

# THE PALEOZOIC UNITS OF DINARIDES AND THE VARDAR ZONE

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**ABSTRACT:** The Paleozoic units in the Dinarides and the Vardar zone belong to five groups: the Veles series, the Central Bosnian Mountains, the Drina-Ivanjica terrane, the East Bosnian-Durmitor unit, and the Jadar block - Sana-Una - Banija-Kordun units. They had different developments, came from different parts of the Tethyan region, and were added in the recent framework at different time.

**Key words:** Paleozoic, Dinarides, Vardar Zone, Balkan peninsula.

## INTRODUCTION

The paleozoic units of the Dinarides and of the Vardar zone (fig. 1) were identified and studied during the last hundred years by numerous scientists (Katzner, Simic, and others). Detailed studies performed in these units during the last thirty years enables a correlation of them, and some conclusions on their geological development can be deduced.

## MAIN FEATURES OF THE UNITS

### **The Veles series (VS - at Fig.1)**

This unit occur as elongated lentoid bodies in the main Vardar zone. The deepest levels consist of amphibolites. They are overlain by biotite and muscovite schists with intercalated marbles and quartzites. The schists contain pollen of Carboniferous age. That rock-association represents most probably the remnant of anc island arc.

**The Central Bosnian Mountains terrane (CBMT - at Fig 1, its evolution is presented at the Fig. 2, column A).**

The oldest rocks are Early Paleozoic (probably from Uppermost Proterozoic) schists of low- to medium-metamorphic grade, with rare quartzites originating from psammitic and pelitic protolithes, and intercalated metabasaltic rocks. They were deformed and metamorphosed before the end of Silurian. The Uppermost Silurian metapsammities and phyllites are followed by thick sequence of dolomites and limestones (Devonian and

partly Tournaisian). Over them Upper Permian sandstones, shales, with rare limestones and gypsum were deposited. In all these formations lenses and sills of rhyolites occur.

The main characteristics of this unit are metabasaltic rocks in Presilurian, rhyolites in Devonian to Permian complexes, large masses of Devonian dolomites and limestones, as well as the break in deposition from Tournaisian to Upper Permian.

The CBMT represents a block detached from a continental margin. It was docked to the main Dinaride trunk before Upper Permian.

**The East Bosnian - Durmitor unit (EBDT** - at Fig 1, its evolution is presented at the Fig. 2, column B).

This unit is the remnant of a former terrane, divided into at least two slices, occurring as the Durmitor and Cehotina nappes.

The oldest rocks are Silurian-Devonian sericite schists, metasandstones, and phyllites. The following Paleozoic sequence is represented by a continuous series of Middle Devonian to Middle Permian low to very low grade metamorphosed sandstones and shales, with lenses of limestones and conglomerates, and very rare rhyolites. Lower and Middle Carboniferous are developed as flysch. In olistostromes of Carboniferous age occur Silurian deep water and Devonian reef limestones olistolithes. After a short break in sedimentation follow Upper Permian evaporites, shales, sandstones and limestones, grading into Lower Triassic.

The main characteristics of the EBDT unit are the predominance of terrigenous sediments and occurrence of sodic rhyolites, the continuity of sedimentation from Devonian to Middle Permian, with Middle Carboniferous flysch, and from Upper Permian to Triassic.

The EBDT represents a block detached from a continental slope. This unit is situated in the trench assemblage of the Dinaridic ophiolite belt (DOB), separated from the Dalmatian-Herzegovinian Composite Terrane by a narrow zone of trench deposits only.

**The Drina-Ivanjica element/terrane (DIE** - at Fig 1, its evolution is presented at the Fig. 2, column C).

The oldest unit are terrigenous sedimentary and mafic volcanic rocks of Cambrian - Lower Ordovician age. After a break in sedimentation during Silurian and partly Devonian when the previously mentioned formations were metamorphosed under low-grade conditions, follow the Tournaisian to Bashkirian anchi- to un-metamorphosed pelites, psammites, cherts, carbonaceous-clastic sediments, flysch and olistostromes. Those units are covered by Triassic continental red beds.

The main characteristics of this unit are the mafic volcanics in lowermost unit, high predominance of terrigenous rocks, and the Late Jurassic to Early Cretaceous hT-IP metamorphism, as well as the breaks in deposition from Ordovician to Tournaisian and from Bashkirian to Triassic.

This unit represents a block detached from a continental margin, probably at the western margin of the Tethys, and docked to the already existing main Dinaride block (DHCT+CBMT, fig.1) before the end of Permian. The DIE was later by Triassic rifting separated from that block, but after the closure of the Dinaridic oceanic realm, before the end of Jurassic, once again docked to the main Dinaridic body.

**The Jadar block terrane (JBT) - the Sana-Una unit (SUU) - the Banija-Kordun unit (BKU)** are presented at Fig.1 and their evolution is given at Fig 2 in columns D, E, and F).

These units are very similar, in some parts almost identical.

The main part of those units consists of Devonian-Carboniferous (up to Middle Bashkirian in JBT, but up to the end of Bashkirian in SUU) flysch or psammitic-pelitic sedimentary rocks. In the SUU in lower levels locally siderite and in the BKU limestone (locally ankeritic) interlayers occur. Only on some elevated areas limestones or carbonaceous rocks were deposited: at the Ub rise (JBT) during the whole period, in the Likodra unit (JBT) and the Sana part of DSU as interlayers from Serpukhovian.

From Moskovian some differences in the sedimentation are evident. In the JBT new cycle starts in the middle of Moskovian with siltstones, later fusulinid limestones and lasts until the beginning of Permian. It seems that similar conditions (without limestone sedimentation) were in the BKU unit. In the SUU part there was no sedimentation.

In Middle Permian new sedimentation with sandstones, siltstones, and shales starts, continues with deposition of gypsum, dolomite (partly porous) and at the top are bituminous limestones. They grade into Lower Triassic deposits.

This group of units is characterised by the predominance of flysch and olistostromal deposits and breaks in deposition during Middle Carboniferous and Lower Permian.

These units represent fragments of a block detached from the waxing, proximal part of a continental slope, and transported into the oceanic realm. The time of its emplacement into the Western branch of the Vardar zone was before Upper Cretaceous.

## DISCUSSION

The described Paleozoic units originated in different parts of the Tethys and its margin, were transported by the oceanic crust during Paleozoic and Mesozoic, and were

docked to the proto-Dinaride trunk before the Upper Permian, during Meozoic, or remained in the oceanic areas and were later included into the present geologic framework.

The Veles series originated as part of an island arc in oceanic realm and was later, during subduction, scratched off from the oceanic crust and incorporated in the Jurassic trench melange, which represents now the MVZ.

The CBMT was primary at the margin of a continental unit, probably close to a rifting zone. Later, because of uplift, it becomes a continental shelf, which, after a long quiescence (Devonian), grades into a continental slope. The DIE originated at a continental margin, probably during an initial rifting, becoming later proximal part of a continental slope. The EBDT is build of formations originated at a waxing to uniform continental slope. The JBT, the SUU and the BKU are almost identical, they represent formations deposited at proximal parts of a continental slope, later in Permian they became parts of a shallow continental margin.

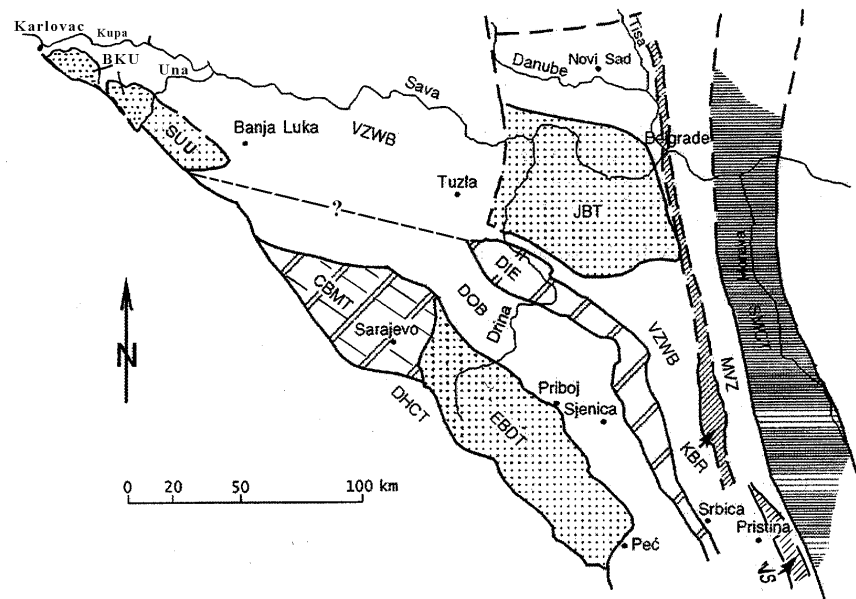
Those units came from different parts of the Tethys. The VS from the oceanic area, the other from the S - SW margin of the Tethys. The shelf unit (CBMT) was docked to the Dinaride block in Permian before the further at the west situated DIE. The continental slope sediments units were added later: the EBDT during Jurassic, the JBT+SUU+BKU in Middle Cretaceous. Additional difference between those two units is that the EBDT belongs to the margin of the Dinaridic oceanic basin and was transported to the actual place probably from the south, the JBT+SUU+BKU (including the Bukkium Paleozoic in N.Hungary) belong to the Vardar zone, and were pulled apart during the, probably south-eastward, transport.

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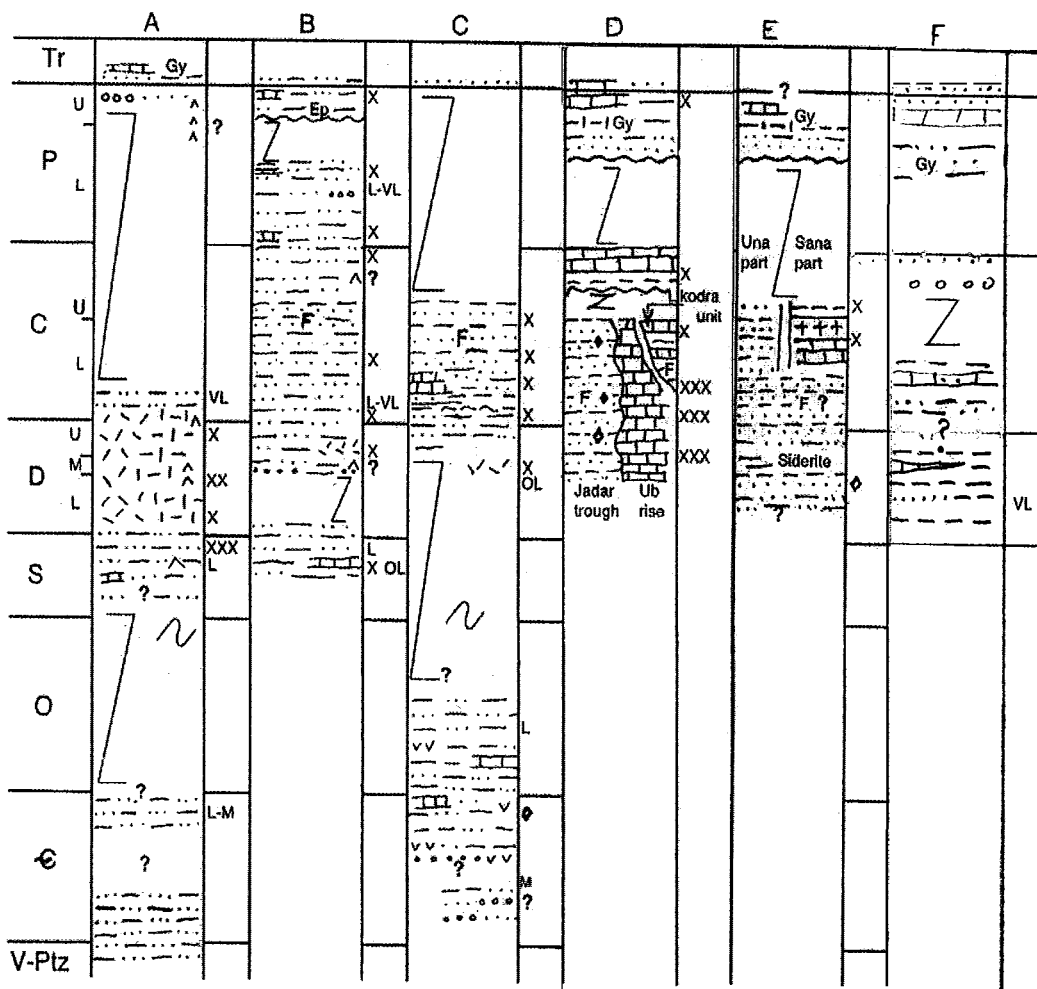
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Additional references in Dimitrijevic, 1997, and Karamata and Vujnovic, 2000.



**Fig. 1.** Paleozoic units in the Dinarides and the Vardar zone: CBMT - Central Bosnian Mountains terrane; EBDT - East Bosnian-Durmitor unit/terrane; DIE - Drina-Ivanjica element/terrane; JBT - Jadar block terrane; SUU - Sana-Una unit; BKU - Banija-Kordun unit; VS - Veles series. Other units: DHCT - Dalmatian-Herzegovinian composite terrane; DOB - Dinaridic ophiolite belt; VZWB - Western belt of the Vardar zone; KBR - Kopaonik block and ridge; MVZ - Main Vardar zone; SMCT - Serbo-Mazedonian composite terrane.



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|---------|-----------|---------|--------|--------|
| 1 ---   | 4 ∇ ∇ ∇   | 7 ~ ~ ~ | 10 ♦ ♦ | 13 XXX |
| 2 . . . | 5 [     ] | 8 ^ ^ ^ | 11 X   | 14 Z   |
| 3 ○ ○ ○ | 6  - - -  | 9 ∇ ∇ ∇ | 12 XX  | 15 Z   |

**Fig. 2.** The graphical presentation of the lithology of Paleozoic units/terraces in the Dinarides and the Vardar zone. A - Central Bosnian Mountains terrane, B - East Bosnian-Durmitor unit; C - Drina-Ivanjica element/terrane; D - Jadar blok terrane; E - Sana-Una unit (acc. Jurkovic a. Pamic, 2001); F - Banija-Kordun unit. Signs: 1 - pelite; 2 - psammite; 3 - conglomerate; 4 - limestone, massive; 5 - limestone, bedded; 6 - dolomite; 7 - chert; 8 - rhyolite; 9 - basalte; 10 - pollen and flora; 11 - various fauna; 12 - corals; 13 - conodonts; 14 - folding, deformations; 15 - break in sedimentation. Gy - gypsum; Ep - evaporites; F - flysch; OL - olistostrome; Metamorphism: M - medium grade, L - low grade, VL - very low grade.