

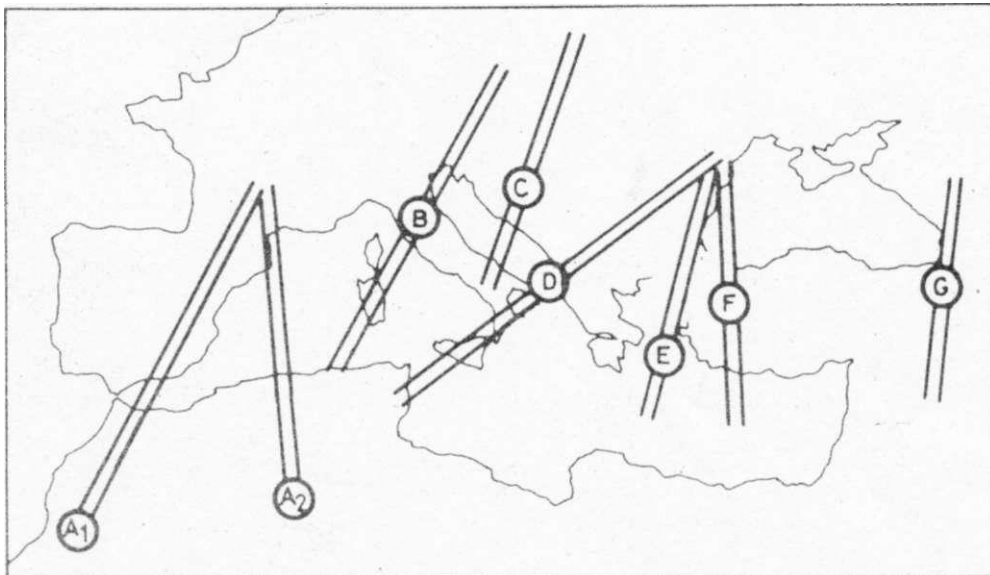


IGCP PROJECT No 5

CORRELATION OF PREVARISCAN AND VARISCAN
EVENTS OF THE ALPINE-MEDITERRANEAN
MOUNTAIN BELT

NEWSLETTER

No 3 (January. 1981)



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PALEOZOIC IN YUGOSLAVIA

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Paleozoic rocks ranging from Cambrian up to the Upper Permian are widespread in Yugoslavia. This review will begin with the Alpine region in NW Yugoslavia and proceed SE through the Dinarids to the Carpatho-Balkanids and the Serbo-Macedonian massif.

The SE parts of the Eastern Alps, extending from Austria to the NE part of Slovenia, reach southwards to the Periadriatic Lineament. Their largest massifs, the Pohorje and Kozjak Mountains, consist predominantly of metamorphic rocks. In the western part of the Pohorje Mountains and in the northern part of Kozjak, however, Paleozoic sediments have been discovered. The age of the metamorphic rocks and sedimentary sequences cannot generally be determined from fossils.

The Pohorje rock sequence belongs to the almandine-amphibolite facies in its lower part; to the transitional zone; to the greenschist facies; to the anchimetamorphic Magdalensberg series; and to the Permo-Triassic clastic series in its upper part. In Mt. Kozjak, Lower Devonian conodonts have been recognized.

The metamorphic rocks of the central zone of the Karavanke Mountains are overlain by the anchimetamorphic Magdalensberg series with diabase effusions, probably of Ordovician and Silurian age. Well-bedded Lower and Upper Devonian limestones have been proven by conodonts; in the Upper Emsian and Middle Devonian reef limestones prevail. The Lower Carboniferous is characterized by flysch and flysch-like facies with "porphyroids". The marine Late Carboniferous begins with the Kassimovian and continues to the end of the Gzhelian, consisting prevalently of clastic rocks of the

Auernig type (molasses facies). Fossiliferous beds with fusulinids, brachiopods, cephalopods, trilobites, bryozoans, gastropods and lamelli-branchiates occur frequently. The sandy shale in the village of Planina pod Golico contains an extraordinarily rich and well-preserved Stephanian flora. The Early and Late Permian marine shallow-water beds are rich in biostratigraphical fossils; the Middle Permian, however, is characterized by green and red clastic Grbden (Val Gardena) strata.

The Middle Carboniferous represents a break in sedimentation because of the main Variscan orogenic movements (Prakaravanke Mountains). The Periadriatic Lineament is marked by the Karavanke magmatic zone. The magmatic rocks associated with granite are monzodiorite and gabbro, of Variscan age.

In the northern Julian Alps paleontologic evidence of Upper Carboniferous beds is shown with Early Permian Zellia-bearing Pseudoschwagerina beds, and Trogkofel carbonate and clastic Grbden beds could not be recognized with certainty. Upper Permian dolomite is indicated by its stratigraphic position and lithological details.

The clastic grey Trogkofel and red Grbden formation is widespread in the Sava fold region, Skofja Loka Mountains, Dolenjska and Kofevska regions. The Upper Permian shallow-water Žažar strata of central Slovenia consisting of limestone, dolomite and "rauchwacke" are rich in calcareous algae and Indo-Armenian/Caucasian brachiopod fauna. This formation is the best marked member of the Paleozoic sequences of central Slovenia. The clastic Trogkofel formation extends eastward to Gorski kotar in western Croatia.

The oldest rocks in Croatia have recently been discovered in Mt. Medvednica (Zagrebačka gora). Badly preserved graptolithids (? Cll-macograptus Hall) in black shales indicate an Ordovician or, more likely, Lower Silurian age (MIHAJLOVIĆ-PAVLOVIĆ & SREMAC, in preparation).

The Paleozoic rocks in Mt. Medvednica are represented by bluish-grey limestones with intercalations of shales, sandstones, breccias, quartz-conglomerates, and diabases. Lower Devonian, Viséan and Upper Carboniferous ages have been proven by conodonts (DURDANOVIČ, 1968 a, 1973). Lower Devonian (Upper Emsian) and Upper Viséan deposits with conodonts have also been found near Dvor na Uni (DURDANOVIČ, 1968 b).

Lower Moscowian algae and fusulinids (Beresella, Dvinella, Ozawainella) from Velebitski jarak (Banija) have recently been described (MILANOVIĆ, in preparation). In the Gvozdansko and Bešlinac area Upper Carboniferous limestones with corals occur (KOSTIČ-PODGORSKA, 1956). Westphalian quartz-sericite-chlorite schists with continental flora have been found in Mt. Papuk (BRKIČ, JAMIČIĆ & PANTIĆ, 1974). At Donja Votča (northern part of the Croatian-Slovenian border), limestone fragments containing Moscowian fossils Beresella, Dvinella, Gyroporella, Herakella and Ozawainella compose Cretaceous or Paleogene breccias. Moscowian fauna from Kriz potok (Gorski Kotar) with Triticites, Paratriticites, Eofusulinella, Quasiendothyra and Archediscus have recently been determined (MILANOVIĆ, in preparation).

The Upper Paleozoic in Croatia is most completely developed on the NE slope of Mt. Velebit; the complete geological column has been published by KOCHANSKY-DEVIDE' (1979). A continuous succession from Kashirian, through Podolskian, Myatschkovian and Gzhelian, to Kassimovian has been established by means of the rich fusulinid fauna and dasyclad algae (KOCHANSKY-DEVIDE', 1959, 1970, 1978, 1979). Abundant macrofauna and Stephanian continental flora have also been found in these deposits.

The Permian in Velebit begins with the calcareous Rattendorf beds (KOCHANSKY-DEVIDE', 1959). Detailed sedimentological investigations of the Kosna clastic deposits have shown the analogy with the upper part of the Trogkofel beds; Moscowian, Lower Kassimovian, Rattendorf and Trogkofel microfossils have been found in the pebbles (KOCHANSKY-DEVIDE', 1973). The Middle and Upper Permian age of the dolomitic-limestone series has been proven by fusulinids (KOCHANSKY-DEVIDE', 1965). Dark fossiliferous limestones occur in three zones and contain, besides microfossils, rich fauna or brachiopods, molluscs, bryozoans, sponges, etc. Clastic Trogkofel deposits are also widely

spread in Gorski Kotar (KOCHANSKY-DEVIDE', 1973). Limestones with Hicorocodium from Mt. Ravna gora represent the prolongation of the Trogkofel zone from Štajerska. Farther to the east these deposits are overlain by younger sediments; they have been drilled in deep boreholes at Zebanec (Hrvatsko Zagorje) at -2472-2476 m, and at Ujfalu (Hungarian border) at -3880-3886 m. In dolomitic limestones from Bregana (Croatian-Slovenian border) Permian microfossils have been found (HERAK & ŠKALEC, 1967). The Neoschwagerina association has been determined from the deep borehole near Rovinj in Istria, at a depth of 3700 m.

In the Drina-Golija region the Paleozoic sediments, up to 7000 m thick, are less known due to their rather monotonous lithology and metamorphism. The absence of the richer biostratigraphical data do not allow us to conclude what it really contains; scarce sources of Cambro-Ordovician, Devonian and Carboniferous paleontological data may give only the time of the geosyncline existence. Mainly transgressive and unconformable overlying Triassic successions may suggest Variscan folding. Recently research on the Drina Paleozoic structures has given us a new interpretation of the fold direction and the complexity of movements "in time" without a definite biostratigraphic base. Instead of an alpine-type direction, they follow a perpendicular, NE-SW direction. It is also clear that the metamorphic degree decreases to the west, where the younger sediments are found. Metamorphism is low-grade and ranges from the greenschist facies to the anchimetamorphic stage.

The Paleozoic strata in the Jadar region belong to fossiliferous Devonian, Carboniferous and Permian beds. The marine Devonian limestones are stratigraphically divided according to conodonts. Carboniferous sediments rich in conodonts, foraminifers and brachiopods are widespread. Three lithological units are distinguished in the Permian system, i.e. the clastic rocks of the Middle Permian, the fusulinid limestone of the Lower Permian, and the fossiliferous shallow-water limestone of the Upper Permian formation, which is the best marked member of the Paleozoic sequence of NW Serbia as well as of central Slovenia.

The Paleozoic of Jadar is the central formation of a basin, while the formations in the lateral areas correspond to the Paleozoic of the Drina-Golija and Praca-Lim areas on one hand, and the basement of the Pannonian basin on the other. Psammitic-pelitic sediments in the Prača-Lim unit belong to the Ordovician, Silurian (?), Devonian and partly Carboniferous. In the upper part of the sequence, Devonian (stromatopod reefs) and Carboniferous carbonate lenses occur. Igneous

rocks are sparse, predominantly basic, occasionally acidic. Sedimentation was interrupted in the Late Carboniferous. The shallow-water Upper Permian transgressively covers this complex. The Paleozoic rocks are metamorphosed in the deepest parts up to the amphibole facies, and anchimetamorphosed in the uppermost strata.

In the basement of the Pannonian basin, the Paleozoic is represented by metamorphic rocks mostly of the greenschist facies: primarily sandstones, clay sediments, marls, with rare mafic igneous rocks.

In the Paleozoic of Western Macedonia, the oldest sediments of the Cambrian-Ordovician outcrop on the slopes of Karaorman and Stogovo (Alipasinica). In the silicified marble intercalations rich in fossil fauna of small lamellibranchs, archaeocyatha has been found.

The Ordovician is displayed on Mt. Stogovo and proven by poorly preserved macrofauna and microfauna. On Babin Srt fragments of trilobites belonging to Synhomalonotus cf. tristani have been found. Among the microfossils numerous species of phytoplankton and histiosperides characteristic of the Ordovician have been found.

The extent of the Silurian is not definitely proven. The schist with crinoids discovered on Mt. Bistra is held as Silurian-Devonian sediment. Similar sediments considered to be of Silurian age have been found on Mt. Šar planina, where stems of crinoids, corals and cephalopods have been found. Among the tetracorals Diphiphyllum and among the orthoceratites Cyrtochoanites have been determined.

The Devonian is very extensive and faunistically proven in many localities, (Bistra planina, Toni Voda, Mavrovo, Tajmište, Judovo, Brždani, Vidrani, Turija, Ilinska planina, Stogovo, and others). In Toni Voda crinoid stems have been found, belonging to Scyphiocrinites, the presence of which is considered as a certain boundary between the Silurian and Devonian-Lohkovian. In this locality the fauna of bivalvia, nautiloids, rare brachiopods, tentaculites and poorly preserved gastropods have been found. These sediments form two parts; the lower formed of crinoid-bearing limestone with Scyphiocrinites, corresponding to the Upper Lohkovian-Gedinian stage. In the upper part nautiloids and bivalvia have been found.

In the Carboniferous volcanic-sedimentary rocks of Suva Gora near Stenče, pollen has been found. The following forms have been determined: Calamospora sp., Canplotriletes cf. amletstus, Cordaitina sp., and others. On Mt. Korab rich Permo-Triassic palyniferous series have been found (Cordaitina ornata, Lueckiaopites virekoe and others).

The Paleozoic of the border part of the Vardar zone is shown in the eastern part of the Pelagonian massif from the village of Smoljani to Jelovica and Čašak. Cambrian or Riphean-Cambrian phytoplankton (synplascospheridium incrustatus, Kildinella sinica and others) have been found in the marble.

In the central part of the Vardar zone the Paleozoic is displayed in a zone extending from the Crna Reka river towards the NW to Crkvino and the Vardar river. It is represented by the so-called "Veles Series", consisting of volcanic and sedimentary rocks. This series contains microflora and belongs to the Carboniferous. The "Veles Series" is divided into three parts; in the lowest microflora (Laevigatosporites medius, Speciosporites cf. minor and others) have been determined. The middle part contains Cordaitina cf. grandireticulata, Cordaitina rotata, Floronites sp. and others. The upper part contains pollen and spores of primitive conifers. The "Veles Series" is partly metamorphosed in the greenschist facies.

In the Yugoslav Carpatho-Balkanian belt the Paleozoic sediments appear in three main belts (Ramovac, Kučaj and Stara planina) separated by a large dislocation due to post-Alpine faulting, bearing no relation to the paleogeographic pattern of the Paleozoic.

Cambrian metasediments were discovered in the eastern part of the country where the metamorphic schists include small lenticular limestone bodies with rare archaeocyatha (= Lower Cambrian). It is supposed that a succession of the spilite-keratophyre association of rocks underlying the Ordovician sediments in the middle part (Kučaj) are of the same age.

The Lower (or Upper) Ordovician rests unconformably on the spilite-keratophyre formation and consists of conglomerates and sandstone. They are graded in turn into the green and reddish siltstone and quartz sandstone yielding an interesting mixture of brachiopods and lamellibranchiates of the Tremadocian Arenigian fauna. Later on the Ordovician basin shows subsidence and the deposition of a thick succession of dark-grey siltstones. Rare trilobite remains have been found in its upper part. Sandstones and siltstones were deposited in the shallower part of the basin. Very rich fauna of brachiopods and paleocrinoids make lumachelle in their upper part of Caradocian or Ashgillian age.

The Silurian is represented by black graptolite shales which are the most widespread, and limestones giving specific orthoceratid and Cardiola faunas in its uppermost part. The scattered disappearance of shelly fauna is very important for wider correlation, both

stratigraphically and ecologically.

Recent research on the Devonian sediments in this region has showed that it was a subsiding area in which a thick terrigenous succession was deposited; except the previously discovered numerous remains of continental flora, marine fossils are present in nearly every sequence. This offers us new possibilities for biostratigraphical zonation as well as paleogeographical examination. Vertical and horizontal changes with corresponding faunal changes make the Devonian sediments more attractive than before. The lowermost part includes the graptolite shale (Uniformis-Hercynicus zones), while the rest of the succession shows a terrigenous or calcareous-terrigenous and calcareous character. Although they are widespread in all of the above-mentioned belts, they are not sufficiently well-known.

The Carboniferous sediments also have a different development in the Carpatho-Balkan belt. In some parts the Upper Devonian grades into marine Lowermost Carboniferous. The marine conditions were broken shortly after by Variscan movements (Sudetic phase?) and the rest of the Carboniferous is represented by continental coal-bearing molassoids (Westphalian B and C and Stephanian). Further on it grades into the Permian "Red Sandstone Formation". There is a break between the Westphalian and the Stephanian.

The Permian terrigenous sediments were held as Verrucano equivalents, but they resemble climatogeneous molassoids which rest on the uppermost part of the Carboniferous or on the older formation (in this case unconformably). It is possible to distinguish this "formation" from the Triassic varicoloured terrigenous sediments by usually visible breaks in the sedimentation and clearly by detailed laboratory investigation of their sediments. Only the rest of the Permian flora, bioturbation channels, and rain-drop prints may be found in them.

In the Serbo-Macedonian massif the Proterozoic is exposed over an extensive area and the Paleozoic in the western margin. The central mass consists of psammitic-pelitic sediments of great thickness, metamorphosed under low- to high-grade amphibolite facies conditions. They include particularly in their middle parts metamafics and their metatuffs, marble, and occasionally quartzite. Two phases of regional and two phases of metasomatic to mobilized pre-Mesozoic metamorphism are found. During the Ordovician granite intruded and migmatite formed in the Leskovac area.

In the western margin of the Serbo-Macedonian massif there is a series of fine clastic sediments with interlayered basaltic lavas and

local bituminous sedimentary bodies metamorphosed under amphibolite facies conditions.

In the east, the Serbo-Macedonian massif consists of a greenschist-facies metamorphic series, abundant metavolcanics, occasional acid metavolcanics and quartzite. Magmatic activity is intensive, basaltic, with a rich terrigenous component.

Further information on the Paleozoic in the regions reached by geotraverses C and D may be found in Newsletter 2, (1980, 53-58, 59-63).

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