Olistostrome/mélanges – an overview of the problems and preliminary comparison of such formations in Yugoslavia and NE Hungary

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Abstract. The term "mélange" means simply a mixture and has itself no genetic significance without a descriptive adjective. Mélanges can be basically of two types of origin: tectonic ("autoclastic mélange") or sedimentary ("olistostrome"). The first type in the language of structural geology can be defined as transposition of S-surfaces, whereas the second one in that of sedimentology as deposit of debris flow. However, if an olistostromal formation suffers pervasive shearing, the distinction between the two types becomes practically impossible. Mélanges may result in different settings, but only those can be regarded as true subduction-related (accretionary) complexes, which contain amongst exotic blocks (chert, limestone, sandstone, etc.) also inclusions of basic and ultrabasic rocks in a matrix of different (mostly argillaceous) composition, e.g. the "ophiolite mélanges". It is essential to see the character of the matrix, as in poorly exposed terrains, like the hilly regions of the ALCAPA Megaunit, having random outcrops of hard rocks, even folded or imbricated, otherwise normal successions (like deep-water limestone - radiolarite - shale) can be misinterpreted (and, unfortunately, often are...) as either "tectonic mélange" or "olistostrome".

Ophiolitic mélanges (the "Diabase-Chert Formation" in the former literature) occur in two zones in Yugoslavia: in the Vardar Zone (VZ) on the East and in the Dinaridic Ophiolite Belt (DOB) on the West, separated by the Drina-Ivanjica Element (DIE) continental block/terrane. The DOB bears evidence of Middle Triassic opening and Late Jurassic closure, with inclusions of all formations of the Triassic DIE carbonate platform, some Permian rocks and blocks from the ocean floor: ophiolites (pillow lavas, gabbros, ultramafics) and radiolarites yielding both Triassic and Jurassic radiolarians. Large ultramafic masses are characterized by metamorphic sole.

The VZ is interpreted as a Paleotethyan oceanic remnant, existing already in the Paleozoic and closed in its most part during the Late Jurassic, with a back-arc basin in its western part, that closed in the Late Cretaceous. Mélanges occur in the central and mainly in the western subzone. They differ from those of the DOB in the absence of large olistoplakae of sedimentary rocks, rarity of limestone and abundance of sandstone blocks, intense shearing of the matrix and the lack of metamorphic sole of large ultramafic sheets. The western subzone, mostly in the Zvornik zone sector, contains blocks of Senonian limestones.

In NE Hungary, olistostromal formations in connection with ophiolites occur in the lower, sedimentary units (which seem to be identical: the Mónosbél Unit) of both the Darnó and Szarvaskő Ophiolite Complexes. As continuous drill cores revealed, they represent toe-of-slope setting, with all transitions between slumps-debris flows-turbidites. Exotic inclusions (Triassic red, cherty limestone and red chert with basalt, Upper Permian limestone) occur as slide blocks (olistothrymmata). Specific are the limestone-rhyolite olistostromes of the Telekesoldal Complex of the Rudabánya Mts., considered to be in connection with a Late Jurassic magmatic arc. The formerly generally accepted "evaporite mélange" character of the Bódva Valley Ophiolite Complex should be severely modified: true autoclastic mélanges occur only in local shear zones.

In the Yugoslavian-Hungarian area ophiolitic mélanges point to the existence of several oceanic domains (partial basins), which were in connection within the Tethys, but cannot be regarded as remnants of a sole oceanic branch. They differ in composition, depending on geotectonic setting and composition of surrounding continental blocks and oceanic areas. The few km^2 sized Darnó and Szarvaskő complexes can be regarded as small relics of Neotethyan accretionary complexes, displaced along the Zagreb-Zemplén Lineament from the NW Dinarides to NE Hungary. They show more conspicuous similarity to the western ophiolite belt (DOB), as indicated by some types blocks common in both areas: Triassic Bódvalenke-type red, cherty limestones with basalts, red cherts, both of Triassic and Jurassic age, also with basalts, and the carbonate-turbiditic ooidal Bükkzsérc Limestone and upper part of the Grivska Fm. (or a new formation).

Key words: olistostromes, mélanges, Yugoslavia, NE Hungary, Dinarides, Vardar Zone, "Bükkium".

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1. Birth of the notion

In the year 1895, three well-known geologists of the time, Griesbach, Diener and Middlemiss worked in the central Himalayan Kiogar area, in the larger area of Nanda Devi. They found there: "... a wild mixture of flysch type sediments, blocks of exotic rocks several meters to several kilometers in size, together with basite and ultrabasite blocks". Diener (1895) made a comparison with the "Klippenzone" of Swiss Alps and Carpathians, suggesting the connection of this mixture with overthrusting ("lambeaux de recouvrement" sensu Bertrand, 1884 and Schardt, 1893).

From the same area, von Kraft gave a new genetic explanation in 1902: the mix formed by volcanic explosions which intermixed sediments and basic volcanics.

In 1909, Suess wrote that "The Kiogar area represents the border of a movement surface of the first order, along which overlap sedimentary series of mutually dissimilar facies".

In the first fifteen years of investigation, the complex has thus been described chaotic in composition, containing blocks of "flysch-type" sediments, exotic rocks and basites to ultrabasites. Two explanations for its occurrence have been proposed, which will be of influence for a very long time - genesis as a volcanic-sedimentary formation, and position in front of regional nappes. Besides, similarity to flysch has been mentioned, also leaving traces in the history of the complex.

The term "*mélange*" still did not exist at that time. In 1919, Greenly published a very extensive explanation of the geology of Anglesey, a small island along the western coast of Scotland. Describing the fabric of the Gwna Group from the Mona Complex, Greenly coined the term "*autoclastic mélange*", writing:

"The essential characters of an autoclastic mélange may be said to be the general destruction of original junctions, whether igneous or sedimentary, especially of bedding, and the shearing down of the more tractable material until it functions as a schistose matrix in which the fragments of the more obdurate rocks float as isolated lenticles or phacoids".

"The term "*autoclastic*" originated by Smyth (1891) for a rock having a broken or brecciated structure, found in place where it was formed as a result of crushing, shattering, dynamic metamorphism, orogenic forces, or other mechanical processes" (from Bates & Jackson, 1980). It is clear that the fabric described by Greenly, in modern language of structural geology will be defined as a product of transposition of S-surfaces, representing a purely structural phenomenon.

However, the term "mélange" persisted. In 1950, Bailey & McCallien - two faithful former students of Greenly, investigated a chaotic complex in Anatolia and named it the "Ankara Mélange" in their mentor's honor, but unfortunately without any descriptive adjective. This complex has nothing to do genetically with Greenly's "autoclastic mélange", being not an issue of transposition of S-surfaces. In 1951, Shackleton applied the term "mélange" even for the lahars in Rusinga Island, giving no genetic significance to it.

The term "mélange" was further on used without distinction for all chaotic mixtures of various rocks not obeying the classical rules of sedimentary sequences (law of superposition, law of original continuity, law of faunistic associations; see Gilluly et al., 1959). Such complexes were found in all parts of the world and in rocks of all ages (Liguria, Alps, Iran, Beluchistan, Celebes, Oman...). Beside a chaotic fabric, one of the most outstanding features of these complexes of regional significance was the presence of the "Steinmann's trinity": blocks of chert, arkose and basites.

Comparing the Celebes ophiolitic complex with ophiolites of Turkey, Kurdistan and Oman, Kündig (1956, and especially 1959) systematized their general characteristics as follows:

- heterogeneity of hypoabyssal, plutonic and volcanic rocks,
- sharp facies differences from both sides of the ophiolite zone,
- association of metamorphic (especially glaucophane) and non-metamorphosed rocks,
- chaotic structure with frequent anomalous contacts,
- absence of roots and channels which would conduct magmatics to present position,
- mostly cold contacts of magmatics toward adjacent rocks,
- "large areas of the shelf edge coverage slid as huge exotics into a foreign environment".

The advent of the Plate Tectonics made a specific kind of mélange one of the very important features in the global architecture. This was the ophiolitic mélange – a mixture of matrix, different in composition, and exotic blocks of various size, where ophiolites, cherts and greywackes played an important role.

During the discussion at the Beneo's lecture at the 4th World Petroleum Congress, Flores (1955) introduced the term and notion of *olistostrome,* and Gansser (1955, 1959) used this mechanism to partly explain the origin of the ophiolitic "colored mélange" of Iran and Beluchistan (olistostrome + tectonics). Thus, two main branches of thinking were opened for the origin of ophiolitic mélange - tectonics and sedimentation ("mega-olistostrome").

General rules of the mélange organization were given by Hsü in 1968 (no stratal continuity; no normal superposition; time-range of deposition is not given by fossils found in the mélange) together with somewhat less important declarations that the lower and upper contacts of the mélange may be depositional or dislocational, and that the roof of the mélange can be autochthonous in one place and allochthonous elsewhere. Several years later, Hsü (1974) published another paper, making a distinction between the mélange (giving no genetic adjective!) and the olistostrome, strictly advocating the tectonic interpretation of the mélange.

Both main explanations of the mélange origin - tectonic and olistostrome - connect this complex with the subduction troughs. A different opinion has been advocated by Belostockij (1978) - from his observations in Albania, the author concludes that the mélanges have their original place in front of large nappes, where the material of the front

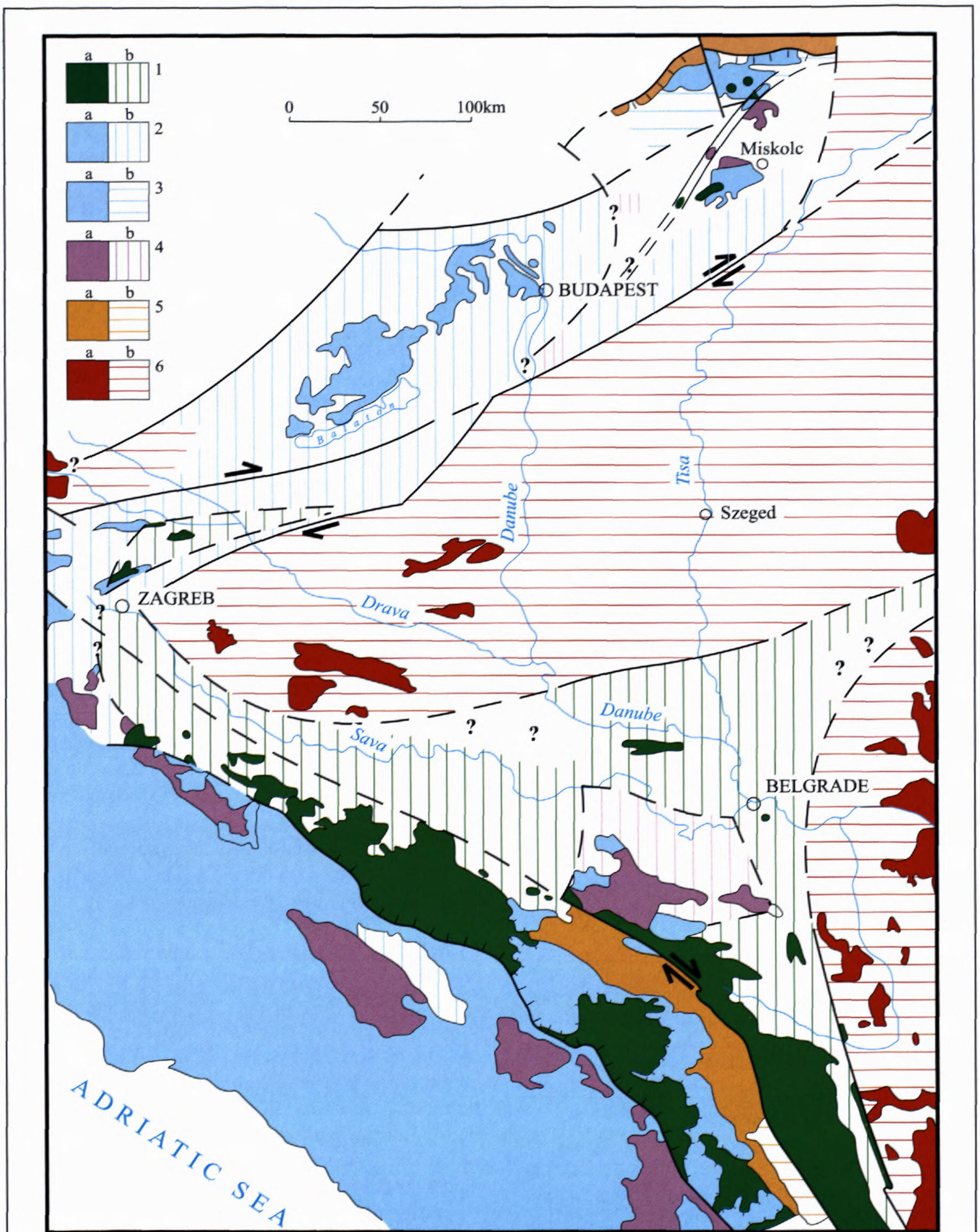

Fig. 1 Tectonic/terrane sketch map of the Dinarides+Vardar Zone and of the Pannonian area.

Legend. 1: Neotethyan ophiolite complexes (Vardar Zone, Dinaridic Ophiolite Belt, and in the Zagorje-Mid-Transdanubian and Bükk Composite Terranes); 2: Units related to the North Tethyan continental margin in the Pelsonia Composite Terrane; 3: Units related to the Adriatic/Apulian continental margin of the Neotethys in the Dinaridic+Vardar Zone and in the Pelsonia Composite Terrane; 4: Areas with marine Upper Carboniferous+Permian within 3. ("Noric-Bosnian Zone" in sense of Flügel, 1990); 5: Paleozoic Units without marine Upper Carboniferous and Permian in the Dinarides and Pelsonia Composite Terrane ("Betic-Serbian Zone" in sense of Flügel, 1990); 6: Units related to the Variscan Median Crystalline+Moldanubian zones (in sense of Neubauer & von Raumer, 1993) and to the North Tethyan (European) continental margin during the Mesozoic.

Green dots in NE Hungary indicate drill hole occurrences of the Neotethyan Bódva Valley Ophiolite Complex, whereas the green triangle the outcrops of the Upper Jurassic (?) Telekesoldal rhyolites in the Rudabánya Mts.

Area in the full colour (a) indicate surface occurrences, whereas those with hachures borehole proven ones in the pre-Tertiary basement slid down, possibly also forming olistostromes and being crushed posteriorly under the nappe by its movement. This explanation seems to be important for mélanges that are not bound to plate/microplate margins, being not necessarily connected with ophiolites. Such mélanges would more or less correspond to the "*chaos*", "a structural term proposed by Noble (1941) for a gigantic breccia associated with thrusting, consisting of a mass of large and small blocks of irregular shape with very little fine-grained material, in a state of semidisorder" (from Bates & Jackson, 1980).

A non-genetic definition of "mélange" has been proposed by Raymond (1984): "A body of rock mappable at 1:24,000 scale or smaller, characterized by a lack of internal continuity of contacts or strata and by the inclusion of fragments and blocks of all sizes, both exotic and native, embedded in a fragmental matrix of finer-grained material."

To overcome all problems connected with genetic aspects, Medley (1994) coined a practical engineering term "bimrock", defined as "a mixture of rocks, composed of geotechnically significant blocks within a bonded matrix of finer texture".

It is well known that olistostromes occur in a variety of geological bodies, ranging in thickness from a few decimeters to several tens of meters. In the terrains of Yugoslavia, these bodies vary in age - from at least the Paleozoic - e.g. Devonian of Eastern Serbia (Krstić & Maslarević, 1990) and the Carboniferous Ivovik Formation in the Jadar Paleozoic (Filipović, 1996), over the Uppermost Jurassic (Ruj Flysch, Dimitrijević & Dimitrijević, 1967) and Cretaceous flysches, up to splendid outcrops in the Upper Eocene of Pčinja (Dimitrijević & Dimitrijević, 1970). These deposits, being bound neither to the microplate boundaries nor to the large nappe fronts, and having no connection with the ophiolites, are not dealt with in this paper. Overviews for general characteristics of such deposits have been given in Yugoslavia by Dimitrijević & Dimitrijević (1973, 1974) and in Hungary by Kovács (1988). The main results of our cooperation were already given in the extended abstract by Dimitrijević et al., 1999.

2. Ophiolitic Mélanges of Yugoslavia

Deposits presently regarded as the ophiolitic mélange were first mentioned by Phillipson (1894) in Greece, and named the "Serpentin-Hornstein-Schiefer Serie". In 1906, Katzer named these deposits the "Ophiolite-Chert Beds", and the name "Diabas-Hornstein Formation" which has lasted up to the recent times, was given by Ampferer & Hammer in 1919. From the time of the first investigations, the main interest has been oriented toward the age of the deposits - Jurassic according to Katzer (1906), Triassic according to a long list of authors, or both (an older, Triassic, and a younger, Jurassic one). The origin has been unequivocally regarded as volcanic-sedimentary, the opinion which tragically persisted up to present times. It was considered a normal "bed-to bed" formation, all clearly visible irregularities being attributed to volcanic or tectonic forces. It seems that the first to see the chaotic fabric of the "Diabase-Chert Formation" was Jovanović (1963), who regarded it an issue of volcanic mixing. It is highly interesting that Kossmat, as early as 1924, pointed to the possible similarities of the depositional environment of the "Schieferhornstein-Gruppe, Radiolaritschiefer" to the deep trenches of the Sunda archipelago!

The ophiolitic mélange (OM) occurs in Yugoslavia mainly in the two broad geotectonic units - the Dinaridic Ophiolite Belt and the Vardar Zone.

2.1. The Dinaridic Ophiolite Belt

This belt starts northwest from the present national territory, at the Zagreb-Zemplin lineament, well-known in Hungary as a regional transcurrent zone. This microplate boundary was covered in Slovenia by the young Sava nappes during the Neogene movements. Excellent outcrops over large areas make it possible to study the complex in details, without ambiguities known from investigations bound to heavily covered areas or drill-hole cores.

The zone could be subdivided into three quite different segments, the middle one being situated in the present Yugoslav territory (from Tuzla to the Albanian boundary), the northwestern one in the western parts of the former Yugoslavia, and the southern one in Albania.

The middle segment bears the most typical ophiolitic mélange, with the following general characteristics:

The floor of the mélange is mostly represented by the Upper Triassic (less frequently the lowermost Jurassic) limestones or, in places, by a rather thick and conspicuous unit of red chert.

The OM consists of a matrix, normally of silty, less frequently sandy composition, dark gray or somewhat lighter in color, and of inclusions varying in size. This matrix is composed of the nonlithified debris from the Drina-Ivanjica Element (DIE), representing originally the sedimentary apron along the border of the DIE. This shows that the biggest part of the OM derived from the passive margin, opposite to the "conveyer" idea where the constituents of the mélange should be scrapped off from the oceanic bottom. Being mostly transported as unlithified, it contains, in places, bodies of strata already lithified at the sedimentary apron, representing blocks of turbidites. During the Alpine movements, the matrix in places obtained a slightly expressed schistosity of nonsystematic orientation.

Inclusions in the matrix (cm-dm clasts, m-dam olistoliths, hm-km olistoplakae/olistonappe) represent (a) fragments of consolidated rocks from the Drina-Ivanjica Element (upper slab in the collisional system, situated presently to the NE and E), and (b) fragments of rocks from the oceanic bottom.

In the first group, fragments from all the Triassic carbonate formations deposited originally over the Drina-Ivanjica Element have been recognized. These are: the Lower Triassic Bioturbate Formation, Middle Triassic Ravni, Bulog and Wetterstein Formations, and Upper Triassic, Dachstein and Ilidža Formations, together with the Grivska

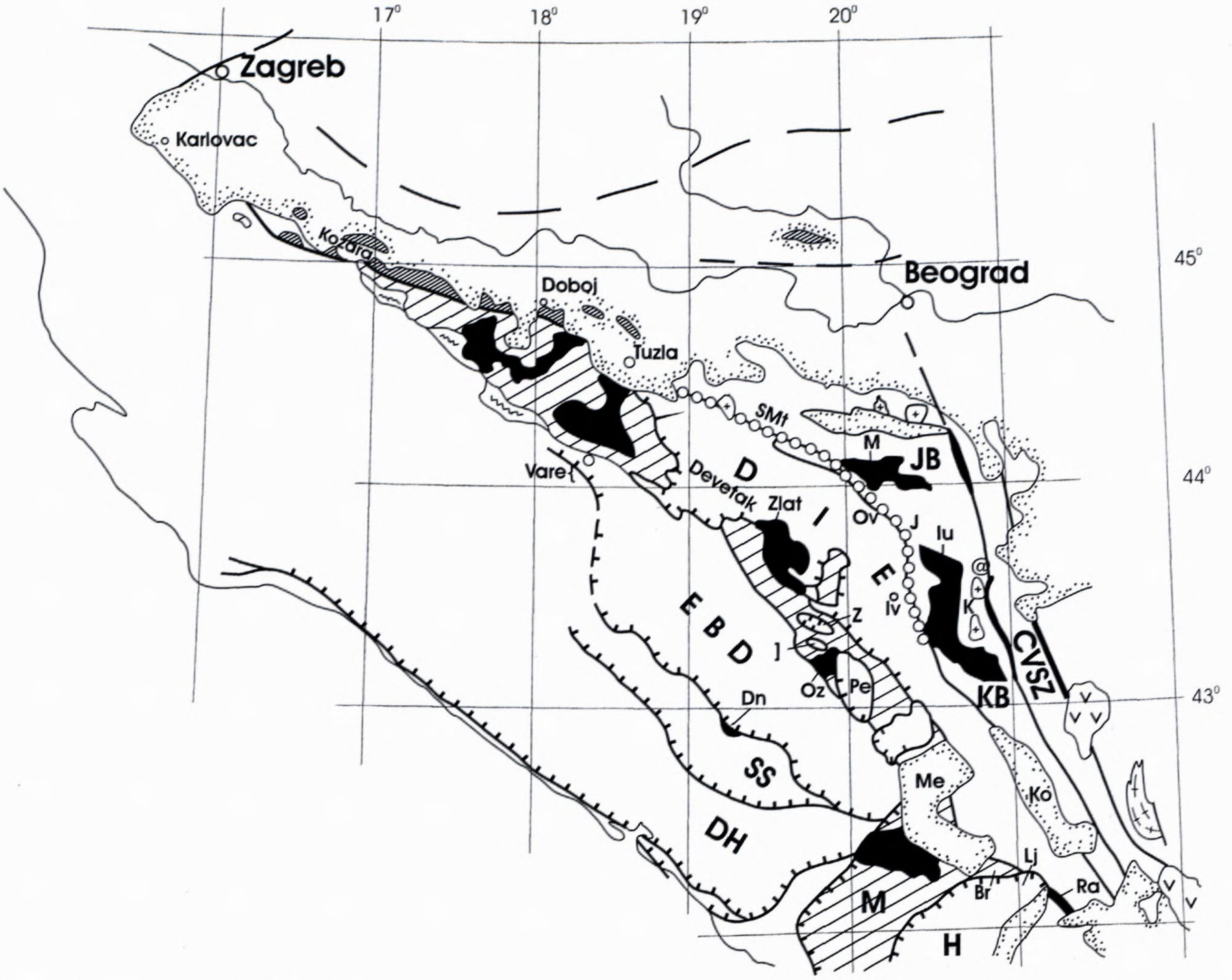

Fig. 2 Sketch of the ophiolite belts in Yugoslavia.
Legend. broad hachure – Dinaridic Ophiolite Belt; close hachure – tectonized mélange; saw-line – radiolaritic floor of the mélange; circles: the Upper Cretaceous mélange of the Vardar Zone; black – ultramafites; vigneted – the Tertiary; M – Mirdita; EBD – East-bosnian-Durmitor Terrane; SS – Sarajevo Sigmoid; DH – Dalmatian-Herzegovinian Terrane; H – Hellenides; DIE – Drina-Ivanjica Element; JB – Jadar Block; KB – Kopaonik Block; CVSZ – Central Vardar Subzone; SMt. – Sokolske Mts.; M – Maljen massif; Ov – Ovčar Mt.; Oz – Ozren Mt.; J – Jelica Mt.; Ž - Željin granodiorite; Iv – Ivanjica; Zlat. – Zlatibor massif; Z – Zlatar Mt.; Ć - Ćetanica; Pe – Peštera; Dn – Durmitor nappe front; Me – Metohija; Ko – Kosovo; Lj – Ljuboten; Br – Brezovica; Ra – Raduša ultramafite; IU – Ibar ultramafite.

Formation regarded as the former blanket of the continental slope, ranging in age from the uppermost Middle Triassic to the (Middle?) Jurassic, (Dimitrijević & Dimitrijević, 1991). Huge olistoplakae (=olistonappe) of Triassic limestones cover parts of the Dinaridic Ophiolite Belt (in the national territory e.g. Pešter, Ćetanica, Zlatar... and Devetak as the westernmost, largest one), and the whole Triassic cover of the Drina-Ivanjica Paleozoic and OM shows traces of gravitational movements, with characteristic local folding along the movement surfaces (Dimitrijević, 1996). Exotic blocks of older rocks, not known from the present surroundings (blocks of *Schwagerina* limestone, conglomerate blocks with Permian clasts, etc.) have also been found.

From the second group, important are fragments of ophiolites, in some places with the original relations conserved (cumulates, sheeted dikes complex, pillow lava), with especially frequent and well-preserved pillow-lava bodies (Karamata & Popević, 1996). Together with large ultramafic bodies, fragments of crystalline schists are transported to the surface (Popević & Pamić, 1973; Karamata et al., 1996). Large bodies of the "Zlatar Chert" (mostly reddish silicified siltstones) are regarded as oceanic sediments, together with blocks of red and green chert, which were formerly considered to represent members of the Triassic volcanic-sedimentary sequence, but yielded, besides Triassic, also Jurassic microfauna (Obradović & Goričan, 1988; Dimitrijević et al., 1996). The Zlatar Chert bears volcanic injections in places; its original position is still under discussion.

Highly enigmatic are lonely dam- to hm-bodies of granitic rocks, disseminated throughout the mélange, occurring also as pebbles in conglomerate olistoliths. One of these bodies (the Straža Granite) gave the age of at least 315 Ma

(Karamata et al., 1996). The original position of these granites remains completely obscure in this segment of the Dinaridic Ophiolite Belt.

Characteristic of the Dinaridic Ophiolite Belt are large bodies of ultramafites - Zlatibor as the largest one, together with Ozren, Brezovica-Kodža Balkan and others. These bodies were introduced as hot masses, producing a conspicuous metamorphic layer in their floor. Zlatibor is interpreted as obducted toward the present NE from its original position below the trough, with subsequent local Alpine movements towards SW. A specific position has the Ozren massif, transported upwards as a hot body without important horizontal movements (Popević, 1985).

The OM is regarded as a deposit of a deep subduction trough. Nevertheless, it is found also some 100 km southwest from the Dinaridic Ophiolite Belt, in normal succession over the Triassic, which opens the problem of its transport to the present place.

The belt had a digitation along the border between the Dalmatian-Herzegovinan and the East Bosnian-Durmitor terranes, shown by a narrow lens of the OM immediately below the front of the Durmitor nappe (Karamata et al., in press) and abnormally high heat flow in the Junik area, where in the Jurassic a rather important body of anatexis-granite was formed, surrounded by high-grade metamorphic rocks within slightly metamorphosed Carboniferous strata (Antonijević et al., 1978).

A remnant of the easterly situated Vardar (Tethys) ocean is present on Brezovica (Kodža Balkan area). Karamata and his associates worked in this area from 1967 to 1996, and they wrote numerous papers considering this area. It is partly covered by the Ljuboten (Kučibaba) nappe, appearing again in the East with the Raduša ultramafic massif. Toward the Vardar zone, it is truncated by young longitudinal faults. It seems to be a former part of the southern, Mirdita segment, presently clenched between the Hellenidic microcontinent and the Dinaridic Drina-Ivanjica Element.

In the national territory, the oldest sediments covering the OM are of the younger Lower Cretaceous age. Further NW, in Bosnia, the "Pogari Series", the first "normal" sediments over the mélange, is reported to be of the Uppermost Jurassic-Lowermost Cretaceous age.

The central segment is interpreted as the site of subduction in an oceanic tract between the main Dinaridic trunk and the Drina-Ivanjica Element - its part separated by the Middle Triassic rifting. The final collision took part in the Uppermost Jurassic, with gravity transport of huge olistoplakae into the mélange and over it.

The northwestern segment shows mostly the same characteristics of the mélange itself. It differs from the central segment in complete absence of olistoplakae, very rare occurrences of tuffs (?) with plagioclase and quartz grains, and specific position of granitic bodies. These bodies, lonely and without clear connections with adjacent rocks in the central segment, occur here together with gabbro-dolerite, representing its acidic differentiates. The age of these granites is not known. Such position, with assumption that the age data for Straža granite are correct, open additional questions, with even a bold hypothesis on the very old age of the astenosphere the magma came from.

Two features are particularly distinct in the zone:

- The floor of the mélange is along the best part of the SW zone boundary represented by a conspicuous unit of varicolored radiolarites over the Triassic limestones. These rocks, up to several hundreds of meters thick, bear intercalations of greywackes, siltstones and silicified limestones. Regarded mostly as the uppermost Triassic/lowermost Jurassic (frequent Upper Triassic conodonts), if correlated with similar radiolarites from the central segment (Obradović & Goričan, 1988), they could be even of a higher Jurassic age.
- In the southeastern part of this zone boundary, near Vareš, the radiolarites are covered with conformable siltstones and silicified marlstones ("Zvijezda formation" of Dimitrijević & Dimitrijević, 1973). These strata are regarded to be of the same age as their radiolaritic floor. The mélange follows with a transitional boundary.

The northern part of the mélange zone, from Kozara Mt. over Doboj to north of Tuzla, is characterized by a mélange described as "tectonized" by Mojićević et al. (1977), Jovanović & Magaš (1986) and others. The composition of the mélange is essentially the same as in the southern belt, with the prevalence of chert and subgreywackes over the basites. Limestone olistoliths are not very frequent, but they seem to correspond to the same Triassic formations as in the southern belt. The complex is pervasively tectonized, and ascribed to the Vardar Zone. It is important that the transgressive roof of this complex is represented by the Upper Cretaceous clastics and *Globotruncana* limestone, not known from the southern belt.

The Tuzla-Zagreb sector is presently the most questionable. The Drina-Ivanjica Element in its present form seems to disappear there, thus making very problematic the boundary between the Dinaridic Ophiolite Belt and the Vardar Zone, which are in immediate contact. The following hypotheses could be discussed:

- Block of continental crust, the present remnant of which is the Drina-Ivanjica Element, had an original continuation west of Tuzla. Material for the matrix originated from the miogeocline of the Drina-Ivanjica Element, as in the Tuzla-Metohija area, and the western part of the element was detached or it disappeared due to tectonic movements.
- This sector represents a remnant of the subduction of the oceanic crust under oceanic crust. Matrix is composed mostly of the material from the oceanic crust, or its terrigenous component originated from the subducted margin.

Data to judge the validity of these hypotheses are insufficient. As the most important, data are lacking on the quantitative relationships between various sediment types and ophiolites as the mélange ingredients. Indicative might be the presence of numerous olistoliths of Triassic limestones in the Kladanj-Stupari section; the domain is, however, too close to the front of the Devetak nappe to be of a sufficiently heavy validity as an argument. According to all the available data, the northwestern segment of the Dinaridic Ophiolite Belt might be interpreted as the site of subduction of oceanic crust under oceanic crust, without intervening the Drina-Ivanjica Element.

2.2. The Vardar Zone

This is a composite terrane with a typical collage tectonics. From the West to the East, it consists of the three subzones: external, central and internal one, with the external subzone being the largest one. The external subzone consists of three blocks (suspect terranes?) highly differing in composition: the Srem block (between the Danube and the Sava rivers), the Jadar block (south of the Sava, bordering the Dinaridic Drina block in the South; truncated by the young faults along the Western Morava depression further SE); and the Kopaonik block in the South. Presence of the ophiolitic mélange in the Srem block is still under question, whereas it represents an important part of the two other blocks.

In the Srem block, which is mostly covered with the Neogene and Quaternary deposits, the Mesozoic is visible at Fruška Gora Mt. only. Čičulić-Trifunović & Rakić (1977) describe here a "highly distorted complex" of argillites, slightly metamorphosed sandstones and quartzites; the part considered by these authors as upper consists of argillite, slates and limestones. Several bodies of "melaphyre", hectometric in size, are also reported from the complex. According to the description and close relations with ultramafic lenses, this complex might represent an ophiolitic mélange of the Jurassic age.

In the Jadar block, the mélange appears only along its SW border, from the Drina river, over Sokolske Planine Mts. and the area of Maljen ultramafic massif, to Jelica Mt. west of Kraljevo.

A large area NW and north of the Maljen ultramafics consists of the ophiolitic mélange, in places over the Lower Jurassic limestone which forms a veneer covering a thick Upper Triassic sequence (Mojsilović et al., 1975). Mélange is there reported to be composed of argillites (most probably the matrix), sandstones, variegated chert, conglomerate, breccia, oolitic limestone, together with bodies of diabase, spilite, porphyrite, as well as gabbro, dolerite and "melaphyre". Several limestone bodies yielded the Middle Dogger forams, and others show sections of tiny ammonites or megalodonts. The mélange is overlain by transgressive Lower Turonian clastics, followed by massive limestones (Filipović et al., 1978). Such position seems to affirm the Jurassic age of the mélange.

At the southwestern boundary of the Jadar block, along the Zvornik suture (boundary toward the Dinarides), a fringe appears of the Upper Cretaceous mélange from the Drina river to the Jelica Mt. (Sokolske Planine - Đuričković & Oršolić, 1988). The main body of the mélange is similar to that in the Jurassic complex, differing in the composition of inclusions (Jelica. Mt. - Brković et al., 1978; the Sklapijevac creek east of Ivanjica - Luković, 1925, Brković et al., 1977) and rounded clasts (Ovčar Mt.) of Senonian limestones, frequently with globotruncanids. East of Ivanjica (Sklapijevac), the outcropping column of the mélange starts with conglomerate bearing fragments of rudist limestone; these are followed by finer-grained sediments passing gradually upward into the mélange of a normal habitus. According to the new observations, in the very complicated area of Gornje Košlje (southernmost part of the Povlen Mt.) both mélanges are present – Jurassic and Upper Cretaceous. This fringe continues further SE into the Kopaonik block.

In the Kopaonik block, the ophiolitic mélange appears in several zones.

At the eastern boundary of the Studenica slice, a discontinuous belt of the mélange is visible beneath the Ibar ultramafite. A very instructive section is seen along the road from Ušće toward the Studenica Monastery, along the Studenica River. In the eastern part of the Studenica slice (Maglić) the mélange contains also diabase, chert and limestone inclusions. Matrix is silty, highly schistose, particularly beneath the ultramafics, with fragments of similarly schistose sandstones. All fragments bear traces of deformation. Well developed turbidites (mostly truncated sequences) are also found. Magmatic rocks and chert inclusions are rare, together with lenses of calc-schists and greenschists. This mélange is interpreted as being deposited in a marginal basin, without important influence of the oceanic crust.

In the southern Kopaonik, east of Kosovska Mitrovica up to the northern edge of Kosovo Polje, a lens of mélange metamorphosed in low P-T conditions occurs (the "Kopaonik metamorphites" of Vukanović et al., 1982), being in a tectonic contact with the surrounding formations. These rocks have been formerly regarded as equivalents of the Paleozoic Veleš Series, but these authors cite a "very poorly preserved microfauna of calcisponges, hydrozoans and algal structures" pointing to the Jurassic age, and consider these as metamorphosed Ophiolitic mélange. The complex consists of phyllitoids, meta-sandstones, calc-schists, epidote-actinolite-chlorite schists and meta-basites. It is interesting that a lens of similar rocks occurs further east, in the Central Vardar Subzone, tectonically jammed in the Lower Cretaceous subflysch. This occurrence might indicate a significant underthrusting of the External below the Central Vardar Subzone.

The western boundary of the Central Vardar Subzone bears rather highly tectonized and in places metamorphosed Ophiolitic mélange, tectonically mixed with the Lower Cretaceous paraflysch along the contacts. The matrix consists of schistose fine-grained silt with some sandy component. In this matrix cm-m bodies of highly silicified limestone of unknown age, diabase, Upper Jurassic limestone, greywacke and chert are inserted. Chert blocks contain numerous radiolarians which cannot be determined, and limestones are shallow marine biosparites with ample organic detritus. Such limestones are found along the borders of the mélange trough.

Some parts of the mélange are slightly metamorphosed. The silty matrix is transformed into sericite-chlorite schists, partly also intensely carbonized and silicified, with some sulfide mineralization.

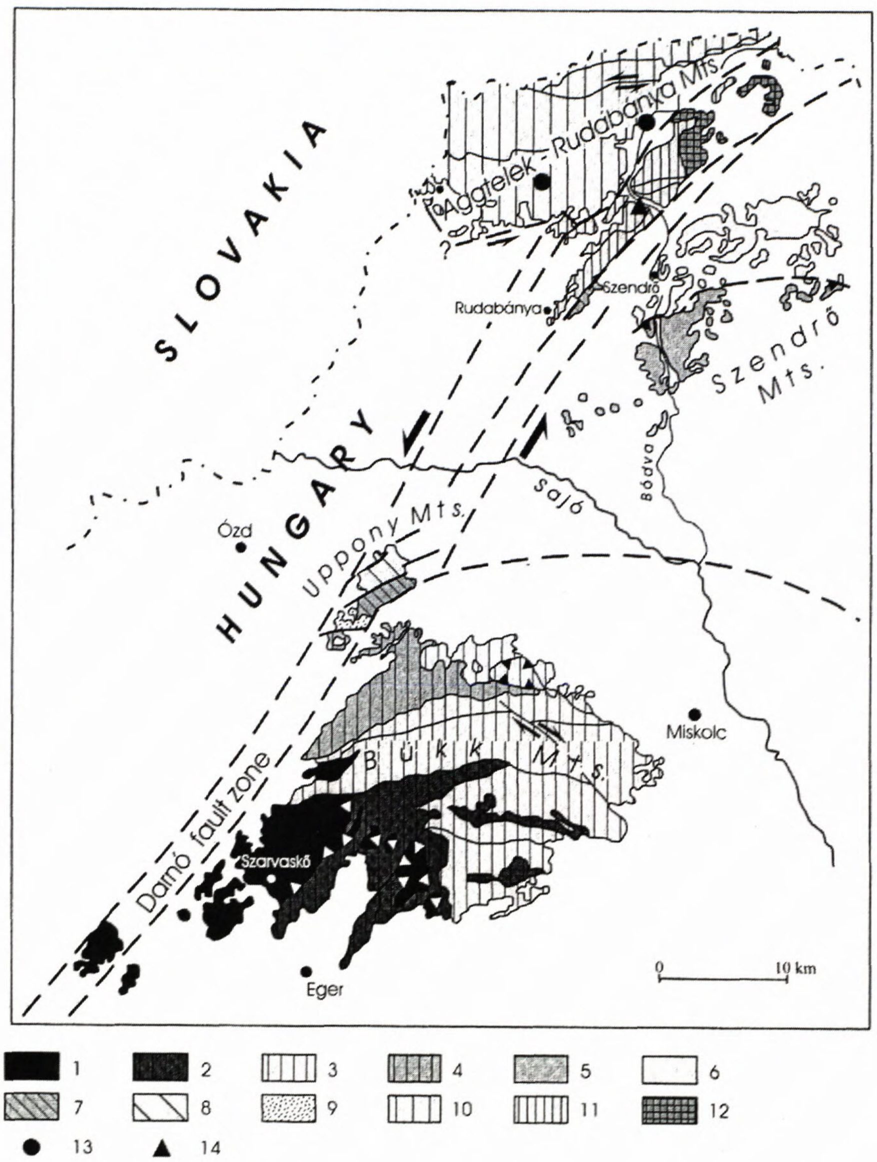

Fig. 3 Geological sketch map of NE Hungary.
Legend. 1-4: Units of the Bükk Mts.: 1: Neotethyan Szarvaskő and Darnó Ophiolite Complexes; 2: Jurassic of the Bükk Parautochthon (PA); 3: Triassic of the Bükk PA; 4: Upper Paleozoic of the Bükk PA; 5-8: Units of the Szendrő and Uppony Paleozoic:5: Abod Subunit; 6: Rakaca Subunit; 7: Tapolcsány Subunit; 8: Lázbérc Subunit; 9: Upper Cretaceous Gosau-type conglomerates in the Uppony Mts.; 10-14: Units of the Aggtelek-Rudabánya Mts.: 10: Aggtelek s.s., Alsóhegy and Derenk Subunits (undifferentiated); 11:Bódva and Szőlösardó Subunits;12: Martonyi (or Torna s.s.) subunit; 13: most important borehole occurrences of the Bódva Valley Ophiolite Complex (=Tornakápolna Subunit); 14: Upper Jurassic (?) rhyolites of the Telekesoldal Subunit of Bódva Unit.

Spilites are not frequent, occurring mostly as pillows, and melaphyres are present as small blocks only. It is interesting that leucocratic alkali granitoids appear as small masses and veins in gabbro and peridotite bodies.
The floor of the mélange is represented with the uppermost Jurassic limestones and the lowermost Cretaceous basal clastics.

In the northwestern segment, the continuation of the Zvornik suture should be expected between the Dinaridic Ophiolite Belt mélange and the "tectonized mélange", regarded as part of the Vardar Zone (presently in Croatia). Along the best part of this segment Upper Cretaceous mélange has not been found, and the "tectonized mélange" is reported to be covered (depositionally? tectonically?) by the Upper Cretaceous (Upper Turonian?) clastics and limestones. This is rather perplexing, contravening the Senonian results further southeast. To make the story more complicated, at the westernmost part of the zone, at Banija near Karlovac, the Senonian clasts were found in the mélange.

The Senonian mélange has been regarded either as an original Jurassic complex, reworked posteriorly by a kind of resedimentation (Dimitrijević & Dimitrijević, 1979, "recycled ophiolitic mélange") or as an original issue of the ultimate closing of the Vardar ocean in the Senonian. The latter opinion prevails recently, opening new problems of the history of the Vardar Zone. According to Karamata et al. (1994) this area represented a back-arc oceanic basin with (immature) island arcs up to the Upper Cretaceous. The closing age of different parts of the suture seems to be slightly different. The same authors envisage the domain west of the Kopaonik-Željin antiform as the closure area of the back-arc basin, and the Central Vardar Subzone (east of the antiform) as the suture of the main, Vardar = Tethys ocean. This ocean played the role of the main link between the southern part of the Tethys and the northern, ALCAPA regions.

In comparison with the OM in the Dinaridic Ophiolite Belt, the Jurassic mélange in the Vardar zone shows the following specific features:

- Inclusions of limestones, highly characteristic for the Dinaridic Ophiolite Belt, are very rare. In the Jadar block Middle Jurassic oolites, unknown from the adjacent areas, occur as clasts and olistoliths, and in the Kopaonik block only infrequent inclusions of dark limestone are found in places, mostly devoid of fauna.
- Blocks of sandstone are very frequent, showing splendid turbiditic features in places.
- Matrix is sparse, intensely tectonized, usually showing traces of transcurrent movements.
- Tectonic mixing with adjacent rocks of all ages (even Cretaceous) is conspicuous in regional zones.

- Ocean-derived magmatics are profuse, mostly predominating, with diapiric movements along the tectonic zones (Milovanović & Karamata, 1957), but with pillow-lavas less frequent than in the Dinaridic Ophiolite Belt.
- Large peridotite masses (e.g. the Ibar mass) are most conspicuous in the western part of the Kopaonik block. Their original position is regarded to be along the western boundary of the Central Vardar Subzone, with a cold overthrusting toward West, over the whole Kopaonik block up to its boundary toward the Dinarides, during the Upper Jurassic. They generally do not show a metamorphic floor. According to this model, the uplift of the complex Željin-Kopaonik dome, caused by the granite intrusion, formed a large erosional window which disconnected a formerly unique ultramafic cover.
- Large olistoplakae of sedimentary rocks are absent in the mélange.
- Some mélange masses exerted a regional (suprasubduction?) metamorphism of the greenschist facies, others being not influenced by it.

3. Olistostrome/mélanges in NE Hungary

Olistostromal deposits in NE Hungary (Darnó, Szarvaskő and Telekesoldal Complexes in the Bükk and Rudabánya Mts.) have been recognized much later, than in Yugoslavia. Till the end of the 1970-ies, they have been considered as "shales with limestone or sandstone lenses" (Balogh, 1964). Up to now no detailed sedimentological work on this topic has been published and only a general review on them, with a detailed terminological discussion, is available (Kovács, 1988). A specific type of "evaporite-ophiolite mélange" was recognized in the Aggtelek Mts. (Bódva Valley Ophiolite Complex; Réti, 1985; Grill et al., 1984). Traces of a further occurrence are known from boreholes near to the SW border of Hungary (Haas et al., 2000).

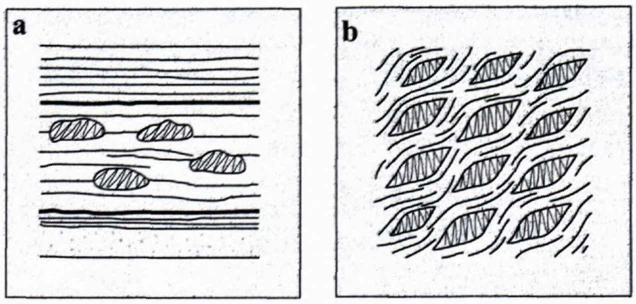

*Fig. 4 Ideal cases of sedimentary (A) and tectonic (B) mélanges. A: "slide bed" or debris flow horizon (=**olistostrome**) with exotic blocks in a normal succession; B: **autoclastic** mélange with pervasively sheared matrix*

It should be mentioned, that purely on facial reasons, ophiolite mélanges of the Austroalpine Gemeric nappe system and of the Dinaridic Bükkian nappe system had been recognized up to the last few years as belonging to the same tectonostratigraphic unit ("Meliaticum s.l."; Kovács, 1984) – a concept, which, first of all on structural geological grounds, should be completely abandoned.

3.1. Szarvaskő Complex

The Szarvaskő Complex (= Szarvaskő–Mónosbél nappes in sense of Csontos, 1988) is built up by the lower Mónosbél Unit composed of shales, olistostromes and carbonate turbidites and by the upper Szarvaskő Unit s.s. formed of mafic extrusive and intrusive rocks and associated shales–sandstones.

The "floor" (e.g. the footwall) of the Mónosbél Unit is constituted by the top part of Bükk Parautochton Unit: Bathonian–Callovian variageted radiolarites overlying Upper Triassic limestones of either platform or basinal facies (without evidences of Liassic and lower Dogger formations) and followed by Upper Jurassic distal turbiditic shales. Opinions about the contact between the two units are controversial: Csontos (1988) and Gulácsi (unpubl.) considers the Mónosbél Unit as a nappe on top of the Bükk PA, whereas Pelikán & Dosztály (2000) consider the two as a basically continuous succession.

Dark gray shales constitute the matrix of olistostromes in part of the outcrops, whereas in others they alternate with carbonate turbidites (as proven also by drill core evidences; Pelikán & Dosztály, 2000). The olistostrome horizons contain dm to meter sized olistoliths from the below described carbonate turbidites, bluish gray limestones of basinal facies (with some evidences of Norian conodonts), black and gray Jurassic (Bajocian to Oxfordian) radiolarites and sometimes basalts. Rarely basalt-breccia, radiolaritebreccia, as well as quartzconglomerate olistoliths also occur.

Carbonate turbidites belong to two types:

1. Ooidal limestone (Bükkzsérc Limestone) with the characteristic foraminifer species *Protopeneroplis striata* (Bérczi-Makk & Pelikán, 1984). These turbidites, deriving from a carbonate platform margin, indicate on the example of the Hellenides, the approaching of the continental margin to the subduction trench (Papanikolaou, pers. comm. on the field in 1993).

2. Basinal limestone (Oldalvölgy Limestone): homogenous microsparite, rarely with microbioclasts, without ooids.

As recognized recently in the Oldal Valley section, olistostromes with olistoliths of these two limestone types represent debris flow horizons within the shale-carbonate turbidite sequence, developed due to renewed gravity flow processes on the unstable slope. The rare exotic blocks can be slide blocks (olistothrymmata). Specific is from these the Triassic basalt–red chert–Hallstatt Limestone block at the eastern part of the complex (Pl. II, fig. 4), similar to those in the explored by the Darnó deep drillings (see below).

The several hundred meters thick Mónosbél sequence represents a proximal, slope facies in respect to the distal turbiditic facies of the top part of the Bükk PA (the latter lacking carbonate turbidites).

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Sediments and extrusive mafic rocks of the Szarvaskő Unit seem to constitute a stratigraphic succession (Balla et al., 1983; Gulácsi, unpubl.). Mafic rocks of the Szarvaskő Unit refer to an incomplete ophiolite complex of back-arc basin or marginal-sea setting (Balla et al., 1983; Józsa in Dosztály & Józsa, 1992 and pers. comm.; Harangi et al., 1996). An olistostrome horizon of a few tens of meters thickness occurs near to the basalt lava flows, containing red radiolarite, red mudstone, gray radiolarite and gray limestone olistoliths of meter size. The red radiolarites yielded Ladinian-Carnian radiolarians, whereas the gray ones proved to be of Callovian-Oxfordian age (Dosztály & Józsa, 1992).

3.2. Darnó Complex

The Darnó Complex has been explored on the Darnó Hill area by the deep drillings Rm-131, -135 and 136, each of them 1200 m deep with continuous coring. Its separation from the Szarvaskő Complex is under discussion: according to the unpublished mapping by Gulácsi, it is thrust onto the Szarvaskő Complex (referring only to the upper, magmatic units) in the area SE of Egerbakta–Bátor. It is built up by two complexes:

- An upper magmatic unit, with subordinate amount of intercalated/intersliced abyssal sediments.
- A lower sedimentary unit, composed of toe-of slope (or apron?) sediments, with exotic slide blocks.

The upper unit consists of several 100 m thick slices/blocks of greenish and reddish, often amygdaloidal basalts of MOR-type (Harangi et al.,1996; Józsa, 1999), as well as intrusive rocks (gabbros, dolerites). The intercalated/intersliced sediments of a few meters to 10-20 m thickness, are represented by red radiolarites, red mudstones and bluish gray or dark gray siliceous shales. The radiolarites yielded alternatively Triassic (Ladinian–Carnian) and Jurassic (Bajocian–Callovian) radiolarians (Dosztály, 1994), whereas the siliceous shales are identical to those forming a significant part of the lower sedimentary unit.

The lower unit is built up of sedimentary rocks showing typical features of distal-type turbidites, and contains slide blocks (olistothrymmata) of exotic type. Two main types of sediments alternating with each other can be distinguished: 1) dark gray shales and bluish gray siliceous shales, deriving from a pelitic source area, showing partly "autochthonous", partly distal turbiditic character, and often shearing; 2) distal-type carbonate turbidites deriving from calcareous-marly source area. The previously settled turbidites were often again redeposited by slump and debris flow processes on the unstable slope. Debris flows with micaceous sandstone clasts indicate a third source area. Exotic slide blocks (olistothrymmata) are represented by Triassic (Ladinian–Carnian) Bódvalenke-type reddish cherty limestone and red chert, partly with amygdaloidal basalts. (A similar block is mentioned above at the Mónosbél Unit). A single block of Upper Permian Nagyvisnyó Limestone and Middle Permian evaporitic sequence was also penetrated by the borehole Rm-136.

The upper unit with subordinate amount of abyssal sediments and large blocks/slices of magmatic rocks, represent a typical accretionary prism, in which both Triassic and Jurassic elements piled up, probably both by gliding and imbrication. By no means, however, can it be an issue of tectonic (=autoclastic) or sedimentary (=olistostrome) mélange. The lower unit represents the lower, toe-of-slope part of a trench complex, and probably is identical with the Mónosbél Unit of the Szarvaskő Complex.

The Darnó and Szarvaskő Complexes were emplaced (according to present coordinates) onto the Bükk Parautochthon from the NW to the SE (Balla, 1987; Csontos, 1988, 1999); however, taking into account the large-scale (70-90°) anticlockwise rotation recognized in the Aggtelek–Rudabánya Unit of the Pelso Megaunit, it could be originally from the NE to SW.

3.3. Bódva Valley Complex

The Bódva Valley Ophiolite Complex occurs as slices/fragments of serpentinite, gabbro and basalt in Upper Permian evaporites (Perkupa Evaporite Fm.) at the base of the Aggtelek Unit of Aggtelek–Rudabánya Mts. Because of the autoclastic-mélange type occurrence in the Perkupa anhydrite mine, it has been generally believed, that there is an overall "evaporite mélange carpet" with incorporated ophiolite blocks in this position, formed during the overthrust of the Aggtelek Unit (Grill et al., 1984; Réti, 1985). Latest studies on drill-cores and in the open-pit Alsótelekes gypsum mine led, however, to the recognition, that true autoclastic mélanges with chaotic fabric occur only in intensively sheared horizons. Larger ophiolite blocks/slivers, on the other hand, occur as tectonic slices at the sole thrust (Csontos, pers. comm.) of the Aggtelek Unit, detached from its Variscan basement along its Perkupa Evaporite Fm.

3.4. Telekesoldal Complex

In the Telekesoldal Unit of the Rudabánya Mts. specific limestone-rhyolite olistostrome horizons lacking distinct matrix are intercalated within dark gray shales. Limestone clasts are mostly of irregular shape, gray, micritic, containing Ladinian to Norian conodonts. It is explained, that part of the lime mud was still unconsolidated during the movement of the debris flow and served as matrix, whereas rhyolite clasts were transported as hard rocks (Kovács, 1988). The latters are considered to derive from a Late Jurassic magmatic arc, which is also supported by the fact, that rhyolite subvolcanic bodies are present in the shales (Szakmány et al., 1989; Kubovics et al., 1990), whereas the olistostromes as representing a coeval trench complex.

It is to be added to this point, that in the sandstones of the Darnó and Szarvaskő Complexes abundant acidic effusive and plutonic lithic fragments are known (Árgyelán & Gulácsi, 1997), whereas in the Vardar Zone Upper Jurassic granitoids are known, but coeval rhyolites have not yet been recognized (Karamata, pers. comm.).

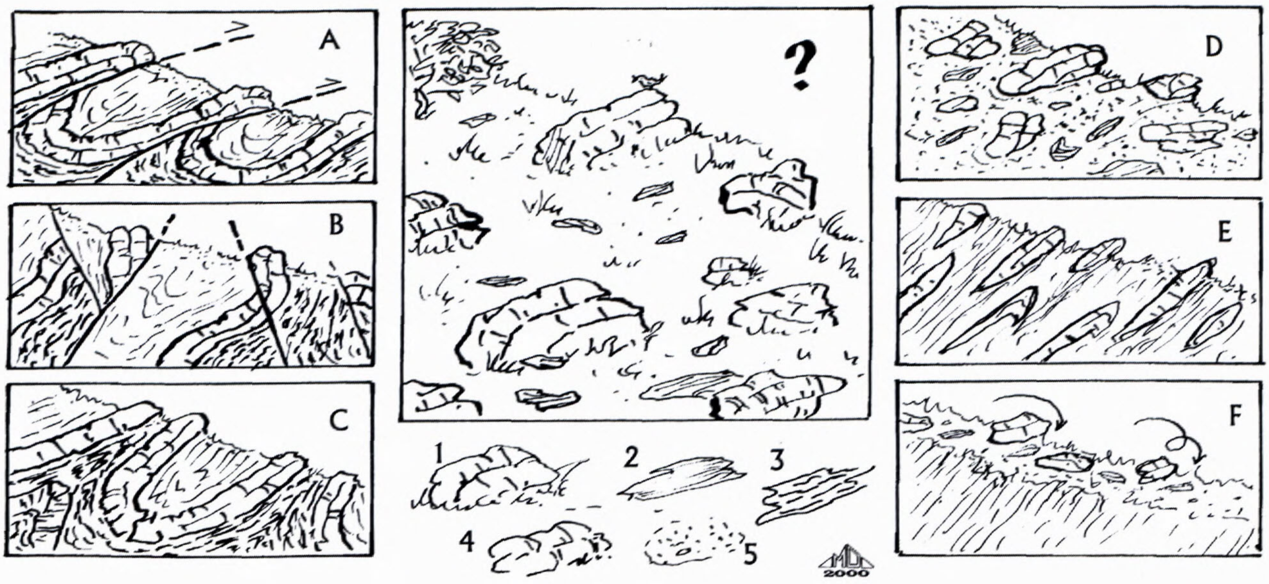

Fig. 5 Possibilities of interpretation/misinterpretation in the poorly exposed terraines of normal (A-C) and disrupted/distorted successions.
A. – overthrusts; B. – faulting; C. - folding; D. – sedimentary mélange (olistostrome); E. – autoclastic mélange sensu Greenly; F. – gravitationally transported blocks in the regolith. 1. – Triassic limestone; 2. – Jurassic shale; 3. – olistostrome matrix or regolith (difficult to distinguish in some cases of poor outcrops); 4. – gravitationally transported blocks in regolith; 5. – regolith. (Original drawing/sketch by M.D. Dimitrijević, 2000).

4. Conclusions

In the Yugoslavian-Hungarian area OM belts point to the presence of several Mesozoic oceanic realms: the Vardar Ocean as the main and highly complex Tethys part between the southern Tethys and the ALCAPA region (?Paleozoic to the Upper Jurassic, with a back-arc basin closed in the Upper Cretaceous), the Dinaridic Ophiolite Belt ocean (Middle Triassic to the uppermost Jurassic) with a possible branch between the present Dalmatian-Herzegovinan and East Bosnian-Durmitor terranes (up the Upper Jurassic). The continuation of these oceanic branches (probably that of DOB) have been displaced to the NE along the transcurrent zone between the ALCAPA and Tisia terranes during the (Late Cretaceous) – Tertiary time (Csontos & Nagymarosy, 1998). Mélanges of these oceanic realms differ significantly in composition, depending on the geotectonic setting and composition of the surrounding continental blocks and oceanic areas. As all oceans do, they had mutual connections during several times, but could not be regarded as one sole oceanic branch.

The few km^2 sized Darnó and Szarvaskő Complexes in NE Hungary can be regarded as small relicts of the Neotethyan accretionary mélange complexes (in the sense of Jones & Robertson, 1991), displaced along the Zagreb–Zemplín Lineament from the NW part of the Dinarides (Haas et al., 2000). In spite their relatively small extension, they are still considerably larger and available for detailed studies, than any other remnants of Neotethyan accretionary complexes in the ALCAPA region. On the other hand, identical/comparable elements are present as constituents in the huge Neotethyan accretionary mélanges of the Dinarides – Hellenides and Vardar Zone. Besides common elements of ophiolite mélanges (matrix composed of shales–siliceous shales, blocks of radiolarites, basalts), some specific constituents are:

- Triassic (Ladinian–Carnian) Bódvalenke-type slide-blocks (reddish, cherty limestones, red cherts) with basalts.
- Middle Jurassic ooidal-bioclastic carbonate turbidites deriving from a platform margin (upper part of the Grivska Fm. or a new formation, Bükkzsérc Lmst.).

Although ultramafic bodies are not known in the Darnó/Szarvaskő Complexes (except some ore-peridotitic differentiates in the latter), the presence of serpentinite detritus in Lower Miocene conglomerates and sandstones on the Darnó Hill (Sztanó & Józsa, 1996) seems to indicate an ultramafic sheet above the Darnó Complex, completely eroded since. The former presence of such a higher unit is made also probable by the intense shearing of its pelitic sedimentary rocks (see above).

5. Summarizing remarks – pitfalls of interpretation of poorly exposed terrains

The term "mélange" for itself, without a specific definition, means simply a mélange = a mixture. In the geological sense, this indicates a more or less chaotic mixture of lithologically and granulometrically differing ingredients; in the broadest sense even a disorganized rudite falls into this definition. Mélanges can be of highly various origin, but for the geotectonic thinking the most important is the ophiolitic mélange. It is considered a manifestation of former oceanic realms, marking thus the boundaries of formerly distant terranes.

Deep-water sedimentary (e.g. limestone-radiolarite-shale) successions occurring in poorly exposed terrains (like those in most part of the ALCAPA-region) can be attractively interpreted (and were and are often did like it) as some kind of mélange, representing a subduction-related complex, even if they are lacking ophiolitic rocks. In such terrains scarce, randomly outcropping cliffs of hard rocks surrounded by shale or marly debris (or even without debris of "matrix-suspected" soft rocks, being the soil completely covered by vegetation), even imbricated or folded, otherwise normal successions can be attractively misinterpreted either as tectonic (= autoclastic) or sedimentary (= olistostrome) mélange (Fig. 5). For pure cases of these often undistinguishable (Dimitrijević & Dimitrijević, 1973) two kinds of melanges see Fig. 4. A further possible misinterpretation, if just a regolith is interpreted as tectonic or sedimentary mélange. Naturally, the probability of a plate tectonic model, if that is based on such a falsely interpreted "subduction-related mélange", is highly questionable.

Consequently, for a correct interpretation of a given complex and to have a solid base for modeling, it is crucial to see the character of both the matrix and of the blocks and their relationship. And, if the complex is considered as representing deposits of an ancient ocean or part of that, it is likewise crucial to have evidences, whether it was really deposited on oceanic crust, e.g. whether it contains some pieces of ophiolites... (allowing its classification as a "true ophiolitic mélange").

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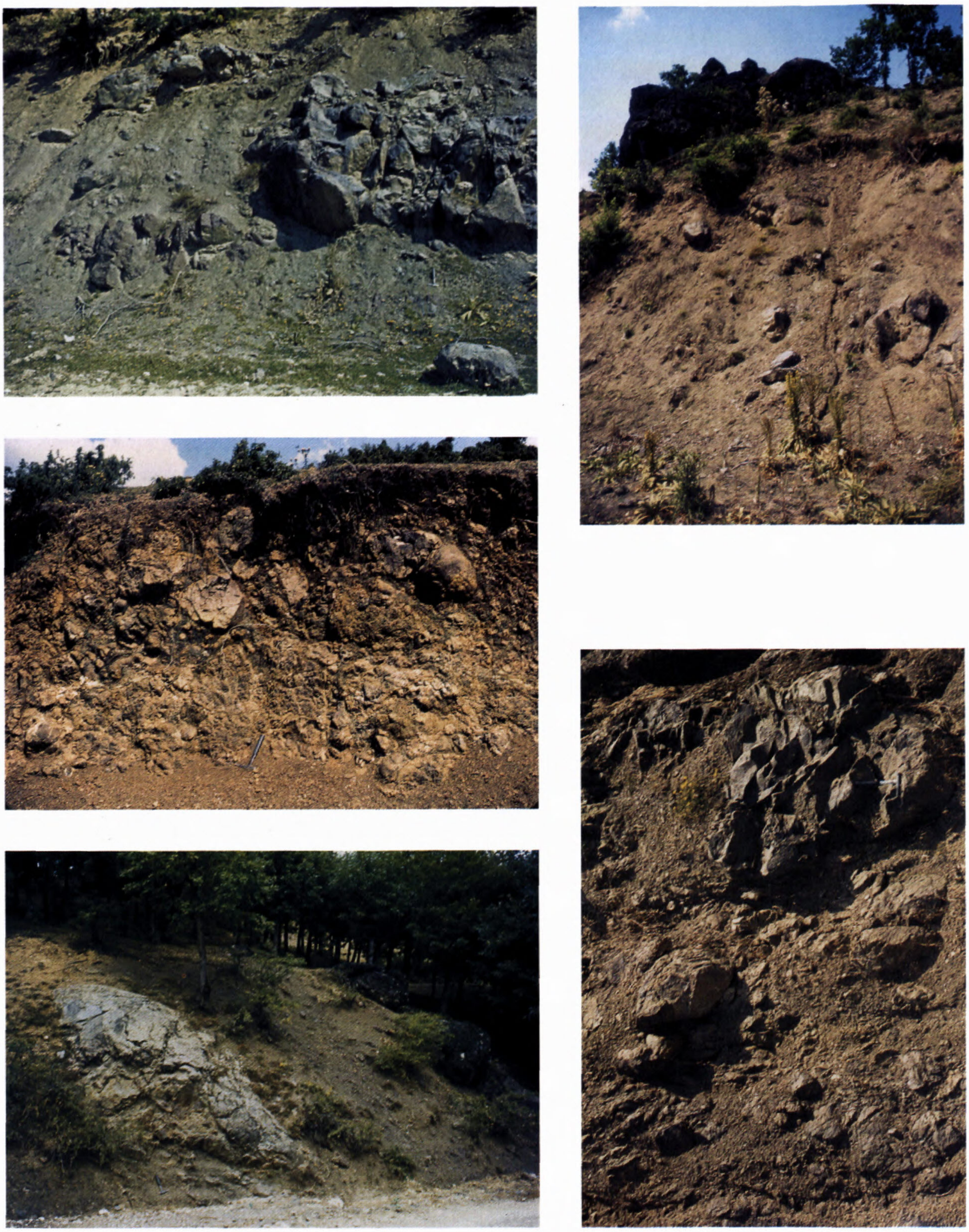

Plate I

Fig. 1 Blocks of characteristic reddish siliceous siltstones in the matrix; Dinaridic Ophiolite Belt, Mileševa.

Fig. 2 Olistolith of pillow-lawa, Dinaridic Ophiolite Belt, old road Mileševa-Sjenica.

Fig. 3 Blocks of limestone and dark gray sanstone in the matrix; Dinaridic Ophiolite Belt, Uvac valley.

Fig. 4 Ophiolitic blocks and clasts in matrix; some of them rounded; Dinaridic Ophiolite Belt, Mileševa.

Fig. 5 Olistoliths and blocks of arenites in matrix; Dinaridic Ophiolite Belt, Mileševa.

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Plate II

Fig. 1 Basalt olistolith (greenish) in dark gray shale matrix. Gorge of Almár Valley, south of Szarvaskő.

Fig. 2 Limestone olistolith in an olistostrome horizon of the Oldal Valley Formation, east of Felsőtárkány, SW Bükk Mts.

Fig. 3 Bódvalenke-type Triassic pelagic limestone with red chert and reddish amygdaloidal basalt. The dark gray siliceous shale matrix of Jurassic age can be seen in the upper right. Darnò Complex, borehole Rm-136, Box No. 81, 367,40–372,30 m.

Fig. 4 Olistothrymma of Triassic red chert, red basalt and light coloured Upper Carnian pelagic limestone in weathered shale matrix. Locality Kavicsos-Kilátó, central part of southern Bükk Mts., north from Bükkzsérc.

Plate III

Fig. 1 Basalt (greenish) associated with Carnian red radiolarite. Road-side outcrop in the valley of Katušnica Creek, Gostilje, Zlatibor Mt., Dinaric Ophiolite Belt.

Fig. 2 Triassic Bódvalenke-type limestone block (below the hammer) associated with basalt (greenish) and with red radiolarite and mudstone. Road-side outcrop in the valley of Katušnica Creek, Gostilje, Zlatibor Mt., Dinaric Ophiolite Belt.

Fig. 3 Triassic Bódvalenke-type red, bedded cherty limestone olistothrymma (right) in shale matrix (left) along the road from Bistrica to Priboj, Dinaridic Ophiolite Belt.

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Plate IV

Fig. 1 Oldal Valley type olistostrome with limestone olistoliths. Exposure in the road curve about 500 m north of Tardos Quarry, between Szarvaskő and Mónosbél, Bükk Mts., NE Hungary. (Photo: courtesy of J. Vozár, Bratislava)

Fig. 2 Deformed bedded cherts (Callovian-Kimmeridgian). Dinaridic Ophiolite Belt, Road Nova Varoš-Bistrica.

Fig. 3 Detail of the deformed bedded cherts (Callovian-Kimmeridgian). Dinaridic Ophiolite Belt, Road Nova Varoš-Bistrica.

Plate V

Fig. 1 Folds in the Triassic limestone (Grivska Fm.); Dinaridic Ophiolite Belt, sharp road curve before Nova Varoš.

Fig. 2 Olistoplaka of Triassic limestone in the melange; Dinaridic Ophiolite Belt, Prijepolje.

Fig. 3 Blocks of Triassic limestone in the matrix; Dinaridic Ophiolite Belt, Uvac valley.