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Correlation of Prevariscan and Variscan events of the Alpine-Mediterranean mountain belt

NEWSLETTER

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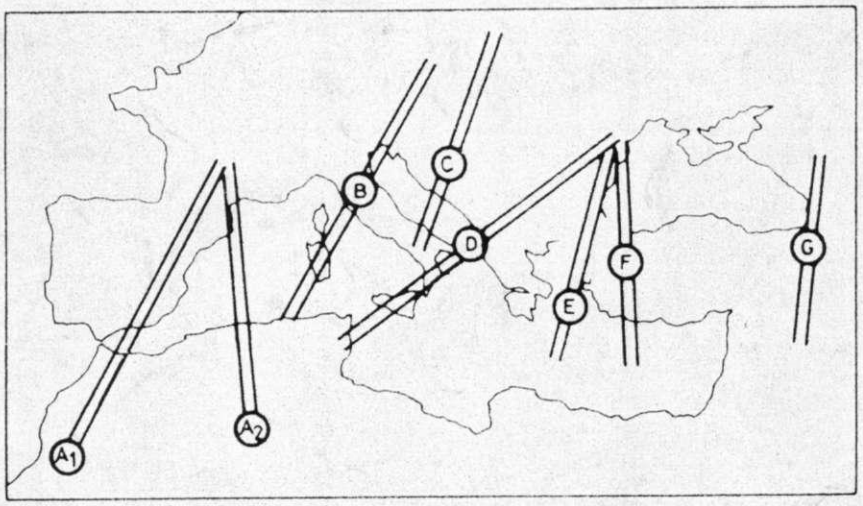

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STRATIGRAPHIC CORRELATION FORMS (SCF) OF THE YUGOSLAV PALAEOZOIC

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INTRODUCTION

In the present paper Stratigraphic Correlation Forms (SCF) are given for nearly all the fossiliferous Paleozoic areas in Yugoslavia. This paper has been prepared within IGCP Project No. 5 on the basis of present knowledge and corresponding to the references given by FENNINGER & OBRADOVIC (1980; IGCP No. 5 Newsletter 2).

The following areas have been correlated:

1 - Southern Karavanke Mountains
2 - Pohorje and Kozjak Mountains
3 - Northern Julian Alps
4 - Central Slovenia
5 - Gorski kotar
6 - Mt. Samoborska gora
7 - Mt. Medvednica
8 - Banija
9 - Mt. Velebit and Lika
10 - Slavonian Mountains
11 - Paleozoic of NW Bosnia (Sana-Una Paleozoic)
12 - Paleozoic of Central Bosnia
13 - Paleozoic of SE Bosnia
14 - Montenegro
15 - Drina-Golija region

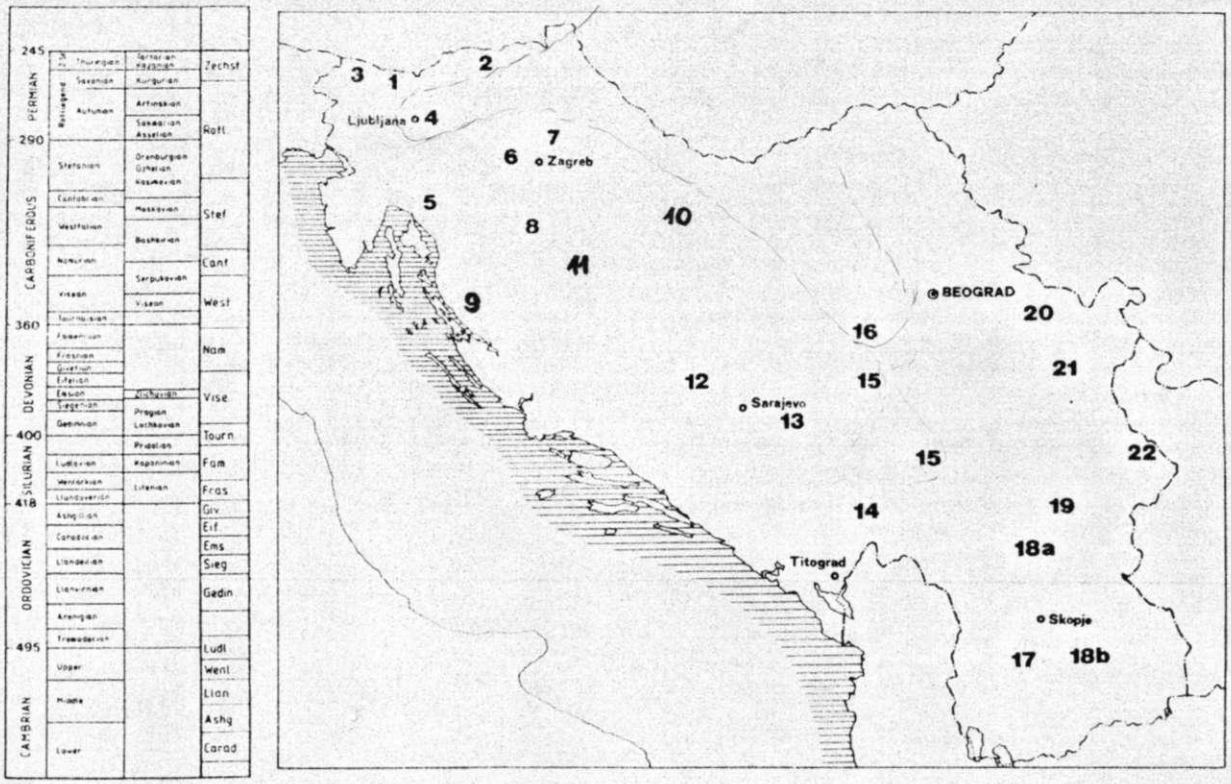

Fig. 1: Position of Stratigraphic Correlation Forms of Yugoslav Paleozoic.

16- Jadar region
17 - Western Macedonian zone
18 - Vardar zone (Veles series)
19 - Serbo-Macedonian Massif (central part)
20 - Ramovac Unit
21 - Kučaj Unit
22 - Stara planina Unit

Isolated findings of Paleozoic rocks have not been taken into consideration. The position of the correlated areas is shown in Fig. 1.

REMARKS ON THE SC FORMS

Form 1: Southern Karavanke Mountains

The SCF of the Northern Karavanke Mountains has already been presented by EBNER et al. (1981, pp. 58-59, Table 3).

Razborje Formation: It is not clear whether the "Kristalline Hüllschiefer des Tonalit", the "Grünschiefer mit Diabas und Diabastuff" (TELLER, 1896) (= Ebriacher Grünschiefer after KAHLER, 1953), and the Magdalensbergserie (KAHLER, 1953) represent one and the same facies realm. In the Yugoslav part of the Northern Karavanke Mountains, limestone intercalations with fossil remnants are unknown in the Razborje Formation. Upper Ordovician and Silurian age are not precisely documented.

The Lower and Upper Devonian age of limestones interpreted as a basinal environment has been proven by conodonts (Kokra Beds). Upper Emsian and Middle Devonian platform carbonates represent the coral, stromatoporid, echinoderm and brachiopod facies.

The nature of the Lower Carboniferous Jezersko Formation is under discussion. RAMOVŠ (1976) assigned shales, subgraywackes, pebbly mudstones and sandstones, mudflows (mostly lyddite), olistostromes, porphyroids and autochthonous limestones with conodonts to flysch and flysch-like sediments. Limestones are mainly treated as allodapic beds. Olistoliths belong to the Lower, Middle and Upper Devonian and Lowermost Carboniferous. The Pericyclus and Goniatites stage of autochthonous limestones has been proven by conodonts. BUSER (1976) considers that these sediments do not represent a flysch, but developed in the outer part of the geosyncline.

Middle Carboniferous sediments are unknown; the results of the Variscan orogeny were folded Proto-Karavanke (RAMOVŠ, 1976).

The Upper Carboniferous is characterized partly by shallow marine, partly by land sedimentation; it is very rich in fusilinids, calcareous algae, brachipods, bryozoans, molluscs and continental plants. These Auernig-type sediments (molasses facies) could not be subdivided into five parts (cf. EBNER et al., 1981) as in the Carnian Alps.

The lowermost Lower Permian Rattendorf beds are represented only by the Grenzlandbänke and Upper Pseudoschwagerina beds. Platform Trogkofel limestone and its clastic equivalent (clastic Trogkofel formation) characterize the upper Lower Permian. Among the most interesting results in the search for the Permian in the Karavanke Mountains was the significant discovery of an Early Permian (Misselina zone) conodont association with Neogondolella slovenica as a platform element.

Reddish shales, sandstones and quartz conglomerates of Middle Permian Age (Gröden Formation) interpreted as fresh-water environment are concordantly overlain by the Late Permian Bellerophon dolomite-limestone beds; a continous transition into the Triassic has been observed.

Form 2: Pohorje and Kozjak Mountains

The Pohorje Group is predominantly composed of biotite gneisses and mica schists; intercalations of amphibolite, eclogite, marble and quartzite are significant. The age of these metamorphic rocks is not precisely known. Augengneisses, marble and smaller amphibolite inclusions occur in the lower level. The overlying metamorphic rocks are characterized by eclogite lenses and amphibolites derived from eclogite. The uppermost part of the almandine-amphibolite sequence is completely phyllonitized(HINTERLECHNER-RAVNIK, 1977).

The greenschist level, tectonically below the Remšnik Formation but stratigraphically partly contemporaneous with it, is characterized by amphibolite varieties, biotite-epidote schist, metakeratophyre, some marble, and phyllite (HINTERLECHNER-RAVNIK, 1977).

The Remšnik Formation consists of dark slate, and red-blue and greenish slate with diabase. In the uppermost part of this formation the slightly crystallized limestone with Early Devonian conodont fauna occur (MIOČ & RAMOVŠ, 1973). The SCF of the Austrian part of Remsnik has been given by EBNER et al. (1981, p. 59, Table 5). The corresponding fossiliferous Silurian units are not found in the Remšnik Formation. The age of the middle and upper part is inferred from the concordantly overlying Lower Devonian with conodonts. The Middle and Upper Devonian and Carboniferous are unknown in this area.

The age of the Permo-Scythian red clastics is based on regional comparison. The same development is represented in the Yugoslav part of the Northern Karavanke Mountains, and the Upper Scythian has been proven there by fossils.

Form 3: Northern Julian Alps

Only Upper Carboniferous and Permian beds are known. These extend from the Southern Karavanke Mountains into the Northern Julian Alps and represent the same development in

oth regions, except for the development in he Middle Permian. Only in this part of the astern Alps is the Middle Permian Neoschwage-ina limestone known, with characteristic SE sian microfauna (Neoschwagerina, Sumatrina, erbeekina); it is represented by reef lime-tone with sponges as predominant reef-building organisms. The fore-reef breccia out-crops.

Very interesting Upper Permian limestone containing highly developed fusulinids (Boultoninae and Reichelina sp.) is known only as redeposited material in the Middle Triassic (Ladinian) conglomerate-breccia at the Vršič Pass in the middle part of the Julian Alps. In the Ladinian clastics pebbles of the Middle Permian Neoschwagerina limestone has also been found.

Form 4: Central Slovenia

The age of the lower part of the Ljubljana beds (= clastic Trogkofel development containing dark shales, sandstones, quartz conglomerates and carbonate intercalations) is discussed here. It is possible that this type of sedimentation began in the Upper Carboniferous and continued without interruption through the Lower Permian. The Ljubljana beds are interpreted as platform sediments. They are probably of the same age as the Ortnek beds and occur in the Sava folds north of the fossiliferous Ortnek beds in an E-W-trending belt about 100 km long. The fossils (Palermocrinus, fusulinids and corals) in the scarce limestone lenses indicate the Early Permian. The same age is supported by the stratigraphic position, underlying the Middle Permian Gröden strata. Large limestone blocks and pebbles are known in the quartz conglomerate east of Ljubljana. They belong to the Late Silurian (Prionopeltis cf. striatus, Orthoceras), Early Devonian with corals and stromatopods, and Middle Carboniferous with Pseudostaffella and Bradynina which indicate the Moscovian stage.

The continental Gröden (Val Gardena) strata, interpreted as land and flood plain sediments, contain uranium deposits in the lower predominantly grey part of the clastic formation (Žirovski vrh). In the mostly red upper part, however, copper deposits may be found. Both are of diagenetic origin.

The lower part of the shallow marine Upper Permian Žažar beds is characterized by a very rich Caucasian/Indo-Armenian brachiopod fauna, small Richthofenia lawrenciana bioherms and Waagenophyllum indicum biostromes. In the highest limestone beds the typical brachiopod elements of the South Tyrolian Bellerophon fauna (Comelicania) occur. A continuous transition into the Triassic has been proven.

Form 5: Gorski kotar

Shales and sandstones with limestone lenses interpreted as of basinal environment (JELASKA & PROHIĆ, 1982) range from the Kassimovian to the Upper Permian. The age of these sediments has been proven by microfossils (KOCHANSKY-DEVIDÉ, 1973; MILANOVIĆ, 1982). Triticites sandstone, Rattendorf, Trogkofel, Gröden and Sosio equivalents may be distinguished. Clastic Trogkofel beds are prolonged from the Southern Karavanke Mountains, through Gorski kotar, Mts. Velebit and Samoborska, and Banija, and eastwards to Bosnia.

Form 6: Mt. Samoborska gora

Sandstones, quartz conglomerates, shales and siltstones of the Gröden type contain iron and copper. Upper Permian microfossils have been found in dolomites and limestones (HERAK, 1956; HERAK & ŠKALEC, 1967).

Continuous transition into the Triassic is presumed.

Form 7: Mt. Medvednica

The shales, limestones and sandstones of Mt. Medvednica are interpreted as basinal sediments. The stratigraphic range from the Lower Silurian to the Upper Carboniferous has been established by graptolites (SREMAC & MIHAJLOVIĆ-PAVLOVIĆ, 1983) and conodonts. The position of the crystalline rocks (predominantly green schists) is still uncertain. MIHOLIĆ (1958) has presumed an Archaean age; MARIĆ (1959) relates them to the young Alpine metamorphism, and CRNKOVIĆ (1963) assigns them to the Lower Paleozoic.

The finding of an Upper Permian microfossil association in a boulder in the Middle Triassic clastics has not been inserted in the column.

Form 8: Banija

The Devonian and Carboniferous age of the shales has been proven by corals (KOSTIĆ-PODGORSKA, 1956), conodonts (ĐURĐANOVIC, 1968b), fusulinids and calcareous algae (MILANOVIĆ, 1982) from limestone lenses.

The Permian age of the shallow-water clastics (predominantly graywackes) has been presumed on the basis of superposition, petrographic characteristics and heavy minerals. No fossil remnants have been found. The local occurrence of gypsum in the uppermost part of the series is also typical for the end of the Permian in Yugoslavia.

Continuous transition into the Triassic has been observed.

Form 9: Mt. Velebit and Lika

The Upper Paleozoic tectonic belt of Mt. Velebit and Lika represents the best known and most completely developed Paleozoic area in Croatia, showing more or less continuous sedimentation from the Middle Carboniferous to the end of the Permian. Partial analogy with the

Carnian Alps may be observed.

Moscovian and Lower Kassimovian carbonate beds with fusulinids and calcareous algae occur sporadically (KOCHANSKY-DEVIDÉ, 1970).

The Upper Kassimovian Triticites sandstone covers a much larger area (SIMIĆ, 1935; KOCHANSKY-DEVIDÉ, 1955). Sedimentaton is presumed of basinal type.

Shales of the Auernig type contain Upper Carboniferous macrofauna (RUKAVINA, 1973; BALAŽ, 1981). Local findings of land flora indicate the vicinity of the shoreline (NĚMEJC, 1936).

Permian sedimentation begins with the Rattendorf limestones. The middle Pseudoschwagerina ("Grenzlandbänke") and upper Pseudoschwagerina beds may clearly be distinguished (KOCHANSKY-DEVIDÉ, 1959).

The molasse Košna beds represent the clastic equivalent of the Trogkofel limestone. Coarse-grained conglomerates with limestone pebbles, fine-grained quartz-conglomerates and pyritic sandstones may be distinguished (RAFFAELLI & ŠĆAVNIČAR, 1968; KOCHANSKY-DEVIDÉ, 1973; KOCHANSKY-DEVIDÉ et al., 1982). The interpretation of the paleo-environment is only tentative.

The Middle and Upper Permian dolomite-limestone series was concordantly deposited on the red Kosna sandstones. These limestones are extremely fossiliferous and occur in three narrow zones (KOCHANSKY-DEVIDÉ, 1965, 1978; HERAK & KOCHANSKY-DEVIDÉ, 1960; KOCHANSKY-DEVIDÉ & HERAK, 1960; MILANOVIĆ & KOCHANSKY-DEVIDÉ, 1968; SREMAC, 1982).

Sedimentation of the "border dolomite" proceeds from the uppermost Permian to the beginning of the Triassic (RAMOVŠ & KOCHANSKY-DEVIDÉ, 1981).

Form 10: Slavonian Mountains

The crystalline rocks of the Kutjevo (Psunj) unit are interpreted as slightly metamorphosed basinal sediments. A Precambrian age has been presumed. Acidic volcanics occur in the lower part of the series (JAMIĆIĆ, in press).

The pre-Devonian Jankovac (Papuk) unit represents the low-metamorphic series ranging from the greenschist to the amphibolite facies. The original sediments were deposited in a basinal environment. The stratigraphic position of the unit is still unknown (JAMIČIĆ, in press).

Litoral sediments of the Radlovac unit reflect the progressive uplift of this area. Carboniferous land flora has been found in the slates (BRKIĆ, JAMIĆIĆ & PANTIĆ, 1974). After the break in sedimentation caused by the Saalian uplift, Upper Permian continental molasses were deposited.

The relation between the units is unknown.

Form 11: Paleozoic of NW Bosnia (Sana-Una Paleozoic

Prevailing shales and various sandstones, vertically and horizontally alternating, contain limestone lenses and range from the Upper Devonian to the Middle Carboniferous. The very scarce Upper Devonian has been proved by conodonts, cephalopods, tentaculites and ostracods, the Lower Carboniferous by conodonts, corals and cephalopods, and the Middle Carboniferous by corals, brachipods, foraminifers, and conodonts. Lower and Middle Carboniferous limestone lenses are interpreted as shallow-water sediments.

The continental Upper Devonian containing Cyclostigma hercynum shows a continuous Devonian/Carboniferous transition with Asterocalamites, and reaches to Westphalian D.

Very characteristic in the Lower Carboniferous are the "Ichnofacies" of Kulm type containing Dictyodora liebeana, Phycosiphon, Nereites and Helminthoidea (KULENOVIĆ, 1983).

The Upper Carboniferous, Lower and Middle Permian are not proven by fossils. The reddish clastic Upper Permian/Triassic sequence is interpreted as of continental environment.

Form 12: Paleozoic of Central Bosnia

Only the Lower, Middle and Upper Devonian limestones are proven by fossils. A continuous transition from the Upper Devonian into the Lower Carboniferous has been observed. The age of the predominant clastic sediments with porphyrite is not precisely known (KULENOVIĆ, 1983).

Form 13: Paleozoic of SE Bosnia

A great similarity in lithologic development in SE Bosnia with that of the Sana-Una Paleozoic may be observed.

Silurian limestones and siliceous slates occur at Prača and Ustikolina; the Early and Late Silurian are proven by conodonts. The marine Lower and Upper Devonian contain limestone intercalations with conodonts. In the valley of Kamenička reka and in the streams Boškovića and Vobićkog potok, Early Devonian limestones bearing conodonts and clastics with Styliolina were discovered in 1983 (RAMOVŠ & KULENOVIĆ). The Middle Devonian is represented by reef development (Klek Limestone). New outcrops of coral and hydrozoan limestone have been found in Kamenička and Varoška rijeka valleys (RAMOVS & KULENOVIC).

The Early Carboniferous is characterized by Early Viséan flora. Fossiliferous sandstones with Asterocalamites scorbiculatus and Lepidodendron losseni are overlain by shales and limestone lenses which contain the well-known goniatite, brachiopod, coral and pelecypod fauna of Prača. The Lower Carboniferous "Ichnofacies" of Kulm type also occurs. The

well-known Upper Permian limestone frequently contains calcareous algae (Gymnocodium bellerophontis, Permocalculus), pelecypods and gastropods (KULENOVIĆ, 1983). The dark shale and sandstone formation near Mt. Klek is newly interpreted as the equivalent of the Lower Permian clastic Trogkofel beds, and may be compared to the corresponding level in central Slovenia and SW Croatia (RAMOVŠ). All papers on the Paleozoic of Bosnia may be found in KULENOVIĆ, 1983.

Form 14: Paleozoic of Montenegro

A review of the Paleozoic of Montenegro is in print in Geološki vjesnik, Zagreb.

Form 15: Drina-Golija Region

Psammitic-pelitic sediments in the Drina-Golija unit are deposited, in addition to local lava effusions, from the Ordovician (perhaps even the Cambrian) to the mid-Carboniferous. Small occurrences of carbonate rocks are noted at upper levels. Volcanism is generally basaltic, sometimes acidic-keratophyric. The lithological composition, rapid variation in granulation and nature of sediments, and rapid change in type of deformation suggest oscillation in the basin from the Ordovician to mid-Carboniferous, within a general subsiding tendency of the basin bottom, resulting in great thickness of the series. The sedimentation breaks in the Middle (?) Carboniferous. This core is unconformably overlain with Permian-Triassic conglomerates and sandstones.

The regional metamorphism of both units (Prača-Lim and Drina-Golija) ranges from low-temperature amphibolite facies at the deepest levels to anchimetamorphic changes at the highest levels. The metamorphism may partly be the result of subsidence and covering with younger sediments (the Paleozoic complex is about 7000 m thick), but high-temperature changes were also certainly caused by high heat flow.

Form 16: Jadar region

Psammitic-pelitic (mostly very fine-grained) sediments formed during the Devonian and part of the Carboniferous. Rare lenses of limestones with conodonts occur. During the Middle and Upper Carboniferous limestones become abundant, containing foraminifers, brachiopods and fusulinids. These rocks are anchimetamorphosed.

The Devonian-Carboniferous series is transgressively covered by Middle and Upper Permian clastics and Bellerophon limestone.

Form 17: Western Macedonian zone

Data on the Western Macedonian zone is published in PETKOVSKI & TEMKOVA, 1980-81.

Form 18: Vardar zone (Veles series) (18a)

Metamorphosed basic, basaltic rocks are abundant in the deep parts of the Veles series. They are interlayered and later covered by quartzites and metamorphosed pelitic and psammitic rocks. Only at the end of this series formation does sedimentation become quiet when carbonate sediments are deposited in large masses. In this series the Carboniferous has been identified paleontologically. All these rocks correspond to amphibolite facies metamorphism.

Data on the Vardar zone are published in PETKOVSKI & TEMKOVA, 1980-81.

Form 19: Serbo-Macedonian Massif(central part)

The oldest formations are located in the Serbo-Macedonian Massif. The Proterozoic is exposed over an extensive area and the Paleozoic occurs 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 the middle parts, metamafics and their metatuffs, marble, and occasionally quartzite.

This complex is polyphase-metamorphosed. Regional metamorphism in the amphibolite facies evolved together with folding and most probably a certain amount of mobilization of some compounds in the interval between the depositions of these sediments (Ptz_1) and Riphean-Cambrian sediments (Ptz_2). Another phase occurred after the deposition of Lower Paleozoic sediments, which are presently found as metamorphic rocks on the western margin of the Serbo-Macedonian Massif. Mobilization and metamorphosis of limited extent occurred during the Ordovician (when the Čukljenik granite was intruded and migmatites were formed in the Leskovac area) and at the time of the Bujanovac granite intrusion. All the metamorphism occurred under low to moderate pressure, corresponding to the areas of increased heat flow.

In the east, the Serbo-Macedonian Massif consists of a greenschist facies metamorphic series, abundant mafic metavolcanics (and their tuffs), occasional acidic metavolcanics and quartzite. Magmatic activity is intensive and basaltic, and the input of the terrigenous component is profuse. This, and the absence of Alpine-type peridotite or ophiolite complexes, indicate the formation of these rocks in a geosynclinal structure, on a continental, heavily faulted and subsided basement.

Form 20: Ramovac unit

The Ramovac unit is characterized in the Riphean/Cambrian by arkosic sediments in the lower parts, and graywackes and porphyritic volcanic rocks accompanied by tuff in the

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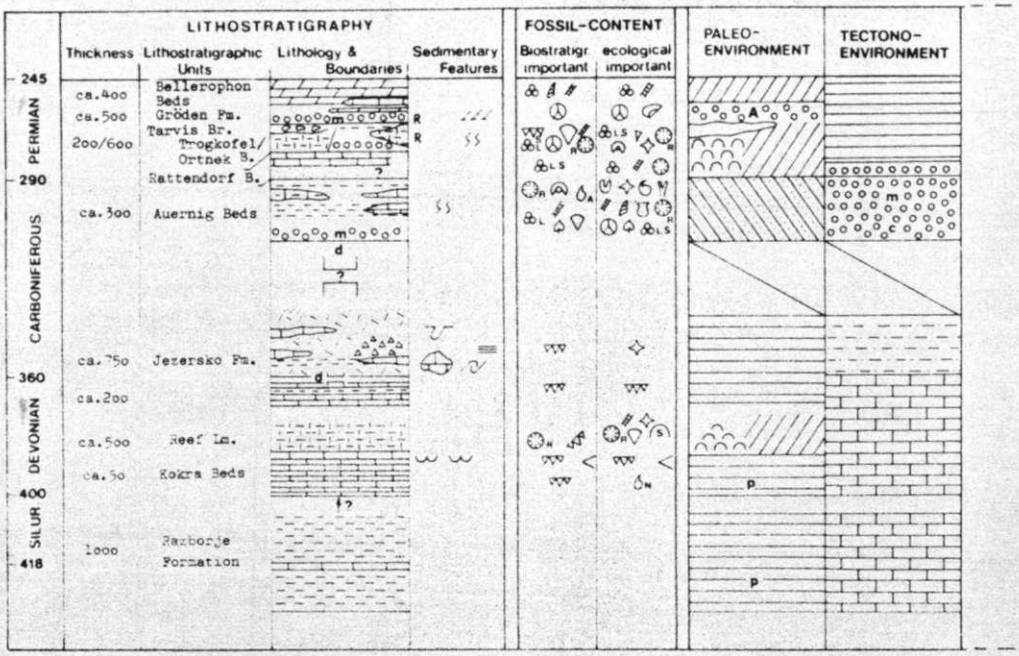
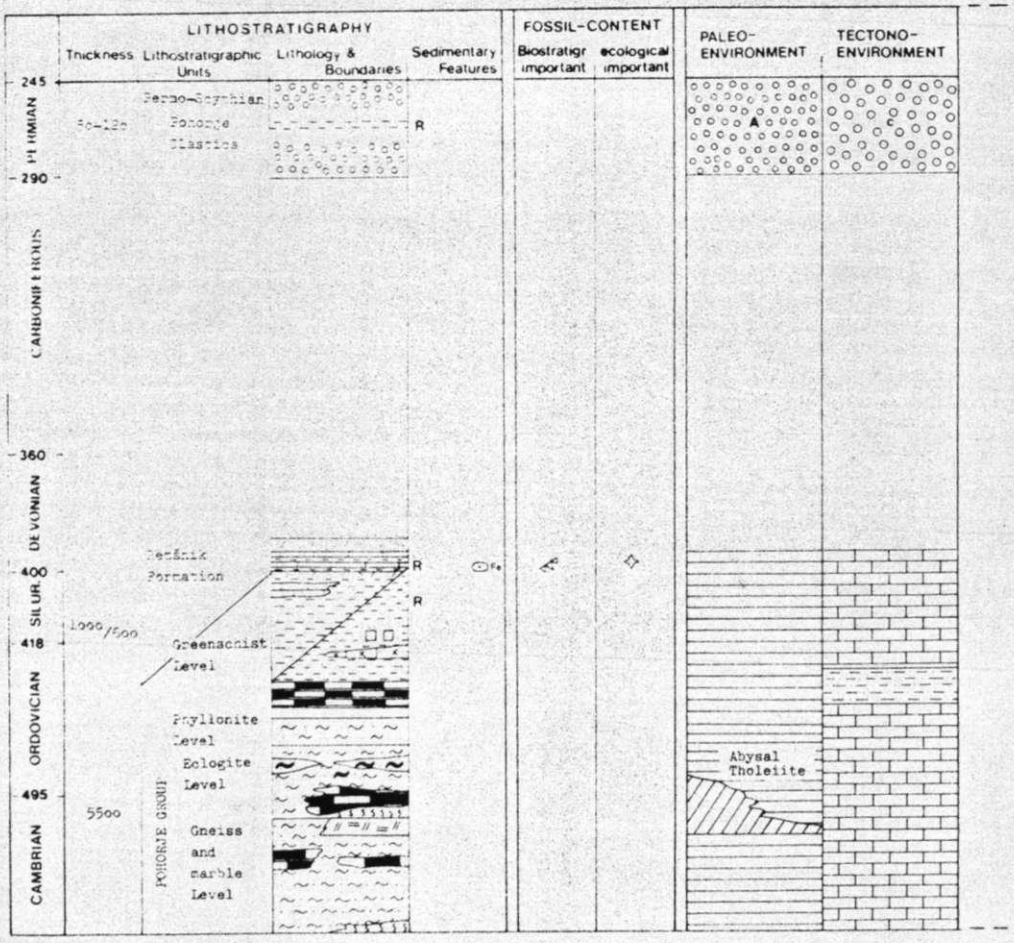
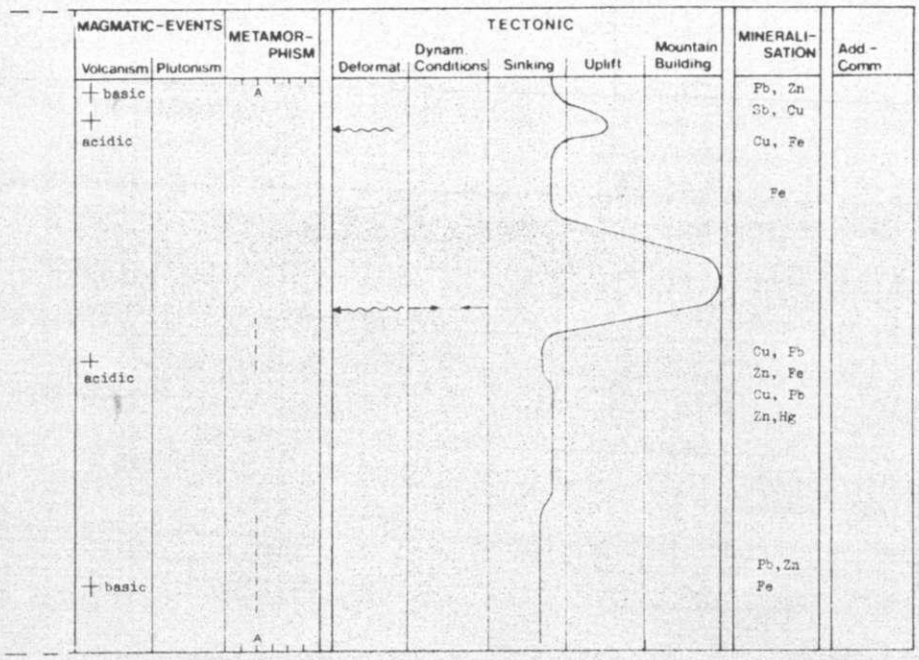


RAMOVŠ ET AL. FORM 2: POHORJE AND KOZJAK MOUNTAINS

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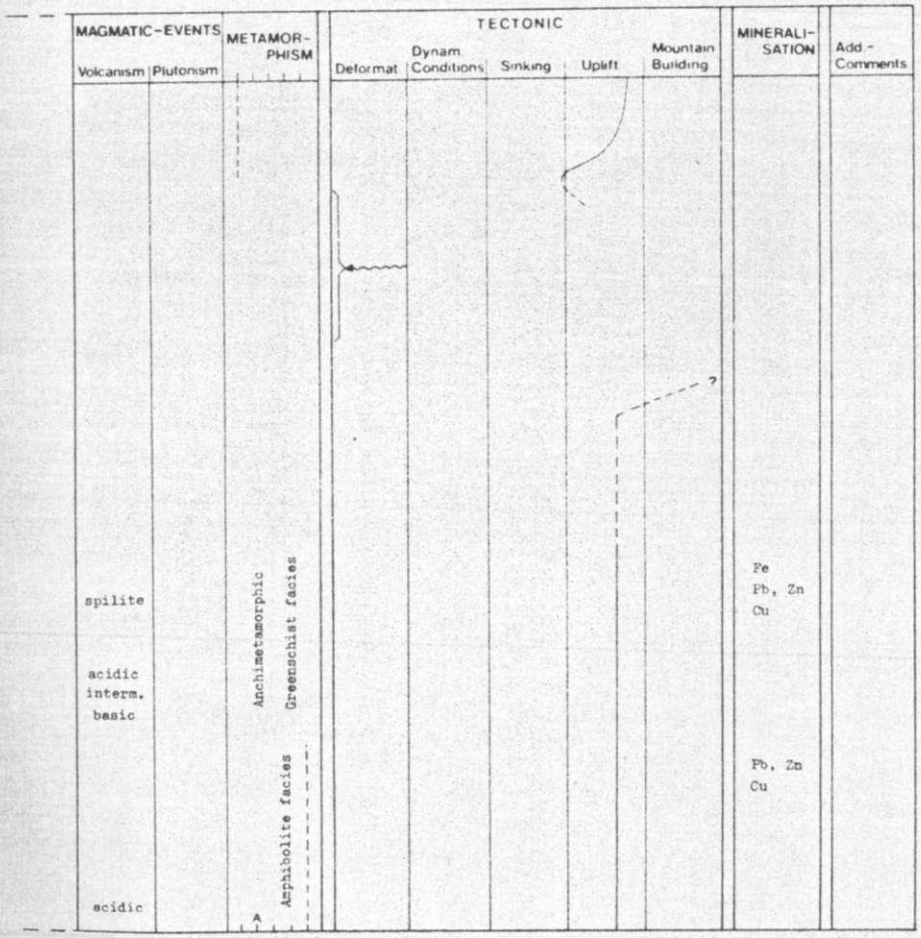
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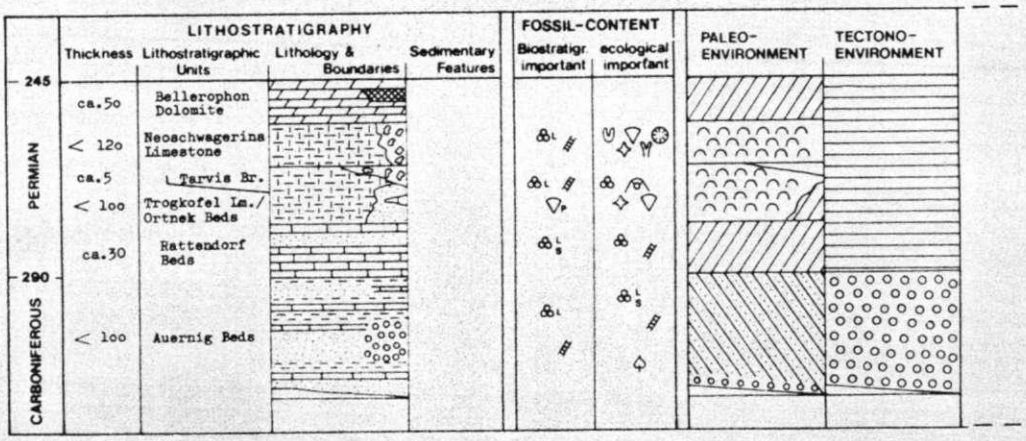
RAMOVŠ ET AL. FORM 3: NORTHERN JULIJAN ALPS



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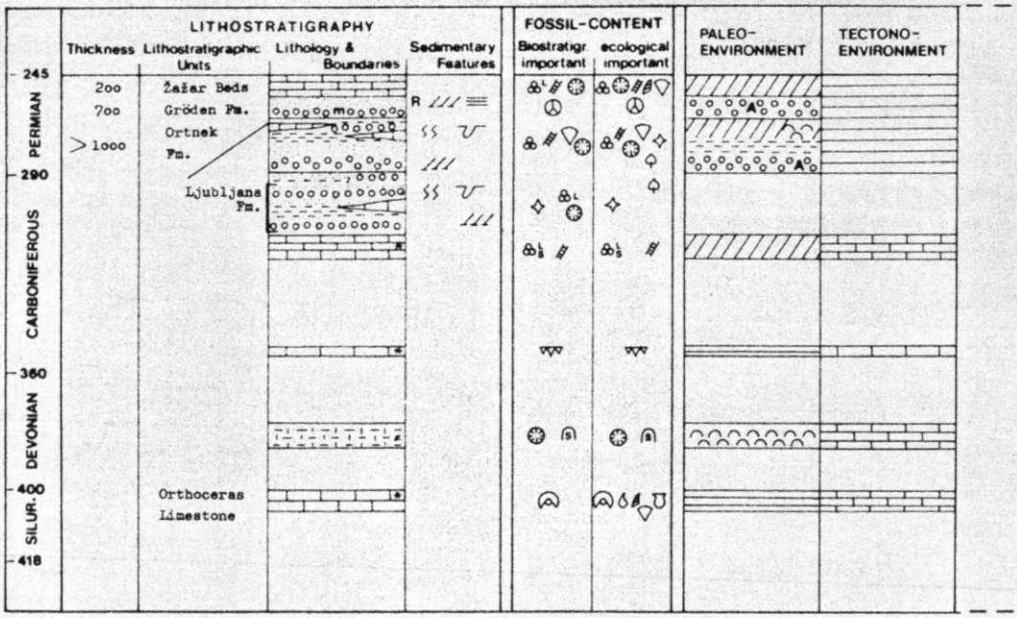

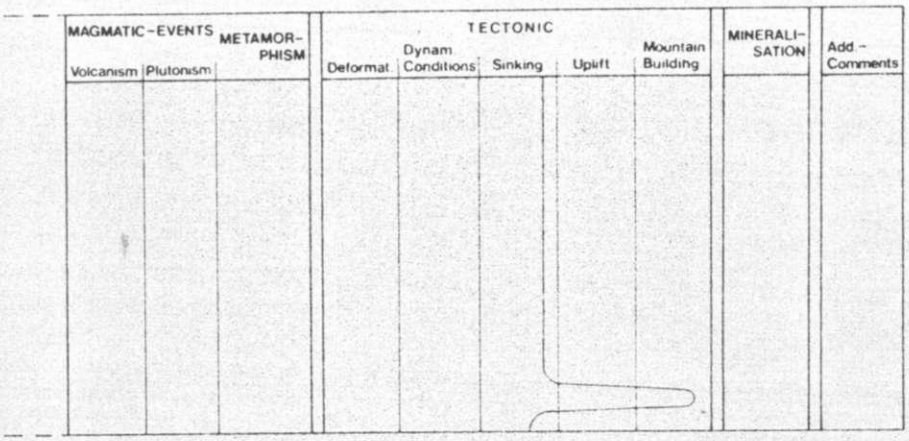
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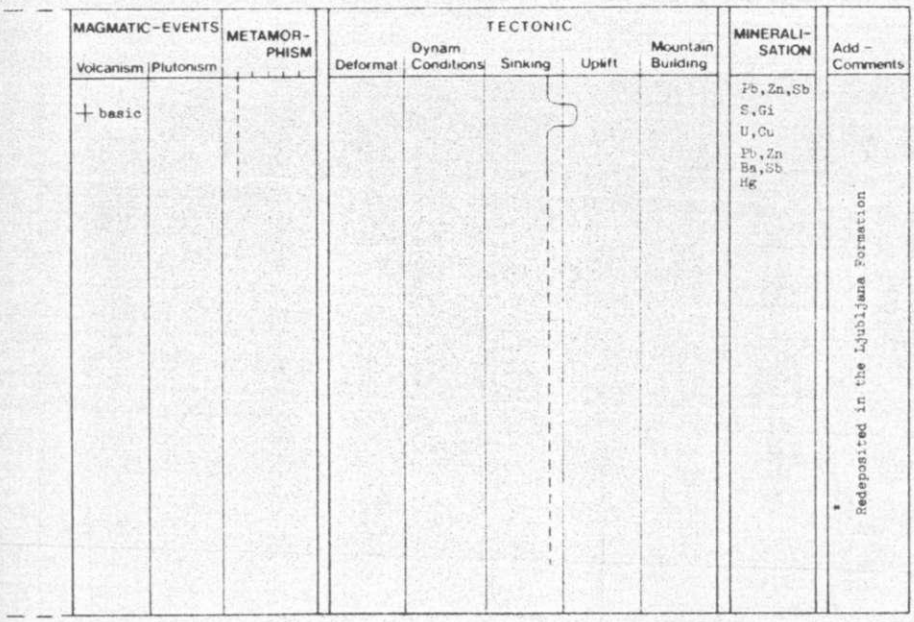
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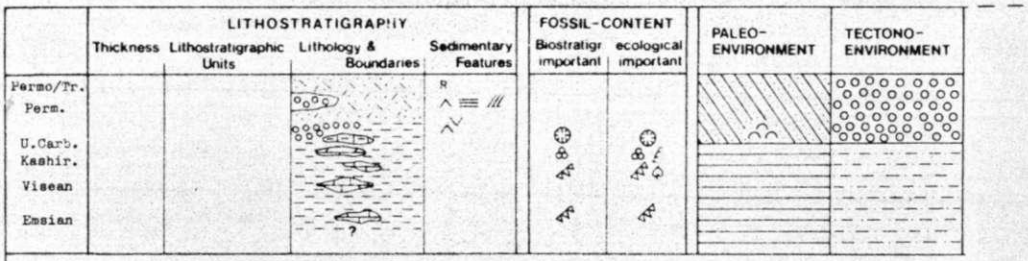
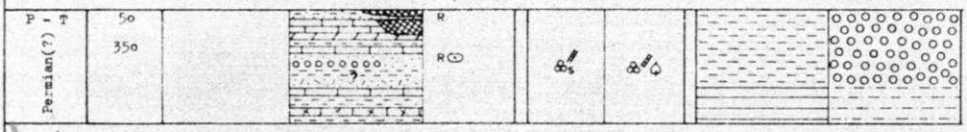


RAMOVŠ ET AL. FORM 6: SAMOBORSKA GORA MOUNTAIN



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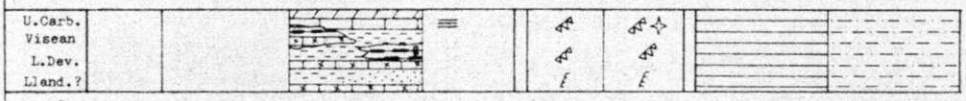
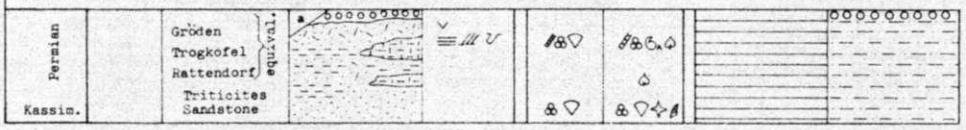
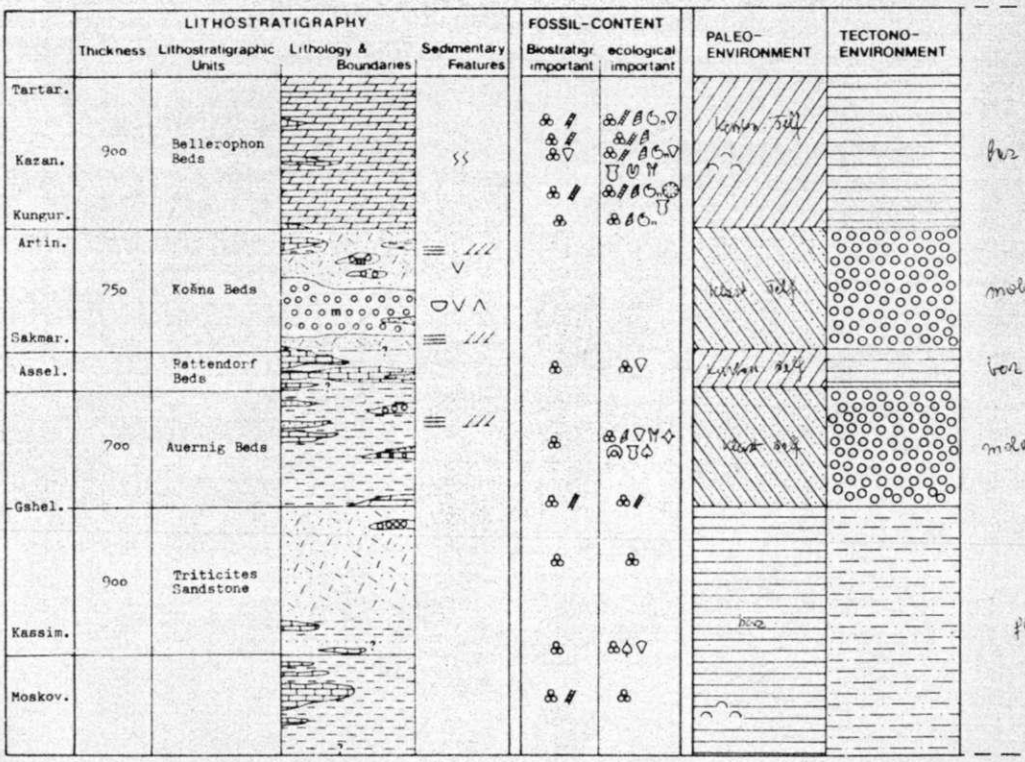
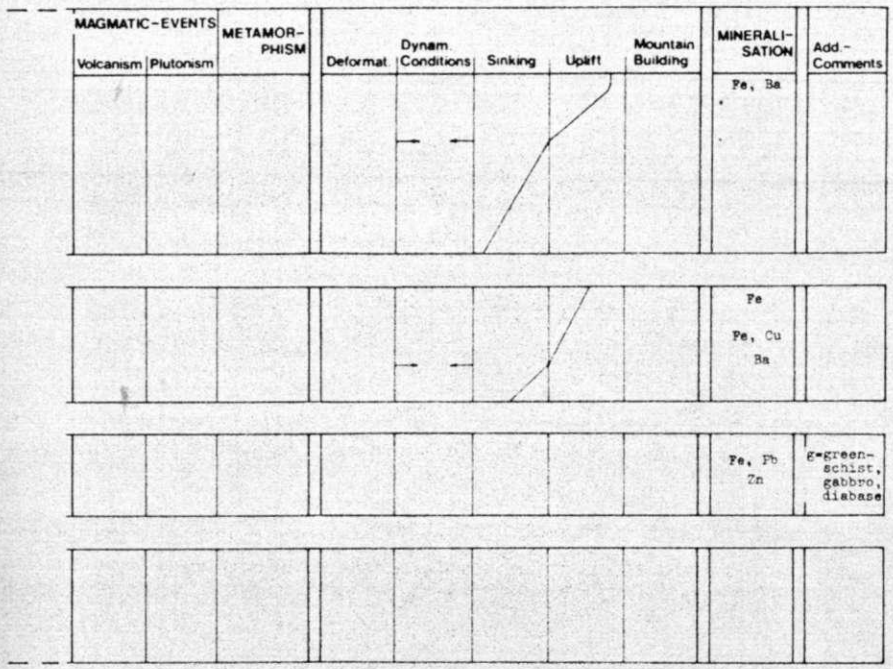


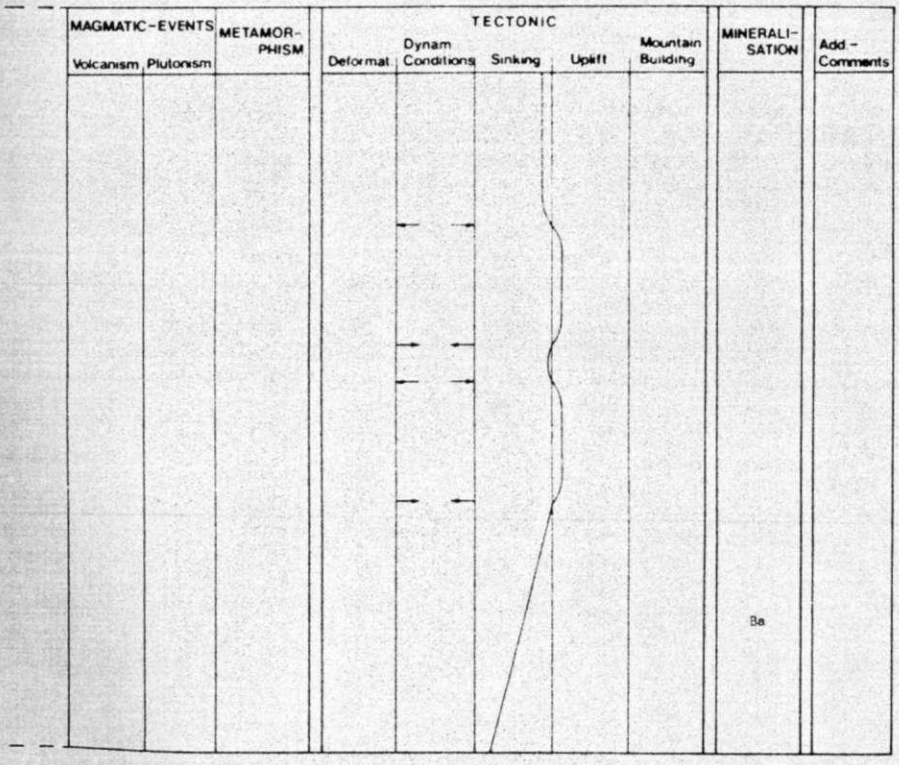
RAMOVŠ ET AL. FORM 5: GORSKI KOTAR



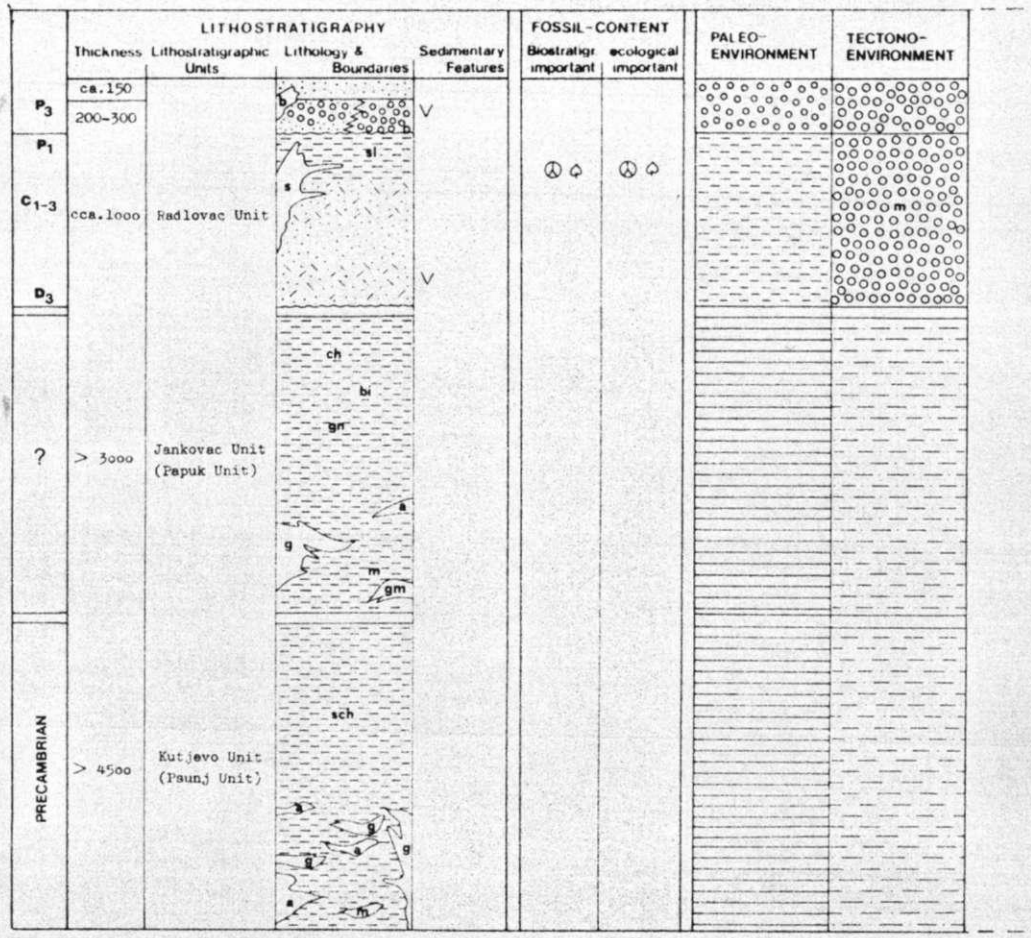
RAMOVŠ ET AL. FORM 9: VELEBIT MOUNTAIN AND LIKA



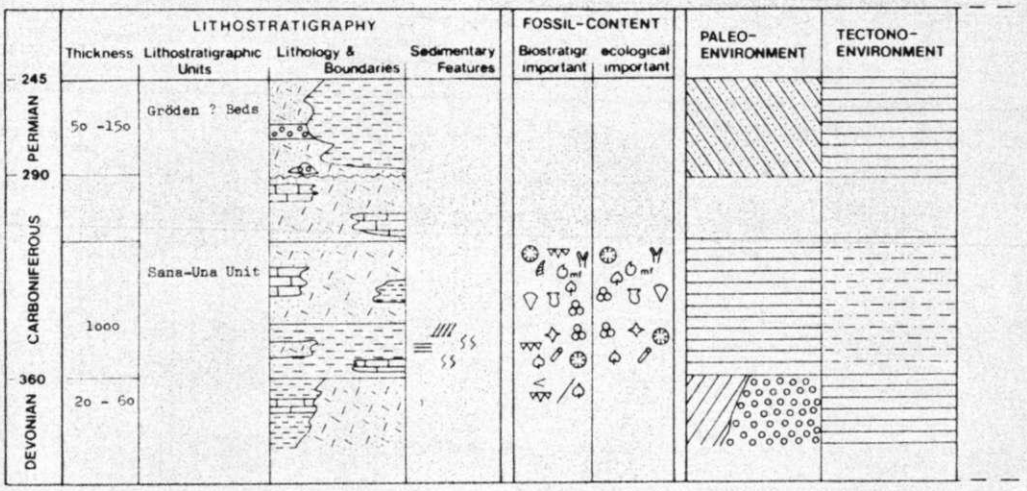

MAGMATIC-EVENTS
Volcanism
Plutonism
METAMOR-PHISM
TECTONIC
Deformat.
Dynam. Conditions
Sinking
Uplift
Mountain Building
MINERALI-SATION
Add.-Comments
Fe, Ba
Fe
Fe, Cu
Ba
Fe, Pb
Zn
g-green-schist, gabbro, diabase

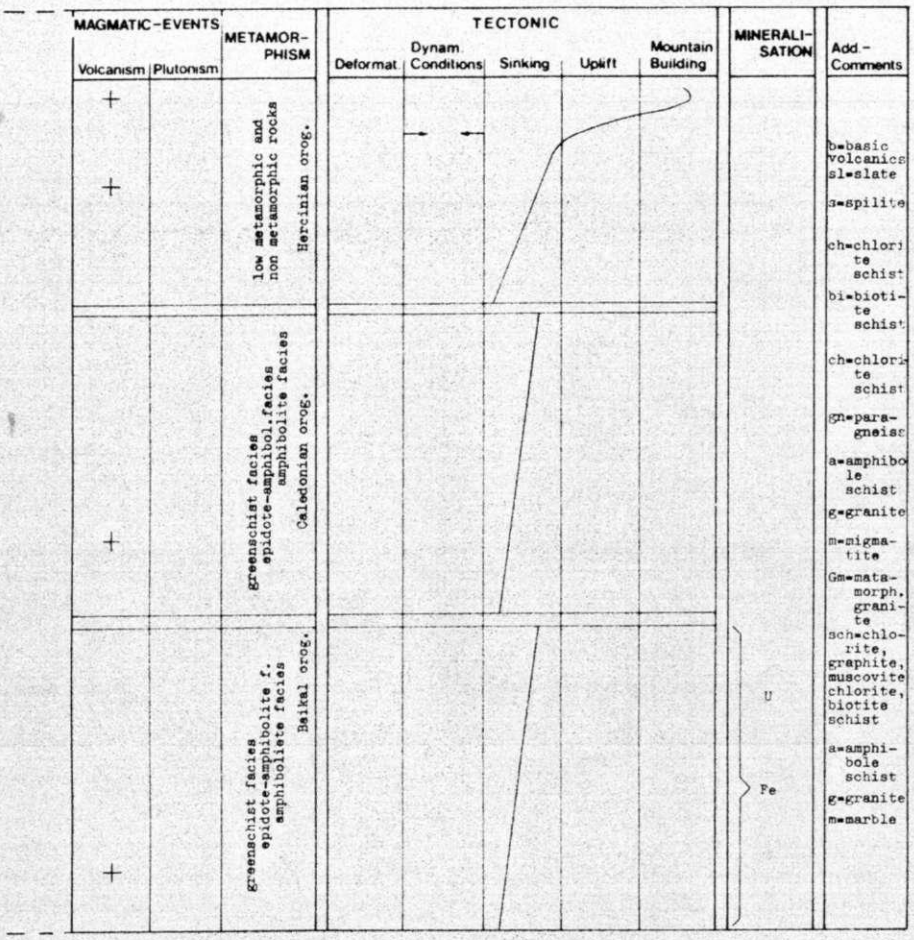

MAGMATIC-EVENTS
Volcanism
Plutonism
METAMOR-PHISM
TECTONIC
Deformat.
Dynam. Conditions
Sinking
Uplift
Mountain Building
MINERALI-SATION
Add.-Comments
Ba

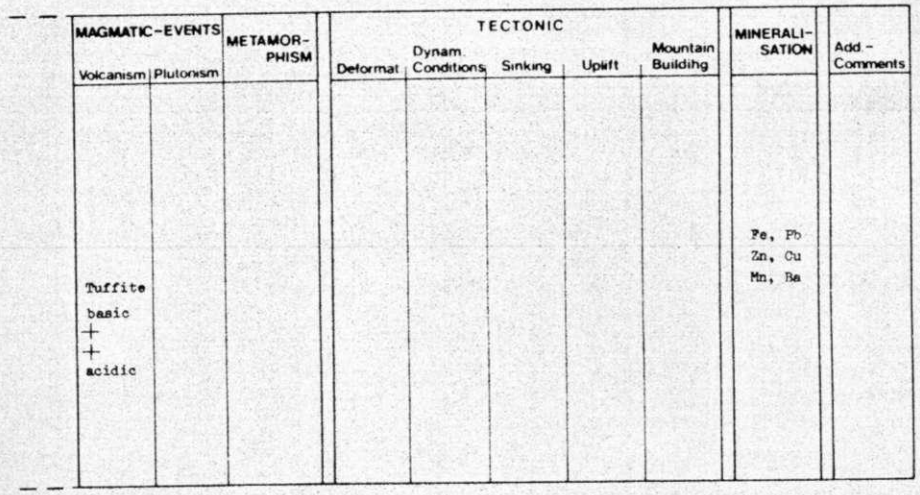
RAMOVŠ ET AL. FORM 10: SLAVONIAN MOUNTAINS



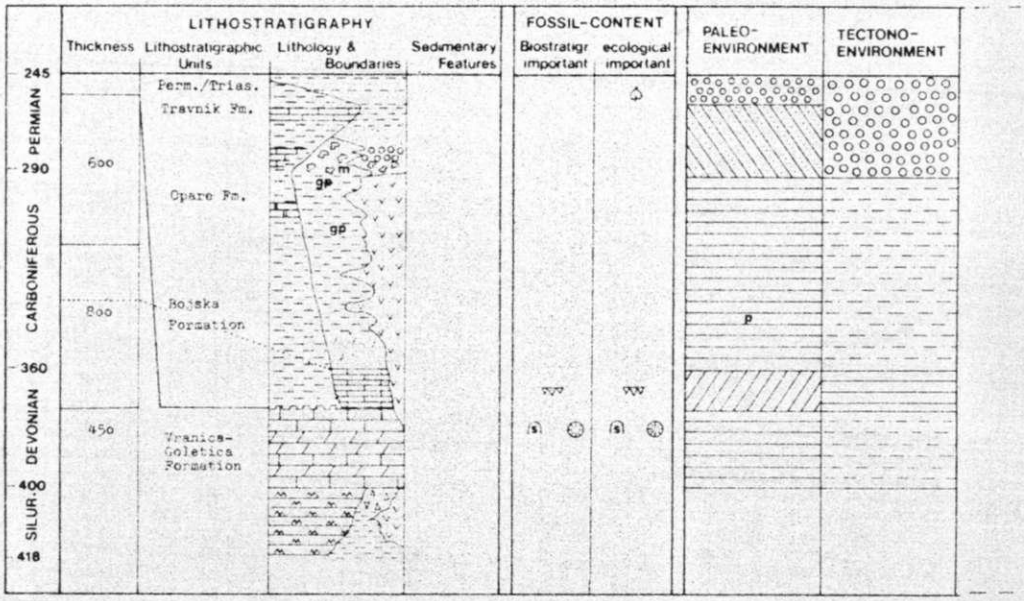
RAMOVŠ ET AL. FORM 11: PALAEOZOIC OF NORTHWESTERN BOSNIA



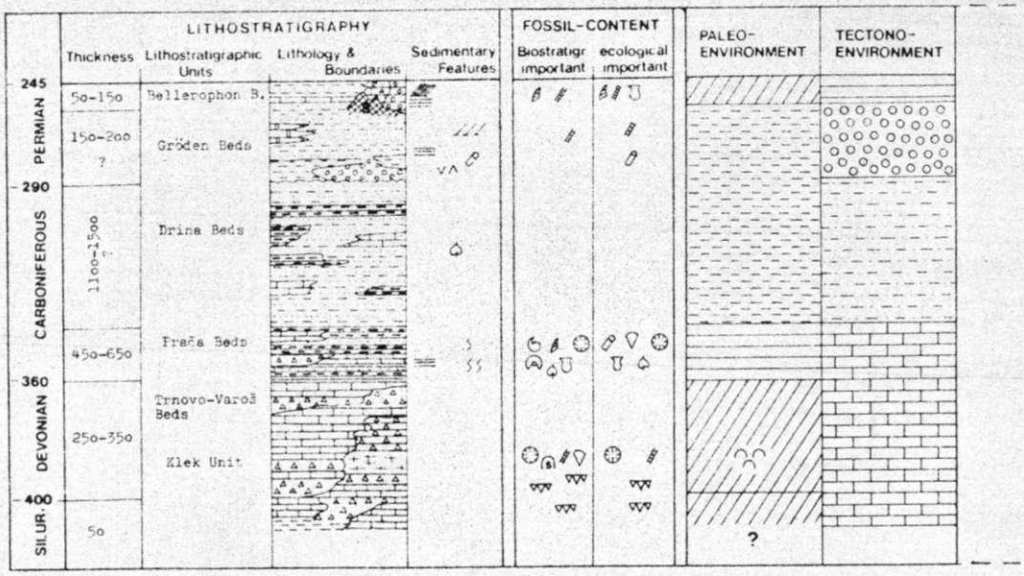

MAGMATIC-EVENTS
Volcanism
Plutonism
METAMOR-PHISM
TECTONIC
Deformat.
Dynam. Conditions
Sinking
Uplift
Mountain Building
MINERALI-SATION
Add.-Comments
low metamorphic and non metamorphic rocks
Hercinian orog.
greenschist facies
epidote-amphibol. facies
amphibolite facies
Caledonian orog.
greenschist facies
epidote-amphibolite f.
amphibolite facies
Baikal orog.
U
Fe
b=basic volcanics
sl=slate
s=spilite
ch=chlorite schist
bi=biotite schist
ch=chlorite schist
gn=paragneiss
a=amphibole schist
g=granite
m=migmatite
Gm=metamorph. granite
sch=chlorite, graphite, muscovite chlorite, biotite schist
a=amphibole schist
g=granite
m=marble

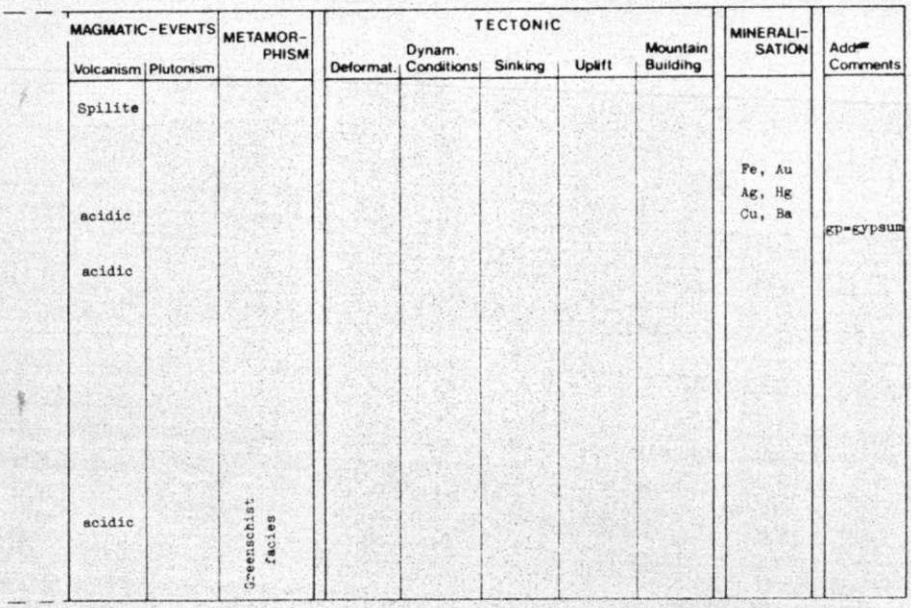

MAGMATIC-EVENTS
Volcanism
Plutonism
METAMOR-PHISM
TECTONIC
Deformat.
Dynam. Conditions
Sinking
Uplift
Mountain Building
MINERALI-SATION
Add.-Comments
Tuffite
basic
acidic
Fe, Pb
Zn, Cu
Mn, Ba

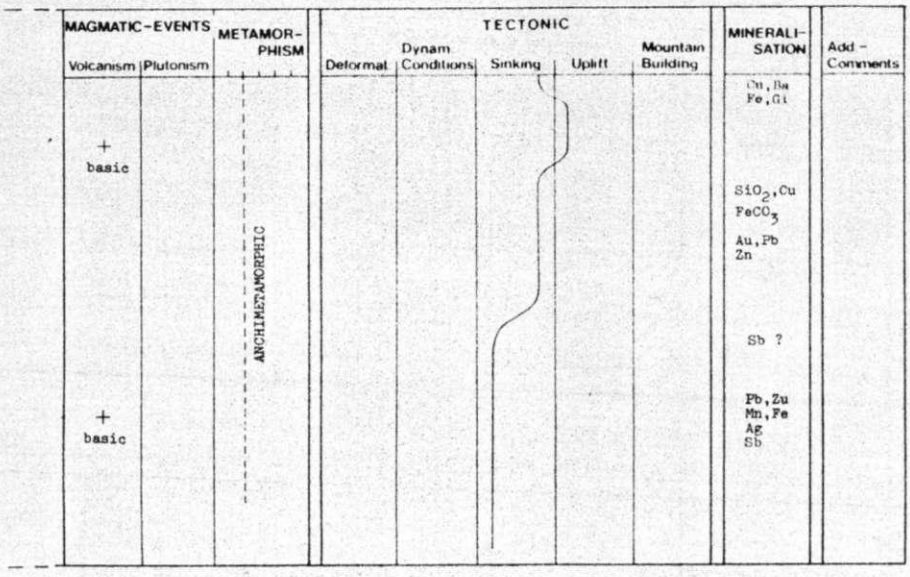
RAMOVŠ ET AL. FORM 12: PALAEOZOIC OF CENTRAL BOSNIA



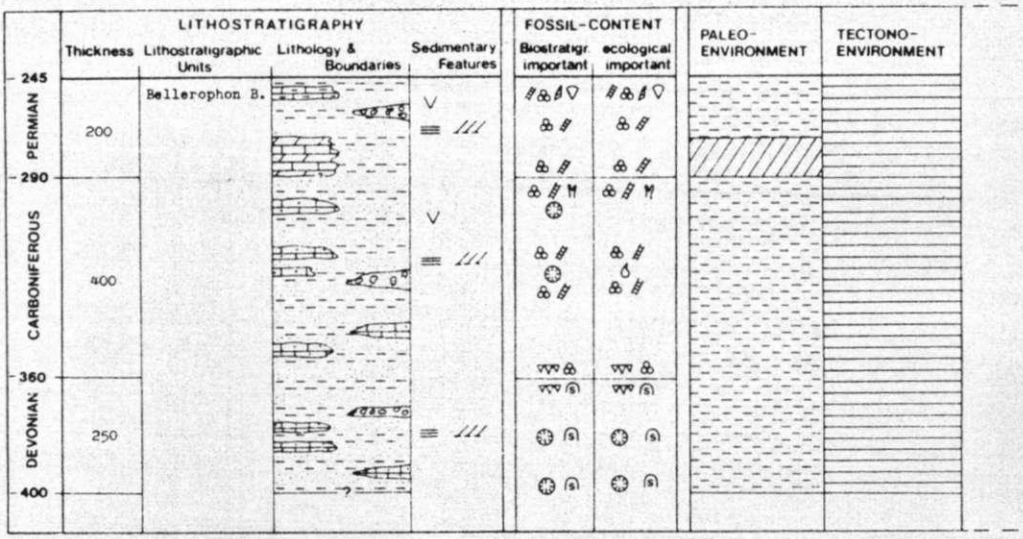
RAMOVŠ ET AL. FORM 13: PALAEOZOIC OF SOUTHEASTERN BOSNIA



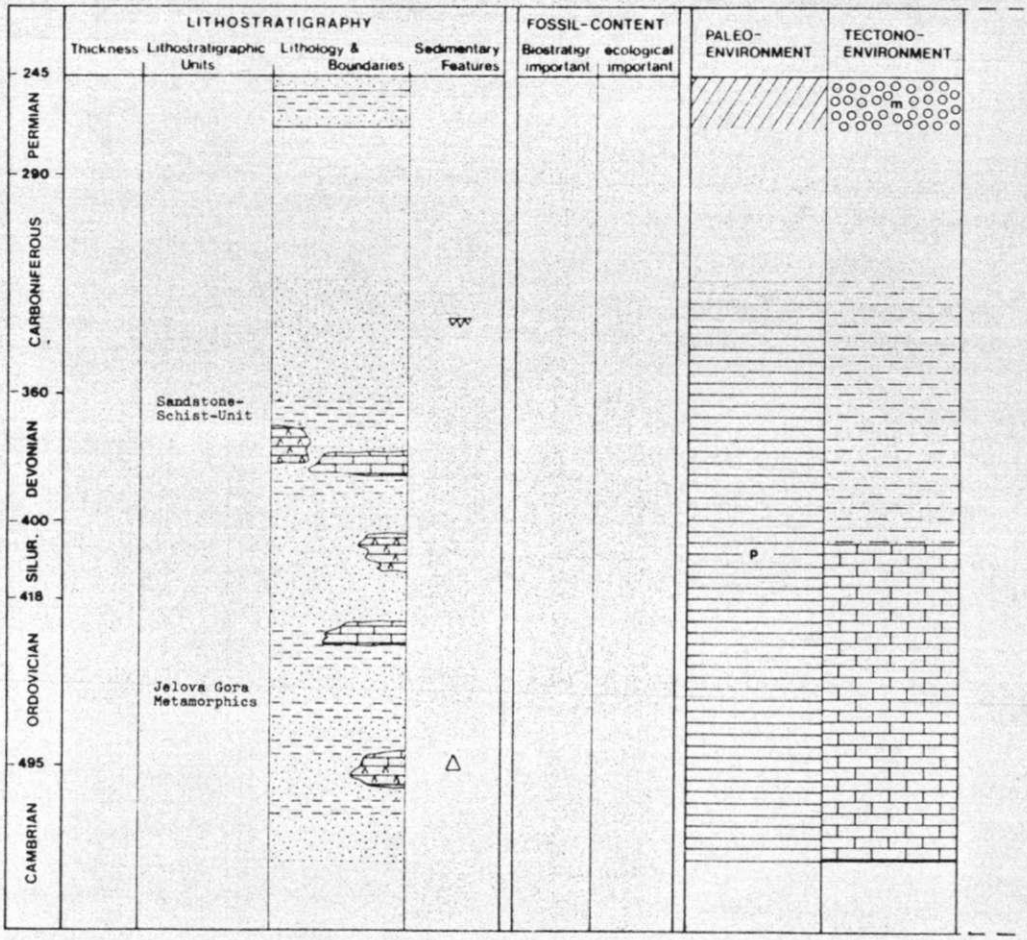

MAGMATIC-EVENTS
Volcanism
Plutonism
METAMOR-PHISM
TECTONIC
Deformat.
Dynam. Conditions
Sinking
Uplift
Mountain Building
MINERALI-SATION
Add-Comments
Spilite
acidic
acidic
acidic
Greenschist facies
Fe, Au
Ag, Hg
Cu, Ba
gp=gypsum


MAGMATIC-EVENTS
Volcanism
Plutonism
METAMOR-PHISM
TECTONIC
Deformat.
Dynam. Conditions
Sinking
Uplift
Mountain Building
MINERALI-SATION
Add.-Comments
+
basic
+
basic
ANCHIMETAMORPHIC
Cu, Ba
Fe, Gi
SiO_2, Cu
$FeCO_3$
Au, Pb
Zn
Sb ?
Pb, Zu
Mn, Fe
Ag
Sb

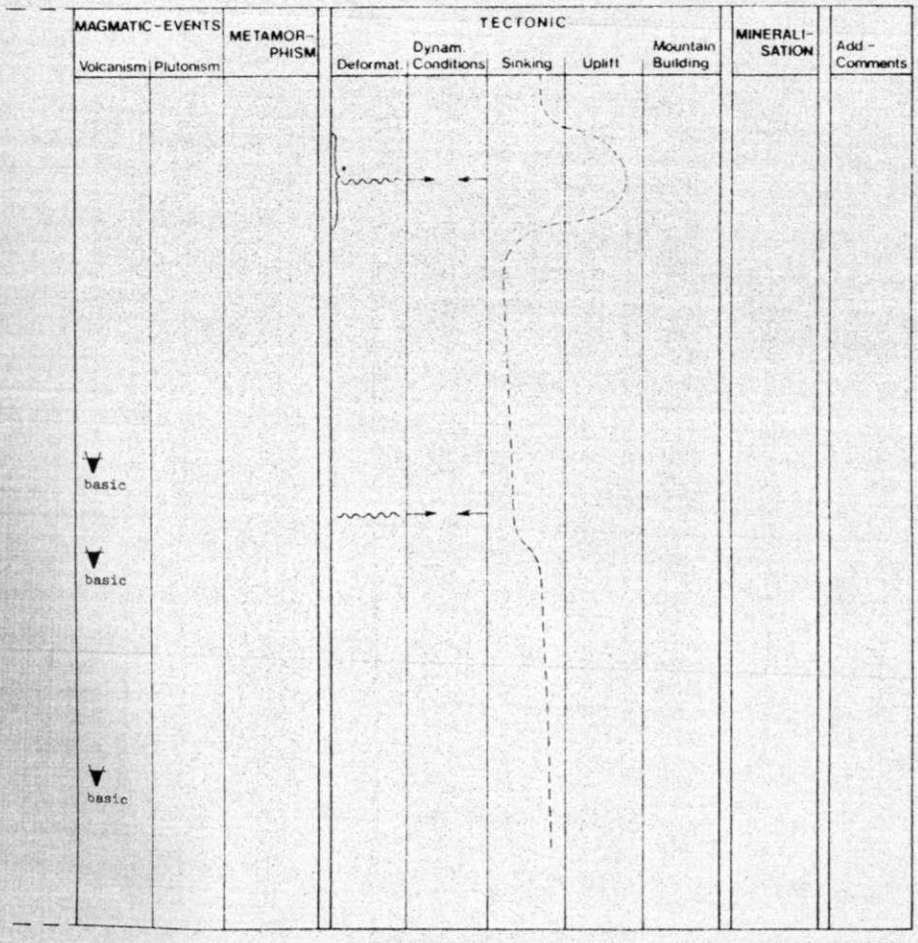
RAMOVŠ ET AL. FORM 14: MONTENEGRO



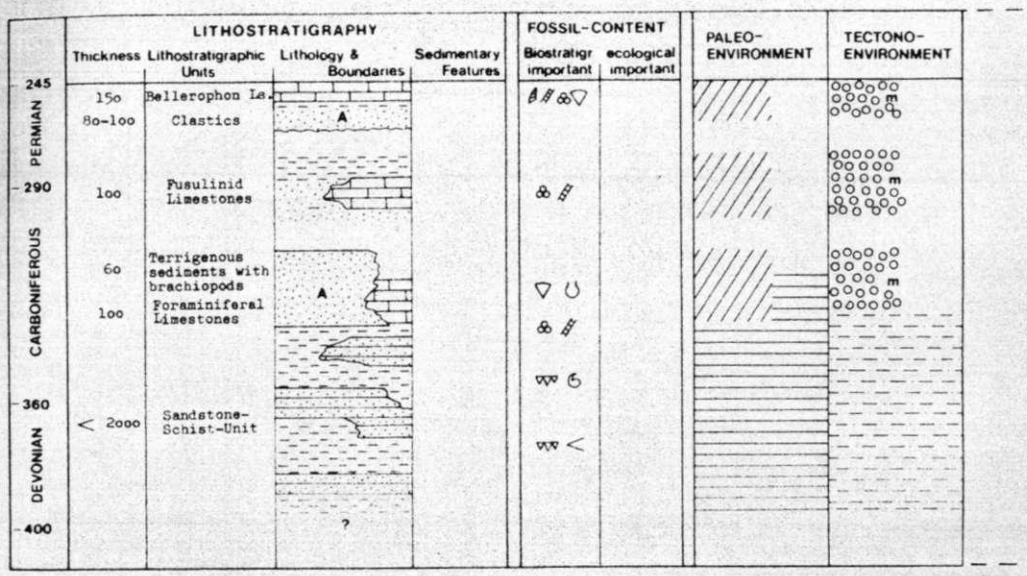
RAMOVŠ ET AL. FORM 15: DRINA-GOLIJA REGION



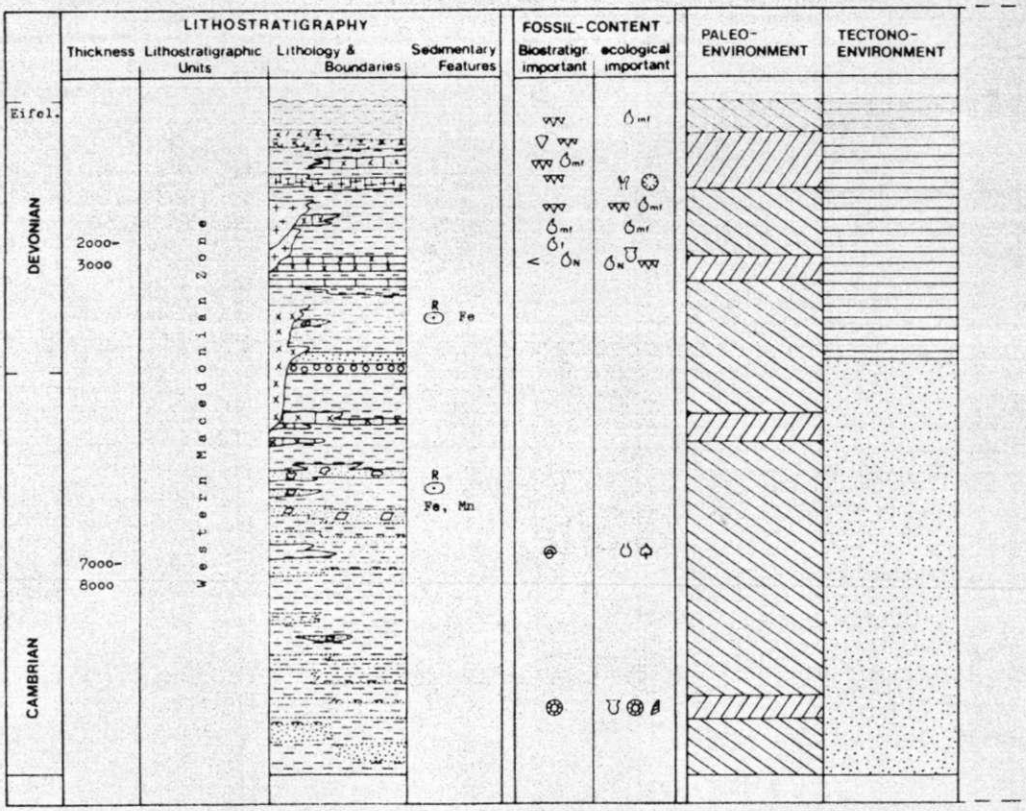
MAGMATIC-EVENTS		METAMOR-PHISM	TECTONIC					MINERALI-SATION	Add.-Comments
Volcanism	Plutonism		Deformat.	Dynam. Conditions	Sinking	Uplift	Mountain Building		
								Pb, Zn	
								Pb, Zn	

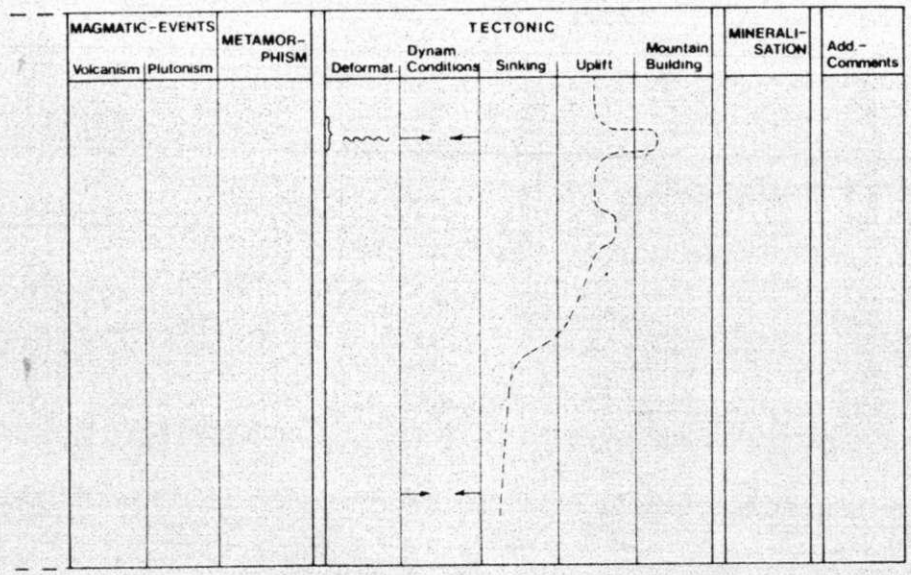


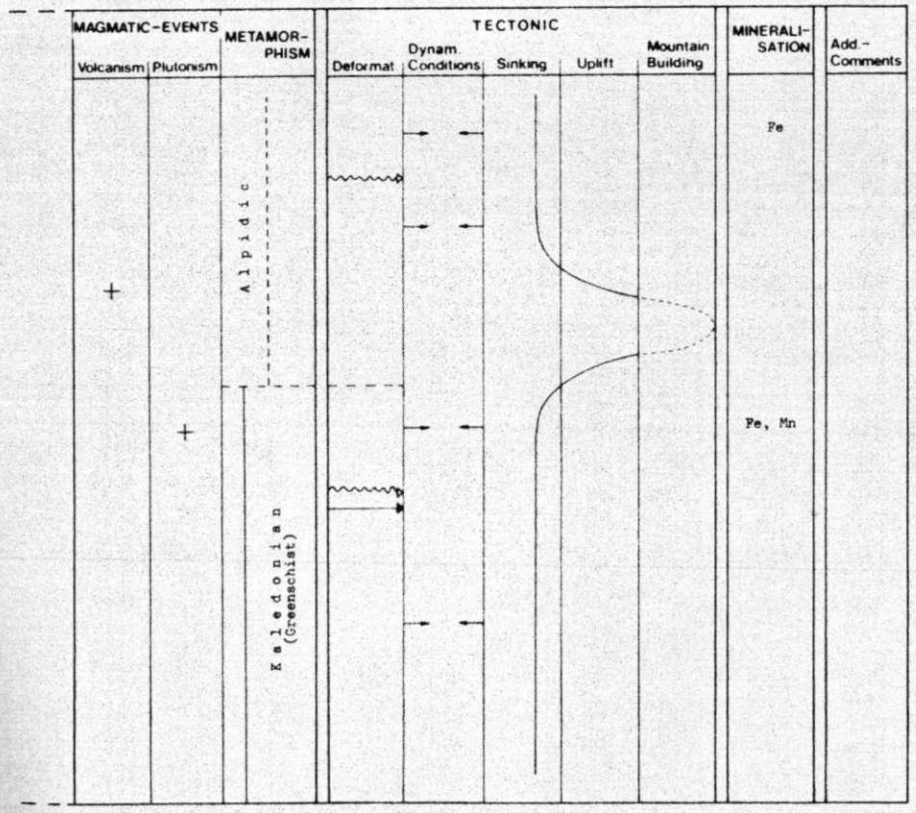
RAMOVŠ ET AL. FORM 16: JADAR REGION



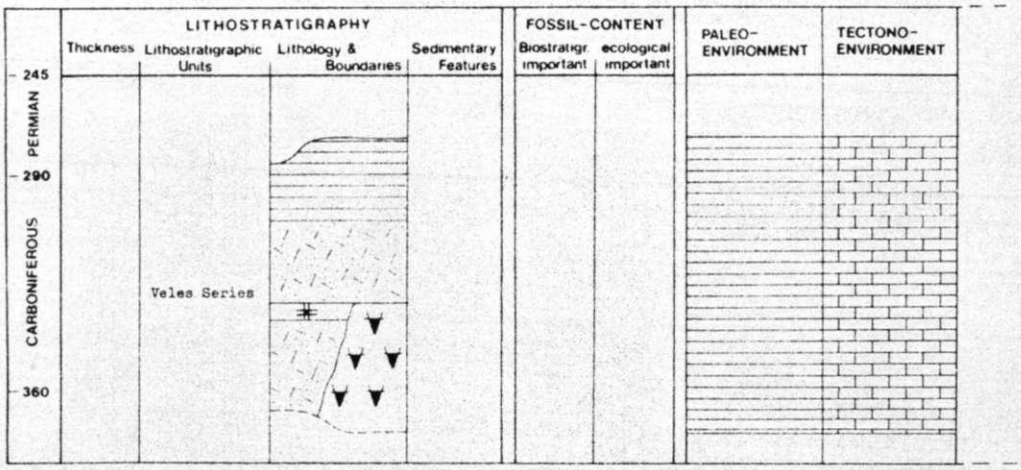
RAMOVŠ ET AL. FORM 17: WESTERN MACEDONIAN ZONE



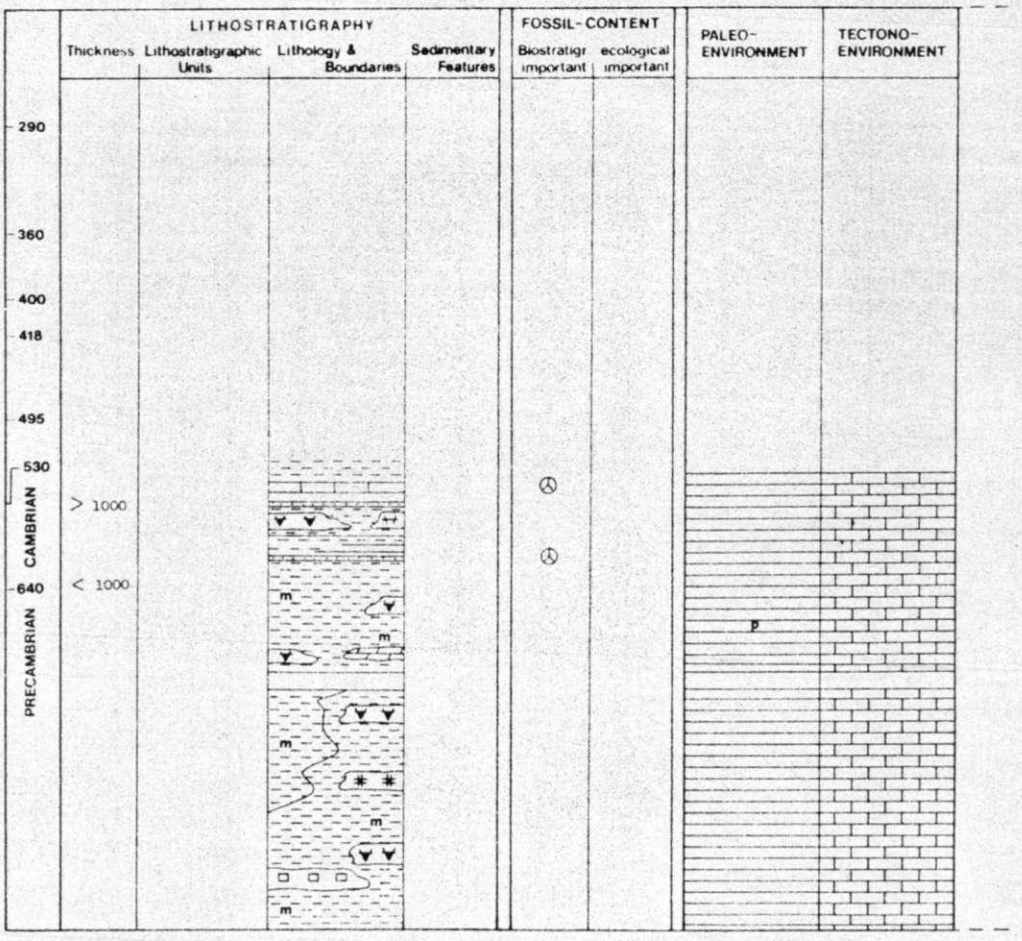

MAGMATIC-EVENTS
Volcanism
Plutonism
METAMOR-PHISM
TECTONIC
Deformat.
Dynam. Conditions
Sinking
Uplift
Mountain Building
MINERALI-SATION
Add.-Comments

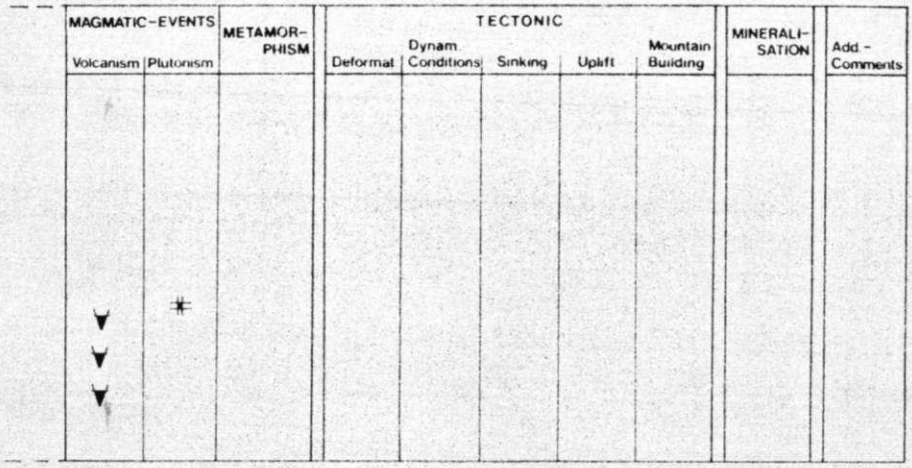

MAGMATIC-EVENTS
Volcanism
Plutonism
METAMOR-PHISM
Alpidic
Kaledonian (Greenschist)
TECTONIC
Deformat.
Dynam. Conditions
Sinking
Uplift
Mountain Building
MINERALI-SATION
Fe
Fe, Mn
Add.-Comments

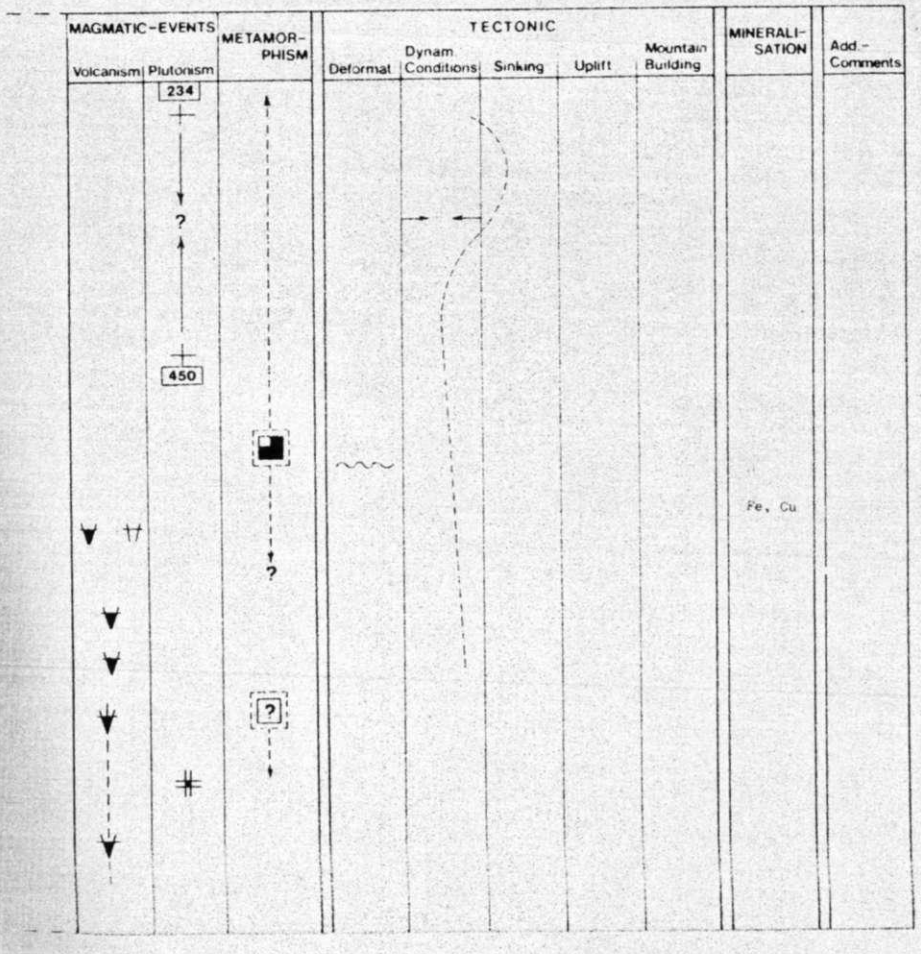
RAMOVŠ ET AL. FORM 18a: VARDAR ZONE, VELES SERIES



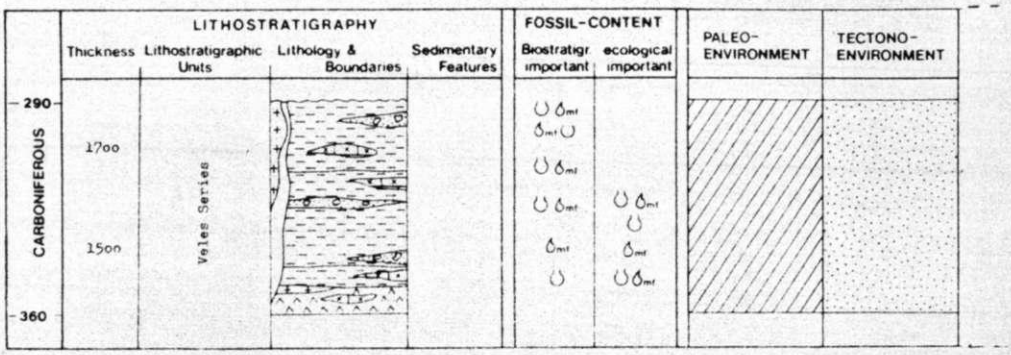
RAMOVŠ ET AL. FORM 19: SERBO-MACEDONIAN MASSIF



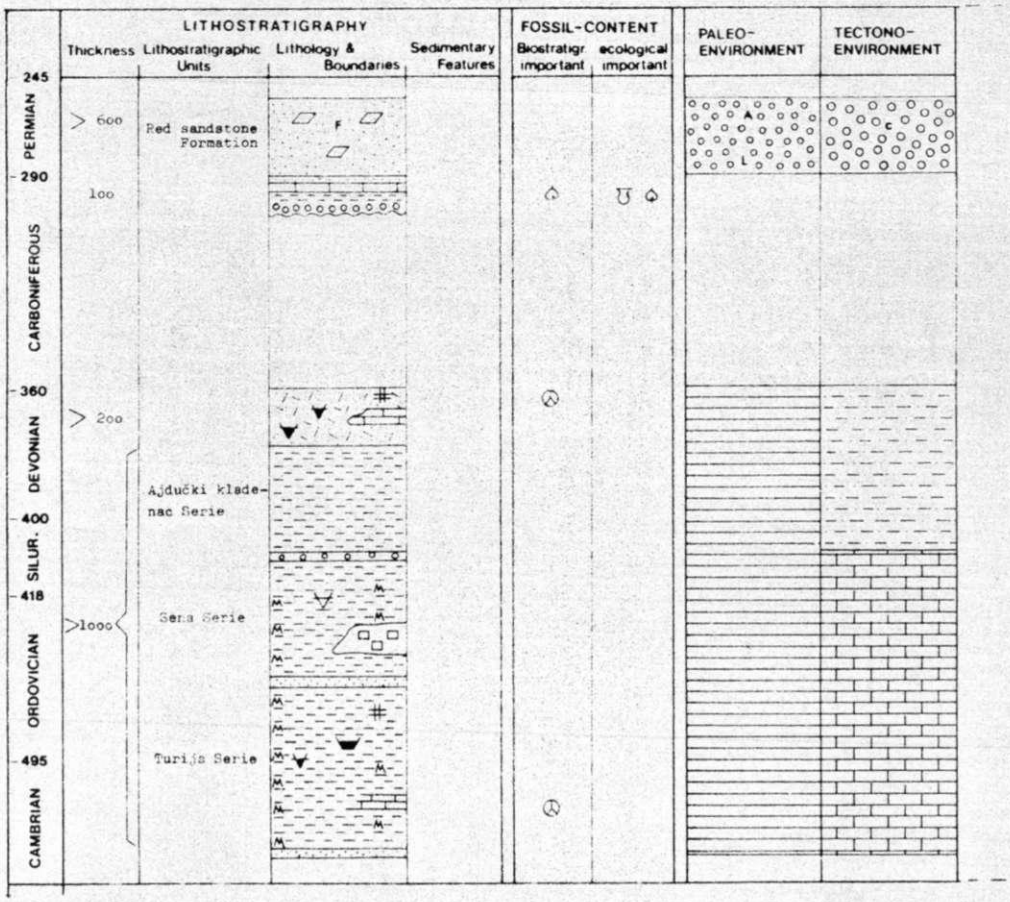

MAGMATIC-EVENTS
Volcanism
Plutonism
METAMOR-PHISM
TECTONIC
Deformat
Dynam. Conditions
Sinking
Uplift
Mountain Building
MINERALI-SATION
Add.-Comments

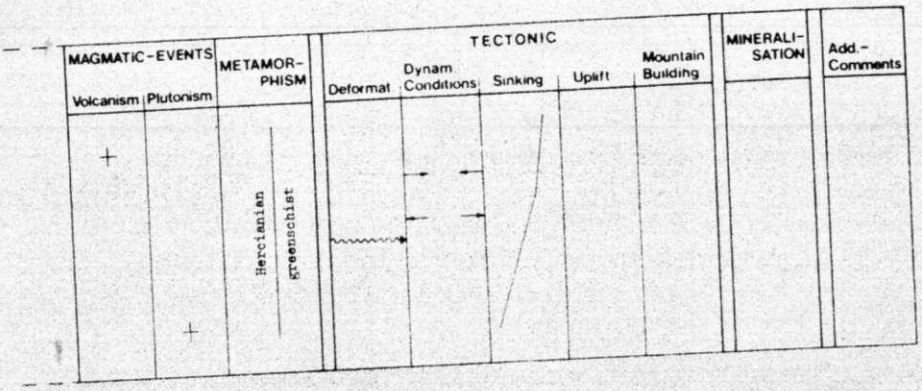

MAGMATIC-EVENTS
Volcanism
Plutonism
234
?
450
METAMOR-PHISM
?
?
TECTONIC
Deformat
Dynam. Conditions
Sinking
Uplift
Mountain Building
MINERALI-SATION
Fe, Cu
Add.-Comments

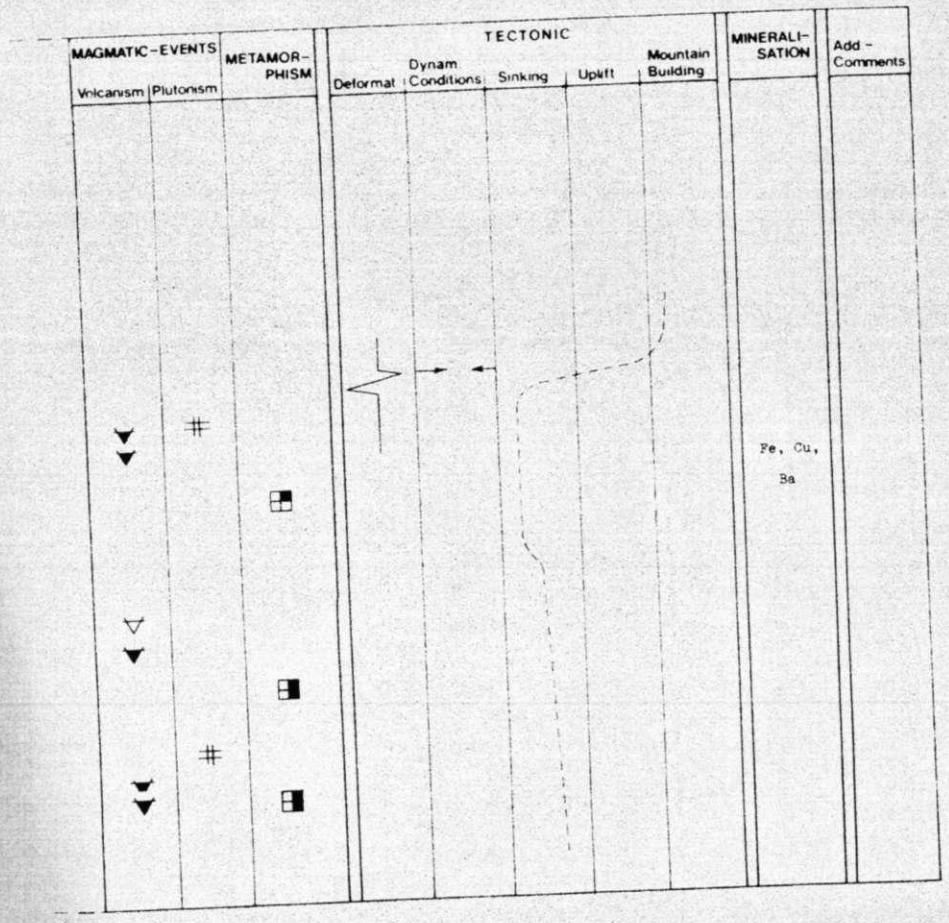
RAMOVŠ ET AL. FORM 18b: VARDAR ZONE, VELES SERIES



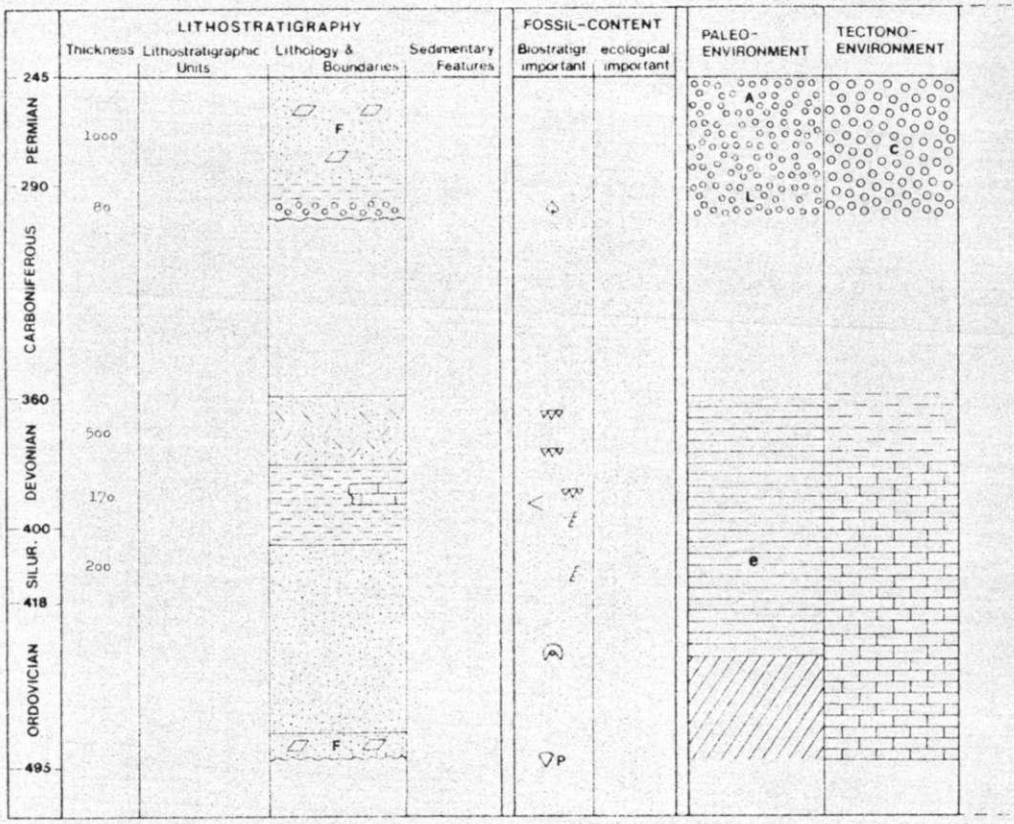
RAMOVŠ ET AL. FORM 20: RANOVAC UNIT

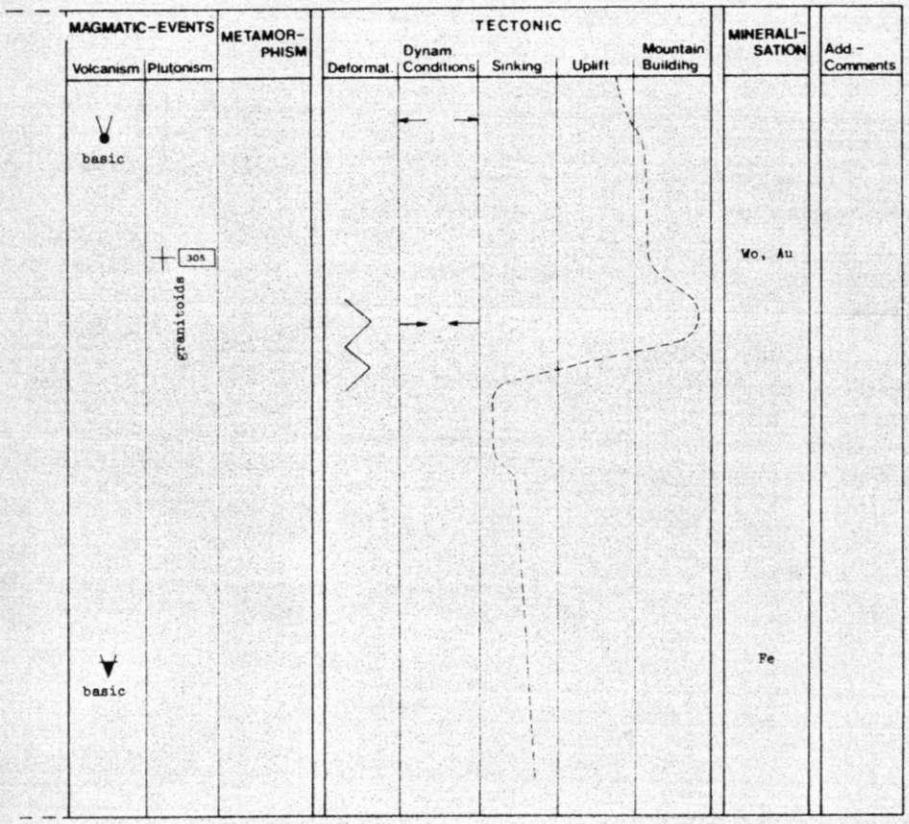



MAGMATIC-EVENTS
Volcanism
Plutonism
METAMOR-PHISM
Hercianian
Greenschist
TECTONIC
Deformat
Dynam Conditions
Sinking
Uplift
Mountain Building
MINERALI-SATION
Add.-Comments

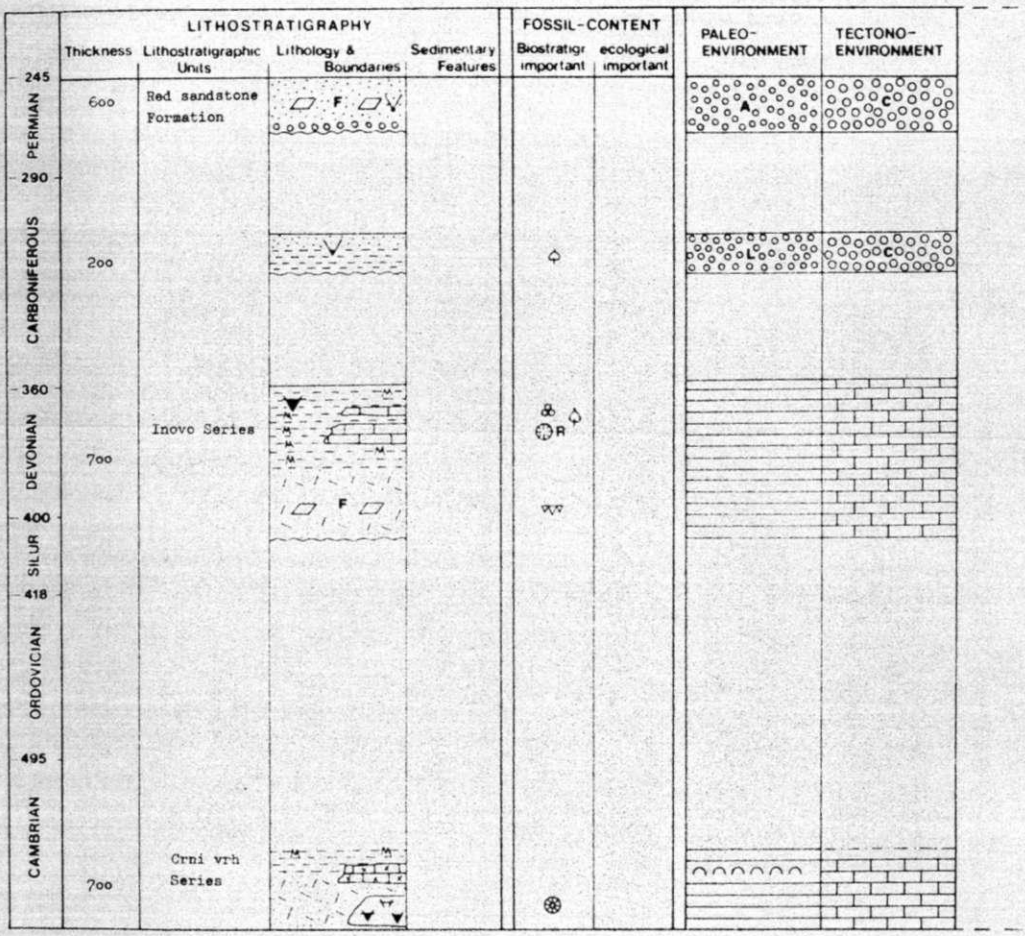

MAGMATIC-EVENTS
Volcanism
Plutonism
METAMOR-PHISM
TECTONIC
Deformat
Dynam Conditions
Sinking
Uplift
Mountain Building
MINERALI-SATION
Add.-Comments
Fe, Cu,
Ba

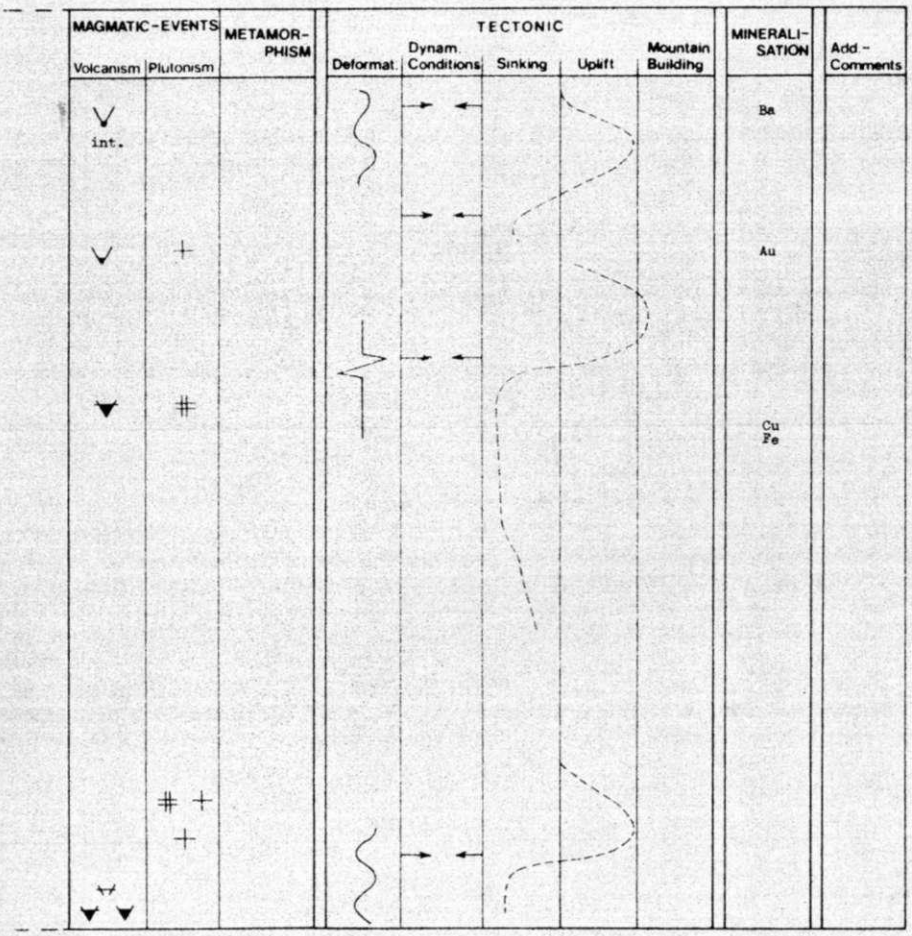
RAMOVŠ ET AL. FORM 21: KUČAJ UNIT




MAGMATIC-EVENTS
Volcanism
Plutonism
METAMOR-PHISM
TECTONIC
Deformat.
Dynam. Conditions
Sinking
Uplift
Mountain Building
MINERALI-SATION
Add.-Comments
basic
305
granitoids
Wo, Au
Fe
basic

RAMOVŠ ET AL. FORM 22: STARA PLANINA UNIT




MAGMATIC-EVENTS
Volcanism
Plutonism
METAMOR-PHISM
TECTONIC
Deformat.
Dynam. Conditions
Sinking
Uplift
Mountain Building
MINERALI-SATION
Add.-Comments
int.
Ba
Au
Cu
Fe

upper parts. Another set of rocks consists of graywackes, shales, basic volcanics, tuffs and keratophyre formed during the Ordovician/Lower Carboniferous. The uppermost part of the series has a flysch character. Quartzite horizone have stratigraphic significance in the region. These formations are deposited on the continental crust with some breaks in sedimentation between sets. Subcrustal magma was pushed upward to the surface along ruptures in the basement. The whole of the complex was metamorphosed several times and finally stabilized under greenschist facies conditions. Molasse sediments of the Upper Carboniferous and Permian lie above it.

Form 21: Kučaj unit

The Kučaj unit has a specific extraordinary development. The basement corresponds to the Proterozoic. The consolidation of the basement, which was later subject to only local infrequent faulting, is succeeded by gradual subsidence and transgression in the Ordovician. Sedimentation continues uninterrupted into the Lower Carboniferous, but the basin depth and nature of input material changes. Thus, conglomerate, sandstone, and sandy-clayey sediments with sparce basaltic effusions of the Ordovician are overlain with monotonous formations of graptolithic schist (Silurian), succeeded by Middle Devonian/Lower Carboniferous clastics of turbidite type, with occasional interlayers of carbonate rocks and acidic volcanics. The whole of this complex is only anchimetamorphosed. Over it lie molasse sediments of the Upper Carboniferous and Permian. Granitic magmas of crustal origin were intruded during the Carboniferous and Permian.

Form 22: Stara Planina unit

The lowermost exposed Riphean/Cambrian complex consists of psammitic, pelitic, and less frequently carbonate rocks, with effusions of basaltic lavas. During the Baykalian phase (Middle/Upper Cambrian) these rocks were metamorphosed in the greenschist facies, and in places up to the amphibolite facies.

These rocks are covered by basin sediments (Crni Vrh series) probably of Upper Cambrian to Ordovician age. They are of volcano-sedimentary origin and associated with mafic magmatism. The series is metamorphosed in the greenschist facies, and intruded by granitic rocks of Caledonian age.

In succession over this complex lie Upper Silurian and Devonian conglomerates, psammitic-pelitic sediments and, less frequently, limestone or magmatic rocks. These rocks are partly metamorphosed under greenschist facies conditions and partly only anchimetamorphosed. After metamorphism, the rocks are transgressively overlain by Permian sandstone.

In this unit, in association with Variscan orogenic movements, granitic magma was formed and pressed upwards in the Paleozoic pre-Permian sediments.

Additional data on Forms 15 to 22 are published in ĆIRIĆ & KARAMATA, 1980, KALENIĆ, KARAMATA & VESELINOVIĆ, 1980, and PETKOVSKI & TEMKOVA, 1980-81.

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Other references on Forms 5-9 may be found in RAMOVŠ et al. (1981), IGCP Project No. 5, Newsletter 3.

LITHOLOGY

CARBONATIC ROCKS

carbonatic rocks in general
L limestone
D dolomite

stratified limestone

stratified dolomite

not stratified limestone

not stratified dolomite

stratified dolomitic limestone

marl (35-65% clay content)

impure stratified limestone

limestone with flaser struct.

cherty stratified limestone

chert

strongly recrystallized stratified limestone

strongly recrystallized not stratified dolomite

evaporite
h halite
g gypsum
a anhydrite
d dolomite

carbonaceous rocks

PSEPHITES

conglomerate
m monomict
o oligomict

breccia
m monomict
o oligomict

PSAMMITES

psammites in general

quartzarenite - quartz-wacke (W)

arcosic arenite

lithic arenite

graywacke

PELITES

claystone, shale, residual clay (RC), bauxite (B)

siltstone

PYROCLASTIC ROCKS

tuff

tuffite

volcanic agglomerate

SEDIMENTARY STRUCTURES

large scale cross stratification

small scale cross stratification
r: rippels

lamination

flaser and lenticular bedding

mud cracks

slumping

sole marks

channels

lag deposits

hard ground

condensation

concretions Fe, Mn, etc.

reddish colours

olistolithes

fissures (Q, S)

fining upward sequences

coarsening upward sequences

fenestrate fabrics

soil (c: calcrete, etc.)

dipmeter

unimodal current direction

bimodal current direction

bioturbation

FOSSIL CONTENT

- marine fossils
- brackish fossils
- freshwater fossils
- terrestric
- mixed fauna/floras
- reworked faunas
- Gastropoda
- Graptolithina
- Insecta
- Lamellibranchiata
- Ostracoda
- Plantae
- Porifera
- Radiolaria
- "Receptaculitida"
- Spicula
- Sporomorpha
- Stromatoporoidea
- Tentaculita
- Trace fossils, f.i.Cruziana-F.
- Acritarchs (Chitinozoa, Hystrichosphaerida)
- Algae
- Algal balls
- Algal stromatolites
- Anthozoa, f.i. R: Rugosa
- Archaeocyatha
- Brachiopoda (P: phosphatic)
- Bryozoa
- "Calcispheres"
- Cephalopoda A: Ammonoidea N: Nautiloidea
- Conodonta
- Conulariida
- Echinodermata
- Foraminifera S: small, L: large
- Trilobita
- Vertebrata

BOUNDARIES

- hiatus
- unconformity, disconformity
- lateral transition
- fault
- overthrust
- strongly tectonized

ENVIRONMENTAL INTERPRETATION

$T_A - T_C$ types of turbidites

c cyclothemes

- regression
- transgression

CONTINENTAL ENVIRONMENTS

- A alluvial deposits
- E eolic
- G glacial
- L lake

TRANSITIONAL AND MARINE ENVIRONMENTS

- litoral(-tidal) in general
- delta
- shorelines
- sabkha
- bar
- reefs
- shelf
- basin p pelagic, e euxinic

TECTONOENVIRONMENT

- platform sedimentation
- foredeep sedimentation
- post-flysch (molasse) stage
  - m marine
  - c continental
- flysch stage
- pre-flysch stage