PERMO-MESOZOIC FORMATIONS OF THE RECSK-DARNÓ HILL AREA: STRATIGRAPHY AND STRUCTURE OF THE PRE-TERTIARY BASEMENT OF THE PALEOGENE RECSK OREFIELD

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Abstract: Re-assessment of several key drill cores has revealed the existence of three tectonostratigraphic units in the pre-Tertiary basement of Recsk-Darnó Hill area, two of them representing the continuation of the units of Bükk Mts. The Bükk Parautochthon Unit is evidenced by the Upper Triassic grey, cherty Felsőtárkány Limestone Fm. The Mónosbél Unit is built up by a Jurassic toe-of -slope facies, with shaley claystone and siliceous shale "autochthonous" sediment and frequent carbonate turbidites, as well as subordinately by sandstone clasts in "microolistostromes". Triassic Bódvalenke-type, red, cherty limestones associated wit amygdaloidal basalts occur as slide blocks. One borehole explored a slide block of marine Permian formations of the Bükk Mts., too. The Darnó Unit s.s. is built up by Ladinian-Carnian reddish-greenish amygdaloidal basalts with limestone inclusions (peperites), green basalts lacking contamination with lime mud (probably of Jurassic age) and associated abyssal sediments (red pelagic mudstones and red radiolarites), yielding either Ladinian-Carnian or Bathonian-Callovian radiolarians.The Mónosbél and Darnó Units can be interpreted as a small, displaced fragment of Inner Dinaridic-Inner Hellenidic Neotethyan accretionary complexes, not continuing into the West Carpathians and Eastern Alps, respectively.

1. HISTORY OF RESEARCH

The geology of the pre-Tertiary basement of Recsk ore-field was rewieved previously by Földessy-Járányi, 1975, whereas that of the adjacent Darnó Hill by Földessy, 1975 and Balla et al., 1980, 1981 (in the latter with a short summary on older works, especially by Schréter and Balogh). More than 100 deep drillings (1000 or 1200m deep) with continuous coring explored this pre-Tertiary basement. The last three of them (Rm-131, -135 and -136) were drilled in the late seventies on the Darnó Hill itself, SE of the Darnó Fault. The cores were stored in the depo of the Recsk Ore Mine Company. In the middle eighties the company and its depo were liquidated and most of the core materials were cast out. Fortunately, the cores of 25 selected boreholes were transported to the depo of the Hungarian Geological Institute, Rákóczitelep, North Hungary, where they are still available for modern studies.

Dosztály & Józsa, 1992 presented radiolarian biostratigraphic data from the Darnó cores, and established, that both Triassic (Ladinian-Carnian) and Jurassic (Bathonian-Callovian) age data were present. Our new research with new documentatition of the cores, detailed sedimentological and biostratigraphic analysis began in the middle of the nineties (Józsa et al., 1996; Dosztály et al., 1998). Józsa, 1999 studied the petrology and geochemistry of magmatic rocks and established their MORB (Mid-oceanic ridge basalt)-type.

The detailed description of the Darnó core sequences with summary of the new investigations is under way for publication (Kovács et al., in press B). Haas et al., 2006 described the Jurassic redeposited platform-derived carbonate sequence (the most proximal-type amongst the cores studied) of the westernmost located Rm-109 borehole, providing important arguments for their Dinaridic origin. Gecse (2006) summarized the available conodont data.

2. GEOLOGICAL SETTING

The Recsk-Darnó area is situated W of the Bükk Mts., in the NE foreground of the Miocene volcanic range of Mátra Mts., along the two sides of the NE-SW trending Darnó Fault *(Fig. 1, Fig. 2).*

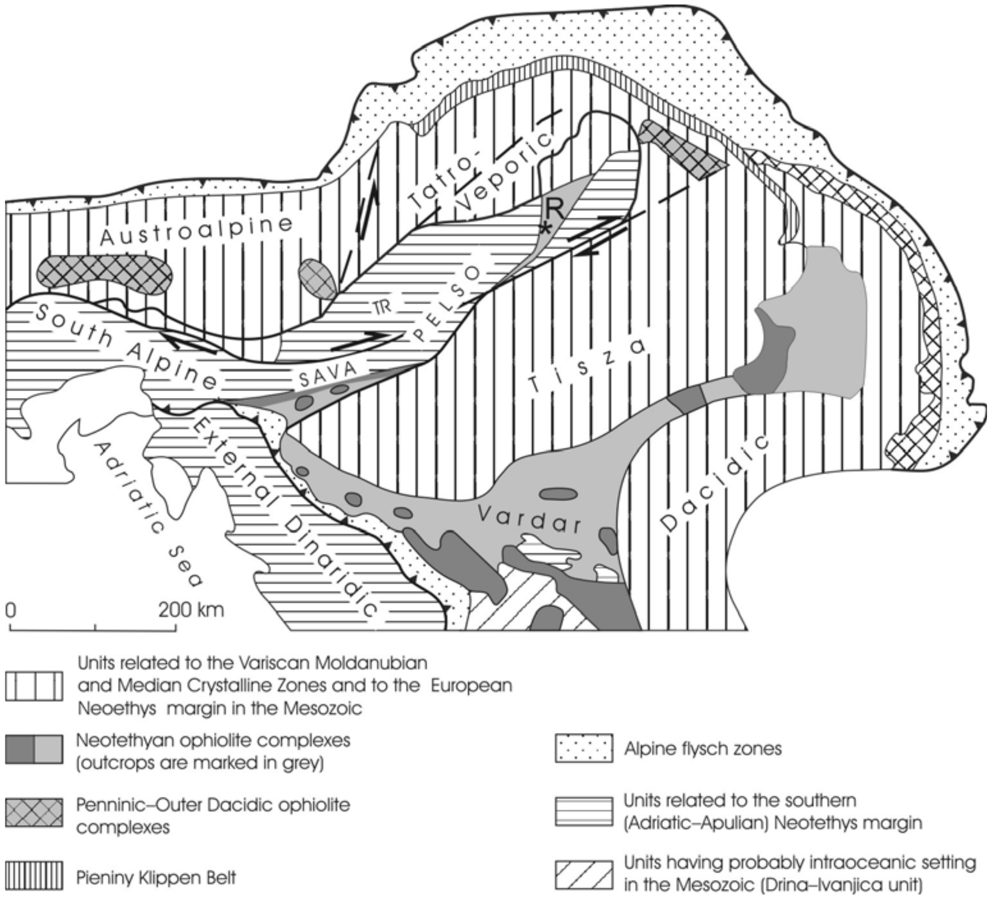

*Fig. 1 Major tectonostratigraphic units (terranes) in the pre-Tertiary basement of the Circum-Pannonian domain, with setting of the Recsk-Darnó area (=a displaced Neotethyan fragment) (after Haas et al., 2006). *R: Location of the Recsk-Darnó area*

Based on the re-assesment of several drillcores of key importance, as well as geological mapping in the wider surrounding of Darnó Hill, three tectonostratigraphic units can be distinguished *(Fig. 3)*, which belong to the Bükk Nappe system (Csontos, 1999) or "Bükkia Composite Terrane" (Kovács et al., 2000): (1) Bükk Parautochthon Unit in the lowermost position; (2) Mónosbél Unit in the median position; (3) Darnó Unit (s.s.) in upper position (preserved only SE of the Darnó Fault).

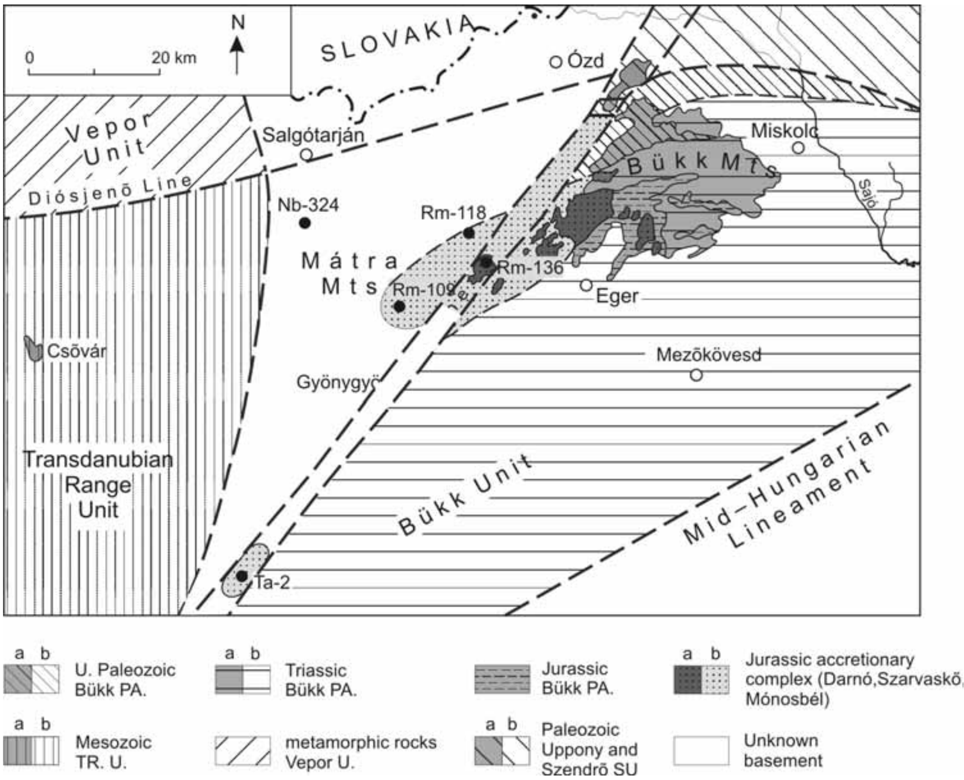

Fig. 2 Simplified pre-Tertiary subcrop geological map of the Mátra—Bükk area, NE Hungary, showing location of some of the boreholes discussed in the text (No. Rm 109, 118 and 136). (After Haas et al., 2006, Fig. 2, slightly modified.). a): surface outcrops; b): subsurface extension of the units/formations

According to the autochthonistic concept of Pelikán, 2005, they form a more or less continuous succession, without major nappe thrusting. It is to be added, that in the Darnó Hill cores no traces of Paleogene volcanics were found, whereas on the NW side of the Darnó Fault, in the Recsk mine area Mesozoic formations were intruded by a swarm of such dykes (see *Fig. 5*, core section of borehole Rm-79 herein).

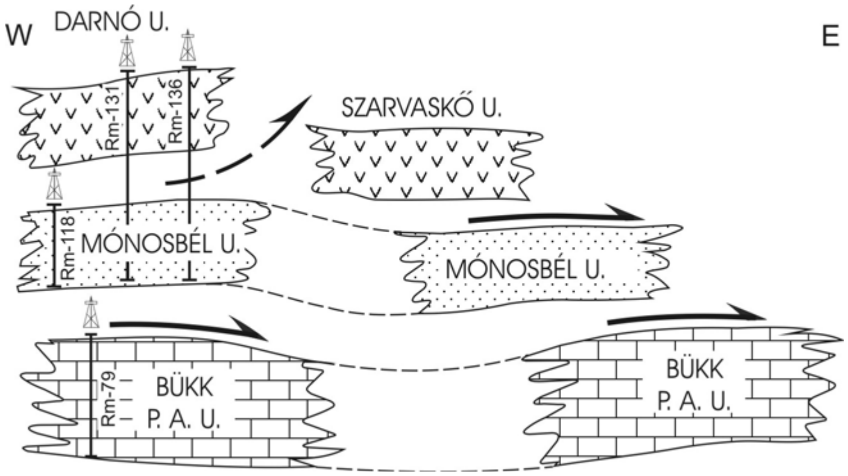

Fig. 3 Tectonic cartoon of the Bükk—Darnó region, with relative structural setting of drill core sections shown on Figs. 6 to 9. (After Haas & Kovács, 2001, modified)

3. SUMMARIZATION OF THE RESULTS OF DRILLCORE EXAMINATIONS

3.1. Bükk Parautochthon Unit

The unit is represented by Upper Triassic grey, cherty, micritic limestones corresponding to the Felsőtárkány Limestone Fm. of Bükk Mts. (cf. Pelikán, 1999, 2005; Velledits, 2000). It was hit by a number of boreholes in the Recsk ore field; however, older formations of the Bükk Triassic succession were not encountered, or at least not yet recognized. It was studied for conodonts in cores Rm-79 and Rm-58 *(Fig. 4)*. Unfortunately, the whole core of the latter no more exists, only selected sample bags are still avalable for investigations in the core depo at Rákóczitelep. Conodonts found indicate Upper Carnian to Rhaetian age (Gecse, 2006). Additionally, some samples taken from similar limestones of the Recsk-II. shaft, provided by T. Zelenka, yielded also Norian conodonts.

Marine Upper Paleozoic formations explored by borehole Nagybátony-324 to the NW of the Recsk ore field (Kozur, 1984; Fülöp, 1994) may represent either part of the Bükk Parautochthon succession (Mályinka and Szentlélek Fm., respectively, in an overturned position) or the NE-most extension of the Transdanubian Range Unit. The latter option could be concluded from the fact, that the Middle?-Upper Permian of the TRU shows an increasingly marine character towards the

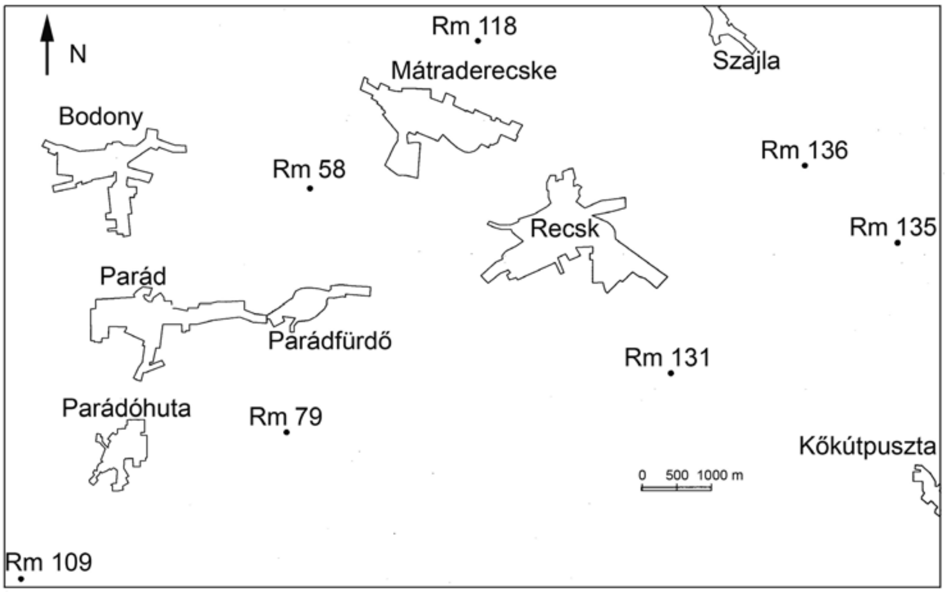

Fig. 4 Locations of boreholes discussed in the text in the Recsk area

NE; Majoros, 1983; Haas & Budai, 1995). However, as it was drilled just 20km NW of the westernmost located Recsk borehole, No. Rm-109 (described in details by Haas et al., 2006) the former possibility seems more likely.

3.2. Mónosbél Unit

The Mónosbél Unit forms the lower, sedimentary unit explored by the Darnó Hill drillcores (Rm-131, -135 and 136; Dosztály et al., 2002; Kovács et al., 2005). It comes up to the surface just to the SE of the Darnó Hill, on the Kis-Várhegy and Nagy-Várhegy Hills at Sirok. Several boreholes also encountered it to the NW of the Darnó Fault, in the pre-Tertiary basement of the Recsk ore field. From among the latters, the cores of Rm-109 (for details see Haas et al., 2006) and Rm-118 *(Fig. 5)* have been the subject of our ongoing investigations.

The lower unit recognizable in the Darnó Hill cores (herein on *Fig. 7* we show only the section of borehole Rm-136; the sections of both Rm-131 and -136 can be seen printed in Haas et al., 2004, p. 186-187 and in Dosztály et al., 2002, p. 107-108; that of Rm-131 alone in Kovács et al., 2005, p. 52) represents a lower slope and toe-of-slope setting, with three types of sediments transported by different types of gravity flows:

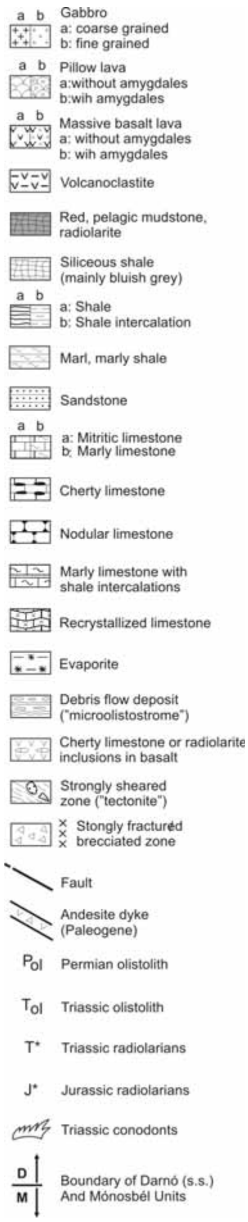

Fig. 5 Legend to the drill core sections shown in Figs. 6 to 9

(1) Dark grey shales and bluish grey siliceous shales; in some horizons these appear as the ”autochthonous” pelagic sediment, whereas in others show thin bedded, distal turbiditic character.

(2) Carbonate turbidites, often of fine laminated distal character. These are of two types deriving from different source areas: (a) grey, marly, micritic limestone deriving from a basinal source area (Oldalvölgy-type of the Bükk Mts.), and (b) light grey bioclastic limestone deriving from a shallow water (platform?) source area (Bükkzsérc-type of the Bükk Mts.).

Peloidal grainstones, partly with small echinoderm fragments are the characteristic microfacies types of the latter. Ooidal grainstones, characteristic of the westerly located borehole Rm-109 and of the easterly located Bükkzsérc outcrops and boreholes (Pelikán & Dosztály, 2000; Haas et al., 2006) were not found here. Dark grey to black chert layers or lenses may occur in both types. Renewed sediment movements subsequent to the settling of turbidites resulted in slump structures, or, in more advanced stage, debris flows (”microolistostromes”) (see also on core photos published by Balla et al., 1980).

(3) In certain horizons a different type of debris flow deposits (”microolistostromes”) occur, with cm-sized micaceous sandstone clasts. Its source area may be related to that of the Vaskapu Sandstone occurring in the Szarvaskő area of the western Bükk Mts. (Pelikán, 2005). Of interest is the occurrence of high amount of plutonic (granite) and extrusive (dacite-rhyolite and andesite) rock fragments in the sandstone clasts, which may derive from a magmatic arc (B.-Árgyelán & Gulácsi, 1997); however, their age has not yet been determined.

In core Recsk-109, under bluish grey silicified shale and radiolarite containing Bathonian to Early Callovian radiolarians, partially dolomitized limestone was encountered in 125 m-thickness (Haas et al., 2006). Based on detailed microfacies studies the carbonate succession consists pre-

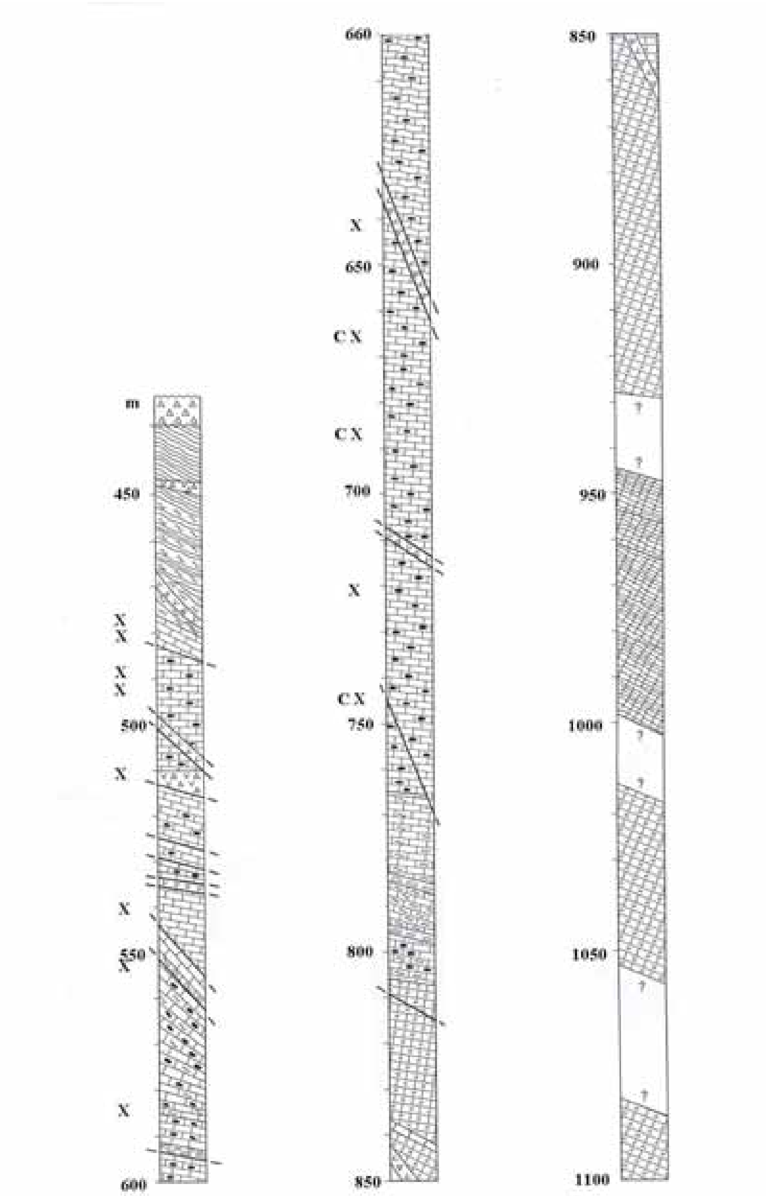

Fig. 6 Drillcore section of borehole Rm 79 (Bükk Parautochthon Unit). X: Negative conodont samples (on the left side of columns)

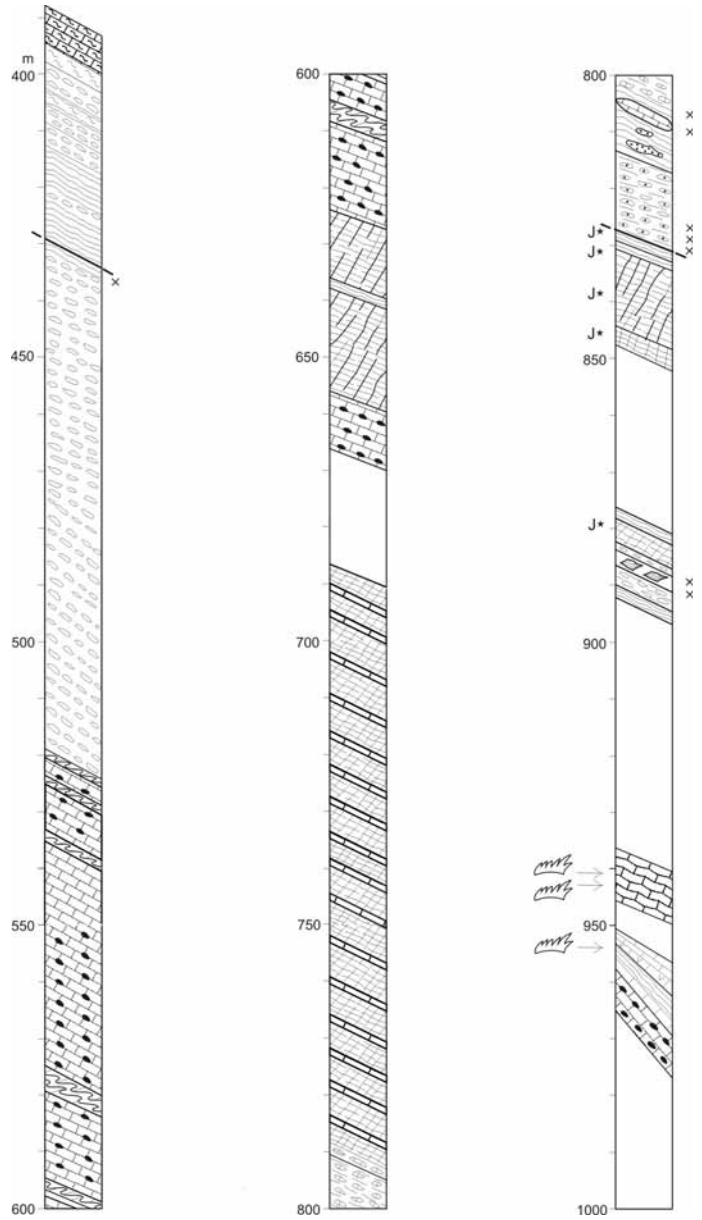

Fig. 7 Drillcore section of borehole Rm 118 (Mónosbél Unit)

dominantly of grainstones with packstone–wackestone intercalations. Peloidal bioclastic grainstone is the most common texture type but oolitic, oncoidal and intraclastic grainstones also occur, locally. The most characteristic feature is the large amount of platform derived coarse to medium sand-sized fragments of calcified cyanobacteria ("Porostromata"). Platform derived foraminifera and fragments of crinoids are also common. Gravity flows transported the carbonate detritus to the site of deposition at the lower platform foreslope and toe-of-slope. Based on foraminifera the carbonate succession can be assigned to the Aalenian (?) to Early Bajocian interval.

Triassic deep-water sediments (Bódvalenke-type, reddish-whitish siliceous limestones with red cherts) associated with reddish, amygdaloidal basalts occur as slide blocks (olisthothrymmae) within the Jurassic shales-siliceous shales, as recorded in the cores of boreholes Rm-131 and Rm-136 *(Fig. 7).* A slide block of Norian red Hallstatt Limestone in similar position was encountered by the borehole Rm-118 below 900m *(Fig. 6).*

At similar depth the borehole Rm-136 explored a block of Upper Permian black, fossiliferous limestone (Nagyvisnyó Limestone) and Middle Permian evaporites – green claystones (Szentlélek Fm.). According to Józsa et al., 1996 and Dosztály et al., 2002 it represents also a slide block, whereas according to Csontos (pers. comm.) it forms part of the Bükk PA Unit, together with the siliciclastics explored below it *(Fig. 7),* assigned by him to the "middle" Carboniferous Szilvásvárad Fm. However, radiolarians found in thin section suggest rather a Jurassic age for the latter (Dosztály & Józsa, 1992; Pelikán, unpubl.). On the other hand, a surface occurrence of the same, fossiliferous Upper Permian limestone is known about 250m to NW of the location of the borehole (Kiss, 1957; Fülöp, 1994;that was the reason why the borehole was drilled: Szabó, in Balla et al., 1980, 1981).

The borehole Rm-131 between 1004,7 and 1200m encountered whitish, cipollino-tye recrystallized limestones, which were considered by some authors to represent the Szendrő Paleozoic (Abod Limestone; Balogh, 1984). However, in the core sequence they occur in irregular "alternation" (with continouos contact and sometimes with transition) with Jurassic-type bluish-grey, wavy bedded micritic limestones, with black clay coatings. Therefore it seems more likely, that they represent just thermally altered (due to the Tertiary magmatism) parts of the latters.

In a quarry at the SW part of Kis-Várhegy Hill at Sirok, where the Mónosbél Unit comes up to the surface, the strongly folded carbonate turbidite – siliceous shale- shale sequence shows a vergency towards ESE. The direction and type of deformation, including stretching and boudinage formation along fold axes, corresponds also to that of the Bükk Mts. (Forián-Szabó, in Szebényi, ed., 2003, p. 11-12 and in Kovács et al., 2005).

3.3. Darnó Unit (s.s.)

This magmatic unit is exposed on the surface in the Darnó Hill area and is represented by the upper unit of the Darnó boreholes (Rm-131, -135 and -136; Józsa et al., 1996; Dosztály et al., 2002; Kovács et al., 2005 and in press B), SE of the Darnó Fault *(Fig. 8, Fig. 9).* It was not found in the boreholes drilled NW of the fault, likely had been eroded prior to the beginning of Paleogene sedimentation and volcanism. On the other hand, the westernmost outcrops of the Bükk Mts. in the Szarvaskő area (Reszél-tető in the northern neighbourhood of Egerbakta and Muszka Valley in the NE neighbourhood of Bátor) represent the easternmost occurrences of Darnó-type basalts (Gulácsi, unpubl. and in Kovács et al., in press; Józsa, 1999; Kiss, 2006).

The unit, considered as "upper unit of the Darnó Complex" in Dosztály et al., op. cit. and in Kovács et al., op. cit., consists predominantly of pillow and massive basalts, penetrated in up to more than 100m thick horizons, and subordinately of abyssal sediments penetrated in a few to max. tens of metres thickness: red radiolarites and pelagic mudstones, and bluish grey siliceous shales. Red radiolarites yielded alternatively Triassic (Ladinian-Carnian) or Jurassic (Bathonian-Callovian) radiolarians in different horizons, whereas bluish grey silicieous shales only Jurassic (Callovian) ones. The borehole Rm-135 explored also intrusive rocks (gabbro, microgabbro) in several hudred metres virtual thickness. Geochemically, these magmatic rocks show a MORB-type, with high Ti-content. K-Ar radiometric dating did not provide unambigouos results: although gabbros yielded Middle Jurassic (175-165 Ma) ages, basalts showed the age of a Middle Cretaceous tectonothermal event (110-95 Ma; Dosztály & Józsa, 1992; Józsa, 1999).

Megascopically, basalts are of two types. Amygdaloidal basalts, rich in pink and white calcite amygdals, as well as containing pink and reddish lime mud inclusions and inter-pillow void fillings, can be considered as of early rift-type (peperitic facies; Palinkaš and Molnar, pers. comm) and as of Triassic age. They are often red or reddish colour (haematitized), but can be green, as well. Basalts lacking calcite amygdals and lime mud inclusions are green coloured and appear to be similar to those of the Szarvaskő Unit (s.s.), like the large overturned pillow lava block exposed in the Nagy-Rézoldal quarry. These may be of Jurassic age.

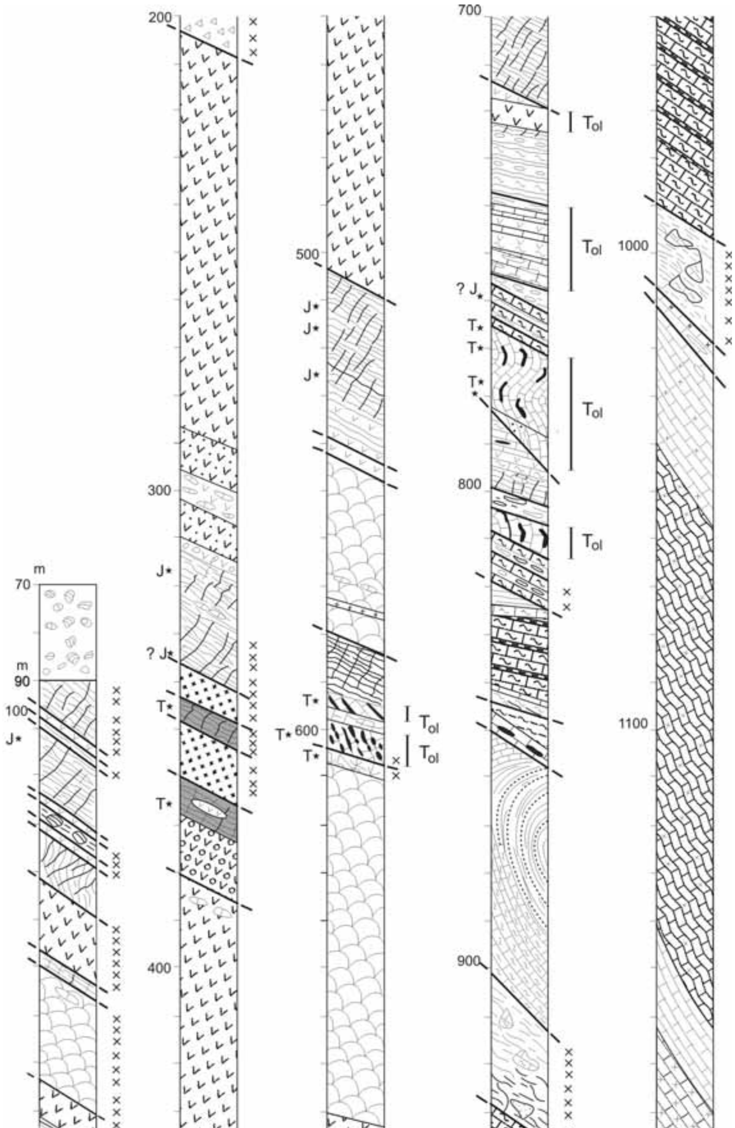

Fig. 8 Drillcore section of borehole Rm 131 (Mónosbél and Darnó s.s. Units)

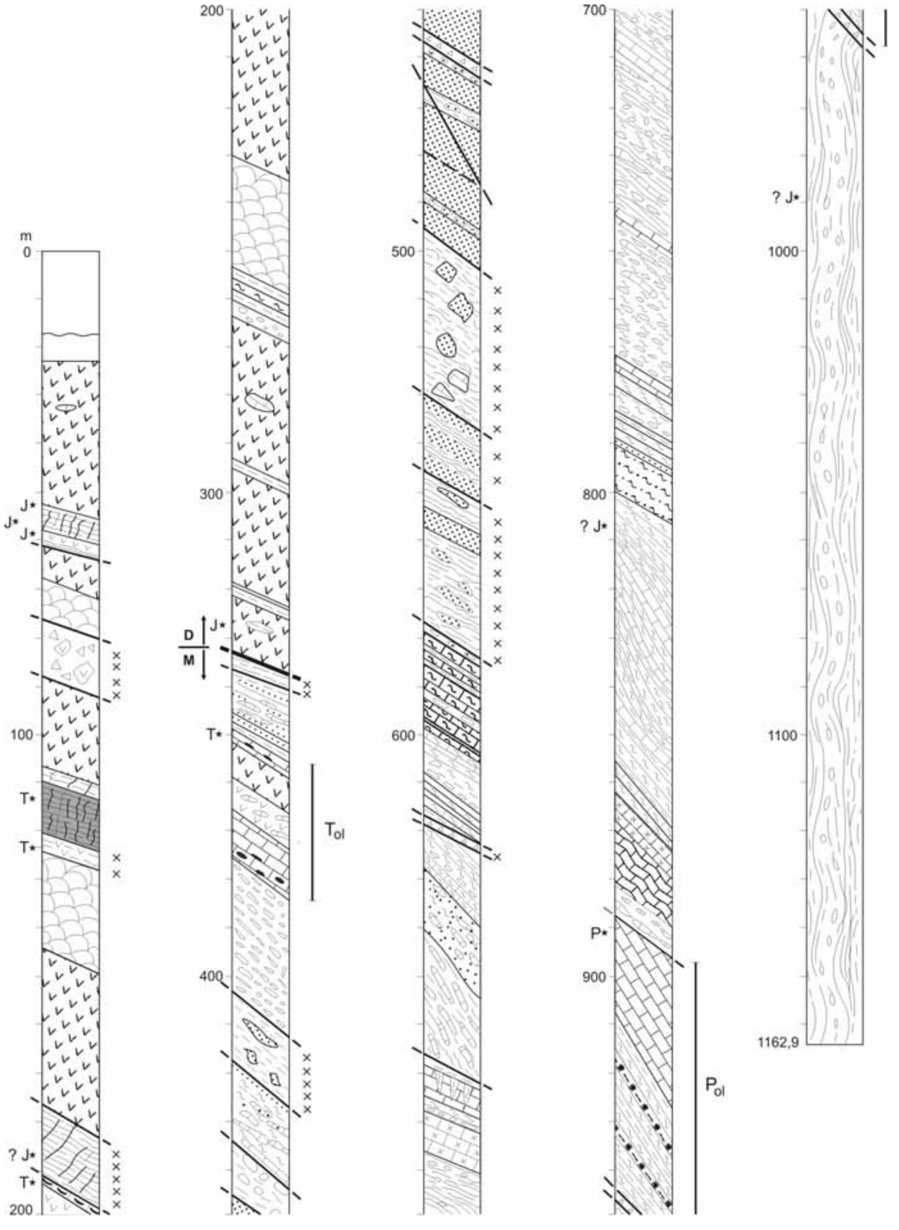

Fig. 9: Drillcore section of borehole Rm 136 (Mónosbél and Darnó s.s. Units)

Ultramafic rocks are not preserved, but the former presence of an ultramafic body of higher position is indicated by serpentinite pebbles in the Lower Miocene Darnó Conglomerate, covering th NE part of the Darnó Hill area, and by serpentinite grains in Lower Miocene sandstones north of the area (Sztanó & Józsa, 1996). It should be added to this last point, that large ultramafic sheets, exceeding several 100km² in extent, are common constituents of the Inner Dinaridic – Inner Hellenidic Neotethyan accretionary complexes (Dimitrijević et al., 2003; Kovács et al., in press A and references therein), where the Recsk-Darnó domain derived from (see below).

4. PALEOGEOGRAPHIC-PALEOTECTONIC RELATIONSHIPS

The Recsk-Darnó area lies within the *termination splays* (=”horse-tail-like termination”; Koroknai, pers. comm.) of the Periadriatic-Balaton Lineament system east of the Danube River. Its pre-Tertiary relationships and setting, together with the whole Bükk units (=”Bükkia Composite Terrane”; Kovács et al., 2000) can only be explained after restoring the major dextral displacement of the ALCAPA Megaunit or Composite Terrane (Fodor et al., 1998; Haas et al., 2000) and rotations of the intervening Tisza Megaunit (Tisia Terrane) (Csontos et al., 1992). From the former point of view it is of major importance, that the Recsk Paleogene volcanic complex represents the easternmost occurrence of the Periadriatic magmatic range extending along the whole Periadriatic Lineament and then from Slovenia, with a break ENE of Velence Hills, up to here (Benedek, 2002; Kovács I. et al., 2007; Less et al., in press; Földessy et al., in the present volume).

The Dinaridic relationship of the Bükk Upper Paleozoic and Triassic has been known since the works of Schréter and Balogh (for references see Balla, 1987 and Filipović et al., 2003). It used to be explained via the ”Igal-Bükk eugeosyncline” introduced by Wein, 1969 (for ref. see Kovács et al., 2000). This zone (named by Pamić et al., 2002 as ”Zagorje-Mid-Transdanubian-Bükk zone) is considered nowadays as the the scar of Tertiary major dextral strike-slip displacements (Csontos et al., op. cit.; Csontos & Nagymarosy, 1998).

Recent detailed comparative studies fully confirmed the formerly recognized Dinaridic relationships of the Bükk Upper Paleozoic and Triassic (Protić et al., 2000; Filipović et al., 2003). Also the Jurassic Dinaridic relationships, strongly emphasized by Pamić (2003) for the Mónosbél Unit, have been proven recently by detailed studies (Dimitrijević et al., 2003; Haas et al., 2006).

Middle Jurassic redeposited carbonates similar to that exposed in core Rm 109 were reported from the margin of the Adriatic Carbonate Platform (ADCP) and from the Slovenian Trough and Bosnian Flysh Zone (Dragičević & Velić, 2002; Jelaska, 2003), that were located in the neighbourhood of the ADCP and served as the depositional area of the platform derived carbonate sediments during the Jurassic. Since no carbonate platforms survived the intense relative sea level rise prior to the Middle Jurassic in the region except the ADCD, this platform must have been the source of the redeposited carbonates and the neighbouring slopes and basins were the sites of deposition. Accretionary wedge formation initiated in the Middle to Late Jurassic. It was followed by multistage tectonic deformation and very low-grade regional metamorphism of the parautochton unit and the nappes in the Early Cretaceous and large-scale horizontal displacement of the Bükk units (=”Bükkia Composite Terrane” in Kovács et al., 2000) during the early Tertiary.

Accordingly, the Darnó Unit with its early rift-type peperitic basalt facies, along with the Bódvalenke Limestone facies of the Rudabánya Mts. (Bernoulli and Krystyn, pers. comm.), represent the NW-most occurrences of these Neotethyan Triassic facies, characteristic of the western ophiolite belt of the Balkan Peninsula, extending from the Maliak Bay in northern Greece (being exposed in northern Euboia Island and Othrys Mts., after which the name ”Maliak Zone” was introduced) through northern Pindos Mountains, Mirdita Zone of Albania and Dinaridic Ophiolite Belt up to the Zagorje region of NW Croatia (Kovács et al., in press A). Having the NW-most Dinaridic outcrops in the Kalnik Mts. (kindly shown to Hungarian geologists by Prof. Palinkaš, Zagreb; see also Kiss, 2006), the continuation was displaced along the Zagorje-Mid-Transdanubian-Bükk Zone (in sense of Pamić et al., 2002), being exposed in the Bükk-Darnó region. Similarly, the carbonate turbidititic facies of the Mónosbél unit has its equivalents in the coeval horizons of the Bosnian Flysch Zone (Pamić, pers. comm. and 2003; Haas et al., 2006). These formations are not found in the Austroalpine Gemeric nappe system of Slovakia and Juvavic nappe system of Austria; consequently, the formerly supposed relationships with the Meliata Unit s.s., according to an old reconstruction by Kovács, 1984, should be seriously revised (cf. Kovács, in Dosztály et al., 2002, p. 106 and in prep.). The genetic relationships of the pre-Tertiary basement of the Recsk ore-field should be considered accordingly (cf. Kovács et al., in press A), likewise that of the Paleogene magmatism in context with the Periadriatic magmatic range (Less et al., in press).

5. CONCLUSIONS

1. The structure of the SW part of the Bükk Mts. continues in the pre-Tertiary basement of the Darnó-Recsk area (nappe system: Gulácsi, Haas, Kovács, Szebényi from among the present authors; practically continuous succession with only minor displacements: Pelikán from among the present authors), with the difference, that the predominantly magmatic Szarvaskő Unit is replaced by the likewise mainly magmatic Darnó Unit of different composition on top of the Mónosbél Unit.

2. The Darnó Fault is not a terrane boundary; however, missing of Paleogene volcanics and associated sediments SE of it (in the Darnó Hill area), on one hand, and of the Mesozoic magmatic Darnó Unit s.s. NW of it (in the Recsk area) indicate strike-slip displacements along it. The latter likely had been eroded before the Paleogene volcano-sedimentary cycle)

3. Jurassic platform-derived carbonate turbidites in the Mónosbél Unit unambigously could only derive from the Adriatic/Dinaridic Carbonate Platform, where the platform evolution continued throughout the Mesozoic, as opposed to the Austroalpine-"Central" West Carpathian shelf area, where platforms drowned overall at the Triassic-Jurassic boundary interval.

4. The nearest equivalents of the Darnó-type early rift-type basalts (peperitic facies) are exposed at the other end of the Zagorje-Mid-Transdanubian-Bükk Zone, in the Kalnik Mts. of NW Croatia, NW-most Dinarides. No equivalents are found in the Austroalpine Gemeric and Juvavic nappe systems in Slovakia and Austria.

5. The peperitic basalts of Darnó Unit s.s., along with the Bódvalenke Limestone of Rudabánya Mts. (the diagnostic facies of the Bódva Unit, transitional between Hallstatt Limestone and red radiolarite), represent the NW-most known occurrences (displaced along the Periadriatic-Balaton and Mid-Hungarian lineaments) of such formations characteristic of the western ophiolite belt of Balkan Peninsula (Maliak-Mirdita-Dinaridic Ophiolite Belt).

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References

BALLA, Z. (1987):
Tectonics of the Bükkian (North Hungary) Mesozoic and relations to the West Carpathians and Dinarides. Acta Geol. Hung., 30/3-4, pp. 257-287

BALLA, Z., BAKSA, CS., FÖLDESSY, J., HAVAS, L., SZABÓ, I. (1980):
The tectonic setting of the ophiolites in the Bükk Mountains (North Hungary). – Geol. Zborn. – Geol. Carpath., 31/4, pp. 465-493

BALLA Z., BAKSA CS., FÖLDESSY J., HAVAS L., SZABÓ, I. (1981):
Mezozoós óceáni litoszféra maradványok a Bükk-hegység délnyugati részén. – Általános Földtani Szemle, 16, 35-88

ÁRGYELÁN, B., GULÁCSI, G., Z. (1997):
Acidic extrusive and plutonic rocks fragments in the siliciclastic sediments of the Darnó and Szarvaskő Units. Terra Nostra, Sediment'97 Kurzfassungen, 3

BALOGH, K., KOZUR, H., PELIKÁN, P. (1984):
Die Deckenstruktur des Bükkgebirges. Geol.-Paläont. Mitt. Innsbruck, 13, 3, 89-96

BENEDEK, K. (2002):
Paleogene igneous activity along the easternmost segment of the Periadriatic-Balaton Lineament. Acta Geologica Hungarica, 45/4, 359–371

CSONTOS, L. (19999:
A Bükk hegység szerkezetének főbb vonásai (Structural outline of the Bükk Mts. (N Hungary). (In Hung., with English abstr.). – Földt. Közl., 129/4, pp. 611-651.

CSONTOS, L., NAGYMAROSY, A. HORVÁTH, M. KOVÁČ (1992):
Tertiary evolution of the Infra-Carpathian area: a model. Tectonophysics, 208, 221-241

CSONTOS, L., NAGYMAROSY, A. (1998):
The Mid-Hungarian line: a zone of repeated tectonic inversions. Tectonophysics, 297, 51-71

DIMITRIJEVIĆ, M. N., DIMITRIJEVIĆ, M. D., KARAMATA, S., SUDAR, M., GERZINA, N., KOVÁCS, S. DOSZTÁLY, L., GULÁCSI, Z., LESS, GY., PELIKÁN P. (2003):
Olistostrome/mélanges – an overview of the problematics and preliminary comparison of such formations in Yugoslavia and NE Hungary. – Slovak Geol. Mag., 9/1, pp. 3-21

DOSZTÁLY, L., GULÁCSI, Z., KOVÁCS, S., 1998:
Az észak-magyarországi jura képződmények rétegtana. In: Bérczi I. & Jámbor, Á. (szerk.): Magyarország geológiai képződményeinek rétegtana, 309-318, MOL Rt. & MÁFI Kiadv., Budapest

DOSZTÁLY, L., JÓZSA, S., KOVÁCS, S., LESS, GY., PELIKÁN, P., PÉRÓ, CS. (2002):
North-East Hungary. 1st Day Programme, Post-Congress Excursion C. In: Vozár, J., Vojtko, R., Sliva, L'. (eds.): Guide to Geological Excursions, XVIIth Carpathian-Balkan Geological Associa-

tion, p. 104-117, Bratislava, Slovak Republic
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., 35/4, pp. 371-393.
DRAGIČEVIĆ, I. & VELIĆ, I. (2002):
The Northeastern margin of the Adriatic Carbonate Platform. Geologica Croatica, 55, 2, p. 185-232
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, 1, 3-21
FODOR, L., JELEN, B., MÁRTON, E., SKABERNE, D., CAR, J., VRABEC, M. (1998):
Miocene-Pliocene tectonic evolution of the Slovenian Periadritic fault. Implications for Alpine-Carpathian extrusion models. Tectonics, 17, 690-709
FÖLDESSY, J. (1975):
Petrological study of a diabase-spilite magmatic rock suite, Darnó-hegy (Sirok, Hungary). – Proceedings of the Xth Congress of the Carpatho-Balkan Geological Association, 1973, Sect. VI, Magmatism, volcanism, metamorphism, GÚDS Bratislava, pp. 55-64
FÖLDESSY-JÁRÁNYI, K. (19759:
A recski mélyszinti alaphegységi üledékes képződmények (Deep-seated sedimentary rocks of the basement at Recsk; in Hung.). Földt. Közl. 105, pp. 598-611.
FÜLÖP, J. (1994):
Magyarország geológiája. Paleozoikum II. (Geology of Hungary. Paleozoic II) (In Hung.). Akad. Press., Budapest, 447 p
GECSE, ZS. (2006):
A Darnó-hegy mezozoós képződményei és környékének triász Conodontái. Szakdolgozat, 58 p., Eszterházy Károly Tanárképző Főiskola, Földrajzi Tanszék, Eger.
HAAS, J. (ed.) (2004):
Magyarország geológiája. Triász (Geology of Hungary. Triassic; in Hung.). 384 p., ELTE Kiadó, Budapest
HAAS, J., BUDAI, T. (1995):
Upper Permian-Triassic facies zones in the Transdanubian Range. Riv. Ital. Paleont. Strat., 101, 3, 249-266
HAAS, J., GÖRÖG, Á., KOVÁCS, S., OZSVÁRT, P., MATYÓK, I., PELIKÁN, P. (2006):
Displaced Jurassic foreslope and basin deposits of Dinaridic origin in Northeast Hungary. Acta Geol. Hung., 49/2, 125-163
HAAS, J., KOVÁCS, S. (2001):
The Dinaridic-Alpine connection – as seen from Hungary. – Acta Geol. Hung., 44/2-3, pp. 345-362
JELASKA, V. (2003):
Carbonate Platforms of the External Dinarides. In: Vlahović, I. & Tišljar, J. (eds.): Evolution of Depositional Environments from the Palaeozoic to the Quarternary in the Karst Dinarides and the Pannonian Basin. 22nd IAS Meeting of Sedimentology, Opatija, Field Trip Guidebook, 67-72, Zagreb
JÓZSA, S. (1999):
Petrology and geochemistry of ocean floor magmatic rocks of Darnó Hill, NE Hungary. PhD thesis, Eötvös University, 173 p., Budapest

JÓZSA, S., DOSZTÁLY, L., GULÁCSI, Z., KOVÁCS, S. (1996):
Ophiolites of Szarvaskő, Darnó Hill and Bódva Valley (Summarized characteristics of North Hungarian ophiolitic magmatic rocks.) – IGCP 369 workshop on „Rift magmatism", Field guide B: Ophiolitic units in NE Hungary, 16 p., Budapest

KISS, G. (2006):
Szubmarin vulkanizmushoz kapcsolódó hidrotermás események jellemzése a Darnó-zóna párnaláváiban. (Characterization of hydrothermal events connected to submarin volcanism in the pillow lavas of Darnó Hill, in Hung.) Manuscript, Dept. Of Mineralogy, Eötvös University, 44 p., 10 pls

KISS, J., (1958):
Ércföldtani vizsgálatok a siroki Darnó-hegyen. (Untersuchungen der Vererzung des Darnóberges im Mátragebirge). (In Hung. with German abstract). Földtani Közlöny, 88/1, 27-41

KOVÁCS, I., CSONTOS, L., SZABÓ, CS., BALI, E., FALUS, GY., BENEDEK, K., ZAJACZ, Z. (2007):
Paleogene–early Miocene igneous rocks and geodynamics of the Alpine-Carpathian-Pannonian-Dinaric region: An integrated approach. In: Beccaluva L., Bianchini G., Wilson M. (eds.) Cenozoic Volcanism in the Mediterranean Area. Geological Society of America Special Paper 418: 93–112

KOVÁCS, S. (1984):
North Hungarian Triassic Facies Types: A review. Acta Geol. Hung., 27, 3, 251-264

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, 3, 225-328

KOVÁCS S., JÓZSA S., GULÁCSI Z., DOSZTÁLY L., B.-ÁRGYELÁN G., FORIÁN-SZABÓ M., OZSVÁRT P. (2005):
Permo–Mesozoic Formations of the Darnó Hill Area, NE Hungary – A Displaced Fragment of the Inner Hellenidic–Inner Dianridic Accretionary Complexes. In: Tomljenović, B., Balen, D. Vlahović, I. (eds) 7th Workshop on Alpine Geological Studies. Abstracts Book. Croatian Geological Society, Zagreb, 51–52

KOVÁCS, S., et al., in press A

KOVÁCS, S. et al., in press B

KOZUR, H. (1984):
A Nagybátony-324. sz. fúrás oligocén előtti képződményeinek rétegtani besorolása és tektonikai értékelése. (Die startigraphische Einstufung der voroligozänen Schichtenfolge der Bohrung Nagyvátony-324 und ihre tektonische Auswertung). Földt. Közl., 114, 1, 61-79

LESS, GY., BÁLDI, T., BÁLDI-BEKE, M., BENEDEK, K., FODOR, L., FÖLDESSY, J., KERTÉSZ, B., PÁLFALVI, S., PÉCSKAY, Z., ZELENKA, T. (submitted):
New data ont he age of the Recsk volcano (NE Hungary), the NE-most member of the Periadriatic magmatic range, with implications to the Paleogene paleogeography of the Alpine-Carpathian region. Intern. J. Earth. Sci.

MAJOROS, Gy. (1983):
Lithostratigraphy of the Permian Formations of the Transdanubian Central Mountains. Acta Geol. Hung., 26, 1-2, 7-20

PAMIĆ, J. (2003):
The allochthonous fragments of the Internal Dinaridic units in the western part of the Panno-

nian Basin. Acta Geol. Hung., 46, 1, 41-62

PAMIĆ, J., KOVÁCS, S., VOZÁR, J. (2002):
The Internal Dinaridic fragments into the collage of the South Pannonian Basin. Proceedings of the XViith Congress of Carpatho-Balkan Geol. Assoc., Geol. Carpath., 53, Spec. Issue, 9-11

PELIKÁN, P. (1999):
Triassic and Jurassic formations of the area of borehole Felsőtárkány-7 (Bükk Mts., N Hungary). (In Hung.) Földt. Közl., 129, 4, 593-609

PELIKÁN P., IN PELIKÁN P. (szerk.) (2005):
A Bükk hegység földtana. Magyarázó a Bükk-hegység földtani térképéhez. 284p., MÁFI, Budapest

PELIKÁN, P., DOSZTÁLY L. (2000):
Jurassic formations of the Bükkzsérc boreholes (SW Bükk Mts., NE Hungary) and their structural setting. (In Hung., with English abstr.) – Földt. Közl., 130/1, pp. 25-46.

PROTIĆ, L., 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., S. Janković (eds.): Proceedings of the International Symposium "Geology and Metallogeny of the Dinarides and the Vardar Zone". 61-69, Banja Luka

SZEBÉNYI, G. (ed.) (2003):
A Darnó zóna geológiája és geofizikája. Kirándulásvezető, Magyarhoni Földtani Társulat, Recsk, 2003. május 29-31. (Geology and geophysics of the Darnó Zone. Hungarian Geological Society, May 29-31, 2003, Recsk). 33 p.

SZTANÓ, O., JÓZSA, S. (1996):
Interaction of basin-margin faults and tidal currents on nearshore sedimentary architecture and composition: a case study from the Early Miocene of northern Hungary. Tectonophysics, 266, 319–341, Amsterdam

VELLEDITS, F. (2000):
Evolution of the area from the Berva Valley to the Hór Valley in the Middle-Upper Triassic. Földt. Közl. 130, 1, 47-93 (in Hungarian, English abstract)

Plate 1
(from upper left) 1: Red, amygdaloidal basalt with mainly intersertal texture. Mély-völgy quarry. 2: Intergranular-ophitic texture of green basalt , without signs of contamination by lime mud. Augite crystals appear amongst albite laths. New quarry next to the valley of Báj-patak from NW. 3: Triassic red radiolarite. Drill core Rm 136, 197,2m. 4: Jurassic red radiolarite. Drill core Rm 136, 56,6m. 5: Jurassic Bükkzsérc-type limestone turbidite, with peloidal grainstone texture. Drill core Rm 136, 583,6-583,7m. 6: Jurassic Oldalvölgy-type fine-grained limestone, showing very distal turbiditic character. Drill core Rm 136, 865,9m. 7: Upper Permian Nagyvisnyó Limestone, bioclastic packstone with calcareous algae (Gymnocodium sp.) Drill core Rm 136, 895,65-895,95m. 8: Jurassic platform-derived detritus (Porostomata-type "algae": recently acknowledged as calcified cyanobacteria, echinoderms, coated grains) in sparite cement.
Drill core Rm 109, 1105,4m.

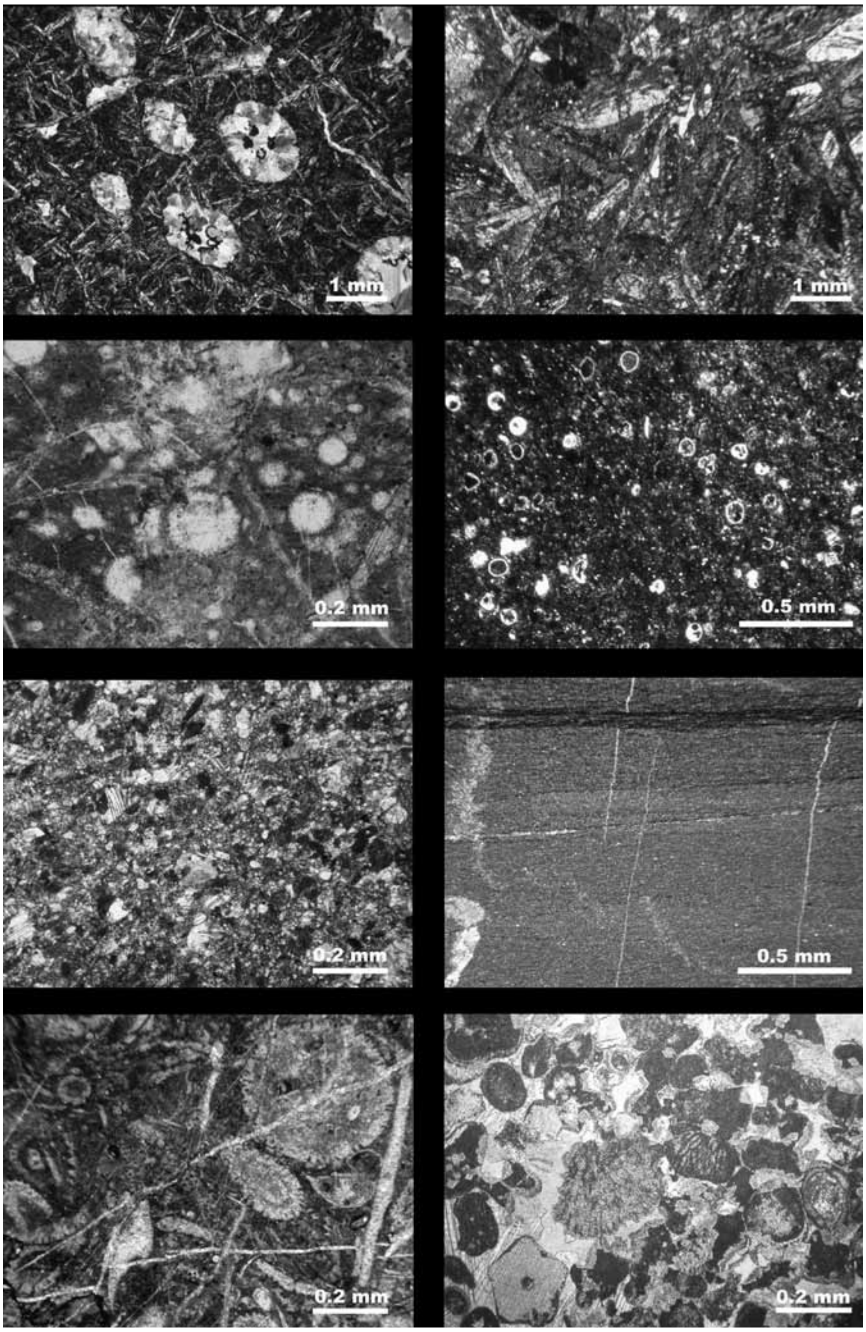
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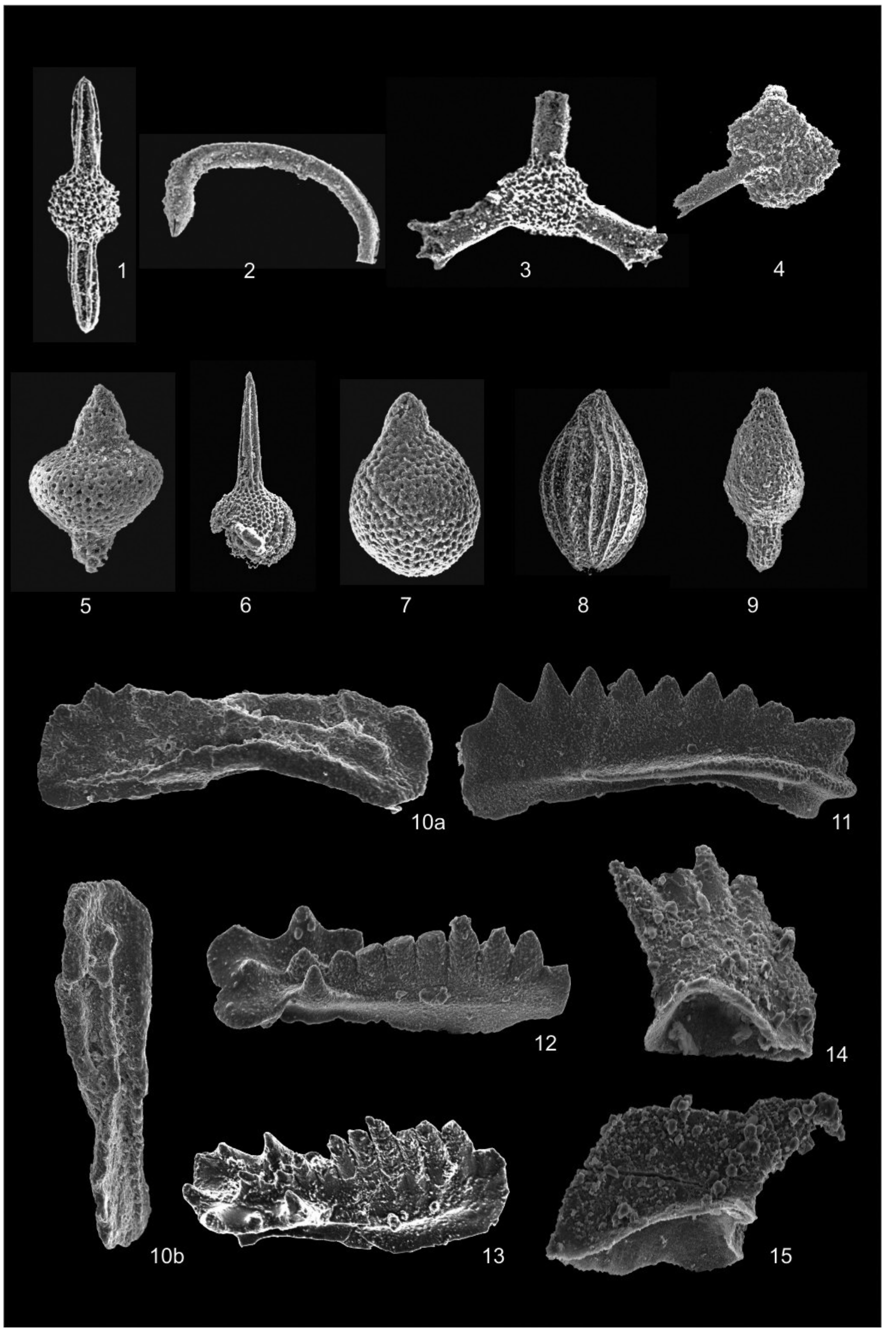
Plate 2
Triassic (Ladinian-Carnian, 1-4) and Jurassic (Bathonian-Callovian; 5-9) radiolarians. 1: Pseudostylosphaera coccostyla (RÜST); borehole Rm-131, 781.4 m. 2: Oertlispongus inaequispinosus DUMITRICA, KOZUR and MOSTLER; Borehole Rm-131, 780.0 m. 3: Capnuchosphaera sp.; Borehole Rm-131, 594.8 m. 4: Capnuchosphaera sp. 1.; Borehole Rm-131, 594.8 m. 5: Stichocapsa sp. E.; Borehole Rm-118, 845.5 m. 6: Triactoma sp.; Borehole Rm-118, 879.2 m. 7: Stichocapsa convexa YAO; Borehole Rm-118, 835.5 m. 8: Protunuma japonicus MATSUOKA and YAO; Borehole Rm-136, 55.8 m. 9: Cyrtocapsa mastoidea YAO; Borehole Rm-136, 55.8 m
Upper Triassic conodonts. 10a-b: Slightly deformed Gondolella polygnathiformis BUDUROV & STEFANOV; Late Carnian. Borehole Rm 58, 928,0m. 11: Gondolella hallstattensis (MOSHER). Late Early Norian. Borehole Rm 118, 942,8-943,3m. 12: Metapolygnathus abneptis abneptis (HUCKRIEDE). Early Middle Norian. Borehole Rm 118, 942,8-943,3m. 13: Metapolygnathus abneptis triangularis (BUDUROV). Early Middle Norian. Borehole Rm 79, 687,0-687,4m. 14: Neospathodus hernsteini MOSTLER. Rhaetian. Borehole Rm 58, 657,0m. 15: Neospathodus posthernsteini (KOZUR & MOCK). Rhaetian. Borehole Rm 58, 657,0m.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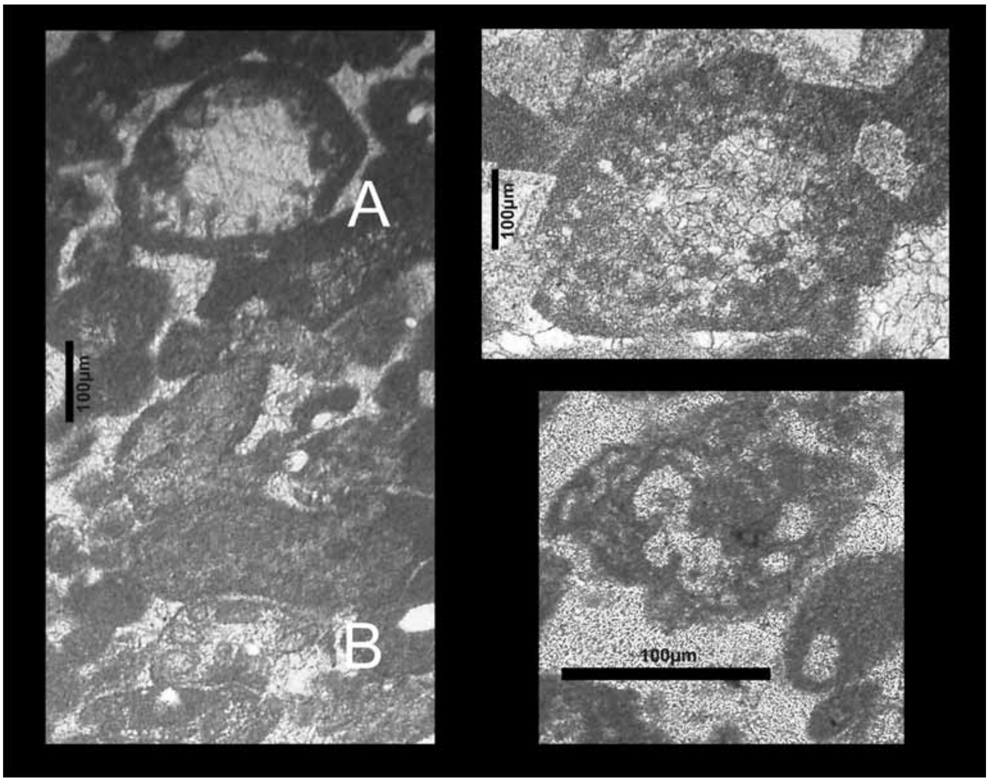

Plate 3
Jurassic (Bajocian-Bathonian) foraminifers. 1: A: Trocholina palestinensis HANSON and B: Trocholina conica (SCHLUMBERGER). Borehole Rm 109, 1143m. 2: Gutnicella gr. cayeuxi (LUCAS). Borehole Rm 109, 1085m. 3: Mesoendothyra croatica GUŠIĆ. Borehole Rm 109, 1107m