

# PERMIAN TO NEOGENE FORMATION OF THE ASSEMBLAGE OF GEOLOGIC UNITS AT THE SOUTH OF THE PANNONIAN BASIN

S KARAMATA<sup>1</sup>, D. STEFANOVIĆ<sup>2</sup> and B. KRSTIĆ<sup>3</sup>

<sup>1</sup>*SANU, Kneza Mihaila 35, YU-11000 Beograd; [inga@eunet.yu](mailto:inga@eunet.yu)*

<sup>2</sup>*Bulevar AVNOJa 116/33, YU-11070 Novi Beograd; [stefandr@eunet.yu](mailto:stefandr@eunet.yu)*

<sup>3</sup>*Geoinstitut, Rovinjska 12, YU-11050 Beograd; [n\\_krstic@ptt.yu](mailto:n_krstic@ptt.yu)*

**ABSTRACT:** The geological units at the south of the Pannonian basin are fragments of Eurasia at the east (Moesian plate), and Gondvana at the southwest (northern part of Adria), and terranes docked to them, as well as relics of oceanic lithosphere that was in-between. These units gradually drifted northward since the Permian steady approaching, and finally closed the Vardar ocean as well as the oceanic realms in-between.

**Key words:** Balkan peninsula, Permian to Neogene, terranes movement.

## INTRODUCTION

Most paleogeological maps of the Central part of the Balkan Peninsula show the character of geological units during different periods from Upper Paleozoic to Tertiary. However, many maps do not include a plausible interpretation of relationships of those units, and in particular their disposition through time and space. During the past 20 years new data were published, and these data enable to present the disposition of geological units in Paleozoic, Mesozoic and Tertiary. There are many data of paleomagnetic investigations, in particular those on the paleolatitudes, as well as results of paleofloristic, and geological-sedimentological investigations. Altogether, those data enable reliable interpretation of geological setting of those geological units.

The area south of the Pannonian basin is of primary interest here. The area includes fragments of the Eurasia at east, i.e. the Moesian plate, and the northernmost part of Adria, i.e. of Gondvana at west, as well as the terranes docked to them since the Paleozoic to Paleocene. The area includes some relics of previously existing oceanic lithosphere that was in-between. This area extends at north up to Tisia, where their boundary is a transcurrent fault extending W-E. This interpretation includes areas up north of Macedonia.

## GEOLOGICAL FRAMEWORK

In the area treated by this study from Late Paleozoic were present the following units and terranes (Fig. 1):

**(I) from Eurasia westwards to the Tethys ocean**, or its north-western part also known as the the Vardar ocean, i.e. from the east to the west:

- the Moesian plate (Moesia);
- the Eastern Serbian Composite terrane (ESCT) docked to the Moesia at the beginning of the Late Carboniferous;
- the Serbian-Macedonian mass composite terrane (SMCT) amalgamated with the previous unit in Early Paleozoic.

**(II) from Gondwana eastwards to the Vardar Ocean**, i.e. from west to east:

- the Dalmatian-Herzegovinian composite terrane (DHCT) that is the north-easternmost part of the Adria, or of the Gondwana, including its Mesozoic cover;
- the East Bosnian-Durmitor terrane (EBDT), included into that framework in Jurassic;
- the Dinaridic Ophiolite Belt (DOBT), the suture of a Middle Triassic-Late Jurassic marginal sea;
- the Drina-Ivanjica terrane (DIT) which was at least since the end of Carboniferous the margin of Gondwana with the attached units.

**(III) the Vardar Ocean** between them. In Upper Triassic at its western side of the main Vardar ocean, behind a ridge, a marginal basin originated. The main oceanic basin was closed in Uppermost Jurassic, and since that time the Main Vardar zone (MVZ) represents its scar. The marginal basin become in Jurassic-Early Cretaceous a wide oceanic realm, which was closed by the end of Cretaceous. Its scar is the Vardar Zone Western Belt (VZWB). Relic of the ridge which separated the oceanic realms is the Kopaonik block and ridge unit (KBR);

- the Jadar block terrane (JBT), composed mainly of Paleozoic and Triassic formations, which was transported into the marginal basin precursor of the VZWB.

## PALEOMAGNETIC, PALEOFLORESTIC, AND GEOLOGIC DATA

The relevant data to this study can be summarized as follows:

Upper Carboniferous - in ESCT: The Stephanian coal bearing lacustrine sediments were deposited at latitudes  $5^{\circ}\text{N}$  under warm and humid climate (Milićević, 1998).

Permian - in ESCT: The Permian red beds deposits originated at the latitudes close to 10 °N (Milićević, 1998), under a very warm and arid climate.

Middle Permian - in JBT: Limestones deposited at latitudes close to 10 °N (Milićević et al., 1995), some limestones in this unit, as well as in other units at the southwest (the EBDT, DHCT, and the Sana-Una unit) are bellerophone bearing.

Lower Triassic - in DHCT, DIT, and the Middle Bosnian Schistous Mts: South Alpine development.

Lower Triassic - in ESCT: red beds grading to marine shallow water deposits.

Middle Triassic - in DHCT, EBDT, at margins of DOB and JBT basaltic to Ca-alkaline rifting or subduction related volcanism.

Middle Triassic - in SMCT and ESCT the volcanism is absent; Albian-Cenomanian - in MVZ: sediments deposited at latitudes 23-28 °N (Veljović & Milićević, 1987); the sediments contain palynomorphs of Eurasian affinity (Dulić, 1999).

Albian-Cenomanian - in DOB: the sediments contain palynomorphs of Gondwana affinity (Dulić, 1999).

Turonian-Senonian - in ESCT: sediments were deposited at latitudes close to 31 °N (Milićević, 1985/86).

Upper Senonian - in ESCT and MVZ: sediments were deposited at latitudes 33-36 °N (Veljović a. Milićević, 1986, 1987).

Upper Senonian - in VZWB and DIT: sediments were deposited at latitudes 32-36 °N (Veljović a. Milićević, 1986, 1987).

Oligocene - in VZWB, MVZ, SMM, and ESCT: sediments were deposited at latitudes close to 37-38 °N (Milićević a. Djurašinović-Gavrilović, 1990; Marović et al., 2001).

It should be mentioned that after the collision and joining of units at the end of Cretaceous there was a clockwise rotation increasing from west to east: in the MVZ, SMCT and in the western parts of the ESCT the rotation was 5-10 °, while the eastern parts of ESCT 15 °, or even 20 ° (Milićević a. Djurašinović-Gavrilović, 1990; Marović et al., 2001).

## DISCUSSION

All the considered geological units, that were at the Equatorial position during the Upper Paleozoic, had drifted north and north-eastward since the Late Carboniferous gradually approaching each other (Fig. 2). However, the geological units that are parts of the eastern and of the western units had moved separately. As a result of the drift of these

units the Vardar ocean, and the associated marginal seas, i.e. the oceanic realms between Gondwana and Eurasia were at the end of Cretaceous closed.

During the Lower Cretaceous the Kopaonik Mt. (KBR), the Gledići Mt. (VZM), and the Kučaj unit (CBAT) were already one entity located at the latitudes 23-28 °N. At that time, between them and the main Dinaridic body/trunk there was a wide Western branch of the Vardar ocean. That is confirmed by the occurrence of palynomorphs of Eurasian character in the KBR and VZM, as well as palynomorphs of Gondwana type found in the DOB samples.

During the Late Senonian the mentioned oceanic realm was closed, and all geologic entities amalgamated. Later on they moved northwards all together. The northwards drifting continued all through the Tertiary: during Late Senonian the already amalgamated assemblage was at the latitude close to 35 °N, in Oligocene at 37-38, and in Quaternary at 44 °N.

A conclusion is that from Upper Paleozoic on, there was a constant northward movement of all units that are, at the present time, south of Tisia. However, during the Tertiary only, all the units, including the eastern and the western ones, have a common history.

## REFERENCES

- Dulić, I.A., 1999: Middle Cretaceous Palynomorphs of Serbia and Paleophytogeography of Central Tethys. Bulletin CXIX, Acad. Serbe Sci. Arts, Cl. Sci. math. nat., 39, 151-161, Beograd.
- Karamata, S., Krstić, B., Dimitrijević, D.M., Dimitrijević, M.N., Knežević, V., Stojanov, R., Filipović, I., 1996-97: Terranes between the Moesian plate and the Adriatic Sea. Annales Geol. des Pays Helleniques, 37, 429-477, Athens.
- Krstić, B., Filipović, I., Maslarević, Lj., Sudar, M., Ercegovac, M.: 2002: Carboniferous of the Carpatho-Balkanides, Vardarides and Dinarides. in: The Carboniferous of the World, V, Inst. Techn. Geominera de Espana, in print.
- Marović, M., Djoković, I., Milićević, V., Toljić, M., Gerzina, N., 2001: Paleomagnetism of the Late Paleogene and Neogene rocks of the Serbian Carpatho-Balkanides: tectonic implications. Ann. Geol. Pen. Balk., 64, in press, Beograd.
- Maslarević, Lj., Krstić, B., 2001: Continental Permian and Lower Triassic red beds of the Serbian Carpatho-Balkanides. Natura Bresciana, Ann. Mus. Civ. Sc. Nat., Monographia 25, 245-252, Brescia.
- Milićević, V., 1985/86: Paleomagnetizam i paleogeografska pozicija turon-senonskih i senonskih sedimanata sa prostora Karpato-balkanida u Jugoslaviji. Vesnik, C - Geofizika, XXVI/XXVII, 63-78, Beograd.
- Milićević, V., 1998: Palinspastika hercinida u kučajskoj zoni Istočne Srbije. Posebna izd. Geoinstituta, 216, 130 pp., Belgrade.
- Milicevic, V., Milovanovic, D., Filipovic, I., Jovanovic, D., 1995: Paleomagnetism of Paleozoic formations in Jadar trough, NW Serbia. Proc. XV Congress Carp. Balk. Geol. Assoc., Geol. Soc. Greece, Sp. Publ, 4/3, 1125-1129, Athens.
- Milićević, V., Djurašinović-Gavrilović, M., 1990: Paleomagnetism of the Paleogene (Oligocene) basins of Serbia. XII Kongres na geolozi na Jugoslavija, V, 276- 286, Ohrid.
- Stefanović, D., Veljović, D., 1981: Paleomagnetic characteristics of some Upper Cretaceous volcanic rocks of the Timok eruptive complex. Glass CCCXXIX, Acad. Serbe Sci. Arts, Classe Sci. nat. math., 48, 53-62, Beograd.

- Veljović, D., Milićević, V., 1986: Izveštaj o rezultatima magnetskih i paleomagnetskih ispitivanja uzopraka stena prikupljenih sa lokaliteta SR Srbije u toku 1985. godine u cilju izrade paleogeografske karte. Geomagnetski Institut, report, pp 53, Beograd
- Veljović, D., Milićević, V., 1987: Izveštaj o rezultatima magnetskih i paleomagnetskih ispitivanja uzoraka stena prikupljenih sa lokaliteta SR Srbije u toku 1986. godine u cilju izrade paleogeografske karte. Geomagnetski Institut, report, pp 83, Beograd

**Fig. 1.** Geologic units south of the Panonian basin, i.e. of Tisia (after Karamata et al.1996-97, slightly modified), with places of analysed samples.

Abbreviations: ESCT - Eastern Serbian composite terrane; SMCT - Serbian-Macedonian composite terrane; MVZ - Main Vardar zone; KBR - Kopaonik block and ridge unit; VZWB - Vardar zone western belt; JBT - Jadar block terrane; DIT - Drina-Ivanjice terrane; DOBT - Dinartidic ophiolite belt; EBDT - East Bosnian-Durmitor terrane; DHCT - Dalmatian-Herzegovinian composite terrane. Samples: circle - Oligocene; diamond - Upper Senonian; pointed diamond - Turonian-Senonian; square - Albian-Cenomanian; pointed circle - Permian; point - Stephanian.

**Fig. 2.** Simplified presentation of general northwards movements of units and their approaching and joining. Explanation in text and on the figure.



