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THE EVOLUTION OF THE NORTHERN PART OF THE VARDAR ZONE IN MESOZOIC

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ABSTRACT

Three subzones, similar to those in the south, can be distinguished in the northern part (north of the line Pristina - Vranje) of the Vardar zone.

The Eastern subzone is characterized at its eastern beneath the Serbian - Macedonian massif underthrusted margin by low to medium grade metamorphosed Triassic (?) and Jurassic formations. Southwards are exposed deeper levels of this margin and the same formations are high grade exposed deeper and magmatized grading into Upper Jurassic S-granites. This indicates that this part of the Vardar ocean was closed in Late Jurassic. Western parts of this subzone as well as the eastern parts of the Central subzone are covered by Neocomian, Aptian - Albian and Upper Cretaceous flysches, as transgressive cover over the Carboniferous (Veleš series) to Jurassic formations (low grade schists, ophiolites and associated rocks of the oceanic realm, olistostrome).

The central subzone contains in addition to the formations mentioned as the basement of the flysches at the west the Kopaonik block, and passes east of the Vardar block. The N-S elongated Kopaonik block a detached margin from the at west situated Drina - Ivanjica terrane, consists of low grade metamorphosed Lower to (begining of) Upper Triassic continental margin sediments. The Jadar block divides at the north the Vardar zone in two branches: the Eastern and the Central subzones continue to north, the Western branch, i.e. the Western subzone, extends towards northwest.

The western subzone represents an oceanic area originated in (or after) Upper Triassic between the detached Kopaonik block at east and the main part of the Drina - Ivanjica terrane at west. The subzone consists of an olistostrome melange containing fragments of graywackers, basaltic rocks (of MORB and Island arc type), Triassic and Jurassic limestones and cherts, but also fragments of early Upper Cretaceous limestones. Such Cretaceous limestones were found also as inclusions in the basalts. Andesitic rocks occur in Turonian-Early Senonian sediments south of Belgrade. This indicates that the Western subzone of the Vardar ocean was closed by an eastward oriented subduction in Senonian. The closing was connected probably with obduction of large ultramafic bodies, which were by later (Paleogene) compressions thrusted eastward over older formations.

INTRODUCTION

The Vardar zone was seperated by Kossmat in 1924. In 1960 it was ex-

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tended by Milovanovic up to Belgrade and the Pannonian basin, Aubouin et al. (1970) considered it in its full extension but as a part of the Dinarides. Dimitrijevic (1974) the first seperates it as a special unit between the Dinarides and the Serbian - Mecedonian massif. The Vardar zone, or the Vardar zone composite terrane is considered here in the sense of Dimitrijevic (1974) but without the easternmost parts in the south, which are regarded as frontal parts of the Serbian - Macedonian composite terrane, and the Jadar block.

GEOLOGY

The Vardar zone represents the relic of the ancient Vardar ocean, existing between Middle Paleozoic (when the at the east situated terranes were already attached to the Moesian plate) and the Upper Jurassic (the eastern parts), respectively Upper Cretaceous (the western parts). After the closing of the Vardar ocean or its parts compressional events occured in Cretaceous and Paleogene when the eastern units of the Vardar zone were pushed below the Serbian - Mecedonian composite terrane and in the suture zone originated trenches where flysches were deposited.

The western boundaries of this terrane are westward oriented thrusts. At the eastern side a system of subparallel eastward oriented underthrusts, which include also frontal fragments of metamorphics of the Serbian-Macedonian mass, is the boundary. At north this suture zone divides in two branches seperated by the Jadar block pushed inbetween at the end of Cretaceous or on Paleogene. The eastern branch is in the north covered by Neogene sediments of the Pannonian basin, and the western branch extends northwestwards as a narrow belt.

In the north the erosional level of the Vardar zone is low, in the south, where the zone is compressed between the Serbian-Macedonian composite terrane and the Pelagonides because of uplift and deep erosion are exposed deeper parts and the picture becomes complicated. North of Pristina in the eastern part of the Vardar zone extends up to Belgrade a belt of Cretaceous (Neocomian, Aptian-Albian and Upper Cretaceous) flysches, and south of Kumanovo large parts of this part of the Vardar zone are covered by transgressive Upper Eocene marine and Neogene lacustrine sediments. At the western margin of the Vardar zone occur Turonian and Lower Senonian sediments, mostly with tectonic contacts and (Campanian -) Maastrichtian flysch transgressive over already deformed units along the contact of the Vardar zone and the adjoining Drina - Ivanjica terrane.

In Greece in the southernmost parts of the Vardar zone Mercier (1966) separated three units, and Bulle and Rollet (1970) followed them northwards until Kecanik - Kumanovo. Using the existing data of geological mapping 1:100.000 succeeded a similar division further to the north but the correlation with the units at the south is possible only with broad adjustments.

The Vardar zone is divided into three subzones, all containing ultramafic and other ophiolitic rocks:

(1) the Eastern subzone extends from Halkidiki to the Pannonian basin. It consists of Veles series low grade metamorphic rocks of Carboniferous age (Crubic & Ercegovac, 1975), ophiolitic (ultramafic to mafic) rocks, Jurassic olistostrome with fragments of basaltic and gabbroic rocks, sandstones, cherts and rare Tithonian limestones with Ellipsactinias. At its eastern margin at the south collisional S-granites of Upper Jurassic age, associated with high to medium grade metamorphics occur, however at the north only low grade metamorphosed (Triassic ?-) Jurassic rocks are exposed.

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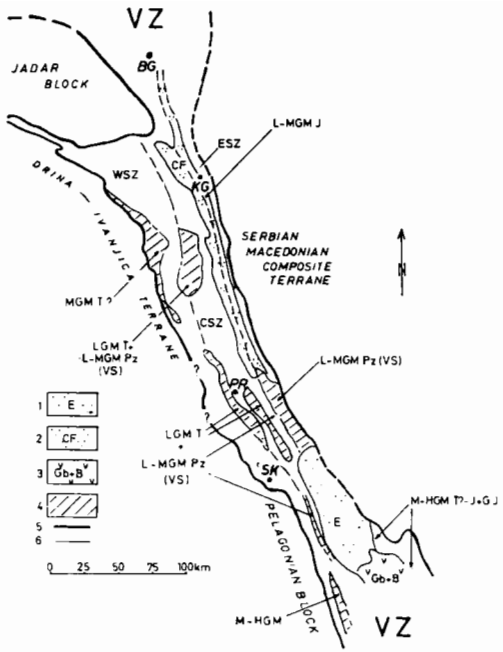

Fig. 1: Geological position of the Vardar zone
Explanations. Towns: BG - Belgrade, KG - Kragujevac, PR - Pristina, SK - Skopje, TH - Thessaloniki,. Legent: 1 - Eocene flysch, 2 - Cretaceous flysches, 3 - Gb+B - The gabbro - diabase massif of Gevgelija, 4 - Paleozoic and Triassic blocks in the Vardar zone, 5 - The boundary of the Vardar zone, 6 - Boundaries of the subzones. Signs: VZ - The Vardar zone, ESZ - The Eastern subzone, CSZ - The Central subzone, WSZ - The Western subzone, L - MG J - Low to medium grade metamorphosed Jurassic, M-HGM T?-J+GJ - Medium to high grade metamophosed Triassic (?) - Jurassic and Jurassic S - granites, MGM T? - Medium grade metamorphosed Triassic (?), LGM T+L-MGM Pz (VS) - Low grade metamorphosed Triassic and low to medium grade metamorphosed Paleozoic (Veleš series), L-MGM Pz (VS) - Low to medium grade Paleozoic (Veles series), M-HGM - Medium to high grade metamorphic rocks.

The thrusting because of postcollisional compression caused detachement of lenses of metamorphic rocks from the front of the Serbian - Macedonian composite terrane and their incorporation into the marginal part of the Vardar zone. As the western boundary of this zone is considered the trench where the Cretaceous (Neocomian, Aptian - Albian, Upper Cretaceous) flysches were deposited transgressively over older formations;

(2) the Central subzone has the same extension and consists of the same Pre-Cretaceous units as the eastern one, but in its western part occur the Kopaonik block and some smaller lenses built up of low grade metamorphosed Lower to Middle Triassic metasandstones, slates, phyllites with interlayered quartzites, limestones, spilites and metatuffs and Upper Trisassic carbonate rocks. This block and associated lenses represent probably marginal parts of the Drina - Ivanjica unit, detached in Upper Triassic or after Triassic. The eastern parts of this subzone are covered with the same flysches as the

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western parts of the Eastern subzone;

(3) the Western subzone extends probably from the Gulf of Thessaloniki, over Klepa, Kacanic area to the Studenica area and further the NW including Jelica and Maljen towards Zvornik. At the western margins of this subzone occur, between Kacanik and Jelica, low to medium grade metamorphosed supposed pre-Triassic and Triassic rocks (metabasics and metaterrigenous rocks wiht lenses of carbonates of marbles in high levels). The characteristic member of this subzone is the olistostrome composed mostlyof graywacke fragments, lesss abudant are chert, basalt, diabase and gabbro fragments, as well as lensshaped olistolites of Triassic and Jurassic limestones, very rare olistolites of metamorphic rocks of ophiolite slices basement, but Cretaceous (up to Campanian) limestones as fragments or inclusions in the basalts were also found. Large ophiolitic bodies (Maljen) or ultramafic overthrusts (Stovoli, Cemerno, Troglav) belong to this subzone. Here has to be mentioned that in the Turonian - Early Senonian sediments south of Belgrade andesitic fragments indicating of volcanism related to the (north-) eastward subduction before the closure of this basin occur. With this subduction is probably related also the emplacement of ophiolitic bodies. However by later compression before Oligocene these ultramafic were pushed westward over older units. This zone represents a marginal basin opened in or after Uper Triassic when also the pre -Jurassic formations in the basement were metamorphosed. Basaltic rocks in this basin are both of MORB and of island arc affinity indicating its complex evolution. The basin, or some of its parts were closed as late as in Campanian.

The closing time of this basin is determinated by the occurences of Campanian limestones in the spilites near Krupanj e.g. (pers. comunication of Dr. I. Filipovic), the transgressive position of Maastrichtian flysch and its base over the already by compression deformed olistostrome and the ophiolites, and by the 32 ma. ago intrusion of the Boranja granodiorite into the already composed framework of this area, i.e. it metamorphoses the olistostrome of this subzone, as well as the neighbouring rocks of the Drina -Ivanjica terrane and of the Jadar block.

The Jadar block consisting of Paleozoic basement with a Triassic to Lower Jurassic and Cretaceous cover, differing from the same formations in the neighbouring terranes, was pushed into the Vardar zone along the boundary of the Central and the Western subzone after Campanian and before Late Oligocene. This protrusion of the Jadar block is connected with rotation of the eastern branch of the Vardar zone and of the other at the east situated geological units clockwise for about 25°.

GEOLOGIC EVOLUTION

The evolution of the Vardar zone of the Vardar ocean as its precousor was considering all the existing data very complex.

The oceanic realm - e.g. Vardar ocean - existed at least from the beginning of Carboniferous since the evolution of Carboniferous formations at both sides of the (now existing) Vardar zone was quite different. Some blocks or terranes were earlier docked to the Moesian plate, but thiw can be related to the existence of a large Tethys, and not directly to the Vardar ocean. The Carboniferous Veles series represents probably an island arc (metamorphosed basaltic rocks, terrigenous, psammitic and pelitic, and siliceous sediments, with shallow water limestones at top), dismembered later.

During Upper Paleozoic, Triassic and Lower - Middle Jurassic a wide oceanic area existed, its relics are the Eastern and the Central subzones of

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the Vardar zone. The processes in Lower - Middle Triassic are not clear. It is possible even that a westward subduction provoking the origin of the Dinaric ophiolite belt and later the detachment of the Kopaonik unit and associated lenses from the Drina - Ivanjica terrane existed, but the geochemical character of the Triassic volcanics in the Dinarides is not enough studied. This oceanic area was closed by an eastward subduction in Upper Jurassic, when in the collision region S-granites and high to low grade metamorphics were formed. These granites and high to medium grade metamorphic rocks are exposed in the uplifted southern parts of the Vardar zone, in the northern parts only (medium to) low grade metamorphics occur at the surface.

During Cretaceous, in Neocomian, Aptian-Albian and in Upper Cretaceous in the north as well, as in Eocene in the south further compression brought to the formation of basins in the relics of this part of the already closed Vardar ocean. In these basins turbiditic sediments were mostly deposited. These basins are considered as the boundary of the Eastern and Central Subzone of the older part of the Vardar zone.

In Upper Triassic (or after Triassic) a new oceanic area, which relic is the Western subzone, developed behind the detached parts of the Drina-Ivanjica terrane (the Kopaonik block and the associated lenses of Triassic rocks). This process was associated with the medium to low grade metamorphism of the detached and marginal Triassic rocks.

During Jurassic and Cretaceous, up to the Maastrichtian the new ocean had a considerable extension: there existed parts built up of MORB basalts, but also island arcs (immature!) existed. The beginning of the closing of this oceanic area could be dated by the age determination of metamorphic sole blocks in the olistostrome, but the formation of flysch-basins in the eastern parts, indicates that the eastern areas of the Vardar zone were under pressure probably because of closing of the western oceanic realm during all the Cretaceous.

Finally the occerence of andesitic rocks of volcanic arc affinity in the Turonian-Lower Senonian cover over the already closed parts of the Vardar zone dates the time of subduction. This oceanic realm was closed in Late Cretaceous.

After the closure of the oceanic realm, but before the middle of Oligocene the Jadar block was pushed into this suture zone and the eastern branch of the Vardar suture zone was clockwise rotated. The intrusions of Oligocene granodiorites of Boranja proves that the framework of the western parts of the Vardar zone was formed in Paleogene.

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