCP Project 276. – Newsletter No. 6, Geol. Soc. Greece, Spec. Publ. **3**, 122–139, Athens.

Kovács, S. (2011): Type section of the Triassic Bódvalenke Limestone Formation (Rudabánya Mts., NE Hungary) – the northwesternmost occurrence of a Neotethyan deep water facies. – Central European Geology, **53**/2–3 (2010), 121–133, Budapest.

Kovács, S. & Hips, K. (1998): Stratigraphy of the Late Paleozoic formations of the Bükk and Aggtelek-Rudabánya Mountains (A Bükk és az Aggtelek-Rudabányai hegység újpaleozóos képződményeinek rétegtana). – In: Bérczi, I. & Jámbor, Á. (Eds.): Stratigraphy of the Hungarian Geological Formations (Magyarország geológiai képződményeinek rétegtana). – 149–153 (in Hungarian), Budapest (MOL Rt. – Magyar Áll. Földt. Int.).

Kovács, S. & Rálisch-Felgenhauer, E. (2005): Middle Anisian (Pelsonian) platform Conodonts from the Triassic of the Mecsek Mts. (South Hungary). Their taxonomy and stratigraphic significance. – Acta Geol. Hung., **48**, 69–105, Budapest.

Kovács, S., Less, Gy., Piros, O., Réti, Zs. & Róth, L. (1989): Triassic formations of the Aggtelek-Rudabánya Mountains (Northeastern Hungary). – Acta Geol. Hung., **32**, 31–63, Budapest.

Kovács, S., Szederkényi, T., Haas, J., Buda, Gy., Császár, G. & Nagymarosy, A. (2000): Tectonostratigraphic terranes in the pre-Neogene basement of the Hungarian part of the Pannonian area. – Acta Geol. Hung., **43**, 225–328.

Kovács, S., Less, Gy., Hips, K., Piros, O. & Józsa, S. (2004): Aggtelek-Rudabánya Units (Aggtelek–Rudabányai egységek). – In: Haas, J. (Ed.): Geology of Hungary. Triassic (Magyarország geológiája. Triász). – 197–288 (in Hungarian), Budapest (Eötvös Kiadó).

Kovács, S., Rálisch-Felgenhauer, E. & Bóna, J. (2006): Conodont colour alteration related to a half-graben structure: an example from the Mesozoic of the Mecsek and Villány Hills area (Tisza Megaunit, Southern Hungary). – Geol. Carpathica, **57**, 257–268, Bratislava.

Kovács, S., Haas, J., Szebényi, G., Gulácsi, Z., Józsa, S., Pelikán, P., Bagoly-Árgyelán, G., Görög, Á., Ozsvárt, P., Gecse, Zs. & Szabó, I. (2008a): Permo-Mesozoic formations of the Recsk-Darnó Hill area: stratigraphy and structure of the Pre-Tertiary basement of the Paleogene Recsk Ore Field. – Geosciences (Publ. Univ. Miskolc), ser. A, Mining, **73**, 33–56, Miskolc.

Kovács, S., Gawlick, H.-J., Haas, J., Missoni, S., Ozsvárt, P. & Suzuki, H. (2008b): New Triassic and Jurassic biostratigraphic constraints for precision of the age of Darnó ophiolitic mélange (NE Hungary). – Journal of Alpine Geology, **49**, 57, Vienna.

Kovács, S., Haas, J., Ozsvárt, P., Palinkaš, L., Kiss, G., Molnár, F., Józsa & Kövér Sz. (2011): Re-evaluation of the Mesozoic complexes of Darnó Hill (NE Hungary) and comparisons with Neotethyan accretionary complexes of the Dinarides and Hellenides – preliminary data. – Central European Geology, **53**/2-3 (2010), 205-231, Budapest.

Kövér, Sz., Fodor, L. & Kovács, S. (2008): Structural position and sedimentary connections of Jurassic formations of the Rudabánya Hills – an overview of old conceptions and a new working hypothesis. – Ann. Rep. Geol. Inst. Hung., **2006**, 97–120 (in Hungarian, English summary), Budapest.

Kövér, Sz., Haas, J., Ozsvárt, P., Görög, Á., Götz, A.E. & Józsa, S. (2009): Lithofacies and age data of Jurassic foreslope and basin sediments of Rudabánya Hills (NE Hungary) and their tectonic interpretation. – Geol. Carpathica, **60**, 351–379, Bratislava.

Kozur, H. (1991): The evolution of the Meliata-Hallstatt ocean and its significance for the early evolution of the Eastern Alps and Western Carpathians. – Palaeogeogr., Palaeoclimat., Palaeoecol., **87**, 109–135, Amsterdam.

Kozur, H. (1999): The correlation of the Germanic Buntsandstein and Muschelkalk with the Tethyan Scale. – In: Bachmann, G.I. & Lerche, I. (Eds.): Epicontinental Triassic. – Zentralbl. Geol. Paläont. Teil I., **1999**, 701–726, Stuttgart.

Kozur, H. & Mock, R. (1973): Zum Alter und zur tektonischen Stellung der Meliata-Serie des Slowakischen Karstes. – Geol. Zborn. Geol. Carpathica, **24**, 365–374, Bratislava.

Kozur, H. & Mostler, H. (1992): Erster paläontologischer Nachweis von Meliaticum und Süd-Rudabányaicum in den Nördlichen Kalkalpen (Österreich) und ihre Beziehungen zu den Abfolgen in den Westkarpaten. – Geol. Paläont. Mitt. Innsbruck, **18**, 87–129, Innsbruck.

Kozur, H. & Réti, Zs. (1986): The first paleontological evidence of Triassic ophiolites in North Hungary. – N. Jb. Geol. Paläont., **5**, 284–292, Suttgart.

Krainer, K. (1985a): Beitrag zur Mikrofazies, Geochemie und Paläogeographie der Raibler Schichten der östlichen Gailtaler Alpen und des Karwendel. – Arch. f. Lagerst.forsch. Geol. B.-A., **6**, 129–142, Wien.

Krainer, K. (1985b): Zur Sedimentologie des Alpinen Buntsandsteins und der Werfener Schichten (Skyth) Kärntens. – Geol. Paläont. Mitt. Innsbruck, **14**/2, 21–81, Innsbruck.

Kräutner, H.-G. & Bindea, G. (1998): Timing of the Ditrău Alkaline intrusive Complex (Eastern Carpathians, Romania). – Slovak Geol. Mag., **4**, 213–221, Bratislava.

Krivic, K. & Buser, S. (1979): Excursion M. Hudajužna in the Bača Valley – Carnian stage. – In: Drobne, K. (Ed.): Guidebook 16th European Micropaleontol. Colloq. Zagreb-Bled. – 229–232, Ljubljana (Croat. Geol. Soc. & Slov. Geol. Soc.).

Kronome, B. (2002): Some constraints to internal division of the Meliata Unit s.l. (Inner Western Carpathians, Slovakia) based on petrographic study and field relations. – Geol. Carpathica, **53**, Spec. Issue, CD-ROM, Bratislava.

Krystyn, L. with contributions by B. Plöchinger & H. Lobitzer (1980): Triassic Conodont localities in the Salzkammergut Region (Northern Calcareous Alps). – In: Schönlaub, H.P. (Ed.): Second European Conodont Symposium – ECOS II. – Field-Trip B, Abh. Geol. B.-A., **35**, 61–98, Vienna.

Krystyn, L. (1987): Zur Rhät-Stratigraphie in den Zlambachschichten (vorläufiger Bericht). – Sitzungber. Österr. Akad. Wiss., Math.-natw. Kl., Abt. 1, **196**, 21–36, Wien.

Krystyn, L. (1991): Die Fossillagerstätten der alpinen Trias. – In: Nagel, D. & Rabeder, G. (Ed.): Exkursionen im Jungpaläozoikum und Mesozoikum Österreich. – 24–78, Wien (Österr. Paläont. Ges.).

Krystyn, L. (1999): The northwestern margin of the Triassic Tethys – an overview. – Tübinger Geowiss. Arbeiten, Reihe A, **52**, 86–87, Tübingen.

Krystyn, L. (2008): The Hallstatt pelagics – Norian and Rhaetian Fossillagerstaetten of Hallstatt. – Ber. Geol. B.-A., **76**, 81–98, Vienna.

Krystyn, L. & Lein, R. (1996): Triassische Becken- und Plattformsedimente der östlichen Kalkalpen. – Exkursionsführer Sediment '96, Ber. Geol. B.-A., **33**, 1–23, Wien.

Krystyn, L., Schäffer, G. & Schlager, W. (1971): Über die Fossil-Lagerstätten in den triadischen Hallstätter Kalken der Ostalpen. – N. Jb. Geol. Paläont. Abh., **137**, 284–304, Stuttgart.

Krystyn, L., Lein, R., Mello, J., Riedel, P. & Piller, W. (1990): “Tisovec Limestone” – an example of the problems of lithostratigraphic correlation between the Northern Calcareous Alps and the central West Carpathians. – In: Minaríková, D. & Lobitzer, H. (Eds.): Thirty years of geological cooperation between Austria and Czechoslovakia. – 125–136, Vienna-Prague (Federal Geological Survey Vienna, Geological Survey Prague).

Krystyn, L., Lein, R., Schlaf, J. & Bauer, F.K. (1994): Über ein neues obertriadisch-jurassisches Intraplattformbecken in den Südkarawanken. – In: Lobitzer, H., Császár, G. & Daurer, A. (Eds.): Jubiläumsschrift 20 Jahre Geologische Zusammenarbeit Österreich – Ungarn, Teil 2. – 409–416, Wien – Budapest (Geol. B.-A. – Magyar Áll. Földt. Int.).

Krystyn, L., Bouquerel, H., Kuerschner, W., Richoz, S. & Gallet, Y. (2007): Proposal for a candidate GSSP for the base of the Rhaetian stage. – In: Lucas, S.G. & Spielmann, J.A. (Eds.): The Global Triassic. – New Mexico Museum Nat. Hist. & Science Bull., **41**, 189–199, Albuquerque, NM.

Krystyn, L., Mandl, G.W. & Schauer, M. (2009): Growth and termination of the Upper Triassic platform margin of the Dachstein area (Northern Calcareous Alps, Austria). – Austrian Journ. of Earth Sci., **102**, 23–33, Vienna.

Kubovics, I., Szabó, Cs., Harangi, Sz. & Józsa, S. (1990): Petrology and petrochemistry of Mesozoic magmatic suites in Hungary and adjacent areas, an overview. – Acta Geod. Geoph. Mont. Hung., **25**, 345–371, Budapest.

Kühn, O. (1936): Die Anthozoen, Hydrozoen, Tabulaten und Bryozoen der Trias von Brașov (Kronstadt). – An. Inst. Com. Geol. Rom., **17** (1932), 109–132, Bukarest.

Lein, R. (1981): Deckschollen aus Hallstätter Buntkalken in Salzbergfazies in den Mürztaler Alpen südlich von Mariazell (Steiermark). – Mitt. Ges. Geol. Bergbaustud. Österr., **27**, 207–235, Wien.

Lein, R. (1982): Paläogeographie und tektonische Deformation des Aflenzer Troges im Bereich der westlichen Mürztaler Alpen südlich Mariazell (Steiermark). – Jahresbericht 1981 Hochschulschwerpkt S **15**, 203–221, Leoben.

Lein, R. (1985): Das Mesozoikum der Nördlichen Kalkalpen als Beispiel eines gerichteten Sedimentationsverlaufes infolge fortschreitender Krustenausdünnung. – Arch. f. Lagerst.forsch. Geol. B.-A., **6**, 117–128, Wien.

Lein, R. (1987): Evolution of the Northern Calcareous Alps during Triassic times. – In: Flügel, H.W. & Faupl, P. (Eds.): Geodynamics of the Eastern Alps. – 85–102, Vienna (Franz Deuticke).

Lein, R. (1989): Neufassung des Begriffes Raminger Kalk (Oberladin–Unterkarn) auf mikrofazieller Grundlage. – In: Krainer, K. (Ed.): 4. Treffen dtsprach. Sedimentologen, Innsbruck 1989. – Zentralbl. Geol. Paläont., Teil I, 1989, **9**/10, 2 S., Stuttgart.

Lein, R. (2000): Die Hallstätter Trias der Mürztaler Alpen. – Mitt. Ges. Geol. Bergbaustud. Österr., **44**, 289–296, Wien.

Lein, R. (2001): Neue Daten zur Mitteltrias-Schichtfolge des Semmeringsystems. – Arbeitstagung der Geol. B.-A. 2001 (Neuberg a.d. Mürz), 61–62, Wien (Geol. B.-A.).

Lein, R. & Gawlick, H.-J. (1999): Die tektonische Stellung der Hallstätter Schichtfolge des Naßwald-Halbfensters – Neuergebnisse auf der Grundlage von stratigraphischen, faziellen und Conodont Colour Alteration Index (CAI) Untersuchungen (Ober-Trias, Nördliche Kalkalpen). – Mitt. Ges. Geol. Bergbaustud. Österr., **42**, 181–186, Wien.

Lein, R. & Gawlick, H.-J. (2003): Zur tektonischen Stellung der Basalschuppen der Kalkkögel (Brenner-Mesozoikum) auf der Basis von Conodont Colour Alteration Index (CAI)-Untersuchungen. – Arbeitstagung der Geol. B.-A. 2003 (Blatt 148 Brenner), 111–116, Wien (Geol. B.-A.).

Lein, R. & Gawlick, H.-J. (2008): Plattform-Drowning im mittleren Anis – ein überregionaler Event. – Journal of Alpine Geology, **49**, 61–62, Wien.

Lein, R., Gawlick, H.-J. & Krystyn, L. (1997): Paläogeographie und tektonische Herkunft des Drauzuges – Eine Diskussion auf der Basis von Fazies- und Conodont Colour Alteration Index (CAI)-Untersuchungen. – Zentralbl. Geol. Paläont. Teil I., **1996**, 471–483, Stuttgart.

Lein, R., Gawlick, H.-J. & Krystyn, L. (2010): Die Annaberger Wende: Neudefinition der Annaberg-Formation als Ausdruck der ersten Öffnungsphase der Neotethys im Bereich der Ostalpen. – Journal of Alpine Geology, **52**, 165–166, Wien.

Lelkes-Felvári, Gy., Frank, W. & Schuster, R. (2003): Chronological constraints on Variscan, Permian-Triassic and eo-Alpine (Cretaceous) evolution of the Great Hungarian Plain basement. – Geol. Carpathica, **54**, 299–315, Vienna.

Leško, B. & Varga, I. (1980): Alpine elements in the West Carpathian structure and their significance. – Miner. Slovaca, **12**, 97–130, Bratislava.

Less, Gy. (2000): Polyphase evolution of the structure of the Aggtelek-Rudabánya Mountains (NE Hungary), the southernmost element of the Inner Western Carpathians – a review. – Slovak Geol. Mag., **6**, 260–268, Bratislava.

Less, Gy. & Mello, J. (Eds.), Elečko, M., Kovács, S., Pelikán, P., Pentelényi, L., Peregi, Zs., Pristaš, J., Radócz, Gy., Szentpétery, I., Vass, D., Vozár, J. & Vozárová, A. (2004): Geological map of the Gemer-Bükk Area 1:100.000. – Budapest (Hung. Geol. Inst).

Linzer, H.G., Ratschbacher, L. & Frisch, W. (1995): Transpressional collision structures in the upper crust: the fold-thrust belt of the Northern Calcareous Alps. – Tectonophysics, **242**, 41–61, Amsterdam.

Lobitzer, H. (1974): Fazielle Untersuchung an norischen Karbonatplattformbecken (Dachsteinkalk – Aflenzer Kalk) im südöstlichen Hochschwabgebiet (Nördliche Kalkalpen, Österreich). – Mitt. Geol. Ges. Wien, **66/67**, 75–92, Wien.

Lucas, S.G., Kolar-Jurkovšek, T. & Jurkovšek, B. (2008): First record of a fossil amphibian in Slovenia (Lower Triassic, Olenekian). – Riv. Ital. Paleontol. Stratigr., **114**, 323–326, Milan.

Lupu, M. (1983): The Mesozoic history of the South Apuseni Mountains. – An. Inst. Geol. Geofiz., **60**, 115–124, Bucharest.

Lupu, M. & Lupu, D. (1967): La présence du Werfénien dans les Carpates Méridionales centrales (Valea lui Stan). – Stud. Cerc. Geol., Geofiz., Geogr., ser. Geol., **12**, 461–464 (in Romanian, French summary), Bucharest.

Lupu, M. & Lupu, D. (1985): L’olistolite de calcaire néotriassique de Bejan (au Nord de Deva – Monts Apuseni du Sud). – Dări de Seamă, Inst. Geol. Geofiz., **69**/5, 37–40, Bucharest.

Lupu, M., Kräutner, H., Țicleanu, N., Boștinescu, S., Bandrabur, T., Kräutner, Fl., Horvath, A. & Nicolae, I. (1983): Geological map of R. S. Romania (Harta Geologică Republica Socialistă România), Sheet 89b, Deva 1:50.000. – Bucharest (Inst. Geol. Geofiz.).

Maheľ, M. (Ed.) (1973): Tectonic map of the Carpathian-Balkan mountain system and adjacent areas 1:1.000.000, Carpathian-Balkan Assoc. Tect. Commission. – Paris, Warsaw (Geol. Ústav D. Štúra, Bratislava/UNESCO).

Maheľ, M. (1984): The West Carpathians. – In: Maheľ, M. & Malkovský, M. (Eds.): Explanations to tectonic map of Czechoslovakia 1:500.000. – 29–50, Bratislava (Geol. Ústav D. Štúra).

Maheľ, M. (1986): Geological pattern of the Czechoslovak Carpathians – Paleoalpine Units 1 (Geologická stavba československých Karpát. Paleoalpínske jednotky 1). – 503 p. (in Slovak), Bratislava (Veda, Vyd. Slov. Akad. Vied).

Mandl, G.W. (1984): Zur Trias des Hallstätter Faziesraumes – ein Modell am Beispiel Salzkammergut (Nördliche Kalkalpen, Österreich). – Mitt. Ges. Geol. Bergbaustud. Österr., **30/31**, 133–176, Wien.

Mandl, G.W. (2000): The Alpine sector of the Tethyan shelf – Examples of Triassic to Jurassic sedimentation and deformation from the Northern Calcareous Alps. – Mitt. Österr. Geol. Ges., **92**, 61–77, Vienna.

Mandl, G.W. & Ondrejicková, A. (1991): Über eine triadische Tiefwasserfazies (Radiolarite, Tonschiefer) in den Nördlichen Kalkalpen – ein Vorbericht. – Jb. Geol. B.-A., **134**, 309–318, Wien.

Mandl, G.W. & Ondrejičková, A. (1993): Radiolarien und Conodonten aus dem Meliatikum im Ostabschnitt der Nördlichen Kalkalpen (Österreich). – Jb. Geol. B.-A., **136**, 841–871, Wien.

Mantea, Gh. (1969): Géologie de la partie nord-ouest des Monts Bihor (région de Ferice). – Stud. Cerc. Geol., Geofiz., Geogr., ser. Geol., **14**, 511–522 (in Romanian, French summary), Bucharest.

Mantea, Gh. (1985): Geological studies in the upper basin of the Someşul Cald Valley and the Valea Seacă Valley region (Bihor-Vlădeasa Mountains). – An. Inst. Geol. Geofiz., **66**, 5–89, Bucharest.

Marjanac, T. (2000): Triassic of Dalmatia – Evidence of a failed rift (Muć section). – PANCARDI 2000, Vijesti Hrvatskoga Geološkog Društva, **37**/2, 117–126, Zagreb.

Maslarević, Lj. & Čendić, R. (1994): Braided river deposits at Stara Planina (Eastern Serbia). – Radovi Geoinst., **30**, 51–63 (in Serbian, English summary), Belgrade.

Maslarević, Lj. & Krstić, B. (2001): Continental Permian and Lower Triassic red beds of the Serbian Carpatho-Balkanides. – Natura Bresciana, Ann. Mus. Civ. Sci. Nat., Monografia No. **25**, 245–252, Brescia.

Mazzoli, C., Sassi, R. & Vozárová, A. (1992): The pressure character of the Alpine metamorphism in the Central and Inner Western Carpathians (Czechoslovakia). – Spec. Vol. IGCP Project 276, 109–117, Bratislava (Dionýz Štúr Inst. Geol.).

Mello, J. (1974): Facial development and facial relations of the Slovak Karst Middle and Upper Triassic (West Carpathians, Southern part of Gemerids). – Schrift. Erdwiss. Komm. Österr. Akad. Wiss., **2**, 147–155, Vienna.

Mello, J. (1975a): Triassische Biohermenkalke im östlichen Teil des Slowakischen Karstes. – Geol. Zborn. Geol. Carpathica, **26**, 21–46, Bratislava.

Mello, J. (1975b): Pelagic and reef sediment relations of the Middle Triassic in the Silica nappe and transitional strata nature (the Slovak karst, West Carpathians). – Geol. Zborn. Geol. Carpathica, **26**, 237–252, Bratislava.

Mello, J. (1996): Meliaticum – geological development, position and relation to surrounding units. – Geol. Práce, Správy, **101**, 41–43, Bratislava.

Mello, J. & Reichwalder, P. (1979): Geological profiles through the SE part of the Spišsko-gemerské Rudohorie Mts. and the adjacent part of the Slovak Karst. – In: Maheľ, M. (Ed.): Tectonic profiles through the West Carpathians. – Conf. Symp. Sem, 199–202 (in Slovak, English summary), Bratislava (Geol. Ústav D. Štúra).

Mello, J., Polák, M. & Ondrejičková, A. (1995): Mesozoic radiolarites of central and inner part of the West Carpathians. – Carpathian-Balkan Geological Association 15th Congress Reports, Geol. Soc. Greece, **4**/1, 232–236, Athens.

Mello, J. (Ed.), Elečko, M., Pristaš, J., Reichwalder, P., Snopko, L., Vass, D. & Vozárová, A. (1996): Geological map of the Slovenský kras Mts 1:50.000. – Regional geological maps of Slovakia, Bratislava (Vyd. Ministerstvo Životného prostredia Slov. Rep.-Geol. Služba Slov. Rep.).

Mello, J. (Ed.), Elečko, M., Pristaš, J., Reichwalder, P., Snopko, L., Vass, D., Vozárová, A., Gaál, Ľ., Hanzel, V., Hók, J., Kováč, P., Slavkay, M. & Steiner, A. (1997): Explanations to the geological map of the Slovenský kras Mts 1:50.000. – 256 p. (in Slovak, English summary), Bratislava (Vyd. D. Štúra, Geol. Služba Slov. Rep.).

Mello, J., Reichwalder, P. & Vozárová, A. (1998): Bôrka Nappe: high-pressure relic from the subduction-accretion prism of the Meliata ocean (Inner Western Carpathians, Slovakia). – Slovak Geol. Mag., **4**, 261–273, Bratislava.

Mello, J. (Ed.), Filo, I., Havrila, M., Ivanička, J., Madarás, J., Németh, Z., Polák, M., Pristaš, J., Vozár, J., Koša, E. & Jacko, S.Jr. (2000a): Geological map of the Slovenský Raj-Galmus Mts. and Hornád Depression 1:50.000. – Regional geological maps of Slovakia, Bratislava (Vyd. Ministerstvo Životného. prostredia. Slov. Rep. – Štátny Geol. Ústav D. Štúra).

Mello, J. (Ed.), Filo, I., Havrila, M., Ivan, P., Ivanička, J., Madarás, J., Németh, Z., Polák, M., Pristaš, J., Vozár, J., Vozárová, A., Liščák, P., Kubeš, P., Scherer, S., Siráňová, Z., Szalaiová, V. & Žáková, E. (2000b): Explanatory text to the geological map of the Slovenský raj, Galmus Mts. and Hornád Depression 1:50.000. – 304 p. (in Slovak, English summary), Bratislava (Vyd. D. Štúra, Štatny Geol. Ústav D. Štúra).

Memović, E., Cvetković, V., Kneževič, V. & Zakariadze, G. (2004): The Triassic metabasalts of Dudin Krš, near Kosovska Mitrovica, Serbia. – Geol. An. Balk. Poluos., **65**, 85–91, Belgrade.

Michalík, J., Planderová, E. & Sýkora, M. (1976): To the stratigraphic and paleogeographic position of the Tomanová Formation of the Upper Triassic of the West Carpathians. – Geol. Zborn. Geol. Carpathica, **27**, 299–318, Bratislava.

Mićić, I., Urošević, D., Kandić, M., Klisić, M. & Simić, D. (1972): Findings of Triassic conodont fauna in the metamorphic complex of Kopaonik Mt. (Nalazak trijaske konodontske faune u metamorfnom komplesku Kopaonika). – Zapisnici Srp. geol. druš. za 1968, 1969 i 1970 (Zbor 10. XII 1968), Belgrade, 103–104 (in Serbian, Cyrillic), Belgrade.

Mietto, P. & Manfrin, S. (1995): A high resolution Middle Triassic ammonoid standard scale in the Tethys Realm. A preliminary report. – Bull. Soc. Géol. Fr., **166**, 539–563, Paris.

Mioč, P. (1981): Tectonic relation between the Sava Nappe and surrounding units in Slovenija and its position in the structure of the Dinarides. – Nafta, **32**, 543–548, Zagreb.

Mirăuţă, E. & Gheorghian, D. (1978): Étude microfaunistique des formations triasiques (transylvaines, bucoviniennes et gétiques) des Carpates Orientales. – Dări de Seamă, Inst. Geol. Geofiz., **64**/3, 109–162, Bucharest.

Mirăuţă, E. & Gheorghian, D. (1993): Nouvelles données biostratigraphiques concernant les dépôts triasiques de Sasca Montană (zone de Reşiţa-Moldova Nouă, Banat). – Rom. Journ. Stratigr., **75**, 29–32, Bucharest.

Mišík, M. & Borza, K. (1976): Obere Trias bei Silická Brezová (Westkarpaten). – Acta Geol. Geogr. Univ. Comenianae, Geol., **30**, 5–49, Bratislava.

Missoni, S. & Gawlick, H.-J. (2010): Evidence for Jurassic subduction from the Northern Calcareous Alps (Berchtesgaden; Austroalpine, Germany). – International Journal of Earth Sciences, **100**/7, 1605–1631, Berlin – Heidelberg (Springer).
http://dx.doi.org/10.1007/s00531-010-0552-z

Missoni, S. & Gawlick, H.-J. (2011): Jurassic mountain building and Mesozoic–Cenozoic geodynamic evolution of the Northern Calcareous Alps as proven in the Berchtesgaden Alps (Germany). – Facies, **57,** 137–186, Berlin – Heidelberg (Springer).
http://dx.doi.org/10.1007/s10347-010-0225-1

Missoni, S., Steiger, T. & Gawlick, H.-J. (2001): Das Gschirrkopffenster in den Berchtesgadener Kalkalpen (Deutschland) und seine Interpretation: Neuergebnisse auf der Basis von stratigraphischen und faziellen Untersuchungen. – Mitt. Ges. Geol. Bergbaustud. Österr., **45**, 89–110, Wien.

Missoni, S., Gawlick, H.-J., Dumitrică, P., Krystyn, L. & Lein, R. (2008): Late Triassic mass-flow deposits in hemipelagic “Slovenian Trough”-like sediments in the Karavank Mountains (Austria) triggered by Late Triassic strike-slip movements. – Journal of Alpine Geology, **49**, 71, Vienna.

Missoni, S., Velić, I., Gawlick, H.-J., Tišljar, J. & Vlahović, I. (2010): How many Middle Triassic carbonate platforms existed in the Outer Dinarides? New insights from the Velebit Mountain (Croatia). – Journal of Alpine Geology, **52,** 185–187, Vienna.

Missoni, S., Gawlick, H.-J., Sudar, M.N., Jovanović, D. & Lein, R. (2012): Onset and demise of the Wetterstein Carbonate Platform in the mélange areas of the Zlatibor Mountain (Sirogojno, SW Serbia). – Facies, **58**/1, 95-111, Berlin – Heidelberg (Springer). http://dx.doi.org/10.1007/s10347-011-0274-0

Mock, R. (1980a): Gemericum – definition and delimitation (Gemerikum — definícia a ohraničenie). – Miner. Slovaca, **12**, 228 (in Slovak), Bratislava.

Mock, R. (1980b): Novel knowledge and some problems as regards the geology of the inner West Carpathians. – Földtani Kutatás, **23**/3, 11–15 (in Hungarian, English summary), Budapest.

Mock, R., Sýkora, M., Aubrecht, R., Ožvoldová, L., Kronome, B., Reichwalder, R.P. & Jablonský, J. (1998): Petrology and stratigraphy of the Meliaticum near the Meliata and Jaklovce villages, Slovakia. – Slovak Geol. Mag., **4**, 223–260, Bratislava.

Monostori, M. (1996): Ostracods and charophytes from the Triassic Kantavár Formation, Mecsek Mts., Hungary. – Acta Geol. Hung., **39**, 311–317, Budapest.

Mostler, H. (1978): Ein Beitrag zur Mikrofauna der Pötschenkalke an der Typlokalität unter besonderer Berücksichtigung der Poriferenspiculae. – Geol. Paläont. Mitt. Innsbruck, **7**/3, 1–28, Innsbruck.

Mostler, H. & Rossner, R. (1984): Mikrofazies und Palökologie der höheren Werfener Schichten (Untertrias) der Nördlichen Kalkalpen. – Facies, **10**, 87–144, Erlangen.

Mudrenović, V. (1995): Cephalopods from the Bulog Limestones of Sirogojno. – Geol. An. Balk. Polous., **59**, 203–214 (in Serbian and English), Belgrade.

Mutihac, V. (1966): Problems of stratigraphy and tectonics regarding the Rarău syncline/Eastern Carpathians (Probleme de stratigrafie şi tectonică privind sinclinalul Rarăului /Carpaţii Orientali/). – Stud. Cerc. Geol. Geofiz. Geogr., ser. Geol., **11**, 483–496 (in Romanian), Bucharest.

Mutihac, V. (1968): Structure géologique de la partie nord du synclinal marginal externe / Carpates Orientales (Structura geologică a Compartimentului nordic din Sinclinalul Marginal Extern /Carpaţii Orientali). – 127 p. (in Romanian), Bucharest (Ed. Acad. Rom.).

Nagy, E. (1968): Triasbildungen des Mecsek Gebirges. – Ann. Inst. Geol. Hung., **51**/1, 1–239 (in Hungarian, German summary), Budapest.

Neubauer, F. & Raumer, J.F. (1993): The Alpine Basement – Linkage between Variscides and East-Mediterranean mountain belts. – In: Raumer, J.F. & Neubauer, F. (Eds.): Pre-Mesozoic geology in the Alps. – 641–664, Heidelberg (Springer Verlag).

O'Dogherty, L. & Gawlick, H.-J. (2008): Pliensbachian Radiolaria in the Teltschengraben (Northern Calcareous Alps, Salzkammergut area, Austria) and their evidence for the reconstruction of Liassic Tethys. – Stratigraphy, **5**/1, 63–81, New York, NY.

Obradović, J. & Goričan, Š. (1988): Siliceous deposits in Yugoslavia: occurrences, types and ages. – In: Hein, J.R. & Obradović, J. (Eds.): Siliceous deposits of the Tethys and Pacific regions. – 51–64, New York (Springer Verlag).

Obradović, J., Milovanović, D. & Vasić, N. (1986): Point No. 1, Locality: Čačak – Ovčar Banja, Siliceous rocks from Diabase-chert formation. – In: Guide-book with Abstracts. – 3rd International Conference on Siliceous deposits, IGCP Project 187, 51–54, Belgrade (Yugosl. Comm. IGCP, Project 187 "Siliceous deposits").

Obradović, J., Milovanović, D. & Vasić, N. (1987–1988): Siliceous rocks in Mesozoic from Serbia in association with Diabase-chert and Porphyrite-chert formation. – Glasnik Prir. Muz, ser. A, **42/43**, 23–49 (in Serbian, English summary), Belgrade.

Ogorelec, B. & Dozet, S. (1997): Upper Triassic, Jurassic and Lower Cretaceous beds in Eastern Sava Folds – Section Laze at Boštanj (Slovenia). – Rud. Met. zb., **44**, 223–235 (in Slovenian, English summary), Ljubljana.

Ogorelec, B. & Rothe, P. (1993): Mikrofazies, Diagenese und Geochemie des Dachsteinkalkes und Hauptdolomits in Süd-West-Slowenien. – Geologija, **35**, 81–181, Ljubljana.

Ogorelec, B., Jurkovšek, B., Šribar, L., Jelen, B., Stojanovič, B. & Mišič, M. (1984): Carnian beds at Tamar and at Log pod Mangartom. – Geologija, **27**, 107–158 (in Slovenian, English summary), Ljubljana.

Palinkaš, A.L., Bermanec, V., Borojević Šoštarić, S., Kolar-Jurkovšek, T., Strmić Palinkaš, S., Molnár, F. & Kniewald, G. (2008): Volcanic facies analysis of a subaqueous basalt lava-flow complex at Hruškovec, NW Croatia – Evidence of advanced rifting in the Tethyan domain. – Journ. Volc. Geotherm. Res., **178**, 644–656, Amsterdam.

Palinkaš, L., Kovács, S., Molnár, F., Haas, J., Józsa, S., Dosztály, L., Gulácsi, Z., Kiss, G., Kövér, Sz., Ozsvárt, P., Mikes, T., Halamić, J., Hrvatović, H., Sudar, M., Jovanović, D., Djerić, N., Migiros, G., Papanikolaou, D. & Tselepidis, V. (2010): Triassic rift-type basalts and related deep-water sediments in the western ophiolite belt of the Hellenides-Dinarides (from Othrys Mts., Greece to Darnó Hill, NE Hungary). – 19th Congress of the Carpathian-Balkan Geological Association, Thessaloniki, Greece, 2010, Abstract Volume, Geologica Balcanica, **39**/1-2, 285–286, Sofia.

Pamić, J. (1982): Triassic magmatism of the Dinarides. – 236 p. (in Croatian, English Abstract), Zagreb (Nafta, Spec. Publ.).

Pamić, J. (1984): Triassic magmatism of the Dinarides in Yugoslavia. – Tectonophysics, **109**, 273–307, Amsterdam.

Pamić, J. (1997): The northwesternmost outcrops of the Dinaridic ophiolites: a case study of Mt. Kalnik. – Acta Geol. Hung., **40**, 37–56, Budapest.

Pamić, J. (2000): Triassic Jablanica gabbro pluton in north Hercegovina. – In: Pamić, J. & Tomljenović, B. (Eds.): Outline of the geology of the Dinarides and South Tisia. – Pancardi 2000: Field trip guidebook, Dubrovnik, 77–80, Zagreb (Vijesti Hrvatskoga Geološkog Društva – Special Issue).

Pamić, J. (2003): The allochthonous fragments of the Internal Dinaridic units in the western part of the South Pannonian Basin. – Acta Geol. Hung., **46**, 41–62.

Pamić, J. & Tomljenović, B. (1998): Basic geologic data on the Croatian part of the Zagorje-Mid-Transdanubian Zone. – Acta Geol. Hung., **41**, 389–400, Budapest.

Pamić, J.J., Gušić, V. & Jelaska, V. (1998): Geodynamic evolution of the Central Dinarides. – Tectonophysics, **297**, 251–268, Amsterdam.

Pamić, J., Kovács, S. & Vozár, J. (2002): The Internal Dinaridic fragments into the collage of the South Pannonian Basin. – Geol. Carpathica, **53** (Spec. Issue), 9–11, Bratislava.

Pamić, J., Kovács, S. & Vozárová, A. (2004): The role of the Dinarides in the evolution in the Pannonian-Carpathians-Dinarides domain. – Manuscript, 36 p., Budapest (MÁFI Archive, No. 21278).

Panin, Şt. & Tomescu, C. (1974): Nouvelles contributions à la biostratigraphie des dépôts triasiques du Plateau de Vaşcău. – Dări de Seamă, Inst. Geol. Geofiz., **60**/4, 51–57 (in Romanian, French summary), Bucharest.

Panin, Şt., Bleahu, M., Tomescu, C., Mirăuţă, E. & Ştefănescu, M. (1982): Structure of the Vaşcău Plateau. – Dări de Seamă, Inst. Geol. Geofiz., **67**/5, 109–124, Bucharest.

Patrulius, D. (1963): Les olistolithes du Massif des Bucegi (Carpates Orientales). – Association Géologique Carpat.-Balkan 5ème Congrès (1961), Comm. Sci., 2ème Sect.: Stratigr., **3**/2, 129–146 (in Romanian, French summary), Bucharest.

PATRULIUS, D. (1967): Le Trias des Carpates Orientales de Roumanie. – Geol. Zborn. Geol. Carpathica, **18**, 233–244, Bratislava.

PATRULIUS, D. (1976): Les formations mésozoïques des Monts Apuseni septentrionaux: corrélation chronostratigraphique et faciale. – Rev. Roumaine Géol. Géophys. Géogr., sér. Géol., **20**, 49–57, Bucharest.

PATRULIUS, D. (1996): The Triassic and Lower Jurassic formations of the Transylvanian Nappe System (East Carpathians – Romania). – Mém. Inst. Géol. Rom., **36**, 21–30, Bucharest.

PATRULIUS, D. & BLEAHU, M. (1967): Le Trias des Monts Apuseni. – Geol. Zborn. Geol. Carpathica, **18**, 245–255, Bratislava.

PATRULIUS, D., POPA-DIMIAN, E. & DUMITRU-POPESCU, IL. (1966): Le série mésozoïque et les nappes de décollement transylvaines dans les environs de Comana (Monts Perşani). – An. Com. Geol., **35**, 397–444 (in Romanian, French summary), Bucharest.

PATRULIUS, D., POPA, E. & POPESCU, IL. (1969): Structure de la nappe bucovinienne dans la partie méridionale du Massif cristallin moldave (Carpates Orientales). – An. Com. Geol., **37**, 71–117 (in Romanian, French summary), Bucharest.

PATRULIUS, D., BLEAHU, M., POPESCU, IL. & BORDEA, S. (1971): The Triassic formations of the Apuseni Mountains and of East Carpathian Bend. – 2nd Triassic Colloquium Carpathian-Balkan Geological Association, Guidebook to excursions, Geol. Inst. Guidebook ser., **8**, 86 p., Bucharest.

PATRULIUS, D., GHEORGHIAN, D. & MIRĂUŢĂ, E. (1976): Corrélation biochronologique du Calcaire de Roşia, formation triasique du système des nappes de Codru (Monts Apuseni). – Dări de Seamă, Inst. Geol. Geofiz., **62**/4, 121–133, Bucharest.

PATRULIUS, D., BLEAHU, M., ANTONESCU, E., BALTREŞ, A., BORDEA, S., BORDEA, J., GHEORGHIAN, D., IORDAN, M., MIRĂUŢĂ, E., PANIN, ŞT., POPA, E. & TOMESCU, C. (1979): The Triassic Formations of the Bihor Autochthon and Codru nappe-system (Apuseni-Mountains). – 3rd Triassic Colloquium Carpathian-Balkan Geological Association, Guidebook to Field Trips, 31 p., Bucharest (Inst. Geol. Geofiz.).

PATRULIUS, D., POPESCU, IL., MIRĂUŢĂ, E. & GHEORGHIAN, D. (1996): The klippen of the Perşani Mountains (East Carpathians). – Mém. Inst. Géol. Rom., **36**, 31–52, Bucharest.

PELIKÁN, P. (Ed.), LESS, GY., KOVÁCS, S., PENTELÉNYI, L. & SÁSDI, L. (2005): Geology of the Bükk Mountains. Explanatory book to the Geological map of the Bükk Mountains 1:50.000. – 284 p. (in Hungarian and English), Budapest (Hung. Geol. Inst.).

PELIN, M. (1969): Sur le Trias du Massif de Hăghimaş – la crête Ciofronca (Carpates Orientales). – Anal. Univ. Bucharest, **18**, 47–54 (in Romanian, French summary), Bucharest.

PENTELÉNYI, L., HAAS, J., PELIKÁN, P., PIROS, O. & ORAVECZNÉ SCHEFFER, A. (2003): Re-evaluation of the Triassic formations in the Hungarian part of the Zemplén Unit. – Földt. Közl., **133**, 1–19 (in Hungarian, English summary), Budapest.

PÉRÓ, CS., KOVÁCS, S., LESS, GY. & FODOR, L. (2002): Tectonic setting of the Triassic Hallstatt (s.l.) facies in NE Hungary. – Proceedings 17th Carpathian-Balkan Geological Congress, Geol. Carpathica, Spec. Issue, **53**, 24–25, Bratislava.

PÉRÓ, CS., KOVÁCS, S., LESS, GY. & FODOR, L. (2003): Geological setting of Triassic "Hallstatt" (s.l.) facies in NE Hungary. – Ann. Univ. Sci. Budapest., Sect. Geol., **35**, 58–60, Budapest.

PILLER, W., EGGER, H., ERHART, C.W., GROSS, M., HARZHAUSER, M., HUBMANN, B., VAN HUSEN, D., KRENMAYR, H.-G., KRYSTYN, L., LEIN, R., LUKENEDER, A., MANDL, G.W., RÖGL, F., ROETZEL, R., RUPP, C., SCHNABEL, W., SCHÖNLAUB, H.P., SUMMESBERGER, H., WAGREICH, M. & WESSELY, G. (2004): Die stratigraphische Tabelle von Österreich 2004 (sedimentäre Schichtfolgen). – 1. Aufl., Wolkersdorf (Kommission für die paläontologische und stratigraphische Erforschung Österreichs der Österreichischen Akademie der Wissenschaften und Österreichische Stratigraphische Kommission).

PIROS, O. (2002): Anisian to Carnian carbonate platform facies and dasycladacean biostratigraphy of the Aggtelek Mts, Northeastern Hungary. – Acta Geol. Hung., **45**, 119–151, Budapest.

PISA, G. (1974): Stratigraphische Tabelle der südalpinen Trias. – Schriftenr. Erdwiss. Komm. Österr. Akad. Wiss., **2**, 157–158, Wien.

PLACER, L. & KOLAR-JURKOVŠEK, T. (1990): The age of the Pseudozilian beds in the east part of the Sava folds. – Rud. Met. zb., **37**, 529–534 (in Slovenian, English summary), Ljubljana.

PLANDEROVÁ, E. & POLÁK, M. (1976): On the age of the Triassic dolomite-shaly beds from the (Tatric) envelope sequence of Veľká Fatra Mts. (O veku triasových dolomiticko-bridličnatých vrstiev z obalovej série Veľkej Fatry). – Geol. Práce, Správy, **65**, 75–79 (in Slovak), Bratislava.

PLAŠIENKA, D. (1993): Structural patttern and partitioning of deformation in the Veporic Foederata cover unit (Central Western Carpathians). – In: RAKÚS, M. & VOZÁR, J. (Eds.): Geodynamic model and deep structure of the Western Carpathians. – Conf., Symp., Sem., 269–277, Bratislava (Geol. Ústav D. Štúra).

PLAŠIENKA, D. (1997): Cretaceous tectonochronology of the Central Western Carpathians (Slovakia). – Geol. Carpathica, **48**, 99–111, Bratislava.

PLAŠIENKA, D. & SOTÁK, J. (2001): Stratigraphic and tectonic position of Carboniferous sediments in the Furmanec Valley (Muráň Plateau, Central Western Carpathians). – Miner. Slovaca, **33**, 29–44 (in Slovak, English summary), Bratislava.

PLAŠIENKA, D., GRECULA, P., KOVÁČ, M. & HOVORKA, D. (1997a): Evolution and structure of the Western Carpathians: an overview. – In: GRECULA, P., HOVORKA, D. & PUTIŠ, M. (Eds.): Geological evolution of the Western Carpathians. – Monograph, 1–24, Bratislava (Miner. Slovaca Corp., Geokomplex).

PLAŠIENKA, D., HAVRILA, M., MICHALÍK, J., PUTIŠ, M. & REHÁKOVÁ, D. (1997b): Nappe Structure of the western part of the Central Carpathians. – In: PLAŠIENKA, D., HÓK, J., VOZÁR, J. & ELEČKO, M. (Eds.): Alpine evolution of the Western Carpathians and related areas. – International Conference, Abstracts, Introductory articles to the Excursion, 139–161, Bratislava (Geol. Survey Slov. Rep. – D. Štúr Publ.).

PLÖCHINGER, B. (1980): Die Nördlichen Kalkalpen. – In: OBERHAUSER, R. (Ed.): Der geologische Aufbau Österreichs. – 217–264, Wien – New York (Springer).

POLÁK, M. (Ed.), FILO, M., HAVRILA, M., BEZÁK, V., KOHÚT, M., KOVÁČ, P., VOZÁR, J., MELLO, J., MAGLAY, J., ELEČKO, M., VOZÁROVÁ, A., OLŠAVSKÝ, M., SIMAN, P., BUČEK, S., SIRÁŇOVÁ, Z., HÓK, J., RAKÚS, M., LEXA, J., ŠIMON, L., PRISTAŠ, J., KUBEŠ, P., ZAKOVIČ, M., LIŠČÁK, P., ŽÁKOVÁ, E., BOOROVÁ, D. & VANĚKOVÁ, H. (2003): Explanations to geological map of Starohorské vrchy Mts., Čierťaž Mts. and northern part of the Zvolenská kotlina Depression 1:50.000. – 218 p. (in Slovak, English summary), Bratislava (Štátny Geol. Ústav D. Štúra).

POPA, E. (1981): La biostratigraphie des formations mésozoïques de la partie orientale de Pădurea Craiului (Monts Apuseni). – An. Inst. Geol. Geofiz., **58**, 203–282, Bucharest.

POPA, E. & DRAGASTAN, O. (1973): Anisian-Ladinian calcareous algae and foraminifera from the eastern part of Pădurea Craiului (Apuseni Mountains). – Stud. Cerc. Geol., Geofiz., Geogr., ser. Geol., **18**, 425–442, Bucharest.

POPESCU, D.A. (2004): Triassic carbonates from north of Rarău Syncline (East Carpathians): microfacies and paleogeographical implications. – Acta Palaeontol. Rom., **4**, 373–384, Bucharest.

POPESCU, D.A. (2008): Geology and microfacies of Triassic carbonate deposits between Moldova Valley and Trotuş Valley. – 221 p. (in Romanian), Iaşi (Ed. Sedcom Libris).

POPESCU, D.A. & POPESCU, L.G. (2004): Microfacies of the Triassic limestones in the Piatra Şoimului klippe (Transylvanian nappes, Rarău Syncline, Eastern Carpathians, Romania). – Stud. Univ. Babeş-Bolyai, Geol., **49**/1, 87–105, Cluj-Napoca.

Popescu, D.A. & Popescu, L.G. (2005a): Microfacies of the Middle Triassic carbonates in the Infrabucovinian nappes (the north compartment of the Crystalline-Mesozoic Area, Eastern Carpathians). – Anal. Univ. "Ştefan cel Mare" Suceava, Secţ. Geogr., **14**, 5–20 (in Romanian, English summary), Suceava.

Popescu, D.A. & Popescu, L.G. (2005b): The Olenekian carbonates of the Bucovinian nappe (the central sector of the Hăghimaş syncline, Eastern Carpathians): lithology and microfacies. – Stud. Univ. Babeş-Bolyai, Geol., **50**/1-2, 53–62, Cluj-Napoca.

Popević, A. (1970): A contribution to the knowledge of the Diabase-Chert formation in the neighbourhood of the Priboj Bath. – Geol. An. Balk. Poluos., **35**, 137–150 (in Serbian, English summary), Belgrade.

Protić, Lj., Filipović, I., Pelikán, P., Jovanović, D., Kovács, S., Sudar, M., Hips, K., Less, Gy. & Cvijić, R. (2000): Correlation of the Carboniferous, Permian and Triassic sequences of the Jadar Block, Sana-Una and "Bükkium" Terranes. – In: Karamata, S. & Janković, S. (Eds.): Proceedings of the International Symposium "Geology and metallogeny of the Dinarides and the Vardar Zone" (Zvornik, 2000). – Acad. Sci. Arts Rep. Srpska, Collect. and Monogr., I, Dept. Nat., Math. Tech. Sci., **1**, 61–69, Banja Luka – Srb. Sarajevo.

Pueyo, E.L., Mauritsch, H.J., Gawlick, H.-J., Scholger, R. & Frisch, W. (2007): New evidence for block and thrust sheet rotations in the central northern Calcareous Alps deduced from two pervasive remagnetization events. – Tectonics, **26**, 25 p., Washington DC, TC5011. http://dx.doi.org/10.1029/2006TC001965

Radoičić, R. (1987): Preplatform and first carbonate platform development stages in the Dinarides (Montenegro-Serbia sector, Yugoslavia). – Mem. Soc. Geol. Ital., **40**, 355–358, Rome.

Radovanović, Z. (2000): Explanatory notes, Sheet Prijepolje 2, GM FR Yugoslavia 1:50.000. – 95 p. (in Serbian, unpublished), Belgrade (Arhiv Geol. Surv. "Gemini").

Rădulescu, D., Cornea, I., Săndulescu, M., Constantinescu, P., Rădulescu, Fl. & Pompilian, A. (1976): Structure de la croûte terrestre en Roumanie. Essai d'interprétation des études seismiques profondes. – An. Inst. Geol. Geofiz., **50**, 5–36, Bucharest.

Ramovš, A. (1987a): The Anisian reef development between Kranjska gora and Mojstrana (Slovenia, NW Yugoslavia). – Razprave IV. razr. SAZU, **27**, 3–13, Ljubljana.

Ramovš, A. (1987b): Ausbildung der Karn-Stufe in östlichen Teil der nördlichen Julischen Alpen. – Geologija, **30**, 67–82 (in Slovenian, German summary), Ljubljana.

Ramovš, A. (1989a): Ausbildung der Ladin-Stufe (Mitteltrias) in den nördlichen Julischen Alpen. – Geologija, **31/32**, 241–266 (in Slovenian, German summary), Ljubljana.

Ramovš, A. (1989b): Development of the Scythian (Lower Triassic) in the Northern Julian Alps (Slovenia). – Rud. Met. zb., **36**, 623–636 (in Slovenian, English summary), Ljubljana.

Ramovš, A. (1998): Conodonten-Stratigraphie der Obertrias von Slowenien. Ergebnisse einiger Untersuchungen. – Geologija, **40**, 223–232, Ljubljana.

Ramovš, A. & Šribar, L. (1992): The Cordevolian reef on the Menina, Kamnik – Savinja Alps, Slovenia. – Geologija, **35**, 73–80 (in Slovenian, English summary), Ljubljana.

Ramovš, A. & Turnšek, D. (1984): Lower Carnian reef buildups in the Northern Julian Alps (Slovenia, NW Yugoslavia). – Razprave IV. razr. SAZU, **25**/4, 161–200, Ljubljana.

Ratschbacher, L., Frisch, W., Linzer, H.-G. & Merle, O. (1991): Lateral extrusion in the Eastern Alps, Part 2: Structural analysis. – Tectonics, **10**, 257–271, Washington, DC.

Ratschbacher, L., Linzer, H.-G., Moser, F., Strusievicz, R.O., Bedelean, H., Har, N. & Mogoş, P.A. (1993): A Cretaceous to Miocene thrusting and wrenching along the central South Carpathians due to a corner effect during collision and orocline formation. – Tectonics, **12**, 855–873, Washington, DC.

Reijmer, J.J.G. & Everaas, S.L. (1991): Carbonate platform facies reflected in carbonate basin facies (Triassic, Northern Calcareous Alps, Austria). – Facies, **25**, 253–278, Erlangen.

Réti, Zs. (1985): Triassic ophiolite fragments in an evaporitic mélange, Northern Hungary. – Ofioliti, **10**, 411–422, Pisa.

Richard, L. (Lein, R.), Gawlick, H.-J., Missoni, S., Suzuki, H., Jovanović, D. & Sudar, M.N. (2010): Triassic and Jurassic radiolarians from the Dinaridic Ophiolite Belt (Zlatibor area, SW Serbia). – 19th Congress of the Carpathian-Balkan Geological Association, Thessaloniki, Greece, 2010, Abstract Volume, Geologica Balcanica, **39**/1-2, 335–336, Sofia.

Riedel, P., Senowbary-Daryan, B., Kovács, S. & Pelikán, P. (1988): The age of the Bánya-hegy reef limestone, Bükk Mts., NE Hungary. – Ann. Rep. Hung. Geol. Inst., **1986**, 105–115 (in Hungarian and English), Budapest.

Robertson, A.H.F., Karamata, S. & Šarić, K. (2009): Overview of ophiolites and related units in the Late Paleozoic – Early Cenozoic magmatic and tectonic development of Tethys in the northern part of the Balkan region. – Lithos, **108**, 1–36, Amsterdam.

Roth, Z. (1939): Geology of Silica surroundings near Rožňava (Geologie okolí Silice u Rožňavy). – Rozpravy II. Tř. České Akad., **49**, 1–23 (in Czech), Praha.

Rožič, B., Kolar-Jurkovšek, T. & Šmuk, A. (2009): Late Triassic sedimentary evolution of Slovenian Basin (eastern Southern Alps): description and correlation of the Slatnik Formation. – Facies, **55**/1, 137–155, Berlin – Heidelberg.

Rozlozsnik, P. (1935): Die geologischen Verhältnisse der Gegend von Dobsina. – Geol. Hung., ser. Geol., **5**, 1–118, Budapest.

Russo-Săndulescu, D., Udrescu, C. & Medeşan, A. (1981): Petrochemical characteristics of the Mesozoic ophiolites of the Rarău-Hăghimaş marginal syncline. – Dări de Seamă, Inst. Geol. Geofiz., **66**/1, 153–185, Bucharest.

Russo-Săndulescu, D., Săndulescu, M., Udrescu, C., Bratosin, I. & Medeşan, A. (1983): Le magmatisme d'âge mésozoïque dans les Carpates Orientales. – An. Inst. Geol. Geofiz., **61**, 245–252, Bucharest.

Sakač, K. (1992): *Discoptychites oenensis* n. sp. and the accompanying ammonite fauna from Anisian deposits in Brotinja, Lika, Central Croatia. – Natura Croatica, **1**, 27–40, Zagreb.

Săndulescu, M. (1964): Structure géologique du massif de Postăvaru-Runcu (Monts du Braşov). - An. Com. Geol., Inst. Geol., **34**/2, 381–432 (in Romanian with French summary), Bucharest.

Săndulescu, M. (1966): Structure géologique des terrains mésozoïques à l'extérieur du massif cristallin de Făgăraş. – Dări de Seamă, Com. Geol., Inst. Geol., **52**/2, 177–208 (in Romanian, French summary), Bucharest.

Săndulescu, M. (1973): Contributions à la connaissance de la structure géologique du synclinal de Rarău (secteur central). – Dări de Seamă, Inst. Geol., **59**/5, 59–92 (in Romanian, French summary), Bucharest.

Săndulescu, M. (1974): Corrélation des séries mésozoïques des synclinaux du Rarău et de Hăghimaş (Carpates Orientales). – Dări de Seamă, Inst. Geol., **60**/5, 119–142 (in Romanian, French summary), Bucharest.

Săndulescu, M. (1975a): Étude géologique de la partie centrale et septentrionale du synclinal de Hăghimaş (Carpates Orientales). – An. Inst. Geol. Geofiz., **45**, 1–200 (in Romanian, French summary), Bucharest.

Săndulescu, M. (1975b): Essai de synthèse structurale des Carpates. – Bull. Soc. Géol. Fr., Sér. 7, **17**, 299–358, Paris.

Săndulescu, M. (1976a): Contributions à la conaissance de la stratigraphie et de la position tectonique des séries mésozoïques du bassin supérieur de la vallée de la Moldova (Carpates Orientales). – Dări de Seamă, Inst. Geol. Geofiz., **62**/5, 149–176 (in Romanian, French summary), Bucharest.

Săndulescu, M. (1976b): La corrélation structurale du tronçon oriental avec celui méridional des Carpates Roumaines. – Dări de Seamă, Inst. Geol. Geofiz., **62**/5, 177–194, Bucharest.

Săndulescu, M. (1980): Analyse géotectonique des chaînes alpines situées autour de la Mer Noire occidentale. – An. Inst. Geol. Geofiz., **56**, 253–262, Bucharest.

Săndulescu, M. (1984): Geotectonics of Romania (Geotectonica României). – 337 p. (in Romanian), Bucharest (Ed. Tehnică).

Săndulescu, M. (1985): Contributions à la connaissance des nappes crétacées des Monts du Maramureş (Carpathes Orientales). – Dări de Seamă, Inst. Geol. Geofiz., **69**/5, 83–96, Bucharest.

Săndulescu, M. (1988): Les problèmes tectoniques de la courbure interne des Carpates roumaines. – Dări de Seamă, Inst. Geol. Geofiz., **72–73**/5, 283–299, Bucharest.

Săndulescu, M. (1994): Overview on Romanian geology. – Rom. Journ. Tect. Reg. Geol., **75**, suppl. **2**, 3–16, Bucharest.

Săndulescu, M. & Dimitrescu, R. (2004): Geological structure of the Romanian Carpathians. – 32nd International Geological Congress (Florence, 2004), Field Trip Guide Book, **B12**, 1, 48 p., Rome (Ed APAT).

Săndulescu, M. & Russo-Săndulescu, D. (1981): The ophiolites from the Rarău and Hăghimaş syncline. Their structure, position, age and geotectonic evolution. – Dări de Seamă, Inst. Geol. Geofiz., **66**/5, 91–101, Bucharest.

Săndulescu, M. & Visarion, M. (1978): Considérations sur la structure tectonique du soubassement de la dépression de Transylvanie. – Dări de Seamă, Inst. Geol. Geofiz., **64**/5, 153–173, Bucharest.

Săndulescu, M., Kräutner, H.G., Balintoni, I., Russo-Săndulescu, D. & Micu, M. (1981): The structure of the East Carpathians (Moldavia-Maramureş area). – 12th Congress Carpathian-Balkan Geological Association, Guide to Excursion B1, Guidebook ser., **21**, 92 p., Bucharest (Geol. Geoph. Inst.).

Satterley, A.K. & Brandner, R. (1995): The genesis of Lofer cycles of the Dachstein Limestone, Northern Calcareous Alps, Austria. – Geol. Rdsch., **84**, 287–292, Berlin – Heidelberg.

Savu, H. (1980): Genesis of the Alpine cycle ophiolites from Romania and their associated calc-alkaline and alkaline volcanics. – An. Inst. Geol. Geofiz., **56**, 55–73, Bucharest.

Savu, H. (1983): Geotectonic and magmatic evolution of the Mureş Zone (Apuseni Mountains, Romania). – An. Inst. Geol. Geofiz., **61**, 253–262, Bucharest.

Schäfer, P. & Senowbari-Daryan, B. (1981): Facies development and paleoecologic zonation of four upper Triassic patch-reefs, Northern Calcareous Alps near Salzburg, Austria. – SEPM Spec. Publ., **30**, 241–259, Tulsa, OK.

Schefer, S., Egli, D., Missoni, S., Bernoulli, D., Fügenschuh, B., Gawlick, H.-J., Jovanović, D., Krystyn, L., Lein, L., Schmid, S.M. & Sudar, M.N. (2010): Triassic metasedimentary rocks in the Internal Dinarides (Kopaonik area, southern Serbia): stratigraphy, paleogeographic and tectonic significance. – Geol. Carpathica, **61,** 89–109, Bratislava.

Schlager, W. & Schöllnberger, W. (1974): Das Prinzip stratigraphischer Wenden in der Schichtfolge der Nördlichen Kalkalpen. – Mitt. Geol. Ges. Wien, **66/67**, 165–193, Wien.

Schmid, S.M., Bernoulli, D., Fügenschuh, B., Matenco, L., Schefer, S., Schuster, R., Tischler, M. & Ustaszewski, K. (2008): The Alpine-Carpathian-Dinaridic orogenic system: correlation and evolution of tectonic units. – Swiss J. Geosci., **101**, 139–183, Basel.

Schmidt, Th., Blau, J. & Kázmér, M. (1991): Large-scale strike-slip displacement of the Drauzug and the Transdanubian Mountains in early Alpine history: evidence from Permo-Mesozoic facies belts. – Tectonophysics**, 200**, 213–232, Amsterdam.

Schönenberg, R. (1946): Geologische Untersuchungen am Nordwestrand des Zips-Gömörer Erzgebirges (Karpaten). – Zeitschr. Deutsch. Geol. Ges., **98**, 70–119, Hannover.

Schroll, E., Köppel, V. & Cerny, I. (2006): Pb and Sr isotope and geochemical data from the Pb-Zn deposit Bleiberg (Austria): constraints on the age of mineralization. – Mineralogy and Petrology, **86**, 129–156, Heidelberg – New York (Springer).

Schuster, R. & Stüwe, K. (2008): Permian metamorphic event in the Alps. – Geology, **36**, 603–606, Boulder, CO.

Schuster, R., Scharbert, S., Abart, R. & Frank, W. (2001): Permo-Triassic extension and related HT/LP metamorphism in the Austroalpine – Southalpine realm. – Mitt. Ges. Geol. Bergbaustud. Österreich, **45**, 111–141, Vienna.

Sciunnach, D., Garzanti, E., Posenato, R. & Rodeghiero, F. (1999): Stratigraphy of the Servino Formation (Lombardy, Southern Alps): towards a refined correlation with the Werfen Formation of the Dolomites. – Mem. Sci. Geol., **51**, 103–118, Padova.

Šikić, K. & Brkić, M. (1975): Lower Triassic of Papuk and Krndija. – Geol. Vjesnik, **28**, 133–141 (in Croatian, English summary), Zagreb.

Šikić, K., Brkić, M., Šimunić, A. & Grimani, M. (1975): Mesozoic succession of the Papuk Mts. – Scientific Committee for Oil of the Croatian Academy of Science and Art, Geol. Geoph. Geochem. Section, ser A, **4**, 87–96 (in Croatian, English summary), Zagreb.

Skourtsis-Coroneou, V., Tselepidis, V., Kovács, S. & Dosztály, L. (1995): Triassic pelagic sedimentary evolution in some geotectonic units in Greece and Hungary: a comparison. – Proceedings Carpathian-Balkan Geological Association 15th Congress, Geol. Soc. Greece, Spec. Publ., **4**, 275–281, Athens.

Stampfli, G.M., Mosar, J., De Bono, A. & Vavasis, I. (1998): Late Paleozoic, early Mesozoic plate tectonics of the western Tethys. – Bull. Geol. Soc. Greece, **32**, 113–120, Athens.

Stampfli, G.M., Mosar, J., Favre, Ph., Pillevuit, A. & Vannay, J.-C. (2001): Permo-Mesozoic evolution of the Western Tethys realm: the Neo-Tethys East-Mediterranean Basin connection. – In: Ziegler, P.A., Cavazza, W., Robertson, A.H.F. & Crasquin-Soleau, S. (Eds.): Peri-Tethys Memoir 6. Peri-Tethyan rift/wrench basins and passive margins. – Mém. Mus. Nat. Hist. Natur., **186**, 51–108, Paris.

Ştefănescu, M., Panin, Şt. & Tomescu, C. (1985): A new tectonic image of the Mesozoic deposits of the Codru-Moma Mountains between Crişu Negru and Rîpoasa valleys (Northern Apuseni). – Dări de Seamă, Inst. Geol. Geofiz., **69**/5, 101–107, Bucharest.

Stefani, M., Furin, S. & Giannola, P. (2010): The changing climate framework and depositional dynamics of Triassic carbonate platforms from the Dolomites. – Palaeogr., Palaeoclimat., Palaeoecol., **290**, 43–57, Amsterdam.

Stingl, V. (1989): Marginal marine sedimentation in the basal alpine Buntsandstein (Skythian) in the western part of the Northern Calcareous Alps (Tyrol/Salzburg, Austria). – Palaeogeogr., Palaeoclimat., Palaeoecol., **72**, 249–262, Amsterdam.

Straka, P. (1981): On the age of the Foederata sequence (O veku série Foederata). – Geol. Práce. Správy, **75**, 57–62 (in Slovak), Bratislava.

Štrucl, I. (1971): On the geology of the easten part of the Northern Karavankes with special regard to the Triassic lead-zinc deposits. – In: Müller, G. (Ed.): Sedimentology of parts of Central Europe. – 8th Int. Sediment. Congr. (Heidelberg, 1971), 285–301, Frankfurt am Main (W. Kramer).

Štrucl, I. (1974): Die Entstehungsbedingungen der Karbonatgesteine und Blei-Zincvererzungen in dem Anisschichten von Topla. – Geologija, **17**, 299–397 (in Slovenian, German summary), Ljubljana.

Sudar, M. (1986): Triassic microfossils and biostratigraphy of the Inner Dinarides between Gučevo and Ljubišnja Mts., Yugoslavia. – Geol. An. Balk. Poluos., **50**, 151–394 (in Serbian, English summary), Belgrade.

Sudar, M. (1996): Triassic conodonts of Zlatibor. – In: Dimitrijević, M.D. (Ed.): Geology of Zlatibor. – Geoinst., Pos. Izd., **18**, 25–26 (in Serbian, English summary), Belgrade.

Sudar, M.N. & Kovács, S. (2006): Metamorphosed and ductilely deformed conodonts from Triassic limestones situated beneath Ophiolite Complexes: Kopaonik Mountain (Serbia) and Bükk Mountains (NE Hungary) – a preliminary comparison. – Geol. Carpathica, **57**, 157–176, Bratislava.

Sudar, M., Jovanović, D. & Kolar-Jurkovšek, T. (2007): Late Permian conodonts from Jadar Block (Vardar Zone, northwestern Serbia). – Geol. Carpathica, **58**, 145–152, Bratislava.

Sudar, M., Gawlick, H.-J., Lein, R., Missoni, S., Jovanović, D. & Krystyn, L. (2008): Drowning and block tilting of Middle Anisian carbonate platform in the Middle Jurassic Zlatibor mélange of the Dinaridic Ophiolite Belt (SW Serbia). – Journal of Alpine Geology (Abstracts, Pangeo 2008), **49**, 106–107, Vienna.

Sudar, M.N., Gawlick, H.-J., Missoni, S., Suzuki, H., Jovanović, D. & Lein, R. (2010): The carbonate-clastic radiolaritic mélange of Pavlovica Cuprija: a key to solve the palaeogeography of the Hallstatt Limestone in the Zlatar Mountain (SW Serbia). – Pangeo 2010, Journal of Alpine Geology, **52**, 53–57, Vienna.

Szoldán, Zs. (1990): Middle Triassic magmatic sequences from different tectonic settings in the Bükk Mts (NE Hungary). – Acta Miner.-Petr., **31**, 25–42, Szeged.

Thöny, W., Ortner, H. & Scholger, R. (2006): Paleomagnetic evidence for large en-bloc rotations in the Eastern Alps during Neogene orogeny. – Tectonophysics, **414**, 169–189, Amsterdam.

Tichy, G. (1975): Fossilfunde aus dem Hauptdolomit (Nor, Trias) der östlichen Gailtaler Alpen (Kärnten, Österreich). – Ann. Naturhist. Mus. Wien, **79**, 57–100, Wien.

Tišljar, J., Vlahović, I., Sremac, J., Velić, I., Veseli, V. & Stanković, D. (1991): Excursion A – Velebit Mt., Permian-Jurassic. – In: Vlahović, I. & Velić, I. (Eds.): Some aspects of the shallow water sedimentation on the Adriatic Carbonate Platform (Permian to Eocene). – Excursion Guidebook; 2nd International Symposium on the Adriatic Carbonate Platform – relations with adjacent regions, 1–49, Zagreb (Croatian Geological Institute).

Tollmann, A. (1976): Analyse des klassischen nordalpinen Mesozoikums. – 580 S., Wien (Deuticke).

Tollmann, A. (1977): Geologie von Österreich, Band 1. – 766 S., Wien (Deuticke).

Tollmann, A. (1985): Geologie von Österreich, Band 2. – 710 S., Wien (Deuticke).

Tomescu, C. & Săndulescu, M. (1978): Note concernant l'âge des calcaires associés aux couches des jaspes de la region de Tătarca-Breaza (Synclinal de Rarău – Carpates Orientales). – Dări de Seamă, Inst. Geol. Geofiz., **64**/4, 193–198 (in Romanian, French summary), Bucharest.

Török, Á. (1993): Storm influenced sedimentation in the Hungarian Muschelkalk. – In: Hagdorn, H. & Seilacher, A. (Eds.): Muschelkalk, Schöntaler Symposium, 1991. – Jb. Ges. Nat. Württemberg, Korb, **2**, 133–142, Stuttgart (Goldschneck)

Török, Á. (1998): Controls on development of Mid-Triassic ramps: examples from southern Hungary. – In: Wright, V.P. & Burchett, T.P. (Eds.): Carbonate ramps. – Geol. Soc. London, Spec. Publ., **149**, 339–367, London.

Török, Á. (2000): Muschelkalk carbonates in southern Hungary: an overview and comparison to German Muschelkalk. – Zentralbl. Geol. Paläont. Teil I., **1998**, 1085–1103, Stuttgart.

Trubelja, F., Burgath, K.-P. & Marchig, V. (2004): Triassic magmatism in the area of the Central Dinarides (Bosnia and Herzegovina): Geochemical resolving of tectonic setting. – Geol. Croatica, **57**, 159–170, Zagreb.

Turculeţ, I. (1971): Recherches géologiques sur les dépôts jurassiques et éocrétacés de la cuvette de Rarău-Breaza. – Stud. Techn. Econ., Inst. Geol. ser. I., **10**, 1–141 (in Romanian, French summary), Bucharest.

Turculeţ, I. (1991a): Sur quelques faunes des mollusques et des brachiopodes néotriasiques des calcaires blancs, associés aux volcanites ophiolithiques dans le synclinal mésozoïque de Rarău (Carpates Orientales Roumaines). – Lucr. Sem. Geol. "Grigore Cobălcescu", **3**, 15–35 (in Romanian, French summary), Iaşi.

Turculeţ, I. (1991b): Considérations géologiques sur les ophiolites de la colline Măcieş (Synclinal de Rarău, Carpates Orientales Roumaines). – Stud. Cerc. Geol., **36**, 19–27 (in Romanian, French summary), Bucharest.

Turculeţ, I. (2004): Transylvanian Triassic paleontology of Rarău. – 175 p. (in Romanian, English summary), Bucharest (Ed. Arvin Press).

Turnšek, D. (1997): Mesozoic corals of Slovenia. – Zbirka ZRC SAZU, **16**, 1–512, Ljubljana.

Urošević, D. & Andjelković, J. (1970): L'étage rétien dans la montagne de Stara planina. – Vesnik Zav. Geol. Geofiz. Istraž., ser. A., **28**, 301–305 (in Serbian, French summary), Belgrade.

Urošević, D. & Gabre, R. (1986): Les unités litostratigraphiques des sédiments triassiques (Région Carpatho-Balcanique interne). – 11. Kongr. Geol. Jugoslavije, Tara, **2**., Stratigr., Paleontol., Reg. Geol., 141–155 (in Serbian, French summary), Belgrade.

Urošević, D. & Radulović, V. (1990): The uppermost Rhaetian – Lower Liassic continental terrigenous Senokos Formation in the Yugoslavian Carpatho-Balkanides (Stara Planina Mts.). – Geol. Paläont. Mitt. Innsbruck, **17**, 25–30, Innsbruck.

Urošević, D. & Sudar, M. (1991a): Ladinian and Carnian Sediments in Ždrelo Section, Eastern Serbia, Yugoslavia. – Geol. An. Balk. Poluos., **55**, 57–66 (in Serbian and English), Belgrade.

Urošević, D. & Sudar, M. (1991b): Triassic Conodont Fauna of the Yugoslavian Carpatho-Balkanides. – Geol. An. Balk. Poluos., **55**, 147–159 (in Serbian and English), Belgrade.

Vai, G.B. (1994): Crustal evolution and basement elements in the Italian area: paleogeography and characterization. – Boll. Geof. Teor. Appl., **36**, 411–434, Trieste.

Vai, G.B. (1998): Field trip through the Southern Alps: an introduction with geologic settings, palaeogeography and Palaeozoic stratigraphy. – In: Perri, M.C. & Spalletta, C. (Eds.): Southern Alps Field Trip Guidebook ECOS 7. – Giorn. Geol. ser. 3a, **60**, Spec. Issue, 1–38, Bologna.

Vai, G.B. (2003): Development of the palaeogeography of Pangea from Late Carboniferous to Early Permian. – Palaeogeogr., Palaeoclimat., Palaeoec., **196**, 125–155, Amsterdam.

Vai, G.B. & Venturini, C. (1997): Moscovian and Artinskian rocks in the frame of the cyclic Permo-Carboniferous deposits of the Carnic Alps and related areas. – In: Crasquin-Soleau, S. & De Wever, P. (Eds.): Peri-Thetys: stratigraphic correlations. – Geodiversitas, **19**/2, 173–186.

Vass, D. (Ed.), Bodnár, J., Elečko, M., Gaál, Ľ., Hanáček, J., Hanzel, V., Lexa, J., Mello, J., Pristaš, J. & Vozárová, A. (1986): Explanations to the geological map of the Rimava Depression and adjoining parts of the Slovenského rudohoria Mts. 1:50.000. – 177 p., Bratislava (Geol. Ústav D. Štúra).

Velić, I., Vlahović, I., Dragicević, I. & Matičec, D. (2001): Adriatic Carbonate Platform from the Middle Permian to the Middle Eocene – a paleogeographic overview. – In: Dragicević, I. & Velić, I. (Eds): 1st Scientific Meeting Carbonate Platform or Carbonate Platforms of Dinarids (2001). – Abstracts, p. 22 (in Croatian, English summary), Zagreb (Croatian Geological Institute).

Velić, I., Tišljar, J., Vlahović, I., Matičec, D. & Bergant, S. (2003): Evolution of the Istrian part of the Adriatic Carbonate Platform from the Middle Jurassic to the Santonian and formation of the flysch basin during the Eocene: Main events and regional comparison. – In: Vlahović, I. & Tišljar, J. (Eds.): Evolution of depositional environments from the Palaeozoic to the Quaternary in the Karst Dinarides and the Pannonian Basin. – Field Trip Guidebook 22nd IAS Meeting of Sedimentology, Opatija 2003, 3–17, Zagreb (Croatian Geological Institute).

Velić, I., Tišljar, J., Vlahović, I., Matičec, D. & Bergant, S. (2004): Introductions to the Adriatic Carbonate Platform. – In: Juračić, M., Palinkaš, L., Barjaktarević, Z., Buljan, R., Bergant, S., Jurak, V., Gušić, I., Marjanac, T., Matičec, D., Mezga, A., Pavisa, T., Sestanovic, S., Šoštarić-Borojević, S., Strmić, S., Sremac, J., Tišljar, J. & Vlahović, I.: Adriatic-Dinaridic Mesozoic Carbonate Platform, environments and facies from Permian to recent time. – Field Trip Guide Book, 32nd International Geological Congress (Florence, 2004), 3–7, Rome (Ed. APAT).

Velledits, F. (1999): Anisian terrestrial deposits in the sequences of the Northern Bükk Mts. (Anisian-Ladinian layers of the Alsó-Sebes-víz key-section and Miskolc 10. borehole = Zsófiatorony). – Földt. Közl., **129**, 327–361 (in Hungarian, English summary), Budapest.

Velledits, F. (2000): Evolution of the area from the Berva Valley to the Hór Valley in the Middle-Upper Triassic. – Földt. Közl., **130**, 47–93 (in Hungarian, English summary), Budapest.

Velledits, F. (2004): Anisian terrestrial sediments in the Bükk Mts. (NE Hungary) and their role in the Triassic rifting of the Vardar--Meliata branch of the Neo-Tethys ocean. – Riv. Ital. Paleontol. Stratigr., **110**, 659–679, Milan.

Velledits, F. (2006): Evolution of the Bükk Mts. (NE Hungary) during the Middle-Late Triassic asymmetric rifting of the Vardar-Meliata branch of the Neo-Tethys Ocean. – Int. Journ. Earth Sci., **95**, 395–412, Berlin.

Velledits, F., Pelikán, P., Hips, K., Harangi, Sz., Haas, J., Józsa, S. & Kovács, S. (2004): Bükk Unit (Bükki egység). – In: Haas, J. (Ed.): Geology of Hungary. Triassic (Magyarország geológiája. Triász). – 139–196 (in Hungarian), Budapest (Eötvös Kiadó).

Velledits, F., Péró, Cs., Blau, J., Senowbari-Daryan, B., Kovács, S., Piros, O., Pocsai, T., Szügyi-Simon, H., Dumitrică, P. & Pálfy, J. (2011): The oldest Triassic platform margin reef from the Alpine-Carpathian region (Aggtelek, NE Hungary): platform evolution, reefal biota and biostratigraphic framework. – Riv. Ital. Paleontol. Stratigr., **117**, 221–268, Milan.

Vishnevskaya, V. & Djerić, N. (2006): Ophiolite-related and non--ophiolite radiolarites of the Balkan Peninsula. – In: Proceedings of the Mesozoic ophiolite belts of northern part of the Balkan Peninsula, International Symposium Ophiolites 2006 (Belgrade--Banja Luka). – 139–143, Belgrade – Banja Luka (Serbian Acad. Sci. Arts, Comm. Geod., Acad. Sci. Arts Rep. Srpska, Comm. Geosci.).

Vishnevskaya, V.S., Djerić, N. & Zakariadze, G.S. (2009): New data on Mesozoic Radiolaria of Serbia and Bosnia, and implications for the age and evolution of oceanic volcanic rocks in the Central and Northern Balkans. – Lithos, **108**, 72–105, Amsterdam.

Vlahović, I., Tišljar, J., Velić, I. & Matičec, D. (2005): Evolution of the Adriatic Carbonate Platform: Paleogeography, main events and depositional dynamics. – Palaeogeogr., Palaeoclimat., Palaeoecol., **220**, 333–360, Amsterdam.

Vojtko, R. (2000): Are there tectonic units derived from the Meliata-Hallstatt trough incorporated into the tectonic structure of the Tisovec Karst? (Muráň karstic plateau, Slovakia). – Slovak Geol. Mag., **6**, 335–346, Bratislava.

Vörös, A. (Ed.) (2003): Budai, T., Kovács, S., Lelkes, Gy., Pálfy, J., Piros, O., Szabó, I. & Szente, I.: The Pelsonian Substage on the Balaton Highland (Middle Triassic, Hungary). – Geol. Hung., ser. Palaeontol., **55**, 1–195, Budapest.

Vörös, A. & Galácz, A. (1998): Jurassic paleogeography of the Transdanubian Central Range (Hungary). – Riv. Ital. Paleontol. Stratigr., **104**, 69–84, Milan.

Vozár, J. (1996): Map of pre-Tertiary basement of the Danube region on the territory of the Slovak Republic. – In: Amann, G., Handler, R., Kurz, W. & Steyrer, H.P. (Eds.): 6th Symp. Tektonik – Strukturgeologie – Kristallingeologie. – Ext. Abstracts, 455–457, Salzburg (Facultas Univ.-Verl.).

Vozárová, A. & Straka, P. (1989): Mezozoikum. – In: Baňacký, V. (Ed.), Elečko, M., Kaličiak, M., Straka, P., Škvarka, L., Šucha, P., Vass, D., Vozárová, A. & Vozár, J.: Explanation to geological map of the Southern Part of East Slovakian Lowland and Zemplín Hills 1:50.000. – 40–43 (in Slovak, English summary), Bratislava (Dionýz Stúr Inst. of Geology).

Vozárová, A. & Vozár, J. (1988): Late Paleozoic in the West Carpathians. – 314 p., Bratislava (Geol. Ústav D. Štúra).

Vozárová, A. & Vozár, J. (1992): Tornaicum and Meliaticum in bore-hole Brusník BRU-1, Southern Slovakia (Brusník Anticline, Rimava Depresion). – Acta Geol. Hung., **35**, 97–116, Budapest.

Vozárová, A., Vozár, J., Ebner, F., Pamić, J., Kovács, S., Szederkényi, T., Vai, G.B., Venturini, C., Kräutner, H.-G., Karamata, S., Krstić, B., Sudar, M. & Mioč, P. (2009a): Tectonostratigraphic terrane and paleoenvironment map of the Circum Pannonian Region. Late Variscan (Latest Carboniferous to Early Permian) environments 1:2.500.000. – Budapest (Geol. Inst. Hung.).

Vozárová, A., Ebner, F., Kovács, S., Kräutner, H.-G., Szederkényi, T., Krstić, B., Sremac, J., Aljinovič, D., Novak, M. & Skaberne, D. (2009b): Late Variscan (Carboniferous to Permian) environments in the Circum Pannonian Region. – Geol. Carpathica, **60**, 71–104, Bratislava.

Wagreich, M. (1995): Subduction tectonic erosion and Late Cretaceous subsidence along the Austroalpine margin (Eastern Alps, Austria). – Tectonophysics, **242**, 63–78, Amsterdam.

Wein, Gy. (1969): Tectonic review of the Neogene-covered areas of Hungary. – Acta Geol. Hung., **13**, 399–436, Budapest.

Zankl, H. (1969): Der Hohe Göll. Aufbau und Lebensbild eines Dachsteinkalk-Riffes in der Obertrias der nördlichen Kalkalpen. – Abh. Senckb. Naturf. Ges., **519**, 1–123, Frankfurt/Main.

Zeeh, S., Bechstädt, T. & Maul, B. (1988): Fazies und frühe Diagenese im obersten Wettersteinkalk (Drauzug, Nördliche Kalkalpen). – Bochumer Geol. Geotechn. Arb., **29**, 245–247, Bochum.

Received: 21. January 2010, Revised: 16. February 2011, Accepted: 8. March 2011

Plate 1

Fig. 1. Norian organic rich Hauptdolomit, Wiesthal, Bavaric Unit, Northern Calcareous Alps (photo: H.-J. Gawlick).

Fig. 2. Dachstein Limestone, reefal facies (Upper Norian), Hochkönig, Tirolic Unit, Northern Calcareous Alps (photo: H.-J. Gawlick).

Fig. 3. Kössen Formation (Rhaetian) Moertlbach (photo: H.-J. Gawlick).

Fig. 4. Well-bedded cherty hemipelagic limestone of the Pötschen Formation with of shallow-marine origin allodapic limestone intercalations (Upper Carnian to Middle Norian). Pötschenwand, Zlambach/Pötschen Facies Zone, Northern Calcareous Alps (photo: Cs. Péró).

Fig. 5. Dachstein Limestone lagoonal facies (Norian) – Kössen Formation (Upper Norian-Rhaethian) – Rhaetian reefal limestone. Section Hohes Freieck, Tirolic Unit, Northern Calcareous Alps (photo: H.-J. Gawlick).

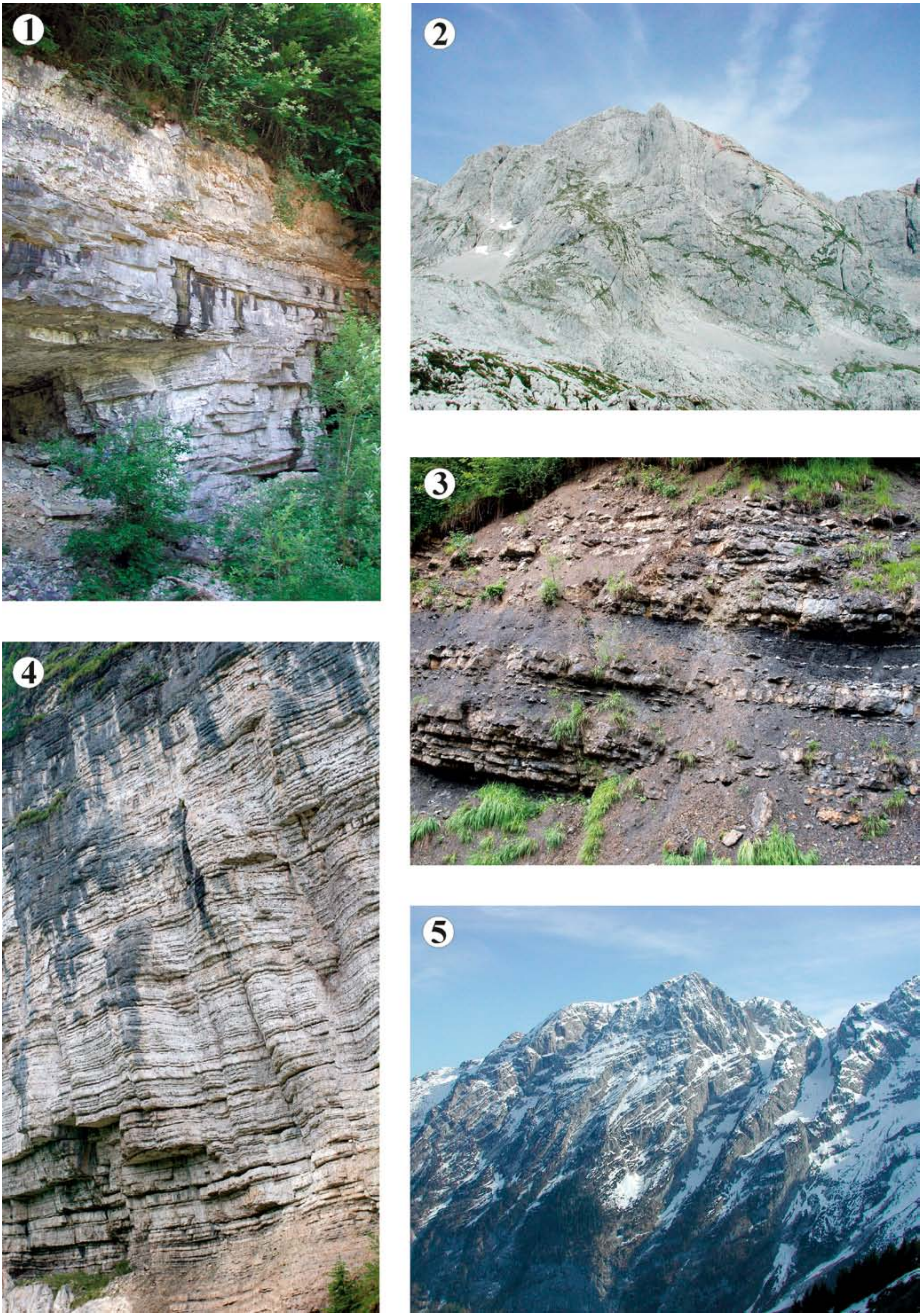

1
2
3
4
5

Plate 2

Fig. 1. Zlambach Formation at the type locality (Rhaetian) (photo: H.-J. Gawlick).

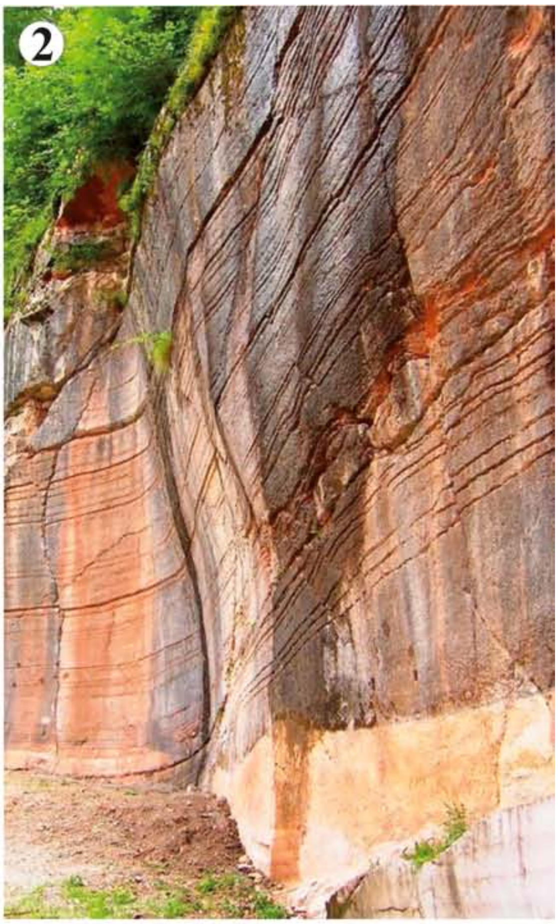
Fig. 2. Light red Hallstatt Limestone, Hangendrotkalk Member (Middle Norian, Alaunian 1–3). Bad Dürrnberg, south of Salzburg, Hallstatt Facies Zone, Northern Calcareous Alps (photo: Sz. Kövér).

Fig. 3. Carnian – Norian Carpathian Keuper with dolomite intercalations. Fatric Unit, Krížna Nappe, Kardolina near Ždiar village, Belanské Tatry, Western Carpathians (photo: Cs. Péró).

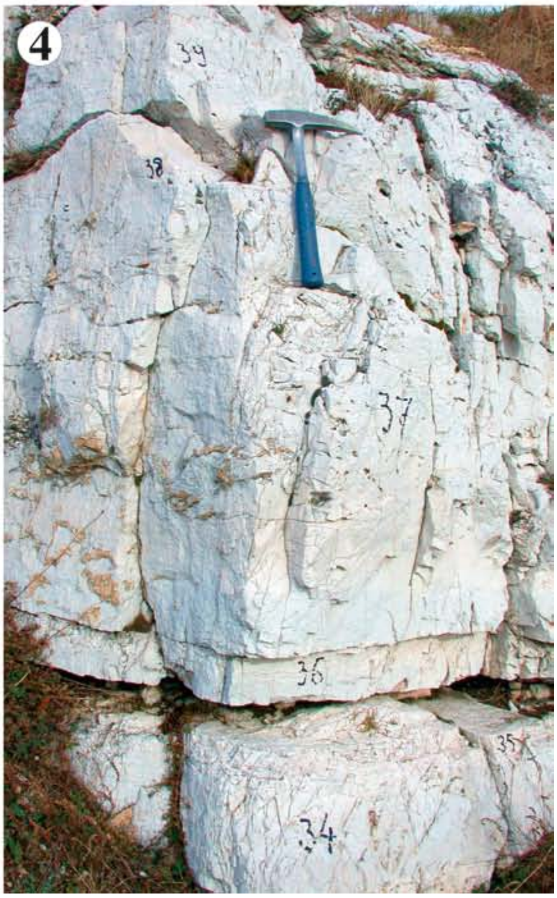
Fig. 4. Ladinian platform dolomite; cyclic lagoonal facies, Budaörs, Buda Mts, Transdanubian Range (photo: J. Haas).

Fig. 5. Thin-bedded, laminated limestone. Felsőörs Formation, Anisian 2 (Pelsonian), Aszófő, Balaton Highland (photo: J. Haas).


1


2


3


4
39
38
37
36
35
34


5
59

Plate 3

Fig. 1. Thin-bedded pelagic limestone (Füred Limestone). Uppermost Ladinian to lowermost Carnian, Pécsely, Balaton Highland, Transdanubian Range Unit (photo: J. Haas).

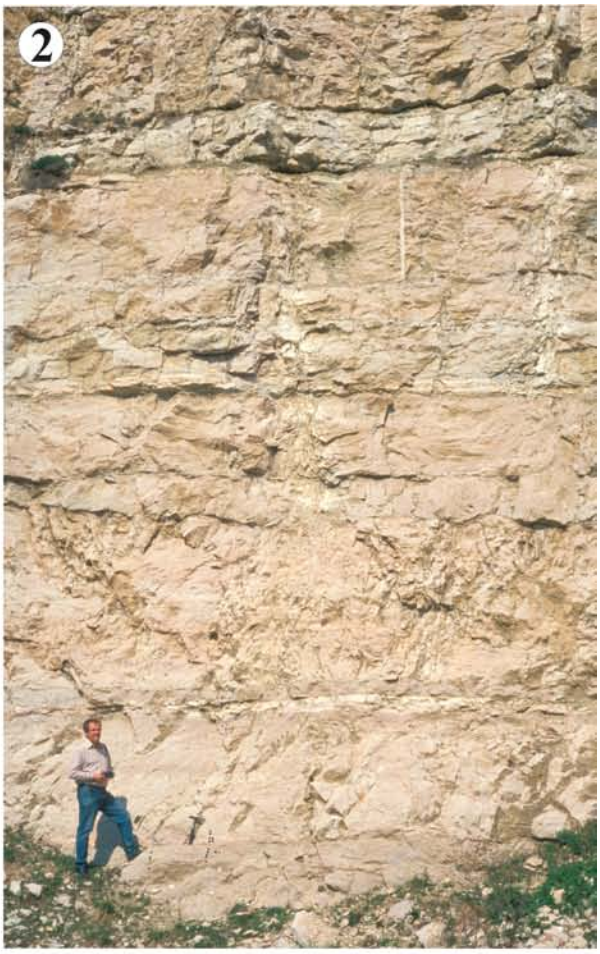
Fig. 2. Lofer-cyclic Dachstein Limestone. Rhaetian. Gorba Quarry, Gerecse Mts, Transdanubian Range Unit (photo: Cs. Péró).

Fig. 3. Chanell structure in a limestone turbidite sequence of slope facies. Csővár Formation. Rhaetian, Csővár, Blocks on the eastern side of Danube, Transdanubian Range Unit (photo: J. Haas).

Fig. 4. Bódvalenke Limestone Formation, Upper Anisian – Ladinian. Road-side cut at the NW margin of Bódvalenke village, Rudabánya Hills, Bódva Unit. Typical development of Bódvalenke Limestone: alternation of purplish red-pink micritic limestone, whitish *Posidonia*-coquina and purplish-red chert layers. Lower Ladinian (photo: Sz.Kövér).

Fig. 5. Bódvalenke Limestone Formation. Road-side cut at the NW margin of Bódvalenke village, Rudabánya Hills, Bódva Unit. Slump fold in alternation of purplish red chert and pinkish micritic limestone. Lower Ladinian (photo: Sz. Kövér).


1


2


3


4


5

Plate 4

Fig. 1. Permian/Triassic boundary in marine succession: P_3 = top of Upper Permian black, fossiliferous Bellerophon-type limestone (Nagyvisnyó Fm.); BCl = "boundary clay"; T_1: base of Lower Triassic oolithic limestone (Gerennavár Fm.). Bálvány-North key section, northern part of Bükk Mts., Gemer-Bükk-Zagorje Unit (photo: J. Haas).

Fig. 2. Peperite: red, micritic limestone enclaves in basalt, Middle Triassic olistolith in Jurassic mélange. Baj-patak Quarry, Darnó Unit, westernmost part of Bükk Mts, Gemer-Bükk-Zagorje Unit (photo: J. Haas).

Fig. 3. Ladinian-Carnian red radiolarite in Jurassic mélange (Dallapuszta Radiolarite Formation). Sirok-Dallapuszta, Darnó Unit (photo: Cs. Péró).

Fig. 4. Folded Carnian beds below Triglav Mt, Julian Alps, Slovenia (photo: B. Jurkovšek).

Fig. 5. "Raibl Beds", Carnian, Belca, Karavanke Mts, Slovenia (photo: B. Jurkovšek).


1
T1
BCl
P3


2


3


4


5

Plate 5

Fig. 1. Dachstein Limestone, cyclic lagoonal (loferite) facies. Triglav Mt, Julian Alps, Julian Carbonate Platform, Gemer-Bükk-Zagorje Unit (photo: Cs. Péró).

Fig. 2. Peperite: basalt mingled with red, micritic limestone. Marginal facies of a Triassic volcano complex (Palinkaš et al., 2008). Hruškovec quarry, Kalnik Mts, Gemer-Bükk-Zagorje Unit (photo: G. Kiss).

Fig. 3. Carnian beds, basinal facies, Kozja dnina, Julian Alps, Slovenia (photo: B. Jurkovšek).

Fig. 4. Permian–Triassic interval, Lukač section, Idrija–Žiri area, Slovenia (photo: B. Jurkovšek).

Fig. 5. Olistolith of Upper Carnian-Lower Norian red and light grey Hallstatt Limestone in the matrix of mélange. Dinaridic Ophiolite Belt, Zlatar Mt, Bučevske Luke locality, road Nova Varoš – Bistrica (photo: D. Milovanović).


1


2


3


4


5

Plate 6

Fig. 1. “Bódvalenke-type” red, cherty limestone (Ladinian) on top (at the right margin) of amygdaloidal basalt. Olistolith in the black shale matrix of ophiolite mélange, locality Potpeć along the road from Bistrica to Priboj. Dinaridic Ophiolite Belt, Zlatar Mts (photo: Sz. Kövér).

Fig. 2. Pillow lava and red chert (Carnian) in the olistostrome/mélange deposits of the Vardar Zone Western Belt. Ovčar – Kablar Gorge (photo: D. Milovanović).

Fig. 3. Folded Carnian platy to bedded grey cherty limestones with thin interlayers of argillaceous or tuffitic material of the Grivska Formation. Dinaridic Ophiolite Belt, Zlatar Mt, valley of Zlošnica River, road Nova Varoš – Akmačići (photo: D. Jovanović).

Fig. 4. Carnian–Norian massive limestone, Transylvanian Nappe System, Zimbru “Series”, Piatra Şoimului klippe, Rarău Mts (photo: D.A. & L.G. Popescu).

Fig. 5. Block of Carnian “Bódvalenke-type” red cherty limestone associated with basalt in the matrix of ophiolite mélange. Dinaridic Ophiolite Belt, Zlatibor Mt, valley of Katušnica Creek, road Sirogojno – Gostilje (photo: D. Jovanović).

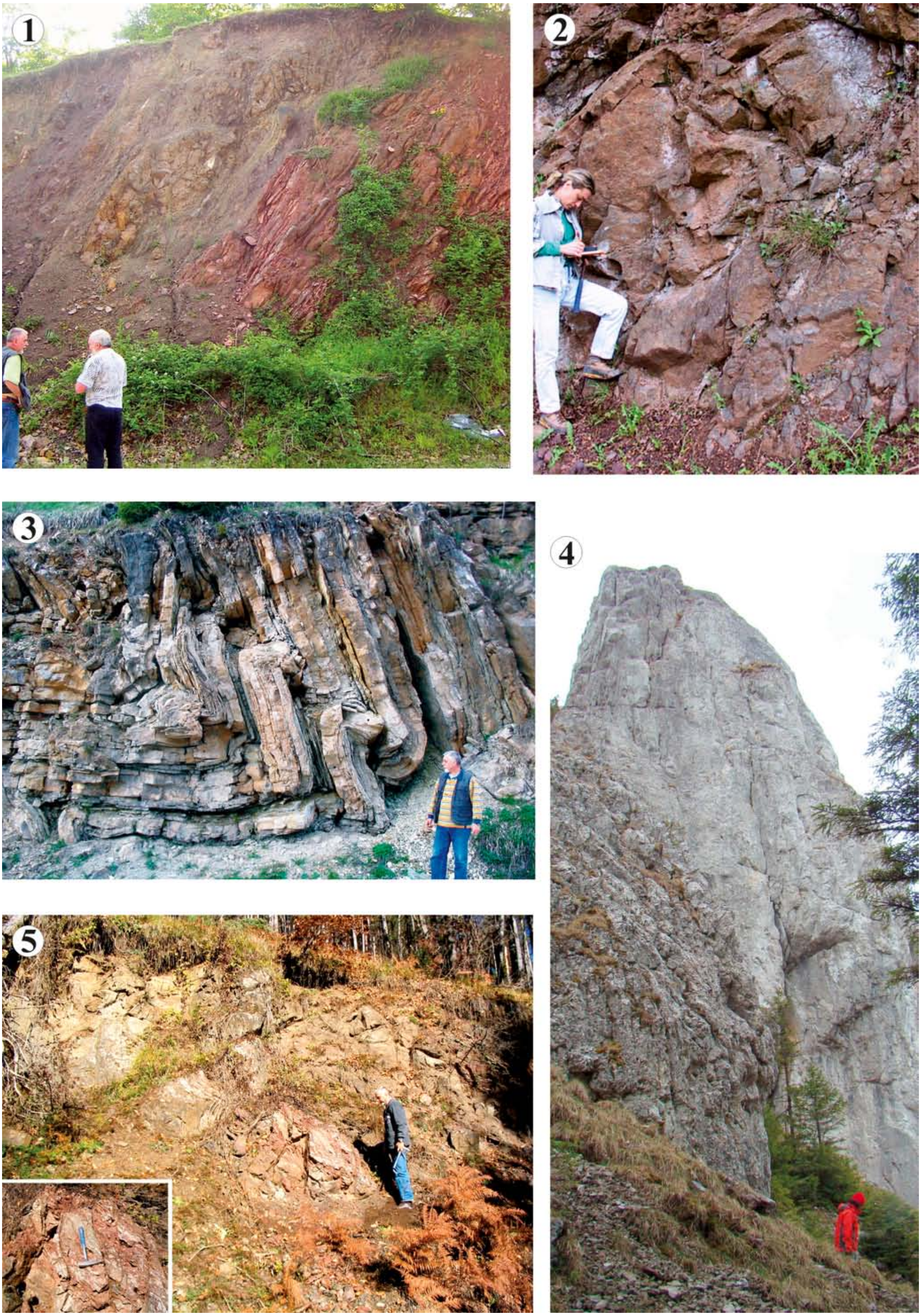

1
2
3
4
5

Plate 7

Fig. 1. Carnian–Norian massive limestone, Transylvanian Nappe System, Zimbru "Series", Popchii Rarăului klippe, Rarău Mts (photo: D.A. & L.G. Popescu).

Fig. 2. Low-angular discordance contact (less than 10 degrees) between Permian sediments of the Topli Do Formation (lower right part) and Lower Triassic continental deposits of braided rivers of the Temska Formation (left and upper parts). Stara Planina – Poreč Unit (Upper Danubian) of the East Serbian Carpatho-Balkanides, Stara Planina Mt, Mrtvački Most locality, canyon of Temska River (photo: D. Jovanović).

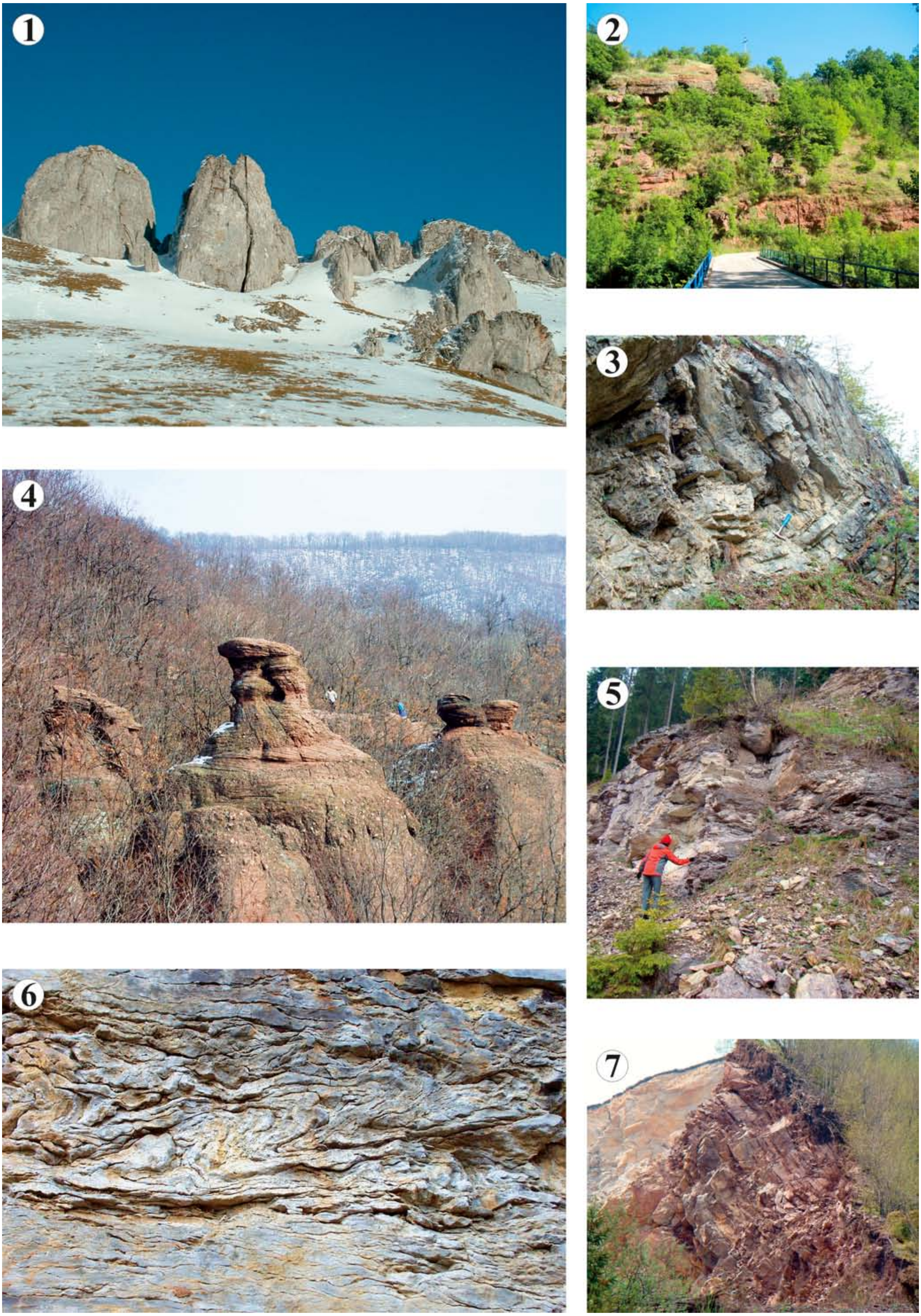
Fig. 3. Recumbent fold in Gutenstein-type bedded bituminous dolomite (Upper Olenekian), Infrabucovinian Iacobeni Unit, Puciosu Quarry (photo: D.A. & L.G. Popescu).

Fig. 4. Lower Triassic Buntsandstein-type continental conglomerate – sandstone: Babás-szerkövek, Mecsek Mts, Mecsek Unit (photo: Gy. Konrád).

Fig. 5. Ladinian–? Lower Carnian variegated limestone, Infrabucovinian Iacobeni Unit, Suhărzelul Mare Quarry (photo: D.A. & L.G. Popescu).

Fig. 6. Slump deformation structure in the "Wellenkalk". Anisian (Pelsonian), Lapis road cut, Pécs, Mecsel Mts. (photo: Á. Török).

Fig. 7. Anisian massive dolomite unconformably covered by Callovian-Oxfordian reddish radiolarite, Bucovinian Nappe, Fundu Moldovei Village, quarry on right bank of Cailor rivulet, inner limb of Rarău Syncline (photo: D.A. & L.G. Popescu).



Zeitschrift/Journal: Jahrbuch der Geologischen Bundesanstalt

Jahr/Year: 2011

Band/Volume: 151

Autor(en)/Author(s): Kovacs Sandor, Sudar M., Karamata Stevan, Haas Janos N., Pero Cs., Gradinaru Eugen, Gawlick Hans-Jürgen, Gaetani M., Mello Jan, Polak Milan, Aljinovic D., Ogorelec Bojan, Kolar-Jurkovsek Tea, Bogdan Jurkovsek, Buser Stanko

Artikel/Article: Triassic Evolution of the Tectonostratigraphic Units of the Circum-Pannonian Region 199-280