Annales de la Société Géologique de Belgique, T. 106 - 1983, pp. 335-399 Décembre 1983

UPPER FAMENNIAN AND TOURNAISIAN DEPOSITS OF THE OMOLON REGION (NE – USSR) [1]

by

K.V. SIMAKOV [2], M.J.M. BLESS [3], J. BOUCKAERT [4], R. CONIL [5], M.H. GAGIEV [2], Ye. V. KOLESOV [2], Yu. I. ONOPRIENKO [6], E. POTY [7], T.P. RAZINA [2], N.A. SHILO [2], L.V. SMIRNOVA [2], M. STREEL [8] & R. SWENNEN [9]

(17 figures, 1 table and 16 plates)

RESUME.- Des dépôts du Famennien supérieur et du Tournaisien ont été étudiés depuis 1979 dans le Massif de l'Omolon (Nord-est de l'URSS) par un groupe de géologues soviétiques, belges et hollandais afin de les comparer aux dépôts de même âge en Belgique. Une revue des recherches géologiques dans la région de l'Omolon est présentée.

Celles-ci ont démêlé l'histoire structuro-sédimentaire de la région depuis les temps pré-Riphéens. Trois domaines sédimentaires principaux peuvent être reconnus pendant le Famennien supérieur et le Tournaisien : la terre de Korkodon avec des volcans dans le sud-ouest, l'archipel de Gizhiga avec des grabens rapidement comblés et des fosses dans le sud-est, et l'archipel de l'Omolon avec des faciès marins littoraux à bathyaux entre les îles, au nord-est.

Quatre sections composites (Pushok, Perevalny/Sikambr, Uljagan et Elergetkhyn) ont été étudiées en détail. Elles sont considérées comme étant représentatives des principaux domaines structuro-sédimentaires dans la partie nord-orientale du Massif de l'Omolon pendant les temps Famenno-Tournaisien. Un résumé des données sédimentologiques, paléoécologiques, biostratigraphiques et paléomagnétiques disponibles jusqu'ici est présenté.

ABSTRACT.- Upper Famennian and Tournaisian deposits in the northeastern part of the Omolon Massif (North-East of the USSR) are being studied since 1979 by a team of Soviet, Belgian and Dutch geologists in order to compare the same with strata of the same age in Belgium. A review of the geological investigations in the Omolon area is presented.

These have unraveled the structural-sedimentary history of the region since Pre-Riphean times. Three main sedimentary domains can be distinguished during the Upper Famennian and Tournaisian : the Korkodon Land with volcanoes in the south-west, the Gizhiga Archipel Sea with quickly infilled grabens and troughs in the south-east, and the Omolon Archipel Sea with marine nearshore to "basinal" facies in between islands to the north-east.

Four composite sections (Pushok, Perevalny/Sikambr, Uljagan and Elergetkhyn) have been studied into detail. These are considered to be representative for the main structural-sedimentary domains in the north-eastern part of the Omolon Massif during Famenno-Tournaisian times. A summary of the sedimentological, paleoecological, biostratigraphical and paleomagnetic data available thus far is presented.

1 *Manuscrit reçu le 28 octobre 1983. Communication présentée le 15 novembre 1983.*

2 *SVKNII, Ul. Portovaja 16, 685005 Magadan, USSR.*

3 *Natuurhistorisch Museum Maastricht, Bosquetplein 6-7, 6211 KJ Maastricht, the Netherlands.*

4. *Geologische Dienst van België, Jennerstraat 13, B 1040 Brussel, Belgium.*

5. *Laboratoire de Paléontologie, Place Louis Pasteur 3, B 1348 Louvain-la-Neuve, Belgium.*

6. *Instit. Biology and Pedology Acad. NAUK, Far Eastern Scientific Centre, 690022 Vladivostok, USSR.*

7. *Laboratoire de Paléontologie Animale, Place du Vingt-Août 7, B 4000 Liège, Belgium.*

8 *Laboratoire de Paléobotanique et Paléopalynologie, Université de Liège, Place du Vingt-Août, 7, B 4000 Liège, Belgium.*

9 *Katholieke Universiteit Leuven, afd. Fysico-Chemische Geologie, Celestijnenlaan 200 C, B 3030 Heverlee, Belgium, (NFWO - aspirant).*

1.- INTRODUCTION

The area under discussion is situated in the north-eastern part of the Omolon Massif (NE Siberia, Fig. 1, Pl. 1), where the outliers of the Gydan Mountains merge with the Uljagan Depression. To the north, east and south, there are the strongly dissected mountain structures of the Ushurakchan and Gydan Mountains. These consist of predominantly volcanogenic Paleozoic and Mesozoic (mainly Cretaceous) rocks with numerous intrusions. The main rivers (the Molandzha and Uljagan rivers and their tributaries) flow to the west and north-west parallel to the major faults.
The valley bottoms and part of their slopes are covered by larch taiga forests. Occasionally, the watershed areas show traces of glacial activity. These belong to the mountain-tundra zone. The highest summits in the axial parts of the Gydan Ridge are between 1700 and 1800 m above sea-level, whereas the Molandzha River flows at about 450 m above sea-level.

The Uljagan Depression is a subdued, low-mountain area which passes into a hilly-spurrish plain near the Omolon River. This depression has been filled with sedimentary and subordinate volcanogenic Paleozoic and Mesozoic strata. The wide valleys of the strongly meandering streams as well as the majority of the gentle slopes are hardly accessible swamps. The vast subdued watershed areas are covered with larch taiga. The highest summits do not exceed 600 to 700 m above sea-level, whereas the Omolon River flows at only 200 m above sea-level.

The climate is continental. The temperature varies between minimum -60° to -64°C in the winter to maximum +35 to +38°C in the summer. The snow cover stabilizes in the second half of September and melts in late May through early June.

The only settlement in this region is Omolon (formerly named Shcherbakovo) with its reindeer breeding state farm "Omolon" and an airport.

2.- HISTORY OF INVESTIGATIONS ON FAMENNIAN AND DINANTIAN DEPOSITS

The geology of this area has been studied since more than 50 years. During a reconnaissance trip in 1930, the first data have been obtained on the geology of the Omolon River area (Obruchev, 1931). Abramov

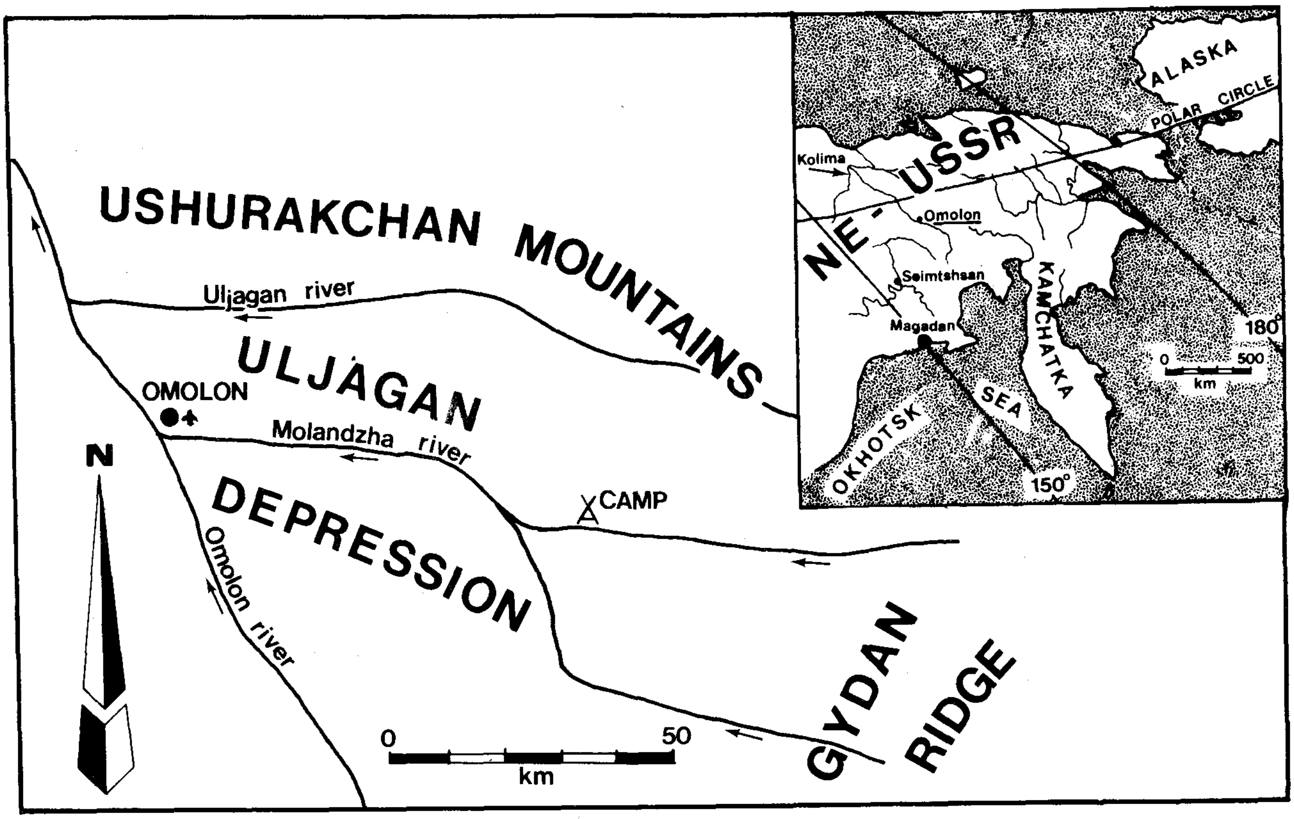


Figure 1.- Location map of study area

and Gursky (participants of the Omolon field trip organized by Dalstroy in 1936-1938) described Dinantian deposits along the middle course of the Omolon River. In 1949-1950, their data have been confirmed by Vitsman, Nikolaev and Tagiltsev. In 1949, Nikolaev discovered faunistic evidence for the presence of Famennian deposits in the Perevalny Valley. One year later, Famennian deposits have been recognized by Tagiltsev in the Ushurakchan Mountains.

Krymov, Misans, Palymsky, Simakov, Shevchenko and Yaskevich studied this region during the second half of the nineteen-fifties. They discovered sedimentary and volcanogenic Famenno-Dinantian deposits throughout the area (Krymov & Misans, 1959). The first stratigraphic scheme of the Upper Devonian to Dinantian strata in the northern part of the Omolon Massif was based on the investigations by Simakov (Simakov, 1965a - b; 1967a ; Simakov & Shevchenko, 1967 ; Nikolaev & Rzhonsnitskaya, 1967).

Several new outcrops of Famennian and Tournaisian sediments showing different lithologies and yielding rich and diverse fossil assemblages have been found during the field work between 1965 and 1970 by Dylevsky, Vjaloy, Golovach and Simakov. Samples from these outcrops have been studied by Bogush and Yuferev (1970, foraminifers), Onoprienko (1973, 1976a-b, 1977 rugose corals), Simakov and Afanasjeva (1970, brachiopods). This work permitted a more detailed subdivision of the Famenno-Tournaisian strata (Simakov, 1970a-b, 1971, 1972 ; Simakov, Yuferev & Bogush, 1970).

The data of the Upper Devonian and Dinantian throughout the entire North-East of the USSR (Simakov, 1974a-b ; Abramov, Ganelin, Simakov & Solomina, 1975, 1979) have been integrated in a uniform stratigraphic scheme for the Famennian and Tournaisian (Anonymous, 1978). An attempt was made to compare these data with those from other regions, and in particular with those from Western Europe, in order to find arguments for a better definition of the Devonian-Carboniferous boundary (Simakov, 1975).

In 1976, the North-Eastern Interdisciplinary Science Research Institute (NEISRI, FESC, USSR Academy of Science) - acting conform the recommendations of the International Working Group on the Devonian-Carboniferous Boundary - initiated a comprehensive study on the reference section of the Elergetkhyn suite in the Perevalny Valley. The staff members of this institute (Gagiev, Kolesov, Razina, Simakov and Smirnova) realized field work in the period between 1976 and 1979 in collaboration with members of the Biology and Soil Science Institute (BSSI, FESC, USSR Academy of Sciences ; Onoprienko) and the Geology and Geophysics Institute (SD, USSR Academy of Sciences ; Yuferev).
The fossil assemblages have been described by Yuferev (1979, foraminifers), Smirnova (1979a-d, stromatoporoids and tabulate corals), Onoprienko (1979a-b, rugose corals), Mironova (1979, gastropods), Bushmina (1979, ostracodes ; also Bushmina & Simakov 1979, ostracodes), Tschigova (1979, ostracodes), Simakov (1979, brachiopods), Gagiev (1979a-b, conodonts) and Radionova (1979, algae). Lithology has been studied by Razina (1979) and paleomagnetism by Kolesov & Linkova (1979).

A description of the studied sections has been presented in the "Field Excursion Guidebook on Tour IX" (Simakov *et al.*, 1979). This excursion had been organized before the XIV Pacific Science Congress at Khabarovsk (1979) ; and it formed part of a special symposium devoted to the "Biostratigraphic and faunal description of the Devonian-Carboniferous boundary deposits".

Since 1979, the joint Soviet-Belgo-Dutch comparative studies of the Famenno-Tournaisian deposits in the Franco-Belgian area and in the North-East of the USSR have been sponsored by NEISRI and the Geological Survey of Belgium. The staff members of NEISRI (Razina, Simakov, Kolesov and Smirnova) investigate the Famenno-Tournaisian strata in the Omolon River area in cooperation with specialists of BSSI (Onoprienko), Paleontology Institute (USSR Academy of Science ; Erlanger), Louvain-la-Neuve University (UCL ; Conil), Liège University (Poty), Museum of Natural History Maastricht (Bless) and Leuven University (KUL ; Swennen). The collected samples are being studied by Conil (foraminifers), Smirnova (stromatoporoids and tabulate corals), Onoprienko and Poty (rugose corals), Simakov, Afanasjeva, Lazarev, Manankov and Erlanger (brachiopods), Bushmina, Kochetkova, Tschigova and Bless (ostracodes), Gagiev (conodonts), Radionova (algae), Streel (miospores) and Razina and Swennen (Lithology). The data obtained suggest that the reference section for the Elergetkhyn suite at Ustyevoy in the Perevalny Valley is a very important one. This section includes some of the principal stratigraphic horizons and their corresponding fossil assemblages, which are regarded as possible alternatives for a new definition of the Devonian-Carboniferous boundary. Some strata in this section seem to belong to a stratigraphic interval that has not been observed in Western Europe.

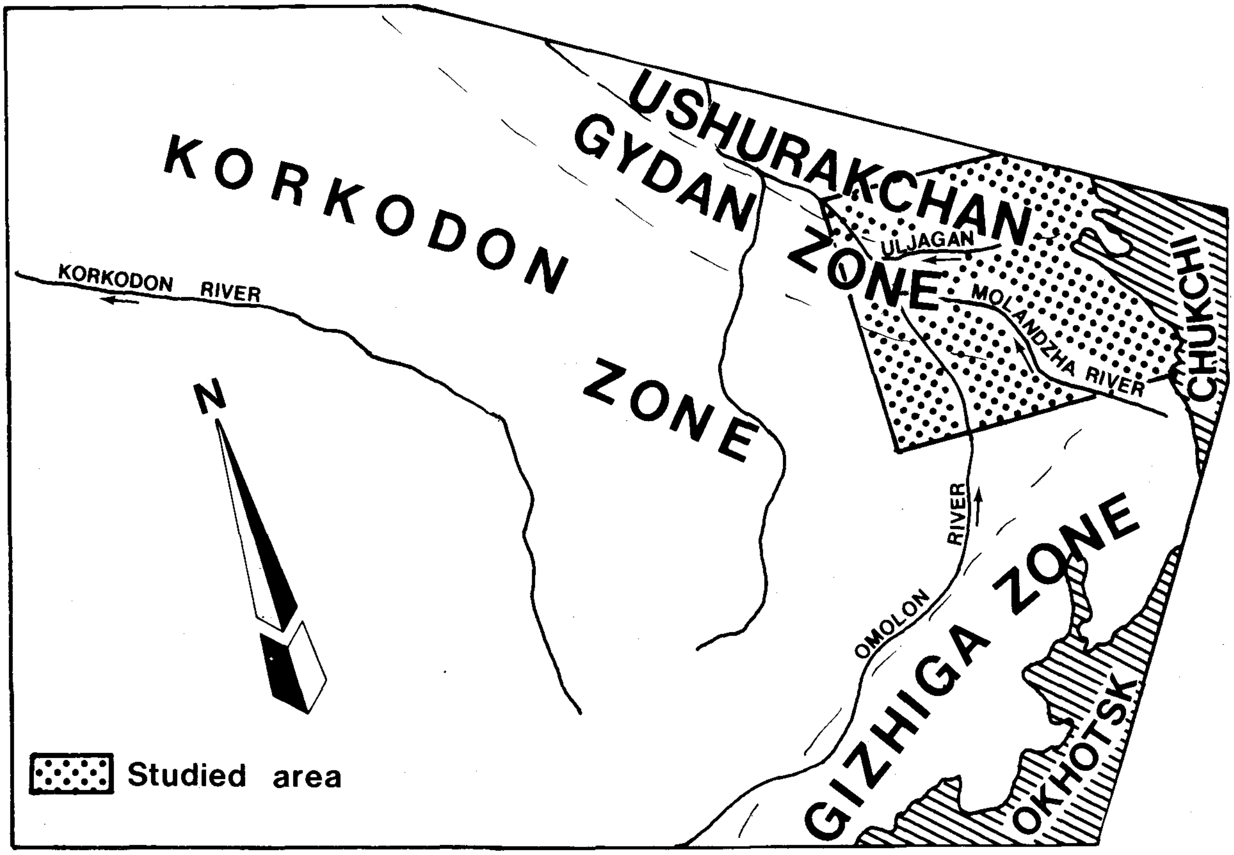


Figure 2.- Main structural zones in Omolon Massif

And last but not least, a detailed correlation between the standard subdivisions of the Tournaisian and Visean in the Franco-Belgian Basin with those of the Omolon Massif may be achieved after the study of sections in the Elergetkhyn Lake (Conil *et al.*, 1982) and Uljagan River areas.

3.- STRUCTURAL-SEDIMENTARY HISTORY OF THE OMOLON MASSIF

The Omolon Massif is a rigid, block-faulted structure surrounded by folded Mesozoic deposits. Both are partially covered by the vulcanogenic rocks of the Okhotsk-Chukchi belt (fig. 2). The basement of the Omolon Massif may be of Pre-Riphean age, but possibly it had not been completely consolidated before the Middle Paleozoic. Important block movements affected this area during Phanerozoic and perhaps also Riphean times. Frequent inversions of these movements can be deduced from variations in the thickness and nature of the deposits. Intrusive and effusive magmatic rocks occur along the faults. The age of the metamorphic, sedimentary, volcanogenic and intrusive rocks in this area ranges from Early Archean through Late Cretaceous (fig. 3).

The principal structural elements within the Omolon Massif are the Ushurakchan (to the north), Korkodon (to the west and south-west), and Gizhiga (to the south-east) zones, which enclose the Gydan zone (fig. 2). These are separated by more or less north-west and east-west striking faults, which are of Early to Middle Devonian age.

The second order structures are represented by horsts of Pre-Upper Paleozoic rocks, depressions and marginal troughs filled with Upper Paleozoic and Lower Mesozoic deposits, as well as by superimposed basins filled with late Mesozoic sediments (Gerasimova *et al.*, 1971). The second order structures in the Korkodon zone are characterized by gently dipping monoclines and folds (fig. 4), and by the "en échelon" pattern of

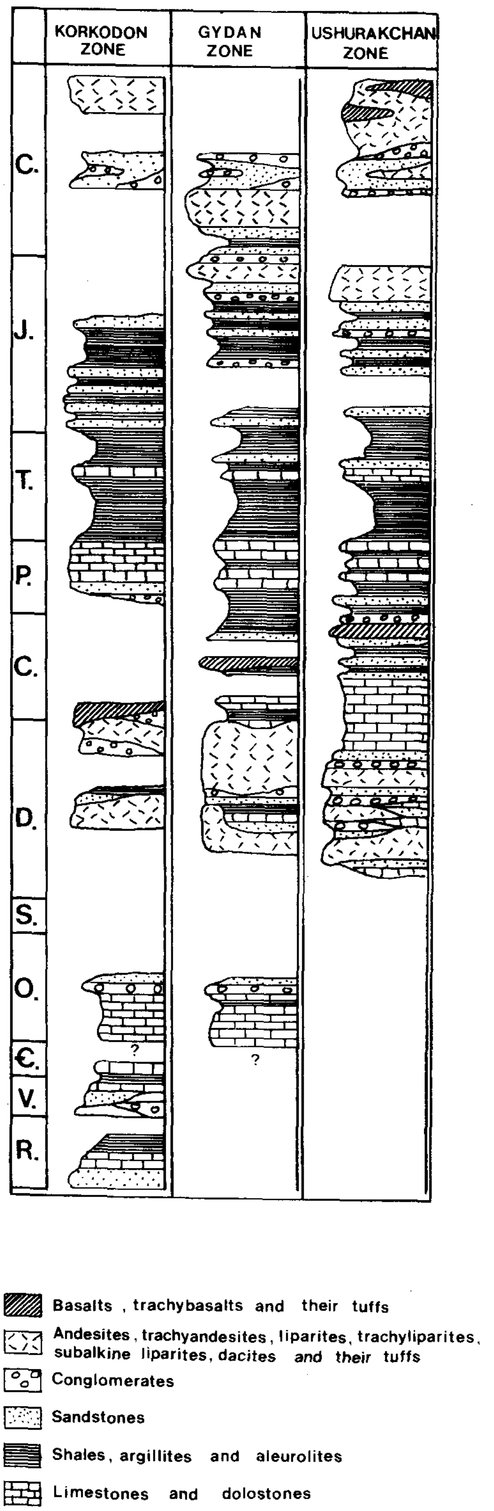


Figure 3

Composite lithostratigraphy of the Korkodon, Gydan and Ushurakchan structural zones in the Omolon Massif.

horsts and grabens. In the Gydan and Ushurakchan zones, the folding is more intricate and intense, especially in fault zones.

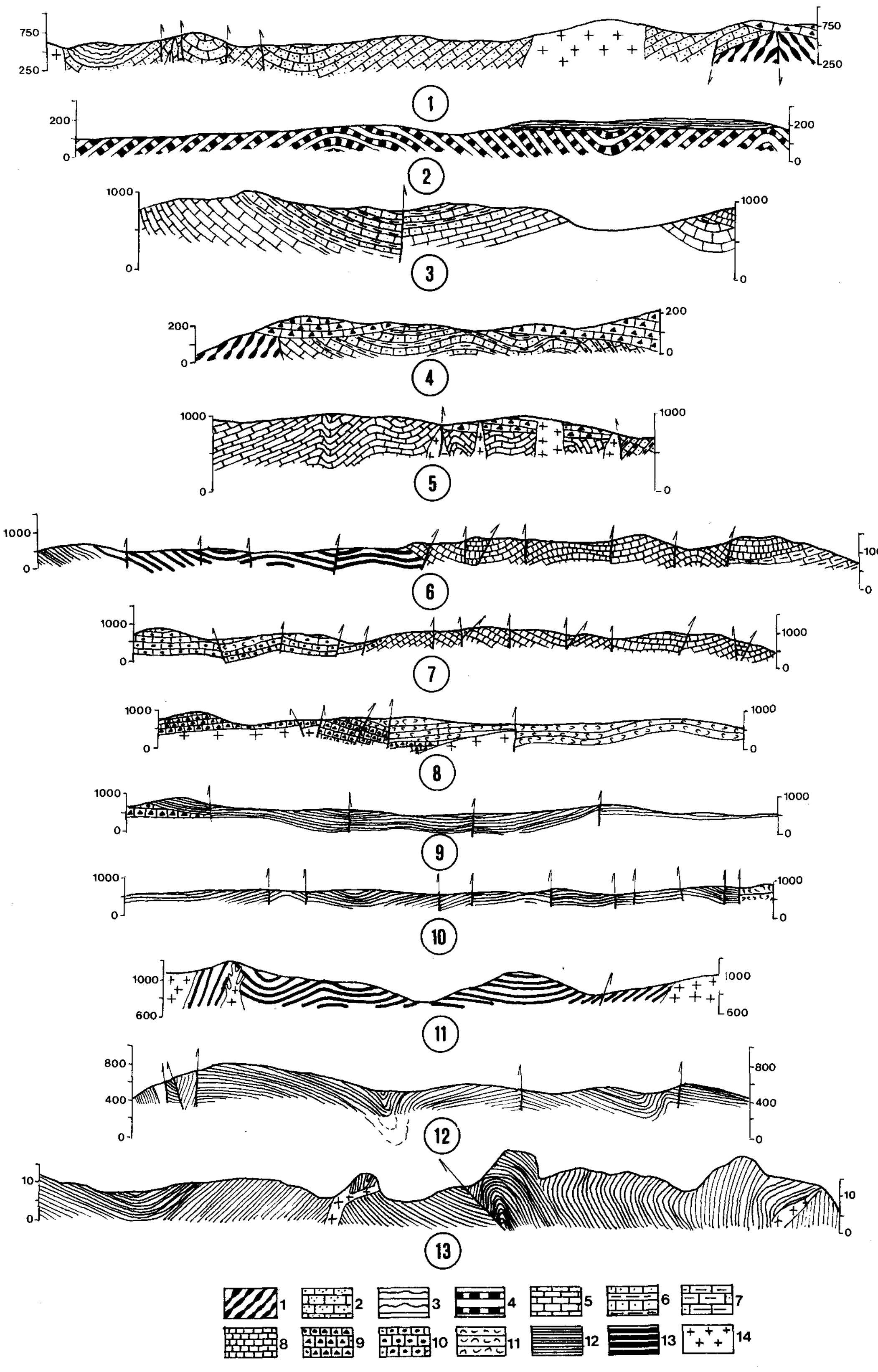
The Pre-Riphean (Lower Archean) basement outcrops in the core of some deeply eroded, fault-bounded and updomed areas in the southwestern (Korkodon) part of the Omolon Massif. The rocks consist of garnet-cordierite and garnet-sillimanite gneisses, and bipyroxene and eclogitic crystalline schists. The primary structure of these Lower Archean rocks has been obscured completely during the Early to Middle Proterozoic amphibolite metamorphic phase. This phase is characterized by the formation of elongate isometric granite-gneiss (plagiomigmatites, microcline migmatites, anatexite quartz-diorites and granodiorites, porphyroblastic granites) domes with an overall north-south strike. Relics of the Lower Archean granites have been preserved in the cores of these domes. Weakly migmatized metadacites, metarhyolites, marbles and calciphyres outcrop in the periphery of the same. Wedges of microcline granites have been observed in the Lower Archean metamorphic rocks.

Important north-east and north-south striking faults developed during Riphean and Early Paleozoic times. Transitory narrow graben-like troughs in the Omolon and Gizhiga areas have been filled with carbonate, sandy schists and sandy conglomerates, occasionally associated with red, terrigenic and volcanogenic deposits (Simakov & Shevchenko, 1972).

The Riphean-Vendian and Cambro-Ordovician rocks have been folded into north-east and north-south striking box-folds with gently pitching domes and steep wings exhibiting small corrugation folds during the late Ordovician. Middle Ordovician plutons of syenites and granosyenites, as well as late Ordovician to early Devonian diorites and granodiorites occur within the metamorphic Pre-Riphean and sedimentary and volcanogenic Riphean to Lower Paleozoic rocks (Simakov & Shevchenko, 1968, 1975 ; Shevchenko, 1975).

Intense tectonic movements and differentiation into smaller structural-sedimentary areas are characteristic for the late Silurian and early Devonian in the North-East of the USSR. During this period, the principal structural lineaments, which characterize the present Omolon Massif, have been established.

The Middle Paleozoic period is marked by an extremely high volcanic activity in the Omolon area. Different volcanic rock types, sometimes derived from



750
250
1
200
0
2
1000
0
3
200
0
4
1000
0
5
1000
0
6
1000
0
7
1000
0
8
1000
0
9
1000
0
10
1000
600
11
800
400
0
12
10
0
13
1
2
3
4
5
6
7
8
9
10
11
12
13
14

subaquaceous volcanoes, accumulated along the northwest and east-west striking faults. This fault pattern determined the structural-sedimentary units within the Omolon Massif, especially in the Korkodon, Gydan and Ushurakchan zones. During this period, important vertical block movements occurred along these faults.

Marine and non-marine sedimentary and volcanogenic strata have been deposited in the Ushurakchan and Gydan zones in early to middle Devonian times. Trachyliparites and subalkaline potassic liparites predominate. Trachybasalts, trachyandesites, silicites and volcanogenic rocks and some limestones with Emsian to Givetian fossil assemblages are intercalated in the sequences.

Subalkaline liparites, dacites, andesites and subordinate basalts have been accumulated in the Korkodon zone during the second half of the Middle Devonian and at the end of the Late Devonian periods.
Occasionally, some intercalations of volcanogenic and siliceous-clayey strata occur in this sequence (Simakov & Shevchenko, 1972). With a few exceptions, the Omolon area is charcterized by a gradual reduction of the volcanic activity since the end of the early Frasnian. From that period onwards, active volcanism remains restricted to some of the major fault zones which separate the updomed areas and graben-like depressions.

Middle to Late Frasnian red-coloured, subalkaline liparites accumulated in the Ushurakchan zone. These are overlain by Famennian to Early Carboniferous red terrigenous deposits and many carbonates with intercalations of gypsum.

An intricate sequence of sedimentary and volcanogenic rocks occurs in the Gydan zone. The volcanogenic rocks consist mainly of trachyliparites, alkaline liparites, trachyandesites and trachybasalts. The volcanic activity came to an end during the Late Famennian. The Late Famennian and Tournaisian deposits consist of carbonates and evaporites.

Volcanic activity in the Korkodon zone continued locally until the Early Carboniferous. In this area, subalkaline liparites, trachytes, trachyandesites and trachybasalts occur together with intercalated molassoid deposits of Late Famennian to Tournaisian age (Simakov & Shevchenko, 1972 ; Simakov, 1974b).

Frequently fault-bounded box-folds and an intricate mosaic pattern of block structures characterize the Middle Paleozoic rocks of the Omolon Massif.

A thick sequence of terrigenous, tuffogenic-siliceous and carbonate deposits as well as some subordinate volcanogenic rocks accumulated in the Ushurakchan and Gydan zones from the Late Visean to Early Serpukhovian untill the end of the Permian.

The Korkodon zone was land area during the larger part of the Carboniferous and during the Early Permian. But at the end of the Carboniferous, the sea invaded this region from the east and flooded practically the complete Korkodon zone some halfway the Permian period, as may be deduced from the presence of thin marine carbonates.

Figure 4.- Folding features of formations of different ages in the Omolon massif.

Sections : 1 - Riphean - Vendian (?) deposits in the watershed of the Mayak Creek (data of R.S. Furdui supplemented by V.M. Merzlyakov) ; 2 - Lower Cambrian (?) deposits in the watershed of the Ogromny C. (data of I.A. Kovalchuk) ; 3 - Ordovician deposits in the Khitana and Murulan interfluve ; 4 - Ordovician deposits in the watershed of the Ushchelny C. ; 5 - Ordovician and Devonian deposits in the watershed of the Right Burgali--Korkodonian R. ; 6 - Devonian and Mesozoic deposits in the Choatanga and Khungandzha interfluve - Ushurakchan zone ; 7 - Devonian deposits in the Uljagan-Molandzha interfluve - Gydan zone ; 8 - Devonian deposits in the Tufovy C. watershed - Korkodon zone ; 9 - Mesozoic deposits in the Koltsevaya R. watershed - Korkodon zone (sections 3-9 of K.V. Simakov and V.M. Shevchenko) ; 10 - Mesozoic deposits at the Rassokha R. (data of Ye.I. Kudlei) ; 11 - Upper Jurassic deposits in the watershed of the Khaptagai and Boyevaya rivers (data of P.P. Syrkin) ; 12 - Mesozoic deposits at the Kedon River (data of I.V. Polubotko and Yu. S. Repin) ; 13 - Mesozoic deposits at the Omolon River (section 15 of Ye. F. Dylevsky).

Conventional Signs

1. Pre-Riphean metamorphic formations ; 2. Riphean deposits ; 3. Vendian (?) deposits ; 4. Lower Cambrian (?) ; 5. Lower Ordovician ; 6. Middle Ordovician ; 7. Lower Devonian ; 8. Middle Devonian ; 9. Upper Middle and Upper Devonian ; 10. Uppermost Devonian and Lowermost Carboniferous ; 11. Uppermost Devonian and Dinantian ; 12. Permian to Middle Jurassic ; 13. Upper Jurassic ; 14. Intrusions.

Thin monotypic aleurolite, clayey and occasionally volcanogenic and terrigenous deposits have been laid down during the Early Triassic to Late Liassic periods throughout the Omolon area. The sedimentation in the Korkodon zone continued through Kimmeridgian times, whereas some insignificant uplift occurred in the Ushurakchan and Gydan zones during the Middle Jurassic.

Inverse block movements along the north-west and east-west striking faults in the northern and eastern parts of the Omolon Massif during the end of the Late Jurassic and Early Cretaceous have resulted in superimposed basins. These have been filled by coal-bearing, molassoid and volcanogenic deposits. A continental regime marked the Korkodon zone during the same period.

Important tectonic movements along the north-east and north-south striking faults and volcanic activity characterize the end of the Early to the beginning of the Late Cretaceous period. The Late Cretaceous is also the period of numerous intrusives (gabbro-diorites, granodiorites as well as subalkaline and alkaline granites). These are usually restricted to the main fault zones (Dylevsky, 1975, 1977, 1980 ; Dylevsky & Simakov, 1975 ; Dylevsky *et al.*, 1968). Gentle folds, becoming more strained near faults, mark the Mesozoic rocks.

4.- UPPER FAMENNIAN AND TOURNAISIAN PALEOGEOGRAPHY OF THE OMOLON MASSIF

The Late Devonian and Dinantian sediments in the Omolon Massif exhibit quite different lithologies reflecting different depositional environments. Three main sedimentary domains may be distinguished during this timespan :

1. The Korkodon Land with volcanoes to the south-west,
2. the Gizhiga Archipel Sea with quickly infilled grabens and troughs in the south-east, and
3. the Omolon Archipel Sea, with marine nearshore to "basinal" facies in between islands (fig. 5).

The Korkodon Land was marked by fault-bounded, north-east trending grabens, which have been filled with volcanic and volcanogenic red-coloured deposits (thickness between 900 and 1100 m). The age of the same has been determined by means of *Cyclostigma/Archaeopteris* and *Sublepidodendron* floras.

Equally north-east trending grabens (width between 5 and 15 km) within the Gizhiga area were characterized by extremely high rates of downwarp. The total thickness of the Late Devonian and Dinantian deposits may vary between 2000 and 2500 m. These consist of rhythmic "Piedmont-type" sequences of conglomerates, gravelites, greywackes, arkosic sandstones and siltstones. Some intercalations of calcareous sandstones may be present. In the upper portion, these grade into silicites and silicified tuffites. The age of these strata has been identified by means of marine fossils at the base of the sequence, where brachiopods and clymeniids, characteristic of the Upper Devonian *Wocklumeria* cephalopod genozones, occur. Higher up in the sequence the strata are dated by means of *Cyclostigma/Archaeopteris* and *Sublepidodendron* floras. Narrow horst zones in between these grabens exhibit Archean metamorphic rocks.

The Omolon Archipel was marked by a more differentiated sedimentation pattern, varying from shallow marine nearshore through deep marine offshore shelf into "basinal" (intra-shelf depression) deposits surrounding areas of (sometimes transitory) non-deposition ("islands"). The shallow marine nearshore deposits include siliciclastics (sandstones, conglomeratic sandstones, siltstones), bioclastic limestones (including coral-stromatoporoid biostromes), dolomites and dolomitized and/or intraclastic to oolitic limestones with sometimes numerous chert concretions and silicified anhydrite nodules (Chowns & Elkins, 1974).

The shallow marine offshore shelf deposits are predominated by bioclastic limestones with sometimes abundant chert concretions.

Relatively deep marine, "basinal" deposits and deep marine offshore shelf deposits include nodular (sometimes clayey) limestones, silicified limestones and silicified shales.

Vertical transitions from marine nearshore through marine offshore shelf into "basinal" environmental conditions have been observed in several sections. It is almost impossible to present generalized sections for larger areas, because of the intricate cakewalk pattern of block movements. This may be deduced also from the figures 6 to 11. The areas of Pushok and Perevalny/Sikambr show a predominance of marine nearshore to offshore shelf deposits, whereas the sediments of the same age in Elergetkhyn are characterized by more important variations of the depositional environment grading from "basinal" conditions for at least part of the Gytgynpylgin deposits to supratidal

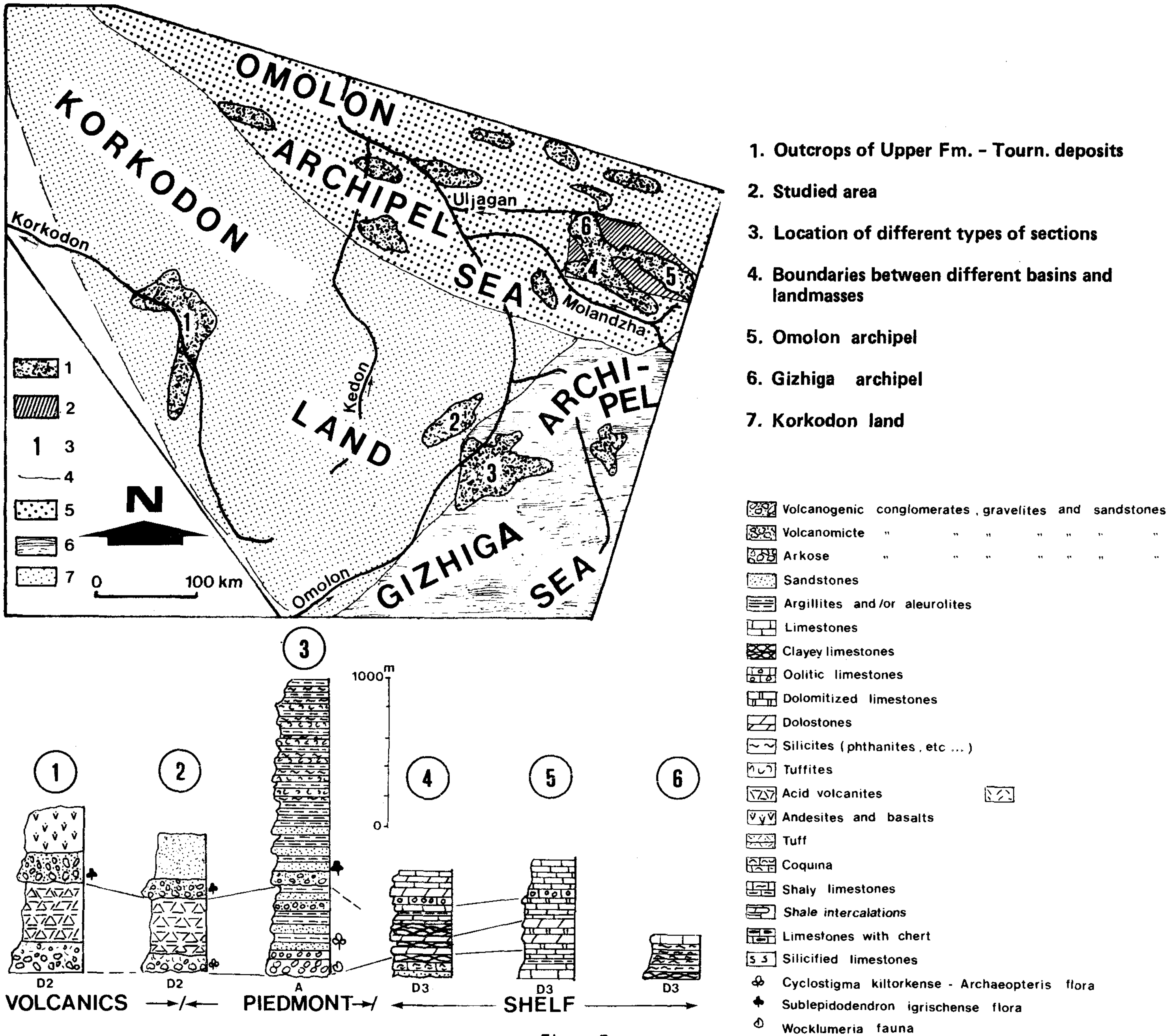


Figure 5

Generalized paleogeography of Omolon area during the Late Devonian and Dinantian and composite sections, representative for the various areas. The legend for the lithology is also valid for figures 7, 8, 10 and 11.

for the overlying Kuluk beds. "Basinal" conditions have persisted during a relatively long period in the Uljagan Intra-shelf Depression, which was located along the important Namyndykan-Murulan fault zone.

The completely different lithologies complicate the comparison between the sections without the help of detailed biostratigraphical investigations. Of course, such important lateral and vertical variations in the depositional environment of the Omolon Massif during the Upper Famennian and Tournaisian are not unique. These can be observed in almost all synsedimentary block-faulted areas with differential rates of subsidence and upwarp. For example, similar conditions have been described for different areas of Northwestern Europe (e.g. Bless *et al.,* 1983), and Southeastern Canada (e.g. Hacquebard, 1972).

Deposition in the Omolon area seems to have occurred during three periods of different tectonic activity.

The first period, which roughly comprises the Late Famennian and Early Tournaisian, is marked by enormous tectonic activity and major transgressions. Considerable variations in the relative rate of subsidence and upwarp have been detected. Differentiated block movements are accompanied by local volcanic activity along faults. This is shown by the frequent occurrence of bentonites, and also by the example of volcanogenic rocks on top of Andylivan-type carbonates of Late Famennian age *(szulczewskí* to *extralobatus* conodont local zones) at Uvnukveem (about halfway between Perevalny and Elergetkhyn). These large-scale oscillations of the individual blocks are reflected also in the important vertical variations in the depositional environment during this timespan. This is clearly demonstrated in the Elergetkhyn area, where "basinal", thin-bedded limestones with shale intercalations (Gytgynpylgin suite) rapidly grade into more restricted dolomite strata with silicified anhydrite nodules (Kuluk suite). Similar time-equivalent regressive events - but of minor importance - have been recognized in the Perevalny and Pushok areas.

The second period, coinciding more or less with the "Middle Tournaisian", is marked by tectonic stability and widespread regressive deposits. Only small-scale oscillations of the blocks may have occurred as it is suggested by the minor variations in the lithology observed at Pushok, Perevalny/Sikambr and Elergetkhyn. The basal part is marked everywhere (except of course for the Uljagan area) by the frequent occurrence of dolomitized, shallow marine limestones, which often bear silicified anhydrite nodules suggesting repeated changes from shallow marine to supratidal environments. The abundance of oolites and intraclasts throughout this interval (with the exception of the lowermost part of the sequence at Perevalny : Mol suite) also suggests extremely shallow marine, high-energy facies. At Perevalny, this sequence is ended by a renewed period of extreme regression with evaporitic conditions as shown by the occurrence of silicified anhydrite nodules in the algal calcilutites and zebra limestones.

The beginning of the third period coincides with the base of the "Upper Tournaisian" and is marked by a deepening of the environment. This might be due to an eustatic sea-level rise at the beginning of the Late Tournaisian. In the Omolon Massif, a structural inversion seems to coincide with this event in the Uljagan Intra-shelf Depression. Here, "basinal" conditions change into a marine, subtidal environment with carbonate deposition until the end of the Tournaisian.

5.- DESCRIPTION OF SECTIONS

Four composite sections have been studied into detail : Pushok, Perevalny/Sikambr, Uljagan and Elergetkhyn (fig. 7). These are considered to be representative for the main structural-sedimentary domains in the northeastern part of the Omolon Massif during Famenno-Tournaisian times. Additional sections have been visited along the border between the Uvnukveem Half-graben, Okralishan Horst and Muralan Intra-shelf Depression. However, the sedimentological and paleontological investigations on these latter sections (a.o. Uvnukveem, Bela Gora and Ferdinand) have not yet been completed. The location of the sections and the principal structural units mentioned in this chapter are shown on figure 6.

Within each section, several suites have been distinguished (Simakov *et al.,* 1979). Only minor changes have been introduced in the present description. As far as possible, the bed numbers referred to in Simakov *et al.,* (1979) have been used also in this paper.

Reference is made to the biostratigraphic data described in chapter 6.

5.1.- PUSHOK

The Pushok section (Pl. 2) is located at the headwaters of the Pushok Creek near the southern border

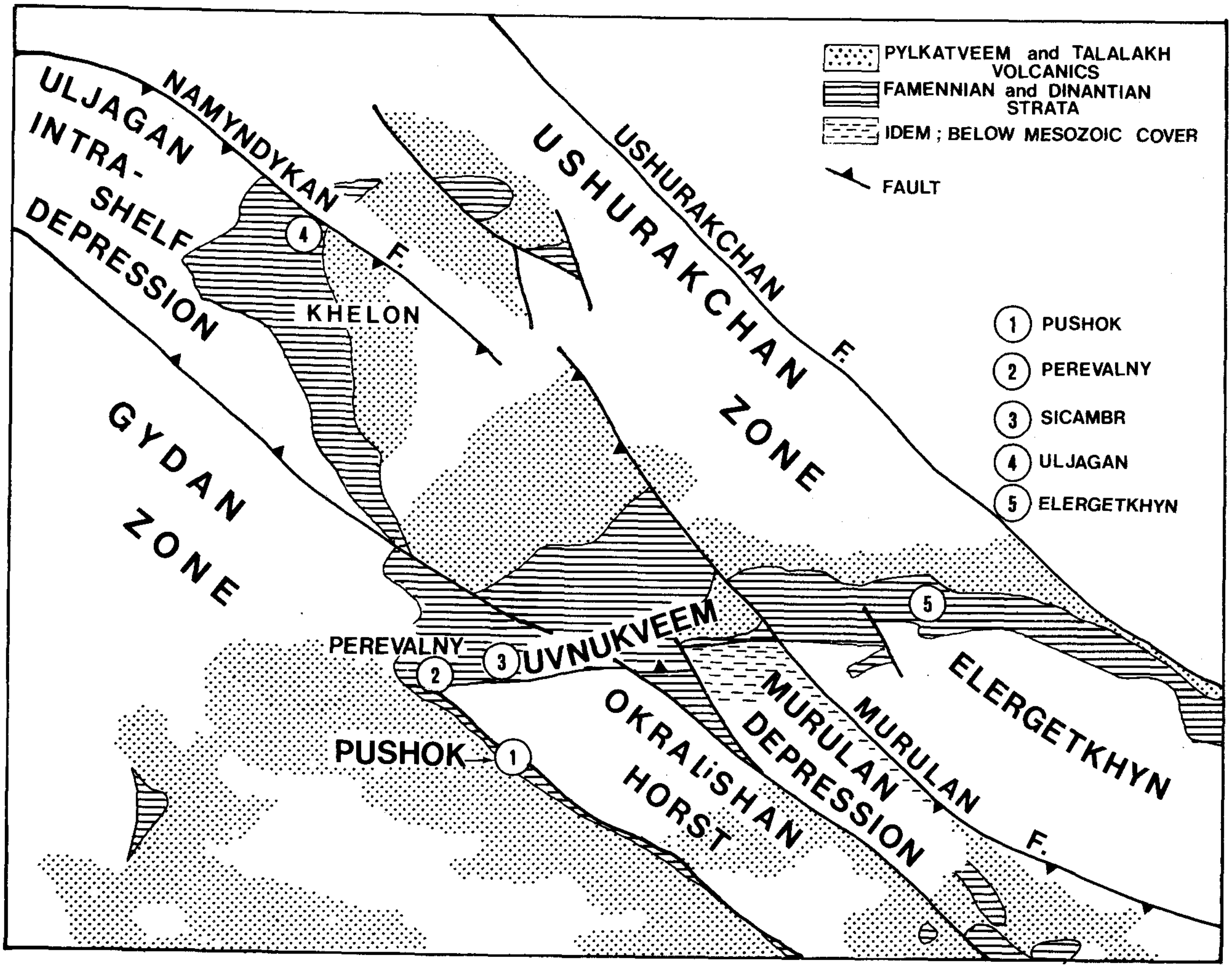


Figure 6
Simplified geologic map of the northeastern part of the Omolon Massif, showing distribution of Upper Devonian and Tournaisian deposits and location of studied sections.

of the studied area. It is the reference section for the Pushok suite. The deposits of this suite in the core of the Pushok Half-graben overlay variegated volcanites of presumably Frasnian age (belonging to the so-called Pylkatveem suite). The Pushok Half-graben has been traced over a distance of some 20-25 km from the north-west to the south-east. The width is only 0.5 to 1.0 km. The deposits of the Pylkatveem and Pushok suites are bound by Lower Cretaceous effusives to the north-east. The dip of the strata in this structure is some 10^{o} - 15^{o}, except for the steeply dipping beds along the fault-line to the east (fig. 6).

5.1.1.- Pushok suite

Base

Lowermost outcropping biostrome in Pushok section (XV-1).

Top

Top of dolostones underlying oolitic limestones in Pushok section (XV-10).

Thickness

± 120 m. In other sections the thickness varies between 100 and 150 m.

Age

Base of suite (XV-1 to XV-3) characterized by foraminifers of *Quasiendothyra kobeitusana* subzone, as well as by "Lower Tournaisian" corals, stromatoporoids and brachiopods. The upper part of the suite has yielded conodonts indicating the presence of, respectively, the *Siphonodella sandbergi* and *Siphonodella crenulata* zones.

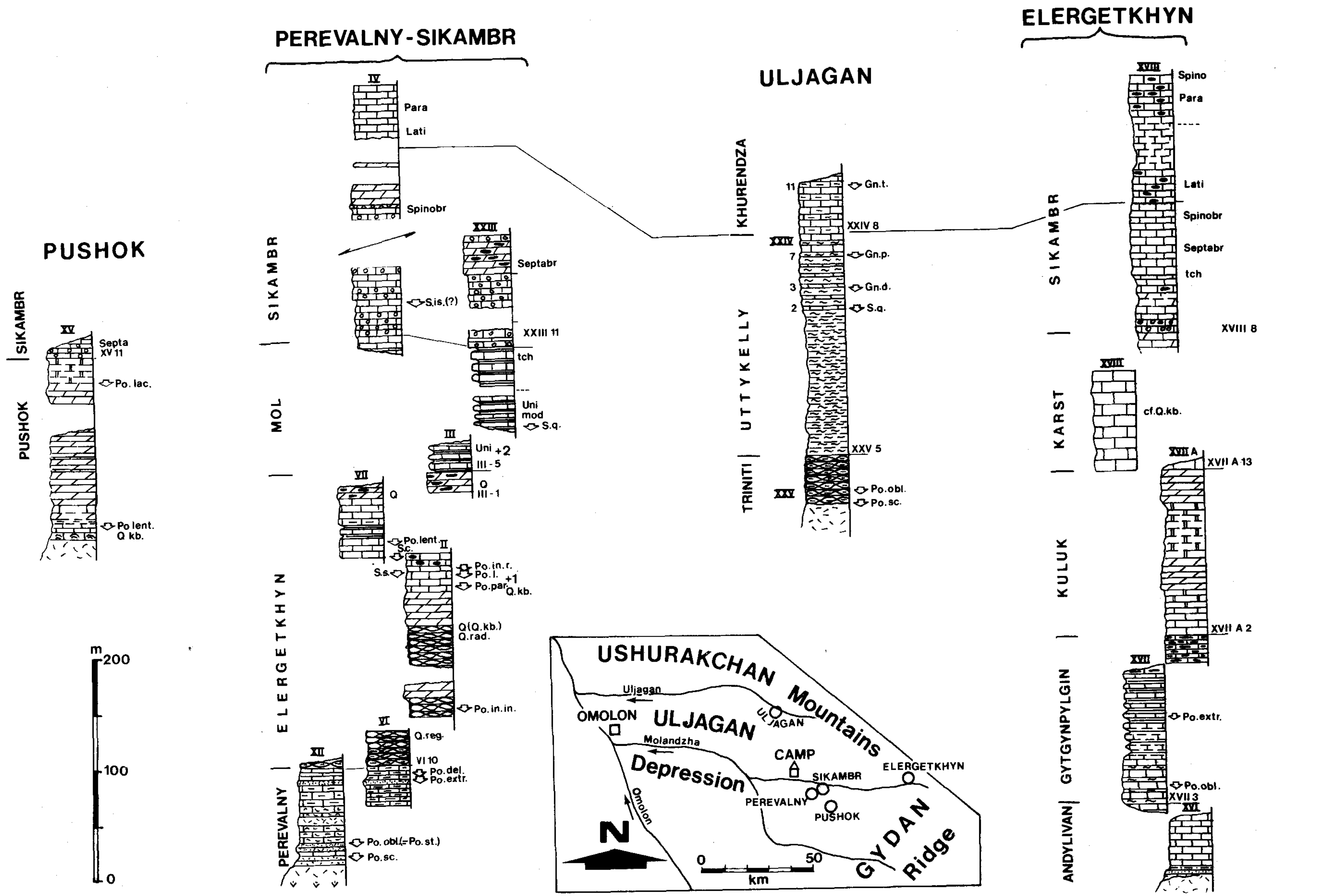


Figure 7

Lithological columns and important fossil horizons (foraminifers, spores (+1, +2) and conodonts ◁) of upper Famennian and Tournaisian age at Pushok, Perevalny/Sikambr, Uljagan and Elergetkhyn. For legend of lithological symbols see figure 5.

Lithology and depositional environment

Lower portion consisting of two, intensively silicified biostromal limestones with corals and stromatoporoids, separated by fault. The top of these biostromes is characterized by the occurrence of dissication cracks and silicified anhydrite nodules, suggesting extinction of the biostrome under supratidal conditions. Higher upward a thick dolomitic sequence occurs, partly in outcrop, partly in debris. Apparent rhythmic alternation of coral-enriched levels, finely laminated probably algal dolostones and horizons with silicified anhydrite nodules occur in ascending order (fig. 12), suggesting rhythmic sedimentation under very shallow marine subtidal to supratidal conditions.

5.1.2.- Sikambr suite

Base

Base of oolitic limestones overlying dolostones in Pushok section (XV-11).

Top

Top not exposed in Pushok section.

Thickness

Only 12 m are exposed, sequence incomplete due to erosion.

Age

Foraminifers of *Septabrunsiina* subzone. " Middle Tournaisian" corals and brachiopods.

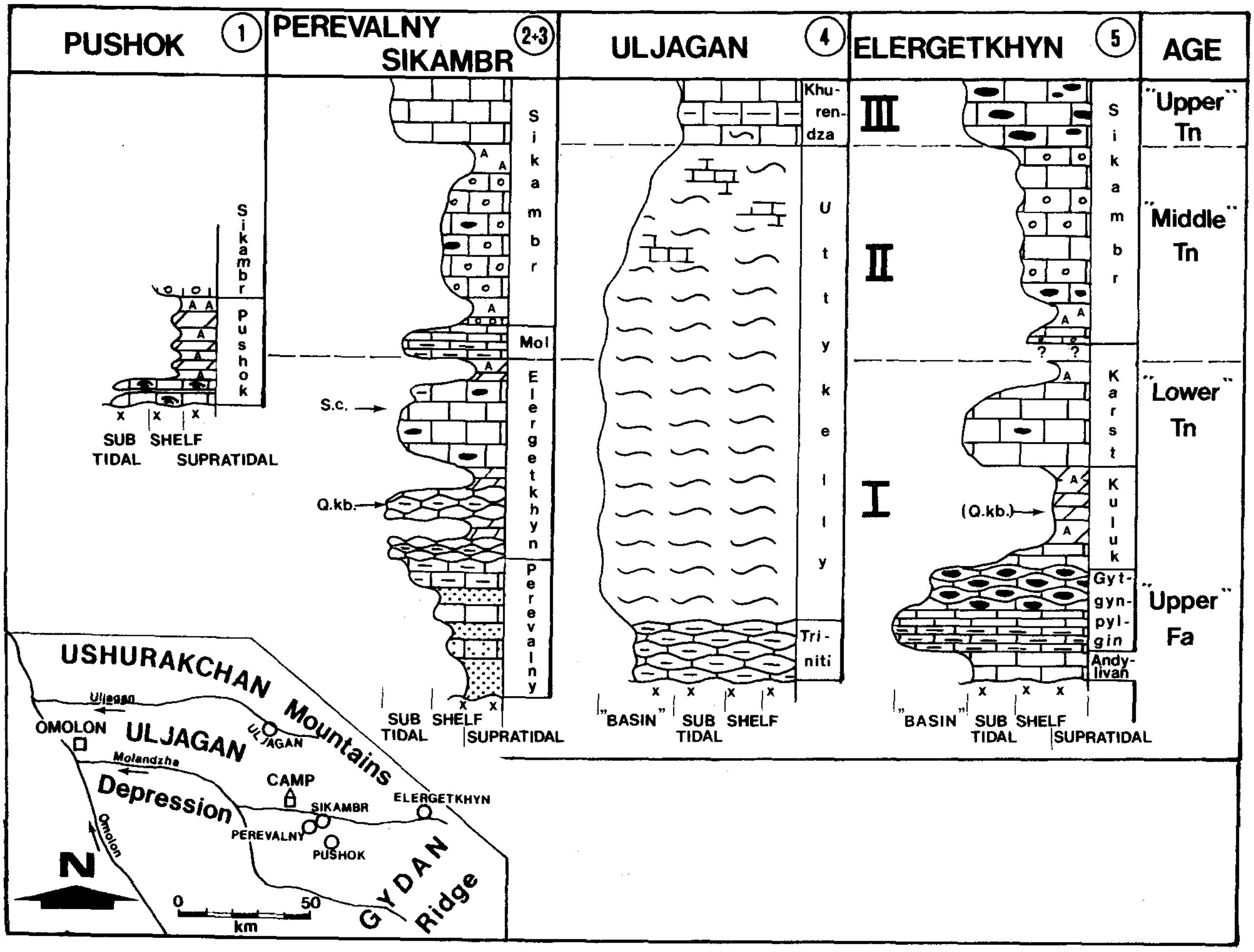


Figure 8

Interpretation of depositional environments in different sections in the northeastern part of the Omolon Massif.

Lithology and depositional environment

Oolitic, intraclastic and bioclastic limestones which presumably have been deposited in very shallow marine, subtidal to intertidal, high-energy facies.

5.2.- PEREVALNY/SIKAMBR

This area is located on the southern flank of the Uvnukveem Half-graben, a structure consisting of several hemianticlines and hemisynclines. The Upper Famennian and Tournaisian deposits in the Oder (Pl. 3), Nizhnenaled (Pl. 4), Verkhnenaled (Pl. 5), Povorotny, Beregovoy and Ustyevoy (Pl. 6) sections occur within the pericline and northwestern flank of the so-called Perevalny hemianticline (fig. 13). The core of this hemianticline consists of variegated volcanites (sub-alkaline and potassic liparites) of the Pylkatveem suite of presumably Frasnian age. Several east-west directed faults have been observed in the pericline, whereas the hemianticline is bound to the north-east and south-west by north-west directed faults, subparallel to the main strike of this structure. Lower Cretaceous volcanites are unconformably overlying the Upper Famennian and Tournaisian deposits on the right slope of the valley (fig. 13). The composite section of the Upper Famennian and Tournaisian deposits in the Perevalny Valley is supplemented by the sections of the Sikambr Creek and Sikambr Mountain, some 3 km to the east (Pl. 1). The deposits belong to (in ascending order) the Perevalny, Elergetkhyn, Mol and Sikambr suites.

5.2.1.- Perevalny suite

Base

Coarse-grained, reddish sandstones and gravel sandstones. Oder section (XII-1).

Top

Top of thick-bedded, argillaceous limestones below nodular limestones in Nizhnenaled section (VI-9).

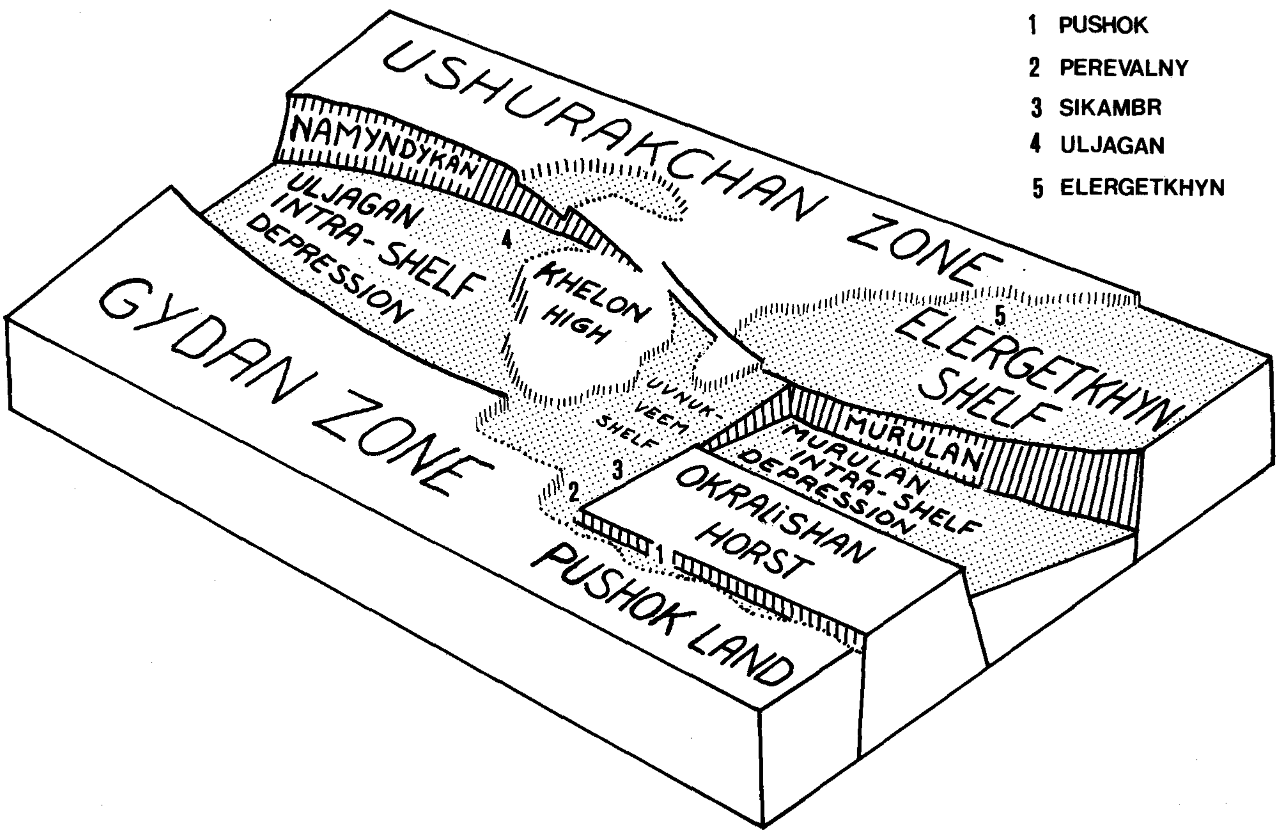


Figure 9

Idealized block-diagram of northeastern part of Omolon Massif during "Middle Tournaisian" times.

Thickness : 80-90 m.

Age

Lower part of section has yielded the conodont *Polygnathus semicostatus* indicating presence of the *Scaphignathus velifer* zone, and slightly higher conodonts of the *Polygnathus obliquicostatus* local zone. In the upper part of this suite, conodonts of the *Polygnathus extralobatus* local zone (presumably equivalent of the lower *Bispathodus costatus* zone in Western Europe) have been recognized. Ostracodes and brachiopods throughout this suite suggest a Late Famennian age.

Lithology and depositional environment

Coarse-grained sandstones, sometimes gravelitic, with rare carbonate intercalations, presumably deposited in shallow-marine *nearshore* environment, passing upward into more fine-grained sandstones and siltstones with frequent nodular carbonate intercalations. These strata are overlain by sandy/silty carbonates with shale partings (well exposed in Nizhnenaled section, VI-1/9) suggesting progressive deepening of environment.

5.2.2.- Elergetkhyn suite

Base

Base of nodular limestones overlying massive-bedded argillaceous limestones in Nizhnenaled section (VI-10).

Top

Top of cherty dolomite below limestone unit with shale intercalations in Beregovoy section (III-4).

Thickness : ± 250 m.

Age

Foraminifers indicate presence of, respectively, *Quasiendothyra regularis, Quasiendothyra* subsp. *radiata* and *Quasiendothyra kobeitusana* subzones in this suite. The conodonts belong to, respectively, the *Polygnathus inornatus inornatus* local zone in the lower part of the suite (Ustyevoy section II-2), and the *Polygnathus parapetus* to *Polygnathus lenticularis* local zones in the middle part of this suite (Ustyevoy section II-16/24 ; Verkhnenaled section VII - 1/15).
Siphonodella sulcata occurs in the Ustyevoy section in bed II-21, whereas *Siphonodella cooperi* has been found in the same section in bed II-24. In the uppermost portion of this suite, in the Verkhnenaled section (VII-15), the conodont *Pseudopolygnathus triangulus inaequalis* has been detected. Below bed II-12, several horizons with "Strunian" brachiopods occur. In the middle portion of this suite *Omolonospirifer* occurs, whereas an *Ectochoristites* brachiopod assemblage has been recognized in the uppermost portion of the Elergetkhyn suite. Throughout this suite, many so-called "Strunian" stromatoporoids have been found. In the middle and upper part of this suite "Lower Tournaisian" tabulate and rugose corals occur. A bentonite bed in the Ustyevoy section (II-18) has yielded miospores, probably of the "VI" miospore zone.

Lithology and depositional environment

The lower portion consists of nodular limestones with shale intercalations (Nizhnenaled section VI-10/14; Ustyevoy section II-1/3 and II-8/11). Two dolomite intervals occur (Ustyevoy section II-4/6 and II-12/14), suggesting short but rapid changes in the environment, which ranged from relatively deep marine subtidal offshore shelf for the nodular limestones to intertidal or maybe even supratidal facies for the dolomites. The upper portion of this suite consists of bioclastic limestones with thin shale intercalations grading upward into dolomites with some cherts and silicified anhydrite nodules in the uppermost portion (Verkhnenaled section VII-19/20 and Beregovoy section III-1/4), suggesting an upward transition from marine subtidal offshore to intertidal of even transitory supratidal conditions.

5.2.3.- Mol suite

Base

Base of limestones with shale intercalations overlying cherty dolomite in Beregovoy section (III-5).

Top

Massive, bioclastic limestone underlying oolitic limestones in Sikambr section (XXIII-10).

Thickness : ± 125 m.

Age

Lower portion contains foraminifers of assemblage "3" belonging to basal part of *Chernyshinella* complex. Foraminifers of assemblage "4" (with *Palaeospiroplectammina tchernyshinensis*) of the same complex occur in the upper half of this suite. The conodont *Siphonodella quadruplicata* occurs throughout this suite, as well as the rugose coral species *Siphonophyllia cylindrica* (indicative of "Middle Tournaisian").

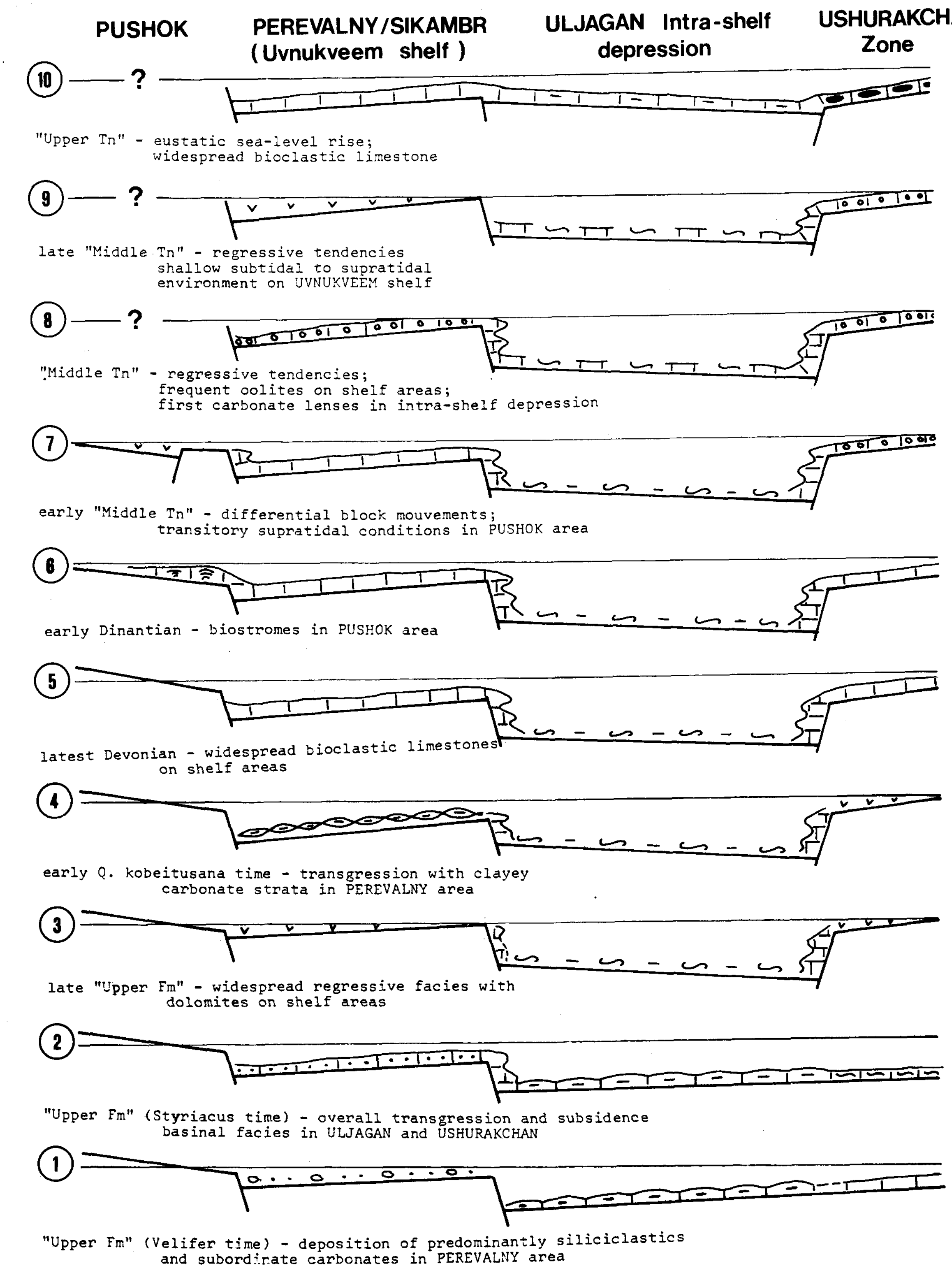


Figure 10

Depositional environment and relative water depth during Upper Famennian and Tournaisian times in idealized section between Pushok and Ushurakchan Zone in northeastern part of Omolon Massif.

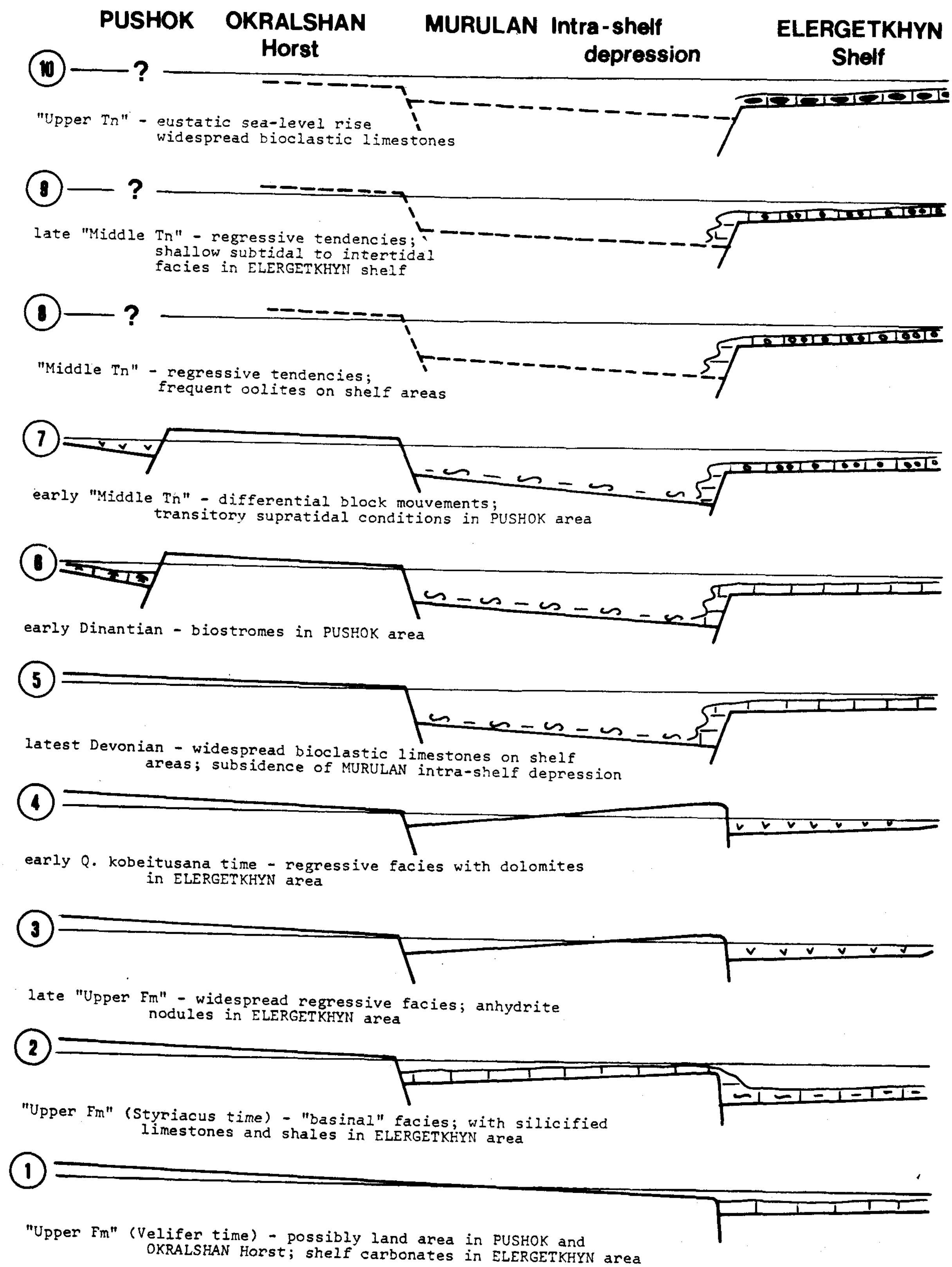


Figure 11

Depositional environment and relative water depth during Upper Famennian and Tournaisian times in idealized section between Pushok and Elergetkhyn in northeastern part of Omolon Massif.

Lithology and depositional environment

Alternation of shales and dark, sometimes nodular, silicified and/or pyritous limestones which grade upward (near the top) into a more massive, bioclastic limestone. A shallow marine, subtidal shelf environment is suggested with possibly slight variations in the relative depth.

5.2.4.- Sikambr suite

Base

Base of oolitic limestone overlying massive, bioclastic limestones in Sikambr section (XXIII-11).

Top

Top not exposed in Povorotny section (IV).

Thickness

At least 200 m (top eroded in Povorotny section).

Age

Lower part of suite with oolitic to intraclastic limestones and evaporitic horizons has yielded foraminifers of, respectively, the *Septabrunsiina* and *Spinobrunsiina* assemblages (belonging to upper part of *Chernyshinella* complex). The intraclastic to bioclastic limestones in the upper portion of this suite have yielded foraminifers belonging to, respectively, the assemblages with *Latiendothyranopsis latispiralis* and *Paraendothyra* (belonging to the *Latiendothyranopsis-Spinoendothyra* complex). The conodonts in the lower portion of this suite probably belong to the *Siphonodella isosticha* subzone. The lower portion of this suite has yielded the brachiopods *Palaeochoristites cinctus* and *Spirifer karagandae.* Corals suggesting a "Middle" to "Upper Tournaisian" age occur in the Sikambr suite of Perevalny/Sikambr.

Lithology and depositional environment

Lower portion consisting of oolitic limestones which grade upward into an alternation of intraclastic to oolitic limestones with at the top dolostones with silicified anhydrite nodules (Povorotny section) or into dolostones and oolitic dolostones with many silicified anhydrite nodules (Sikambr section). These strata are overlain by a succession of algal calcilutites alternating with zebra limestones (Povorotny section). Silicified anhydrite nodules also occur in these strata. Towards the top, intraclastic to bioclastic limestones occur. A regressive trend grading from shallow marine subtidal high-energy facies for the oolitic limestones into restricted intertidal to supratidal facies for the dolostones is apparent. The general environment seems less restricted in the Povorotny section than in the Sikambr section. The presence of the algal limestones and zebra limestones in the Povorotny section suggests that regressive intertidal to supratidal sedimentation conditions continued. The intraclastic and bioclastic limestones in the upper portion of the Sikambr suite indicate a slight deepening of the environment into a rather shallow marine subtidal facies.

5.3.- ULJAGAN

The sections Triniti (XXV) and Bazov (XXIV ; Pl. 7a) are located along the southern banks of the middle course of the Uljagan river. This area is on the periclinal part of the Khelon hemianticline. The Khelon hemianticline is about 30 km in lenght and 10-15 km in width. Variegated volcanites of the Pylkatveem suite occur in the core. These have been intruded by several Lower Cretaceous diorites and granodiorites. The Pylkatveem volcanites are overlain by Upper Famennian and Tournaisian carbonates and siliciclastics which have been deposited under relatively deep marine conditions within the Uljagan Intrashelf Depression, bound to the north-east by the Murulan and Namyndykan faults (fig. 6). This depression separates the Ushurakchan and Gydan zones.

5.3.1.- Triniti suite

Base

Base of nodular limestones overlying volcanogenic rocks in Triniti section (XXV-2).

Top

Top of nodular limestones underlying black, silicified shales in Triniti section (XXV-4).

Thickness : 40-50 m.

Age

Lowermost part characterized by occurrence of conodonts belonging to the *Polygnathus szulczewski* (= *velifer* zone of Western Europe) and *Polygnathus obliquicostatus (= styriacus* zone of Western Europe) local zones.

Lithology and depositional environment

Nodular limestones with shale intercalations comparable to those described in Belgium (Ourthe

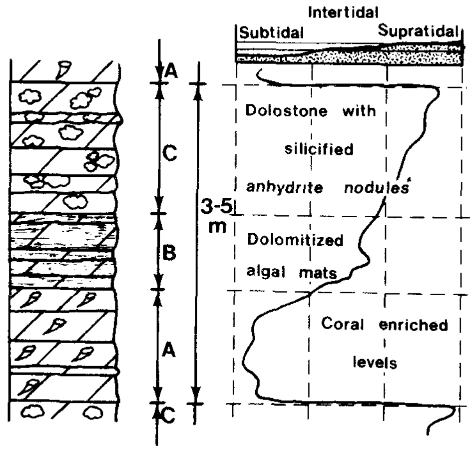


Figure 12

Idealized rhythm of Pushok suite at Pushok showing upward sequence of coral-enriched carbonates passing through dolomitized algal mats into dolostone with silicified anhydrite nodules, suggesting repeated change from subtidal through intertidal into supratidal facies.

Valley) as "Souverain-Pré" deposits. Presumably, these sediments have been deposited in a relatively "deep" marine offshore shelf environment.

5.3.2.- Uttykelly suite

Base

Base of silicified black shales in Triniti section overlying nodular limestones (XXV-5).

Top

Top of silicified black shales below massive-bedded crinoidal limestone in the Bazov section (XXIV-7).

Thickness : ± 200 m.

Age

In upper half of this suite conodonts and foraminifers have been recognized in limestone lenses. The lowermost limestone (XXIV-2) has yielded the conodont *Siphonodella quadruplicata.* Bed XXIV-3 yielded the conodont *Gnathodus delicatus* and bed XXIV-7 *Gnathodus punctatus.* A poor foraminifer assemblage, indicating a "Tournaisian" age, has been discovered in bed XXIV-4.

Lithology and depositional environment

Phthanites and black silicified shales with isolated lenses and nodules of thin limestones, suggesting a marine basinal environment comparable to that of the silicified "Kulm" shales in the Ruhr Basin of the Federal Republic of Germany.

5.3.3.- Khurendza suite

Base

Well-bedded, poorly silicified crinoidal limestone overlying silicified black shales in Bazov section (XXIV-8).

Top

Top not exposed in Bazov section (XXIV-11).

Thickness : at least 50 m (top not observed).

Age

In the upper part of this suite, the conodont *Gnathodus typicus* occurs in bed XXIV-11.

Lithology and depositional environment

Well-bedded crinoidal limestones with brachiopods and bryozoans suggesting a marine subtidal shelf environment.

5.4.- ELERGETKHYN

The area is located south of the Elergetkhyn Lakes (Pl. 7b) on the northern flank of the Elergetkhyn Half-graben. This half-graben is some 35-40 km in lenght and has a width of only 7 to 10 km. To the north-east, this structure is bound by the Ushurakchan fault, and to the south-west by the Murulan fault (fig. 6). Upper Devonian, red-coloured volcanites of the Talalakh suite are exposed on the northern and north-eastern flanks of this structure. These are overlain by, respectively, Upper Famennian, Dinantian and younger Paleozoic and Mesozoic rocks. The Upper Famennian and Dinantian are well exposed in a large, south to south-west dipping monocline (dip 25^o–30^o). In some fault zones in the eastern part of the studied area, the dip of the beds may be up to 60^o–70^o. The deposits have been studied in the Livan (Pl. 8) Gytgynpylgin (Pl. 9) and Karst Mountain (Pl. 9-10) sections.

5.4.1.- Andylivan suite

Base

Base of bioclastic limestones overlying volcanic rocks in Livan section (XVI-1).

Top

Top of bioclastic limestones below well-bedded

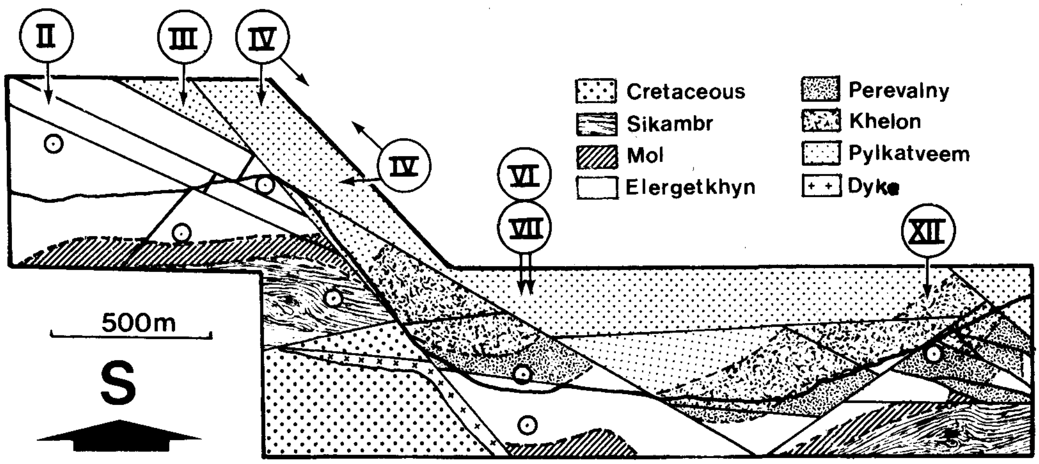


Figure 13.- Geology of the Perevalny area and location of studied sections.

silicified limestones with shale intercalations in Gytgynpylgin section (XVII-2).

Thickness : 70 to 120 m.

Age

Unilocular foraminifers belonging to assemblage "1" with *Umbellina, Bisphaera* and *Diplosphaerina.* Upper Famennian brachiopod species such as *Cyrtospirifer tschernyshevi, Zigania ursus* and *Athyris tau.*

Lithology and depositional environment

Brachiopod, stromatoporoid and subordinate coral-bearing limestones suggesting a marine subtidal shelf facies.

5.4.2.- Gytgynpylgin suite

Base

Base of well-bedded, silicified limestones with shale intercalations in the Gytgynpylgin section (XVII-3).

Top

Top of silicified nodular limestones with cherts in the Gytgynpylgin section (XVII-A-1).

Thickness : ± 150 m.

Age

Foraminifers belonging to assemblage "1" with *Diplosphaerina.* Rugose coral *Nalivkinella profunda* and brachiopods suggesting Upper Famennian age. Near the base, the conodont *Polygnathus obliquicostatus* occurs, whereas in the middle portion of this suite the conodont species *Polygnathus extralobatus* has been recognized.

Lithology and depositional environment

Lower portion consisting of uniformly thin-bedded alternation of silicified limestones and shales with rare macrofossils, except abundant large fragments of presumably floating, marine non-calcareous algae, suggesting marine "basinal" facies. These grade into turbiditic limestones in the middle portion of this suite. The upper portion (in XVII-A-1) is characterized by silicified nodular limestones with cherts, and has been deposited probably in relatively deep marine offshore shelf facies.

5.4.3.- Kuluk suite

Base

Irregularly bedded, intraclastic limestones with rare silicified anhydrite nodules overlying nodular limestones with cherts in Gytgynpylgin section (XVII-A-2).

Top

Top of red-coloured dolomites underlying bioclastic, stromatoporoid-bearing limestones in the Gytgynpylgin section (XVII-A-12).

Thickness : ± 150 m.

Age

In the middle portion of this suite, the foraminifer *Quasiendothyra kobeitusana* has been discovered.

Lithology and depositional environment

Lower portion consisting of not well-bedded, intraclastic limestones with irregularly distributed, silicified anhydrite nodules, grading upward into dolomitized limestones and red-coloured dolomites with silicified algal mats and silicified anhydrite nodules. Near top of this sequence, a dolostone breccia occurs. This sequence suggests a depositional environment ranging from marine intertidal/subtidal to intertidal/supratidal. An evaporitic collapse origin for the dolostone breccia near the top of this suite seems probable.

5.4.4.- Karst suite

Base

Light-grey limestone with stromatoporoids overlying dolomites in Gytgynpylgin section (XVII-A-13).

Top

Base of the coarse oolitic limestones in Karst Mountain section (XVIII-8).

Thickness : More than 90 m (top not seen due to a fault).

Age

Foraminifers of *Quasiendothyra* ex gr. *kobeitusana* and stromatoporoid genus *Actinostroma* indicating "Strunian" age.

Lithology and depositional environment

Lower portion consisting of thick-bedded, massive bioclastic limestones with occasionnally some silicified stromatoporoids suggesting a marine, relatively shallow subtidal shelf facies. In the upper portion, which has been recognized only in debris throughout the Elergetkhyn area, quartz nodules pseudomorphic after anhydrite occur in the limestones. These suggest a regressive tendency towards intertidal/supratidal facies.

5.4.5.- *Sikambr suite*

Base

Coarse oolitic limestone bed in Karst Mountain section above fault (XVIII-8).

Top

Top of bioclastic limestones with massive cherts in top of Karst Mountain section (XVIII-21).

Thickness : More than 240m (top obscured by dyke).

Age

Oolitic and intraclastic limestones in lower half of suite have yielded foraminifers belonging to, respectively, the assemblages "5" and "6" (with *Septabrunsiina* and *Spinobrunsiina*), whereas foraminifers characteristic of the assemblages "7", "8" and "9" (belonging to the *Latiendothyranopsis-Spinoendothyra* complex) have been observed in the bioclastic limestones with cherts in the upper half of this suite. A rich brachiopod and coral assemblage in the bioclastic limestones with cherts in the upper half of this suite indicates an "Upper" Tournaisian age. Characteristic are large rugose corals, such as *Uralinia,* as well as the brachiopods *Stegacanthia sibirica, Pustula altaica, Tolmatschoffia robusta, Tomiproductus elegantulus* and *Spirifer attenuatus.*

Lithology and depositional environment

Lower portion consisting of oolitic, intraclastic and bioclastic limestones. Near the base (at position of bed XVIII-10), dark limestones with quartz nodules pseudomorphic after anhydrite and corals occur in the debris (also recognized at the same lithostratigraphic position in debris in other sections of the Elergetkhyn area), suggesting an environment oscillating between shallow marine and supratidal conditions. The upper portion (starting in bed XVIII-14) consists of bioclastic, frequently coral/brachiopod-bearing limestones with cherty horizons, presumably deposited in a subtidal facies.

6.- BIOSTRATIGRAPHY AND PALEOMAGNETISM

The very intricate structural-sedimentary history of the Famennian-Tournaisian deposits in the Omolon Massif can be unraveled only by means of detailed investigations on the successions of the different fossil assemblages.

Actually, the following fossil groups have been or are being studied :

- **Miospores**
- **Microfossils** (foraminifers, conodonts, ostracodes)
- **Megafossils** (stromatoporoids, tabulate and rugose corals, brachiopods, gastropods and lamellibranchs, crinoids).

Unfortunately, the sediments have yielded only a few cephalopods and trilobites, useful guides for the Famennian and Tournaisian strata on the Russian Platform, in Western Europe and in North America.

Moreover, a start has been made to study the paleomagnetic reversals in this area. Comparison of biostratigraphic and paleomagnetic data may provide an excellent tool for long-distance correlations.
However, much work is still to be done as will be shown briefly in the chapters dealing with the different fossil groups and paleomagnetic data.

6.1.- MIOSPORES

A total of 52 samples collected in 1981 and 1983 in the Upper Famennian and Tournaisian shales of different sections has been macerated. Most of them do not contain any specifically recognizable palynomorphs. This is probably the result of the presence of numerous volcanic intrusions which might have contribute to some extend to the destruction of the fossils.

Two samples however contain better preserved material.

One sample (+ 1 on fig. 7) was taken in the Ustyevoy (II) section, some 7.5 metres (not 6 m. as mentioned wrongly in Conil *et ál.*, 1982) below the first specimen of *Siphonodella sulcata* (Smirnova *et al.*, 1979 II, 18˙). It contains an assemblage of spores listed below : *Aneurospora greggsii, Auroraspora asperella, Convolutispora oppressa, Diducites poljessicus, Empha-*

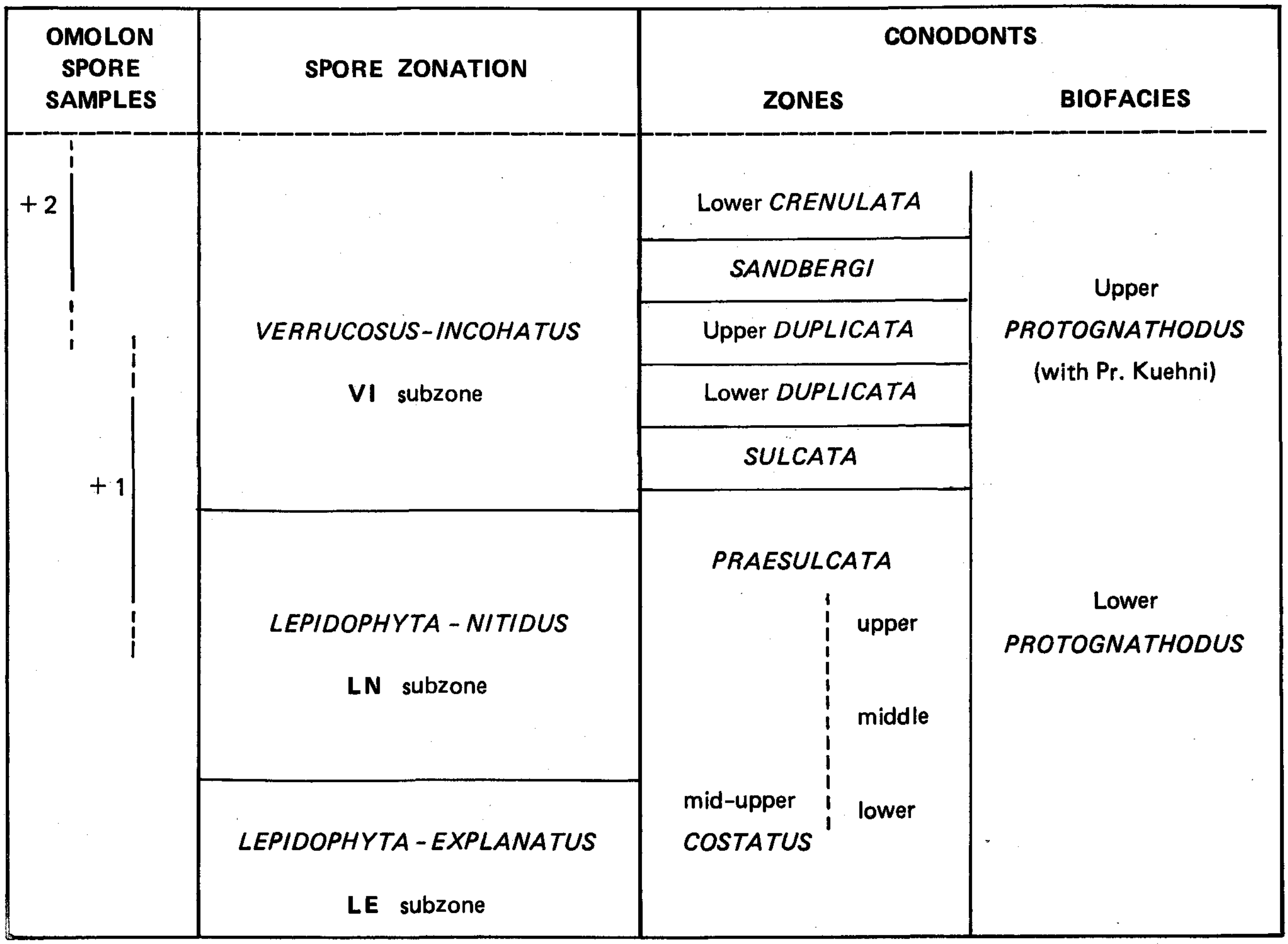


Figure 14

The Omolon spore samples compared to the Irish spore succession and their correlation with the conodont zonation in Germany (after Higgs & Streel, 1983).

nisporites rotatus, Grandispora echinata, Pustulatisporites div. sp., *Raistrickia* cf. *spathulata, Raistrickia* sp., *Retusotriletes incohatus, Verrucosisporites depressus, Verrucosisporites nitidus.* This assemblage probably belongs to the uppermost part of the LN subzone or to the VI subzone of the Irish spore succession. See the discussion and illustration of specimens in Conil *et al.*, 1982, p. 148 and plate IV.

The other sample (+ 2 on fig. 7) is from the Beregovoy (III) section taken more or less 5 metres above the base of the Mol Suite. The spores are poorly preserved but the following species have been identified : *Convolutispora oppressa, Grandispora echinata, Pustulatisporites* div. sp., *Raistrickia* sp., *Verrucosisporites depressus.* This assemblage is partly similar to the former one but lacks *Verrucosisporites nitidus* and therefore might also belong to the VI subzone. Poorly preserved specimens of *Kraeuselisporites* might indicate the middle portion of the VI subzone matching the *crenulata* conodont zone.

This sample also contains a few acritarchs with *Micrhystridium* div. sp. and also several species of *Gorgonisphaeridium,* a typical genus of the Devonian/Carboniferous transition beds. The probable stratigraphical position of both samples is compared with the Irish spore succession on fig. 14.

6.2.- FORAMINIFERS

The Omolon Massif is a key area for the study of foraminifers (Yuferev, 1979 ; Conil *et al.*, 1982). Three foraminifer complexes have been distinguished. These can be compared to those of the classic areas of Eastern and Western Europe (fig. 15). In all these regions, there seems to exist a close relationship between the sedimentary megasequences and the foraminifer complexes. These reflect changes of provincialism and thus of paleogeography.

In detail, nine foraminifer assemblages have been recognized (Conil *et al.*, 1982). A temptative regional biozonation is proposed here.

First megasequence Fa(2) - T(1); Fa2c-Tn1b belg. auct.

This sequence starts with the Upper Famennian transgressions since *velifer* conodont times and ends with an evaporitic phase at the end of the Lower Tournaisian (within the *sandbergi* conodont zone). Two main foraminifer assemblages can be recognized : assemblage "1" with unilocular foraminifers and assemblage "2" with *Quasiendothyra.*

Four subzones may be distinguished within the *Quasiendothyra* assemblage, which shows Eurasiatic affinities, but also some mild endemic characteristics. The colonisation in the area is very progressive. The following stages are distinguished :

- Appearence of uniloculars : *Diplosphaerina, Bisphaera* (assemblage "1")
- Fa(2) β : *Quasiendothyra communis* and *Septabrunsiina.* Only the top of this subzone has been identified in the Omolon area
- Fa(2) γ : Appearance of *Quasiendothyra regularis*
- Fa(2) δ : Appearance of radiated *Quasiendothyra* (subsp. *radiata*)
- Fa(2) ϵ : Appearance of *Quasiendothyra kobeitusana kobeitusana*
- Appearance of *Chernyshinella glomiformis* (at the same level as in Western Europe).
- Sudden abundance of *Quasiendothyra,* appearance of *Endothyra* ex gr. *parakosvensis* and *Paracaligelloides.* These characteristics remain constant until the top of the megasequence. No lithological or ecological changes have been observed between the beds just below *Siphonodella sulcata* and the lower part of the *sandbergi* conodont zone.

The endemism affects the Endothyridae, Tournayellidae and large *Quasiendothyra,* which are not so abundant and diversified as in the Franco-Belgian Basin. The appearance of some large *Quasiendothyra* and *Klubovella* in the upper part of this zone has not yet been confirmed.

The comparison with Western Europe by means of conodonts clearly shows a prolongation of the *Quasiendothyra* complex into the *sandbergi* conodont zone (Simakov, 1979). In the Franco-Belgian Basin, this complex suddenly disappears well below the *duplicata* zone. In Avesnois (NE-France), it is replaced by the appearance of the *Chernyshinella* complex (Conil & Lys, 1970).

Second megasequence T(2); Tn2a-Tn2c belg. auct.

Renewed transgression on a more uniform substrate leveled by the sediments of the first megasequence. Period of tectonic stability. Many argillaceous layers in the lower part. This megasequence comprises the lower *Siphonodella crenulata* to the upper *Siphonodella* (with *Gnathodus delicatus*) conodont subzones, as well as the foraminifer assemblages "3" to

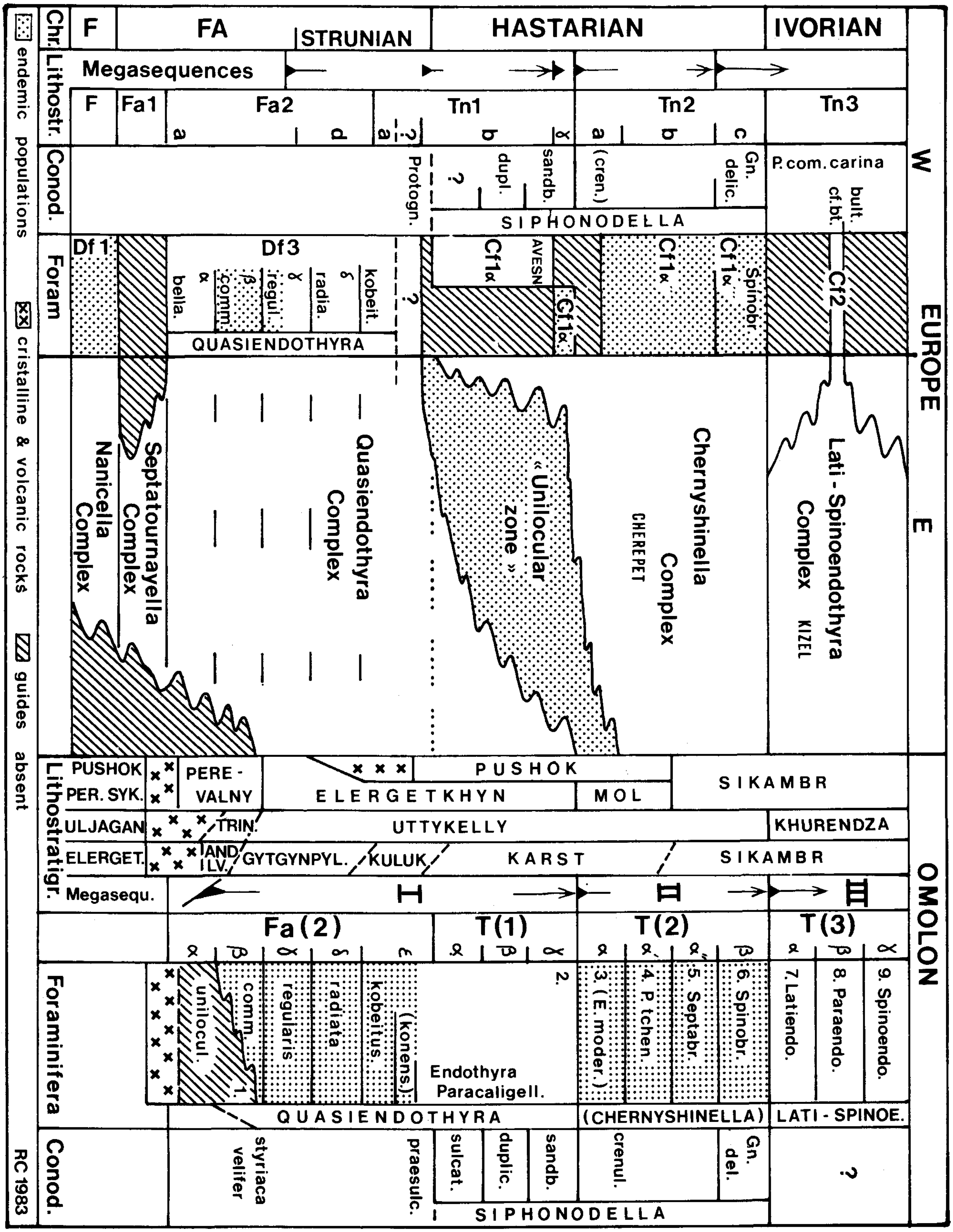


Figure 15

Correlation of lithostratigraphic and biostratigraphic (conodonts and foraminifers) zones in Western and Eastern Europe with those of Omolon Massif.

"6" of the *Chernyshinella* complex. This complex is endemic, of Omolon type, and characterizes a megasequence with frequent occurrence of evaporites and very shallow water deposits.

Four assemblages have been recognized in the *Chernyshinella* complex, of which the lower three are introduced in this paper :

- T(2) α : Assemblage "3". Characteristic elements of the *Quasiendothyra* complex have disappeared suddenly *(Quasiendothyra, Paracaligelloides)* ; uniloculars and *Earlandia* are more abundant. *Endothyra* and Tournayellidae *(Septatournayella, Septabrunsiina)* remain present, but rare, in the lower part of this subzone.
- T(2) α' : Assemblage "4". The abundance of *Palaeospiroplectammina tchernyshinensis* and the presence of large *Endothyra parakosvensis* characterize this phase of the colonisation.
- T(2) α'' : Assemblage "5". The Tournayellidae become more abundant and diversified. *Septabrunsiina* are well developed. New Endothyridae (new taxa ?) appear. Areas with alternating oolitic and evaporitic facies contain a poor assemblage (Sikambr section) in comparison with other areas where bioclastic and oolitic sediments alternate (Elergetkhyn section).
- T(2) β : Assemblage "6". Appearance of *Spinobrunsiina.* This feature is known both in Western Europe and the Omolon region, in the *Siphonodella* + *Gnathodus delicatus* conodont subzone (Cc1 γ).
- The "unilocular zone", which separates the *Quasiendothyra* and *Chernyshinella* complexes, has not the same stratigraphic range throughout Eurasia. It depends on the time of disappearance of the *Quasiendothyra* complex and on local conditions of recolonisation. Some paleogeographic changes probably complicate this problem. A correlation between the base of the Omolon T(2)-strata and the Franco-Belgian sequences might be located somewhere in the "Tn1bγ" or in the lower "Tn2a" of the latter.

Third megasequence T(3) ; Tn3a-b-c partim belg. auct.

The sediments of this possibly eustatic transgression are essentially bioclastic with rich and diversified foraminifer assemblages. This megasequence comprises the Upper Tournaisian.

It is characterized by the *Latiendothyranopsis–Spinoendothyra* foraminifer complex with Uralian affinities. This complex is subdivided in three subzones. All are characterized by large *Latiendothyranopsis latispiralis, Septabrunsiina, Spinobrunsiina* ex gr. *implicata, Granuliferella* and *Earlandia minor.*

- T(3) α : Assemblage "7". Appearance of *Latiendothyranopsis latispiralis*
- T(3) β : Assemblage "8". Appearance of large *Paraendothyra, Tournayella discoidea* and *Plectogyranopsis. Umbellina* and *Bisphaera irregularis* are still present. Zone Cf2 of Western Europe.
- T(3) γ : Assemblage "9". Appearance of *Spinoendothyra, Tuberendothyra, Spinobrunsiina* aff. *ramsbottomi,* cf. *Bessiella.*

6.3.- STROMATOPOROIDS

Stromatoporoids are common in the Upper Famennian and Strunian strata of the Omolon Massif.

Species belonging to the *Stylostromata* and to the *Labechiida (Rosenella)* characterize the Upper Famennian. The assemblages observed in the Omolon area are similar to those known from Novaya Zemlya and Timan.

Numerous stromatoporoid colonies occur in the lower portion of the Strunian. But these belong all to the endemic species *Atelodictyon columnarium.*

New species of the genera *Atelodictyon, Stictostroma* and *Trupetostroma* appear in the upper half of the Strunian deposits. This complex bears some similarity to the Strunian assemblages of Belgium.

6.4.- TABULATE CORALS

Rare specimens of two species of *Syringopora* occur in the middle portion of the Upper Famennian strata of the Omolon area. These species become more abundant in the latest Famennian.

A rich and more diverse assemblage of tabulate corals appears in the Lower Tournaisian. Several species of *Syringopora* occur, as well as Thecostegitidae *(Fuchungopora, Ortholites, Thecostegites),* Favositiditae *(Roemeripora, Michelinia)* and Cleistoporidae *(Yavorskia).* This assemblage resembles those observed in the Lower Tournaisian strata of Kazakhstan, Kuznetz and Donetz. The presence of *Fuchungopora,* originally described from the Visean of China, should be noticed.

Tabulate corals are practically absent in the Middle Tournaisian strata of the Omolon area. Only small colonies of *Syringopora* seem to occur.

Numerous specimens of several species of *Michelinia* occur in the Upper Tournaisian deposits of this area. The size of the colonies is variable. The largest specimens are up to 30-40 cm in diameter. The *Syringopora* species are the same as those already known in the Lower Tournaisian deposits of the Omolon region. This assemblage of *Michelinia* and *Syringopora* is well-known from other parts of the world (for example, Kuznetz, Donetz, North Caucasus, China, Western Europe, Australia).

6.5.- RUGOSE CORALS

The Upper Famennian strata in the Omolon area have yielded a.o. small solitary corals, which have been assigned to the genus *Nalivkinella* (Smirnova *et al.,* 1979). These occur in the Perevalny Suite of the Oder (XII) section, in the Lower Gytgynpylgin Suite of the Gytgynpylgin Creek (XVII) section, and in beds with conodonts of the local zones *Polygnathus szulczewski* to *Polygnathus extralobatus* of the Uvnukveem (XXII) section. This relatively poor coral assemblage shows affinities with as yet underscribed corals from the Upper Famennian (pre-Strunian) of Belgium.

The Strunian strata are characterized by a more diverse coral assemblage. In the Franco-Belgian Basin of Western Europe (including the Aachen area of the Federal Republic of Germany) this Strunian assemblage includes :

1. caninomorphic corals such as *Campophyllum flexuosum* (Goldfuss 1826) ;
2. "*Palaeosmilia aquisgranensis* group" including large *Palaeosmilia* which are attributed to *P. aquisgranensis* (Frech, 1885) sensu stricto, smaller corals showing a morphology intermediate between *P. aquisgranensis* and *Campophyllum flexuosum,* and large corals resembling *P. aquisgranensis* in transverse section but with caninomorphic longitudinal sections ;
3. corals with an axial structure such as "*Clisiophyllum*" *omaliusi* Salée, 1913 and "*Dibunophyllum*" *praecursor* Frech 1885. The latter species shows affinities with both the Frasnian *Tabulophyllum implicatum* Tsien 1976 (which sometimes possesses an axial structure) and the Dinantian *Axophyllum* Milne-Edwards & Haime 1850. This suggests that the Axophyllidae (M.-E. & H.) might have evolved from the genus *Tabulophyllum* through the Strunian species "*D.*" *praecursor.*
4. corals with Devonian affinities, such as *Tabulophyllum* sp. ;
5. long-ranging, "cosmopolitic" corals, such as *Mela-*

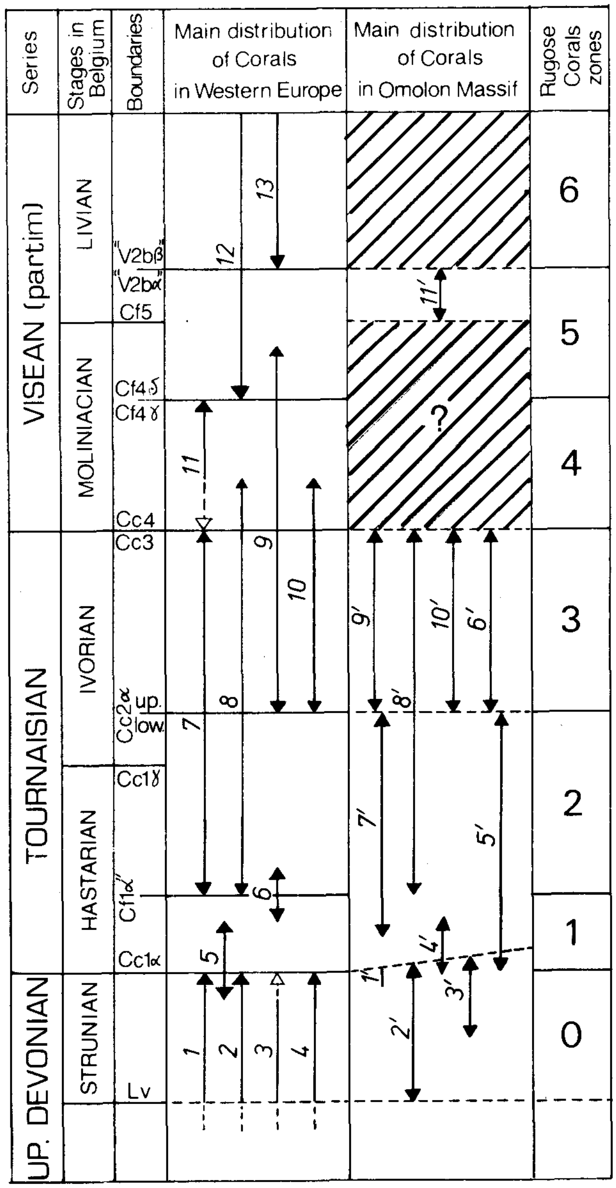


Figure 16

Comparison of the main Rugose Corals assemblages recognized in the Lower Carboniferous of Western Europe and of the Omolon Massif.

1 : Palaeosmilia aquisgranensis *group ; 2 :* Campophyllum flexuosum ; *3 :* "Dibunophyllum" praecursor -"Clisiophyllum" omaliusi *group ; 4 : genus* Tabulophyllum - *genus* Melanophyllum; *5 :* Caninia tregaensis ; *6 :* Saleelasma delepini ; *7 : genus* Lophophyllum ; *8 :* Siphonophyllia cylindrica ; *9 :* Caninophyllum patulum *group ; 10 :* Cyathoclisia modavensis ; *11 :* "Konincko-phyllum" praecursor ; *12 : genus* Siphonodendron ; *13 : genus* Lithostrotion.

1' : "Strunian" columellate corals ; 2' : genus Tabulophyllum *sensu Onoprienko ; 3' : genus* Protocaninia *Onoprienko ; 4' : genus* Molophyllum *Onoprienko ; 5' : genus* Caninophyllum *partim sensu Onoprienko ; 6' : genus* Caninophyllum *s. str. ; 7' : genus* Parasiphonophyllia *Onoprienko ; 8' :* Siphonophyllia cylindrica ; *9' : aff.* Cyathoclisia ; *10' :* Uralinia *group ; 11' : genus* Siphonodendron.

nophyllum Gorsky 1951. This genus is known from the uppermost Devonian and Carboniferous, and shows resemblances to the Devonian Stringophyllidae Wedekind 1922.

In the Omolon Massif, corals showing affinities with those of the "*Palaeosmilia aquisgranensis* group" ("*Tabulophyllum*" and "*Protocaninia*" sensu Onoprienko, 1979a) are common in "Strunian" deposits. Corals with an axial structure are extremely rare. One specimen, showing affinities with "*Dibunophyllum*" *praecursor* has been recognized in bed XV-1 of the Pushok section, whereas a second specimen has been found in bed II-21 (first occurrence of conodont *Siphonodella sulcata*) of the Ustyevoy section.

In Western Europe, this "Strunian type" coral assemblage disappears at the boundary between the Devonian and Carboniferous (boundary defined by first occurrence of the conodont *Siphonodella sulcata*), and is replaced by another coral assemblage including only caninomorphic corals of "Tournaisian type". In the Omolon area, however, these "Strunian type" corals cross the boundary (apart from the corals with an axial structure which seem to be absent in the lowermost Tournaisian) and persist in the lowermost Tournaisian (with the addition of forms such as "*Molophyllum* Onoprienko 1979a" and *Caninophyllum* sensu Onoprienko 1979a, corals of "Tournaisian type" such as "*Parasiphonophyllia* Onoprienko 1979a" and Eurasiatic forms such as "*Neokeyserlingophyllum* Onoprienko 1979a" = ? *Melanophyllum* Gorsky 1951 and/or *Vesiculophyllum* Easton 1944).

The Middle Tournaisian in Western Europe is characterized by a relatively poor coral assemblage including mainly Eurasiatic species such as *Siphonophyllia cylindrica* sensu stricto. However, the "Middle Tournaisian" coral assemblages of the Omolon Massif seem to be more diverse and include also forms already occurring in the "Lower Tournaisian". In contrast to Western Europe, there is no clear-cut boundary between the "Lower" and "Middle Tournaisian" coral assemblages.

The "Upper Tournaisian" coral assemblages in the Omolon Massif include :

1. Asiatic corals such as *Uralinia* and *Keyserlingophyllum*.
2. Eurasiatic forms such as *Cyathoclisia* and *Caninophyllum* sensu stricto, which are closely related to the Western European species.

Thus, in spite of the differences at the specific and/or generic level between the North-Eastern Siberian and Western European coral assemblages, it is possible to distinguish more or less contemporaneous assemblages, since these are characterized by a similar general structure and morphology. Therefore, an Eurasiatic coral zonation might be defined, which is not based on the stratigraphic distribution of taxa, but rather on the distribution of "morphotype" assemblages ("morphozones"). This "morphozonation" is not in contradiction with the more precise local or regional coral zones, such as those defined for the Omolon Massif (Onoprienko *in* Smirnova *et al.*, 1979) or for the Bristol and South Wales areas of Britain (Mitchell, 1980).

6.6.- BRACHIOPODS

Brachiopods are quite common in the Upper Famennian and Tournaisian deposits of the Omolon Massif. A number of local brachiopod zones has been established, which are characterized by assemblages of Productacea and Spiriferacea (Simakov, 1979).

6.7.- OSTRACODES

The study of ostracodes is far from being completed. Only the ostracode assemblages of Perevalny (Oder, Nizhnenaled, Verkhnenaled, Povorotny, Beregovoy and Ustyevoy) have been investigated into some detail. In the other areas, only spot samples have been analyzed.

Some of the results of a preliminary study of the Perevalny area have been published in the guidebooks of the excursion to the Omolon Massif (Tour IX) at the occasion of the XIV Pacific Science Congress in Khabarovsk (USSR) in August 1979 (Bushmina, 1979 ; Bushmina & Simakov, 1979 ; Tschigova, 1979). These papers are restricted to qualitative data on the ostracode assemblages from some sixty different horizons randomly distributed throughout the sequence. These data show the frequent occurrence of seven genera :

- *Bairdia* (80 o/o of the samples)
- *Bairdiacypris* (70 o/o of the samples)
- *Bairdiocypris* (60 o/o of the samples)
- *Acratia* (45 o/o of the samples)
- *Microcheilinella* (25 o/o of the samples)
- *Amphissites* (20 o/o of the samples)
- *Knoxiella* (18 o/o of the samples)

All the other genera are relatively rare and have been recognized in less than 10 o/o of the samples.

Remarkable is the apparent absence of the Eridostracan genus *Cryptophyllus* in the Famennian and

Strunian deposits of the Oder, Nizhnenaled and Ustyevoy sections. *Cryptophyllus* has a worldwide distribution in the marine shelf deposits of this age and has been described from a.o. Canada, Western Europe and the Russian Platform, as well as from Australia, Iran and Lybia where the genus ranges into the Visean.

Equally surprising is the apparent absence of many Paraparchitacean genera, in particular *Shishaella*

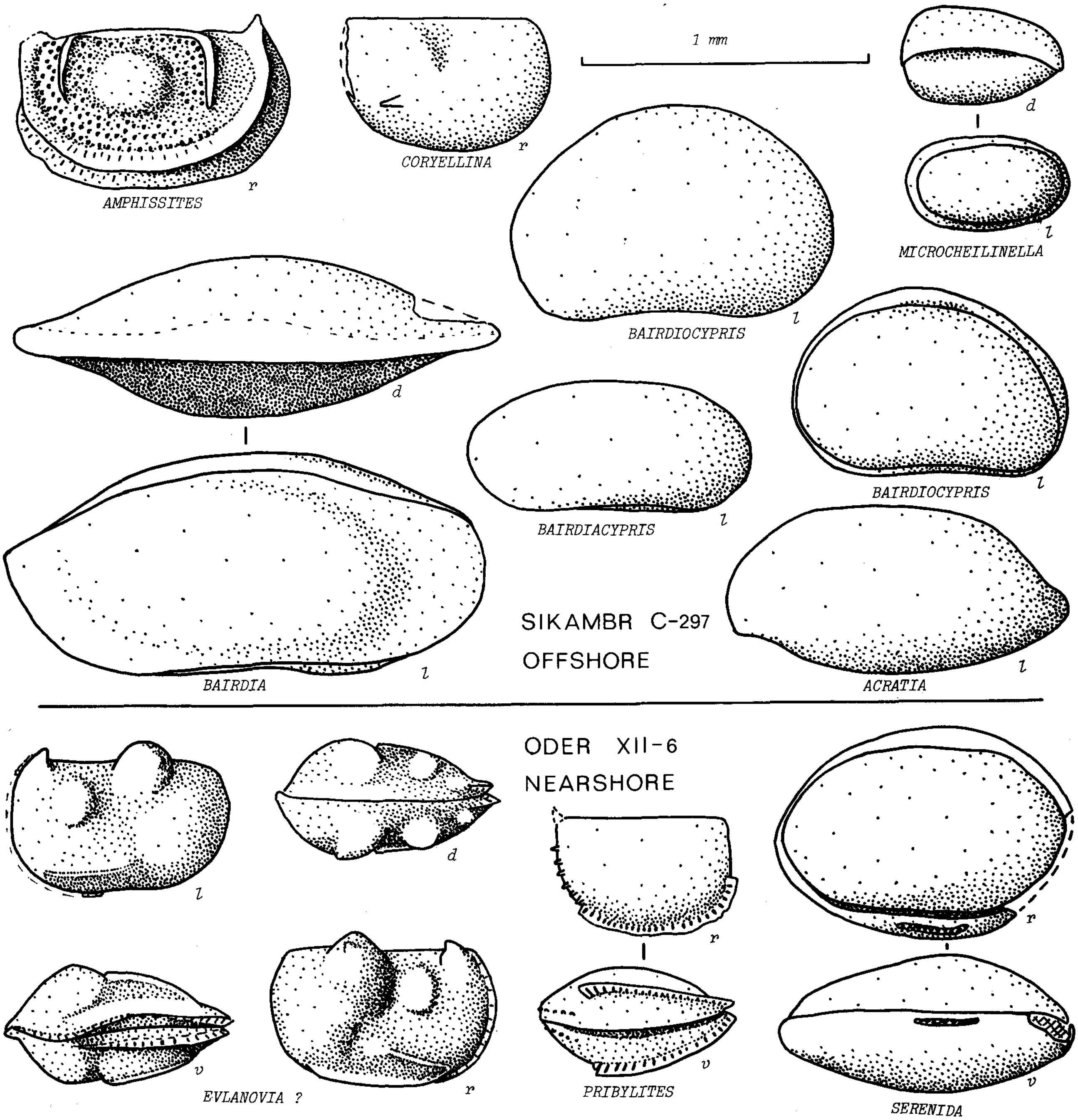


Figure 17

Representative ostracode assemblages characterizing marine nearshore and offshore shelf deposits of Upper Famennian and Tournaisian age in northeastern part of Omolon Massif.

and *Shivaella,* in the Strunian and Tournaisian deposits. At many other places in the world, these genera are frequent in strata of this age interval, where these occur in the *Bairdia-Bairdiocypris* assemblages.

Other genera, which may occur frequently in the *Bairdia-Bairdiocypris* assemblages of Tournaisian age seem to be practically absent as well. One of these is *Pseudoleperditia,* a genus common in the Lower to Middle Tournaisian marine shelf deposits of a.o. North America, Western Europe and the Russian Platform. Only some questionable specimens possibly belonging to this genus have been cited and figured from the Upper Famennian of Perevalny (Bushmina, 1979 ; Pl. 1 : 22-23).

Apparently, some important ecological barriers have prevented these ostracodes to enter the Omolon area. This suggests a strongly endemic environment. This idea is supported by the fact that many species are restricted to this area or to the North-East of the USSR.

Quantitative analysis of the Perevalny/Sikambr samples collected by Dr. N.M. Kochetkova (Geology Institute, Ufa, USSR) in 1979 and by the second author in 1983 suggests a close relationship between the composition of the ostracode assemblages and the depositional environment.

A good example is the transgressive sequence of the Perevalny suite exposed at Oder (XII) and Nizhnenaled (VI). This sequence shows a gradual change from predominantly siliciclastics (deposited in a nearshore facies) at the base into more offshore, open-marine shelf carbonates towards the top. This gradual change in facies is matched by a change in the ostracode assemblages. The assemblages from the lower half of the sequence are characterized by the presence of many weakly to strongly ornamented ostracode genera (a.o. *Carboprimitia, Selebratina, Kozlowskiella, Evlanovia?, Pribylites*) and (sometimes predominant) smooth-shelled genera (a.o. *Serenida*). In the upper half, the relatively large, smooth-shelled genera *Bairdia, Acratia, Bairdiacypris* and *Bairdiocypris* become predominant, whereas ornamented forms (a.o. *Evlanovia?, Selebratina*) are subordinate or rare. The uppermost portion of this transgressive sequence is exposed in the Nizhnenaled (VI) and Ustyevoy (II) sections in the basal portion of the Elergetkhyn suite. There, rich and diverse ostracode faunas with abundant specimens of *Bairdia* and *Bairdiocypris* have been found, which are associated with relatively large numbers of *Amphissites* and other Kirkbyacean ostracodes as well as sometimes large amounts of *Microcheilinella.* These samples have also yielded a rich and varied macrobenthos, including brachiopods, bryozoans, crinoids and small corals.

Similar examples have been described from the Upper Devonian and Carboniferous deposits of Western Europe, North America and North Africa (Bless, 1983). As a rule, relatively small and/or (slightly) ornamented ostracodes predominate in the marine nearshore shelf (sometimes restricted) environment, whereas relatively large, smooth-shelled ostracodes belonging to the genera *Bairdia* and *Bairdiocypris* characterize the more open-marine, offshore shelf. Occasionally, these *Bairdia-Bairdiocypris* assemblages are enriched by large amounts of *Amphissites* and other Kirkbyacean ostracodes (*Kummerowia, Kirkbya,* etc.), Glyptopleurids and/or Hollinellids. These enriched assemblages suggest optimal environmental conditions on a well-aerated substratum ; a suggestion which is corroborated by the often rich and diverse macrobenthos in the same samples.

6.8.- CONODONTS

Many of the guide species of the standard conodont zones as defined in Western Europe are absent or rare in the Omolon area. This concerns especially the Upper Famennian and Lower Tournaisian. Therefore, a number of local conodont zones has been established (Gagiev, 1979 a-b). These have been tentatively correlated with the standard conodont zones (Table 1).

The presence of the species *Siphonodella praesulcata* (a.o. in Nizhnenaled VI-8/10 and Ustyevoy II-9/23) and *Siphonodella sulcata* (a.o. in Ustyevoy II-21/22) should be noticed, since the IUGS International Working Group on the Devonian-Carboniferous Boundary has proposed since 1979 that the first occurrence of *Siphonodella sulcata* (preferably in a continuous sequence where the phylogenetic lineage *S. praesulcata - S. sulcata* can be observed) should be taken as the lower boundary of the Carboniferous.

6.9.- PALEOMAGNETISM

The paleomagnetic investigations in the Omolon area include studies on fluctuations of the paleomagnetic field intensity and geomagnetic reversals during the Famenno-Tournaisian period.

A coincidence has been noticed between an increased paleomagnetic field intensity and the rapid diversification of some fossil groups (such as foraminifers, corals and brachiopods) at certain intervals, for example interval II-14/16 in the Ustyevoy section

Table 1

Tentative correlation between standard conodont zones (after Sandberg 1979) and Omolon local conodont zones (after Gagiev 1979, except for names between brackets).

STANDARD CONODONT ZONES		OMOLON LOCAL CONODONT ZONES	AGE
Gnathodus typicus		*(Gnathodus typicus)*	"T3"
Siphonodella isosticha – Upper Siphonodella crenulata		*(Gnathodus punctatus)*	"T2"
		(Gnathodus delicatus)	"T2"
Lower Siphonodella crenulata		*(Siphonodella quadruplicata)*	"T2"
Siphonodella sandbergi		*Polygnathus lenticularis*	"T1"
Siphonodella duplicata		*Polygnathus inornatus rostratus*	"T1"
Siphonodella sulcata		*Polygnathus lobatus*	"T1"
Siphonodella praesulcata		*Polygnathus parapetus*	"Fa2"
Bispathodus costatus	*upper*	*Polygnathus inornatus inornatus*	"Fa2"
	middle	*Polygnathus inornatus inornatus*	"Fa2"
	lower	*interregnum*	"Fa2"
		Polygnathus extralobatus	"Fa2"
Polygnathus styriacus		*Polygnathus obliquicostatus*	"Fa2"
Scaphignathus velifer		*Polygnathus szulczewski*	"Fa2"

(Kolesov & Linkova, 1979). This might suggest a possible influence of variations in the magnetic field intensity on the evolution of organisms.

Geomagnetic reversals have provided an excellent means for precising or confirming biostratigraphic and/or lithostratigraphic correlations. Good examples in the Omolon area are the negative-positive reversal in Oder XII-10, Triniti XXV-4 and Gytgynpylgin XVII-2 (which roughly matches the correlation by the conodont *Polygnathus obliquicostatus*), and the positive-negative reversal in Oder XII-13 and Gytgynpylgin XVII-4, in between the occurrences of the conodonts *Polygnathus obliquicostatus* and *Polygnathus extralobatus*.

ACKNOWLEDGEMENTS

This review would not have been possible without the help and contributions of many colleagues and institutions.

Primarily our thanks go to the USSR Academy of Sciences, to the North-Eastern Interdisciplinary Science Research Institute of the USSR Academy of Sciences, and to the Geological Survey of Belgium for sponsoring the joint Soviet-Belgo-Dutch comparative studies of the Famenno-Tournaisian deposits in the Franco-Belgian area and in the North-East of the USSR since 1979. We acknowledge the financial support of the Belgian "Nationaal Fonds voor Wetenschappelijk Onderzoek" ("Fonds National de la Recherche Scientifique"), of the Belgian Ministry for National Education and of the Geofiles Foundation. This allowed us to organize the necessary field trips and meetings, as well as the publication of this review. Finally, we owe more than our thanks to the many friends, colleagues and technicians for their stimulating and skilful help in the field, in the laboratory, during the many unforgettable hours of discussions, and in the preparation of the manuscript.

BIBLIOGRAPHY

ABRAMOV, B.S., GANELIN, V.G., SIMAKOV, K.V. & SOLOMINA, R.V., 1975. Stratigrafia kamennougolnyh otlozheny Severo-Vostoka SSSR. Tezisy dokladov VIII Mezhdunarodnogo kongressa po stratigrafii i geologii karbona, M. Nauka : 3.

ABRAMOV, B.S., GANELIN, V.G., SIMAKOV, K.V. & SOLOMINA, R.V., 1979. Stratigrafia kamennougolnyh otlozheny Severo-Vostoka SSSR. Regionalnaya biostratigrafia karbona sovremennyh kontinentov, M. Nauka : 105-112.

AFANASJEVA, G.A. & SIMAKOV, K.V., 1970. Spiriferids. Karbon Omolonskogo i jugo-zapadnoi chasti Kolymskogo massivov, M. Nauka : 81-95.

ANONYMOUS, 1978. Resheniya II Mezhvedomstvennogo stratigraficheskogo soveshchaniya po dokembriyu i fanerozoyu Severo-Vostoka SSSR (Magadan, 1974-1975).

BLESS, M.J.M., 1983. Late Devonian and Carboniferous ostracode assemblages and their relationship to the depositional environment. Bull. Soc. belg. Géol., 92 (1) : 31-53.

BLESS, M.J.M., BOUCKAERT, J. & PAPROTH, E., 1983. Recent exploration in Pre-Permian rocks around the Brabant Massif in Belgium, the Netherlands and the Federal Republic of Germany. Geol. Mijnbouw, 62 (1) : 51-62.

BOGUSH, O.I. & YUFEREV, O.V., 1970. Foraminifery. Karbon Omolonskogo i jugo-zapadnoi chasti Kolymskogo massivov, M. Nauka : 68-74.

BUSHMINA, L.S., 1979. Upper Devonian ostracods of the Central Kolyma River Basin. Field Excursion Guidebook, Tour IX, XIV Pacific Science Congress Khabarovsk 1979, suppl. 5 : 3-70.

BUSHMINA, L.S. & SIMAKOV, K.V., 1979. Correlation of the Upper Famennian - Lower Tournaisian deposits of different facies in the central Fore-Kolyma area by the aid of microfossils. Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk 1979, suppl. 8 : 71-90.

CHOWNS, T.M. & ELKINS, J.E., 1974. The origin of quartz geodes and cauliflower cherts through the silicification of anhydrite nodules. Jour. Sediment. Petrol., 44 : 885-903.

CONIL, R. & LYS, M., 1970. Données nouvelles sur les Foraminifères des couches de passage du Famennien au Tournaisien dans l'Avesnois. Congr. Coll. Univ. Liège, 55 : 241-265.

CONIL, R., POTY, E., SIMAKOV, K.V. & STREEL, M., 1982. Foraminifères, spores et coraux du Famennien supérieur et du Dinantien du massif de l'Omolon (Extrême-Orient Soviétique). Ann. Soc. géol. Belg., 105 (1) : 145-160.

DYLEVSKY, E.F., 1975. K Stratigrafii melovyh vulkanitov Omolonskogo massiva. Mezozoi Severo-Vostoka SSSR, Magadan : 111-113.

DYLEVSKY, E.F., 1977. Melovye vulkanogennye obrazovania Omolonskogo massiva i ih petrochimicheskie osobennosti. Voprosy geologii sredinnyh massivov Severo-Vostoka SSSR, Magadan : 104-119.

DYLEVSKY, E.F., 1980. Pozdnemezozoiskie granitoidnye assotsiatsii severo-vostochnoi chasti Omolonskogo sredinnogo massiva. Materialy po geologii i poleznym iskopaemym Severo-Vostoka SSSR, Magadan, 25 : 38-47.

DYLEVSKY, E.F. & SIMAKOV, K,V., 1975. O shchelochno--bazaltovoi assotsiatsii Omolonskoi glybovoi oblasti. Magmatizm Severo-Vostoka Azii, Magadan, 2 : 94-99.

DYLEVSKY, E.F., SIMAKOV, K,V, & SHEVCHENKO, V.M., 1968. Pozdnemezozoiskie magmaticheskie formatsii Omolonskoi glyby. Magmatizm Severo-Vostoka SSSR, Magadan : 54-56.

GAGIEV, M.H., 1979a. Division and correlation of the Perevalny and Elergetkhyn suites by the aid of conodonts. Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk 1979, suppl. 8 : 91-112.

GAGIEV, M.H., 1979b. Conodonts from the Devonian-Carboniferous boundary deposits of the Omolon Massif. Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk 1979, suppl. 2 : 3-104.

GERASIMOVA, N.A., GUSAROV, B.M., DYLEVSKY, E.F., KOVALCHUK, I.A. & SIMAKOV, K.V., 1971. Osnovnye cherty tektoniki Omolonskoi glybovoi oblasti. Mezozoisky tektogenez, Magadan : 150-156.

HACQUEBARD, P.A., 1972. The Carboniferous of Eastern Canada. C.R. 7me Congr. Intern. Strat. Géol. Carbonifère, Krefeld 1971, 1 : 69-90.

HIGGS, H. & STREEL, M., 1983. Spore stratigraphy in the uppermost Devonian of Ireland and the "Rheinisches Schiefergebirge". X Intern. Congress of Carboniferous stratigraphy and Geology Symposium n° 6, Madrid. Devonian - Lower Carboniferous boundary, Abstract.

KOLESOV, Ye. V. & LINKOVA, T.I., 1979. Paleomagnetic characteristics of the Upper Famennian - Lower Tournaisian rocks in the Omolon River watershed. Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk 1979, suppl. 6 : 41-80.

KRYMOV, V.G. & MISANS, Ya. P., 1959. Novye dannye po stratigrafii paleozoya pravoberezhya Omolon. Tr. soveshch. po stratigrafii Severo-Vostoka SSSR, Magadan : 52-55.

MIRONOVA, M.G., 1979. Gastropods from the Devonian-Carboniferous boundary deposits in the Omolon River basin. Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk 1979, suppl. 4 : 29-48.

MITCHELL, M., 1981. The distribution of Tournaisian and Early Visean (Carboniferous) coral faunas from the Bristol and South Wales areas of Britain. Acta Palaeont. Polonica, 25, 3-4 (1980) : 577-585, 2 fig.

NIKOLAEV, A.A., & RZHONSNITSKAYA, M.A., 1967. Devonian of the North-Eastern USSR. Intern. Symp. Devonian Strat., Calgary 1967, 1 : 483-502.

OBRUCHEV, S.V., 1931. Kolymo-Indigirsky krai. Tr. SOPS ser. Yakutskaya, Izd. vo AN SSSR, 1.

ONOPRIENKO, Yu.I., 1973. Stratigrafia i rugozy nizhnego karbona Severo-Vostoka SSSR. Avtoref. kand. diss. Kievsky univ. : 1-27.

ONOPRIENKO, Yu.I., 1976a. Nekotorye voprosy morfologii, sistematiki i evolutsii uralinid. Paleozool. sbornik, Tr. BPI, nov. ser. 38 (141) : 5-10.

ONOPRIENKO, Yu.I., 1976b. Nekotorye uralinidy iz turneiskih otlozheny Omolonskogo massiva. Ocherki geologii i paleontologii Dalnego Vostoka, Vladivostok : 20-29.

ONOPRIENKO, Yu.I., 1977. Rannekamennougolnye rugozy severo-zapadnoi chasti Tihookeanskogo poyasa. Evolutsia organicheskogo mira Tihookeanskogo poyasa, Vladivostok : 50-62.

ONOPRIENKO, Yu.I., 1979a. New Rugosa findings in the Devonian-Carboniferous transitional deposits of the Omolon Massif. Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk 1979, suppl. 2, Magadan : 5-73, pl. I-XIX.

ONOPRIENKO, Yu.I., 1979b. The rugose evolutionary stages at the Devonian-Carboniferous boundary within the Omolon Massif. Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk 1979, suppl. 8 : 141-154.

RADIONOVA, E.P., 1979. Algae from the Elergetkhyn suite (the Omolon Massif). Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk 1979, suppl. 4 : 52-62.

RAZINA, T.P., 1979. Main rock types of the Perevalny and Elergetkhyn suites of the Omolon Massif. Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk 1979, suppl. 6 : 3-26.

SANDBERG, Ch.A., 1979. Devonian and Lower Mississippian Conodont Zonation of the Great Basin and Rocky Mountains. Brigham Young Univ. Geol. Stud., 26 (3) : 87-106.

SHEVCHENKO, V.M., 1975. Sostav i objom abkitskogo granitoidnogo kompleksa na Omolomskom massiva. Materialy po geol. polezn. iskopaemym Severo-Vostoka SSSR, Magadan, 22.

SIMAKOV, K.V., 1965a. K voprosu o stratigrafii nizhnekamennougolnyh otlozheny severo-vostochnoi chasti Omolonskogo massiva. Uch. zap. NIIGA, Paleont. Biostrat., 7 : 8-15.

SIMAKOV, K.V., 1965b. K stratigrafii verkhnedevonskih otlozheny severo-vostochnoi chasti Omolonskogo massiva. Uch. zap. NIIGA, Paleont. Biostrat., 8 : 22-29.

SIMAKOV, K.V., 1967a. Dopermskie otlozheniya Omolonskoi glyby. Geol. Geofizika, 12.

SIMAKOV, K.V., 1967b. Razrez Zhivetskih otlozheny v severo-vostochnoi chasti Omolonskoi glyby. Novye dannye po biostratigrafii devona i verkhnego paleozoya Sibiri, M. Nauka : 10-13.

SIMAKOV, K.V., 1970a. Stratigrafia i cyrtospiriferidy famenskogo i turneiskogo yarusov basseina srednogo techeniya Omolon. Avtoref. kand. diss. IGIG SO AN SSSR, Novosibirsk : 1-24.

SIMAKOV, K.V., 1970b. Devonskaya sistema Omolonsky massiv. Geologia SSSR, 30 (1), M. Nedra.

SIMAKOV, K.V., 1971. O granitse devonskoi i kamennougolnoi sistem na Severo-Vostoka SSSR. Geol. Geofizika, 1971 (1) : 29-38.

SIMAKOV, K.V., 1972. Biostratigrafia famenskogo i turneiskogo yaruzov Severo-Vostoka SSSR. Materialy po geol. polezn. Iskop. Severo-Vostoka SSSR, Magadan, 20 : 51-65.

SIMAKOV, K.V., 1974a. Problemy biostratigrafii i granitsy turneiskogo yaruza na Severo-Vostoka SSSR. Dokembry i Paleozoi Severo-Vostoka SSSR, Magadan : 144-150.

SIMAKOV, K.V., 1974b. Stratigrafia srednepaleozoiskih otlozheny basseina verkhnego techeniya Omolon. Osnovnye problemy biostratigrafii i paleogeografii. Severo-Vostoka SSSR, Magadan : 234-270.

SIMAKOV, K.V., 1975. K diskussii o granitse devona i karbona. Magadan, preprint : 1-81.

SIMAKOV, K.V., 1979. Division and correlation of the Upper Famennian and Lower Tournaisian deposits of the Omolon Massif by the aid of brachiopoda. Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk 1979, suppl. 8 : 183-214.

SIMAKOV, K.V., & SHEVCHENKO, V.M., 1967. Kratky ocherk dopermskogo razvitiya Omolonskoi glyby. Geol. Geofizika, 7.

SIMAKOV, K.V. & SHEVCHENKO, V.M., 1968. Paleozoiskie magmaticheskie formatsii Omolonskoi glyby. Magmatizm Severo-Vostoka SSSR, Magadan.

SIMAKOV, K.V. & SHEVCHENKO, V.M., 1972. Kratky ocherk stratigrafii dodevonskih otlozheny Omolonskoi glybovoi oblasti. Rifei tsentralnogo sektora Arktiki, L. Nedra.

SIMAKOV, K.V. & SHEVCHENKO, V.M., 1975. Paleozoiskie magmaticheskie obrazovania Omolonskoi glybovoi oblasti. Magmatizm Severo-Vostoka Azii, Magadan, 2.

SIMAKOV, K.V., BOGOSLOVSKY, B.I. & GAGIEV, M.H., 1979. K karakteristike pogranichnyh otlozheny devona i karbona Mugodgar. Biostratigrafia pogranichnyh otlozheny devona i karbona, Magadan, preprint ; 1-51.

SIMAKOV, K.V., GAGIEV, M.H., DYLEVSKY, E.F., KOLESOV, Ye.V., RAZINA, T.P., SMIRNOVA, L.V. & SHEVCHENKO, V.M., 1979. Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk 1979 : 3-123.

SIMAKOV, K.V., YUFEREV, O.V. & BOGUSH, O.I., 1970. Biostratigrafia kamennougolnyh otlozheny Omolonskogo massiva. Karbon Omolonskogo i jugozapadnoi chasti Kolymskogo massivov, M. Nauka : 10-24.

SMIRNOVA, L.V., 1979a. Division and correlation of the Upper Devonian and Lower Tournaisian deposits of the Omolon Massif by the aid of Tabulata. Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk 1979, suppl. 8 : 215-236.

SMIRNOVA, L.V., 1979b. Distribution of Stromatoporoidea in the Elergetkhyn suite. Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk 1979, suppl. 8 : 237-246.

SMIRNOVA, L.V., 1979c. Tabulatomorphic corals in the Elergetkhyn suite. Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk 1979, suppl. 2 : 93-128.

SMIRNOVA, L.V., 1979d. Stromatoporoidea in the Elergetkhyn suite. Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk 1979, suppl. 2 : 129-146.

SMIRNOVA, L.V., DYLEVSKY, E.F., GAGIEV, M.H., SIMAKOV, K.V. & SHEVCHENKO, V.M., 1979. Illustrations. Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk, 1979, suppl. 1 : 1-69.

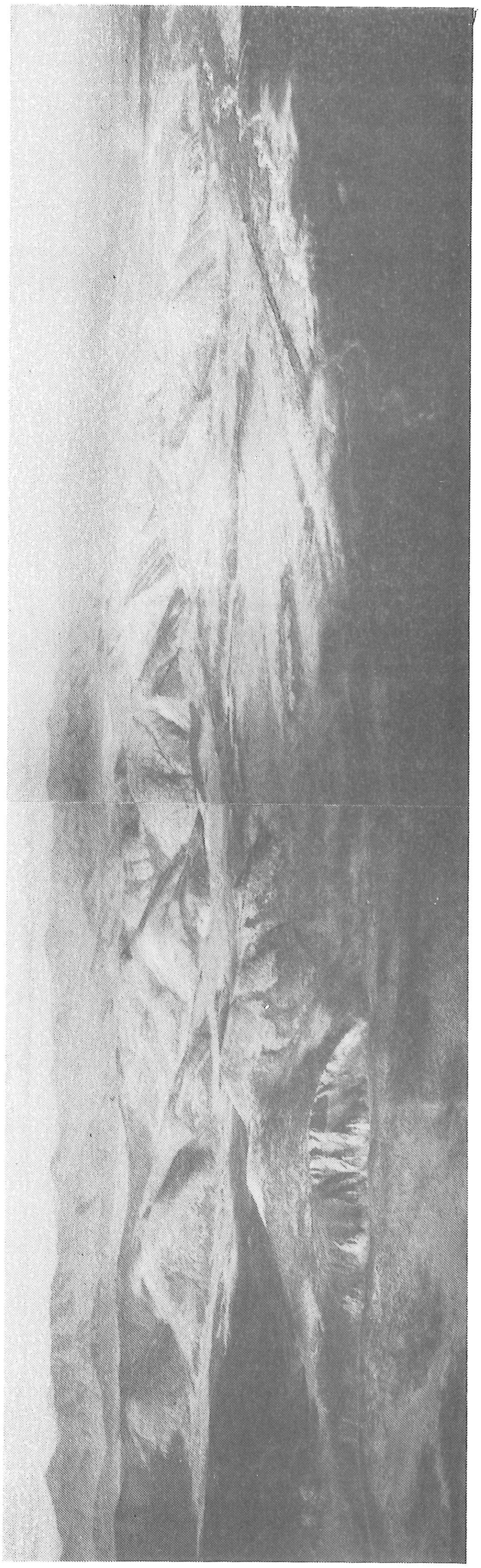
TSCHIGOVA, V.A., 1979. Division of the Devonian-Carboniferous boundary deposits in the Omolon Massif by the aid of ostracods. Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk 1979, suppl. 8 : 257-278.

YUFEREV, O.V., 1979. Division of the Devonian-Carboniferous boundary deposits by the aid of foraminifers in the Perevalny Creek Basin (Omolon Massif). Field Excursion Guidebook Tour IX, XIV Pacific Science Congress, Khabarovsk 1979, suppl. 4 : 5-28.

PLATE 1

Characteristic landscape in the northeastern part of the Omolon Massif showing outliers of the Gydan Mountain Range in the background passing through low, subdued rounded hills into the hilly-spurrish plain of the Uljagan Depression to the right. The vegetation in this area is predominated by lichen, mosses, larch, dwarch birches and bilberries. Locally, perennial ice fields (Russian : "naled") occur in the valleys, a.o. in the Perevalny area between sections III and XII.

This aerial view in southwestern direction shows the locations of the 1983 camp site along the Uvnukveem River (to the right) and of the sections Sikambr (XXIII ; sections on both sides of the Sikambr Creek and of the Sikambr Mountain), Pushok (XV), Ustyevoy (II), Beregovoy (III), Povorotny (IV), Verkhnenaled (= "Upper Ice Field"; VII), Nizhnenaled (= "Lower Ice Field"; VI) and Oder (XII). The distance between the sections Ustyevoy (II) and Oder (XII) is about 5.7 km (see also figure 13).



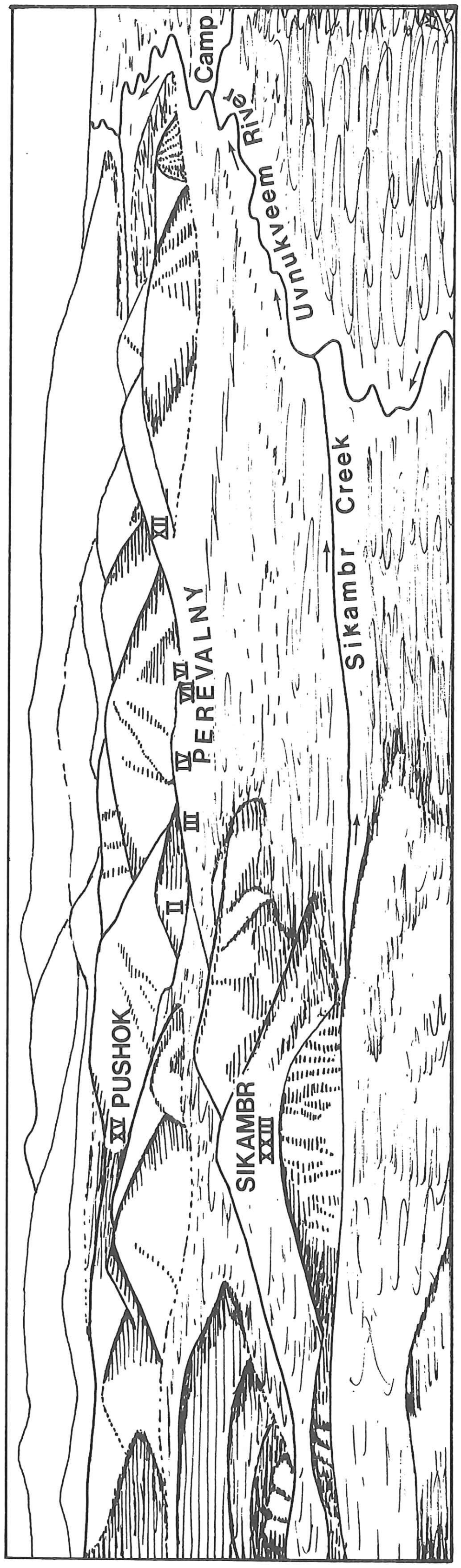

Camp
Uvnukveem River
Sikambr Creek
XII
PEREVALNY
VII VI
IV
III
II
XV PUSHOK
SIKAMBR
XXIII

PLATE 2

View to the South showing Pushok section (XV). This outcrop measures about 1 km from the steeply dipping eastern flank of the biostromes at the base of the Pushok Suite (to the left) to the cliff with oolites belonging to the Sikambr Suite in the top of the same in the western part of the section (to the right).

The rocks below the cliff have been intensively weathered by frost action producing a thick layer of more or less "in situ" debris of angular rock fragments. Careful analysis of this debris permits the recognition of a rhythmic alternation (from bottom to top) of coral-enriched levels, finely laminated probably algal dolostones and horizons with silicified anhydrite nodules (cf. plate 11 : d), similar to that observed in the dolomites outcropping below this debris (right half of picture).

The contact between the Pushok Suite and Sikambr Suite occurs near the top of the cliff.

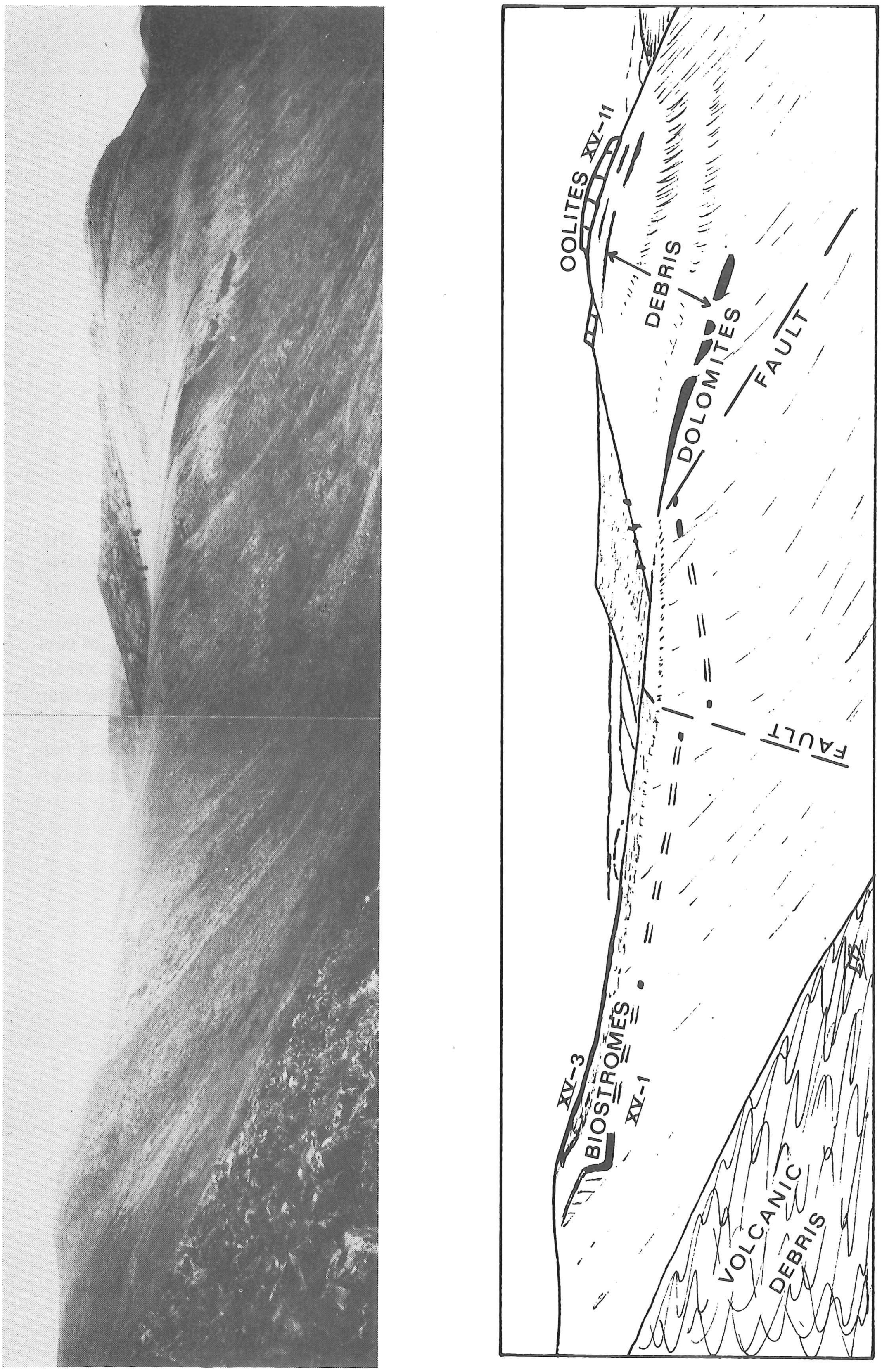

OOLITES
XV-11
DEBRIS
DOLOMITES
FAULT
FAULT
XV-3
BIOSTROMES
XV-1
VOLCANIC
DEBRIS

PLATE 3

View from the Perevalny Valley to the North-West showing Oder section (XII). The outcrop is distributed over two slopes along the northern flank of Perevalny Valley, separated by a narrow secondary valley with shrubs. The western slope exhibits the lower part of the Perevalny Suite (beds XII-1/9). These consist of coarse-grained, sometimes gravelitic, reddish volcanogenic sandstones with a few intercalations of carbonate beds (XII-6 and XII-8). The easily distinguished (almost 4 m thick) bed XII-9, consisting of reddish, coarse-grained volcanogenic sandstones, also outcrops at the base of the sequence on the eastern slope. This exposure is marked by two small faults. The topmost bed in this outcrop (bed XII-20) consists of nodular limestones and has been correlated with bed VI-10 of the Nizhnenaled section. This bed marks the base of the Elergetkhyn Suite.

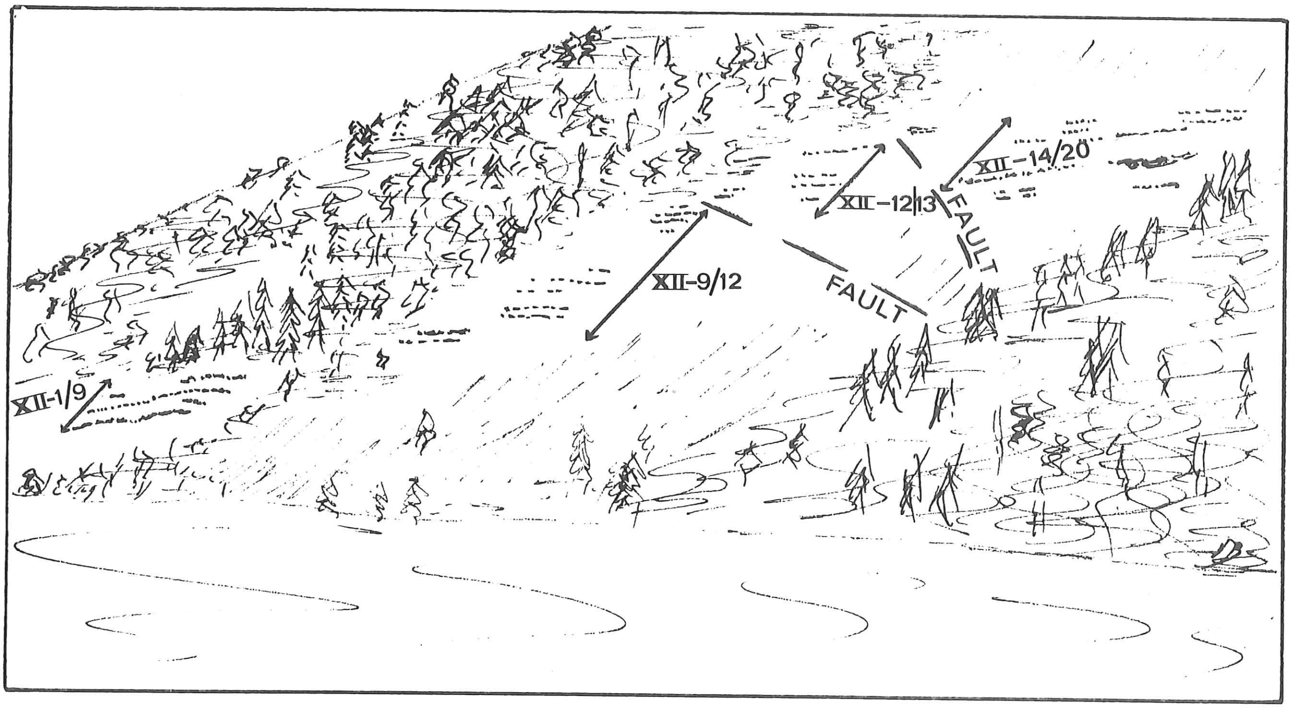
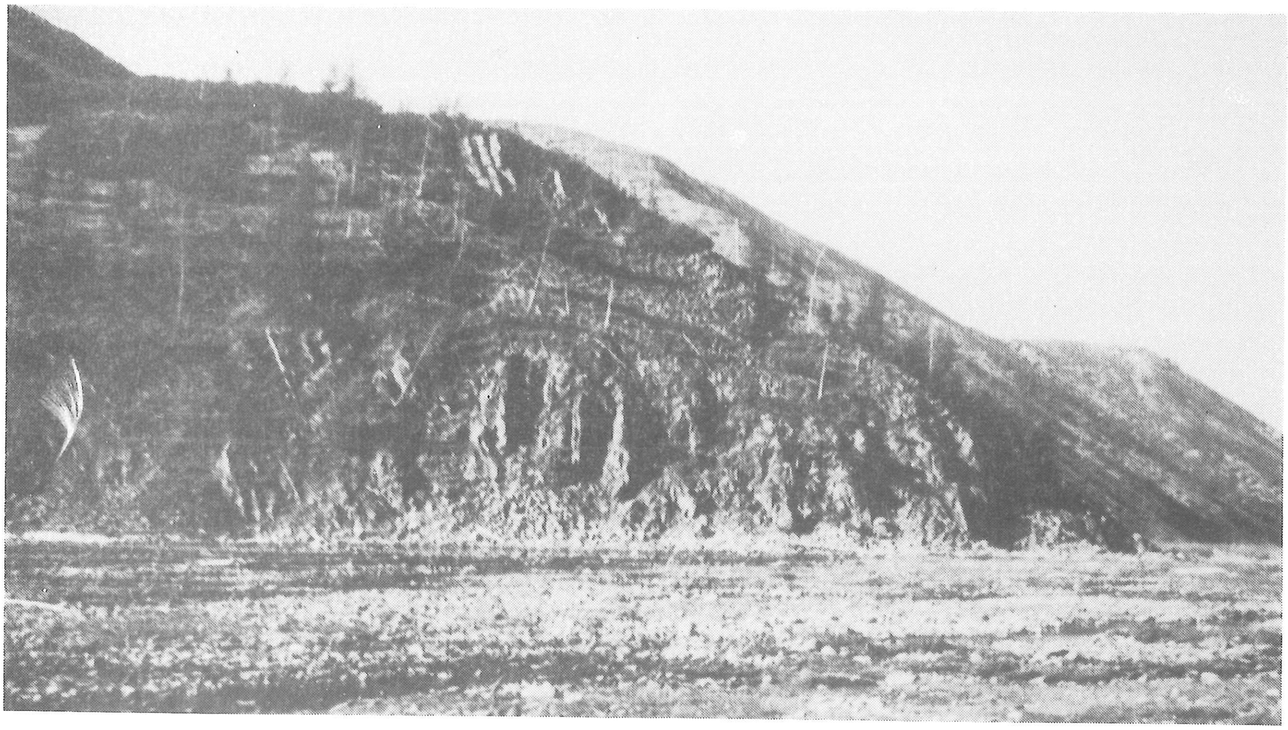

XII–14/20
XII–12/13
FAULT
XII–9/12
FAULT
XII-1/9

PLATE 4

View in western direction from the Perevalny Valley showing Nizhnenaled (= "Lower Ice Field") section (VI) with steeply dipping rocks of the Upper Perevalny Suite (beds VI-1/9) and Lower Elergetkhyn Suite (beds VI-10/14).



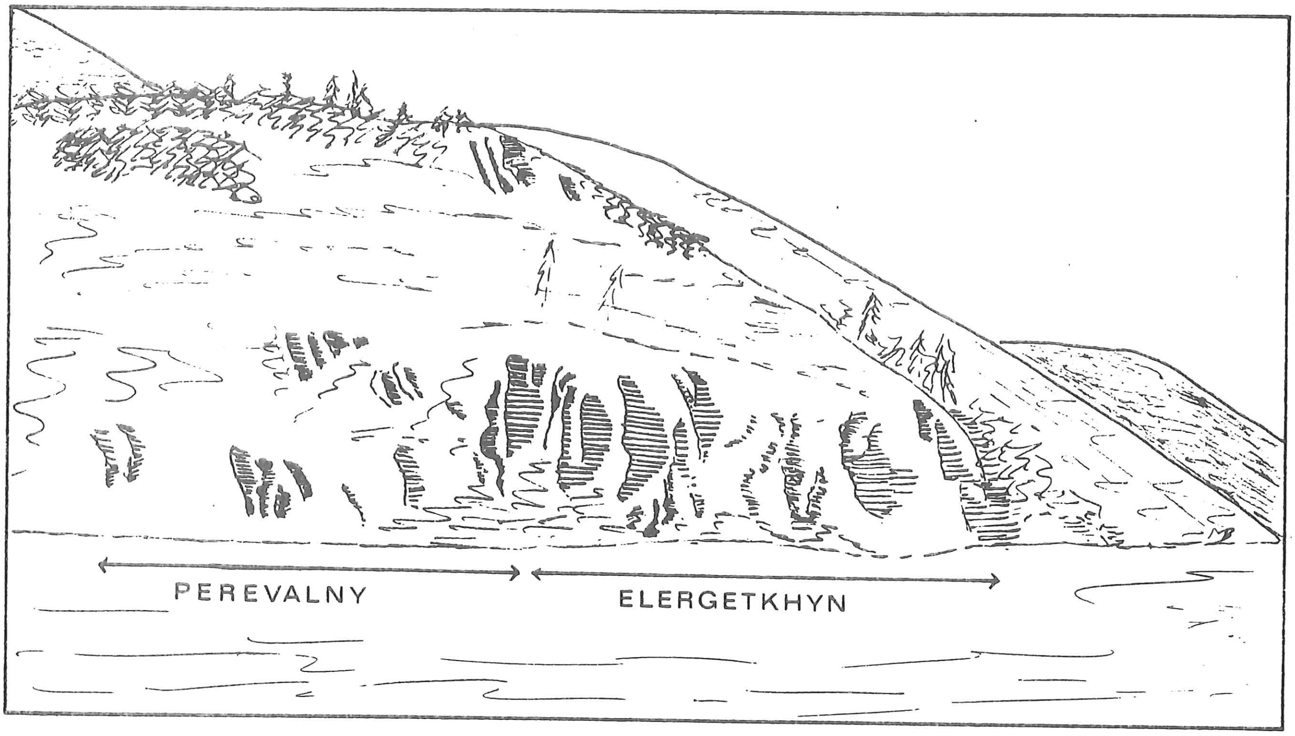
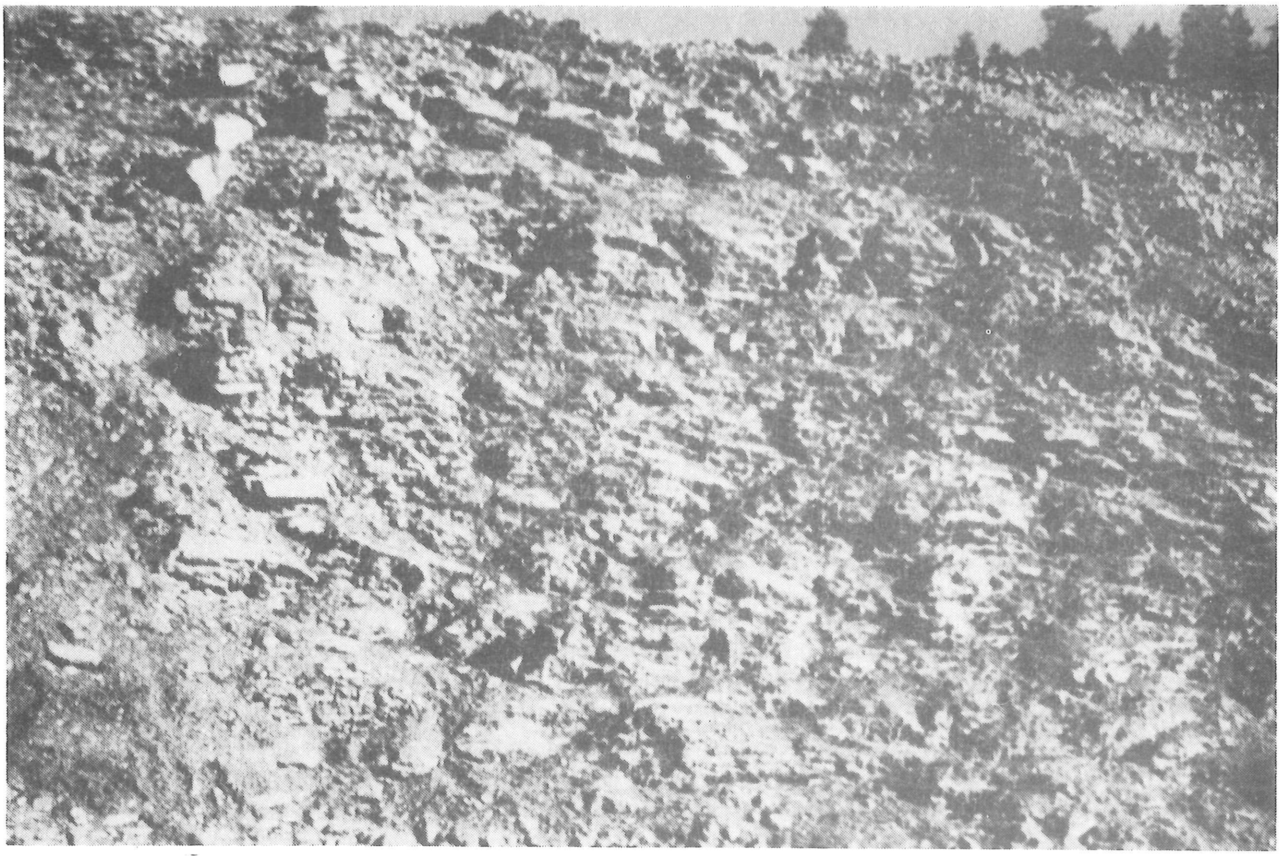

PEREVALNY
ELERGETKHYN

PLATE 5

View in eastern direction from the Perevalny Valley showing the gently dipping strata of the Upper Elergetkhyn Suite in the Verkhnenaled (= Upper Ice Field") section (VII). This very steep exposure with a height of some 60 m is badly affected by weathering because of frost action. Remarkable is the occurrence of abundant solenoporacean red algae (*Parachaetetes garwoodi* Hinde sensu Radionova 1979) in a.o. beds VII-9 and VII-14. The uppermost portion of the sequence (beds VII-19/20) consists of dolomites with cherts.



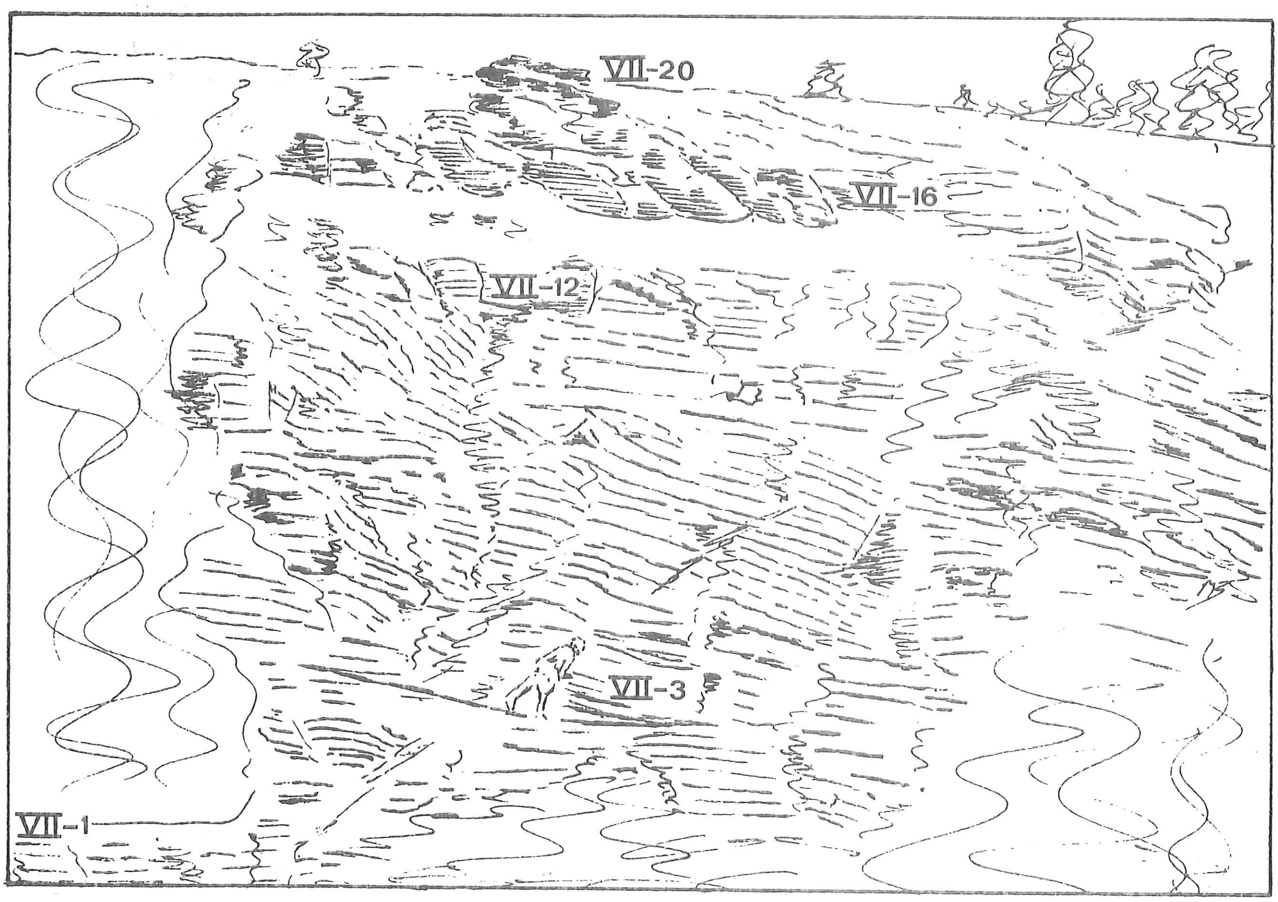
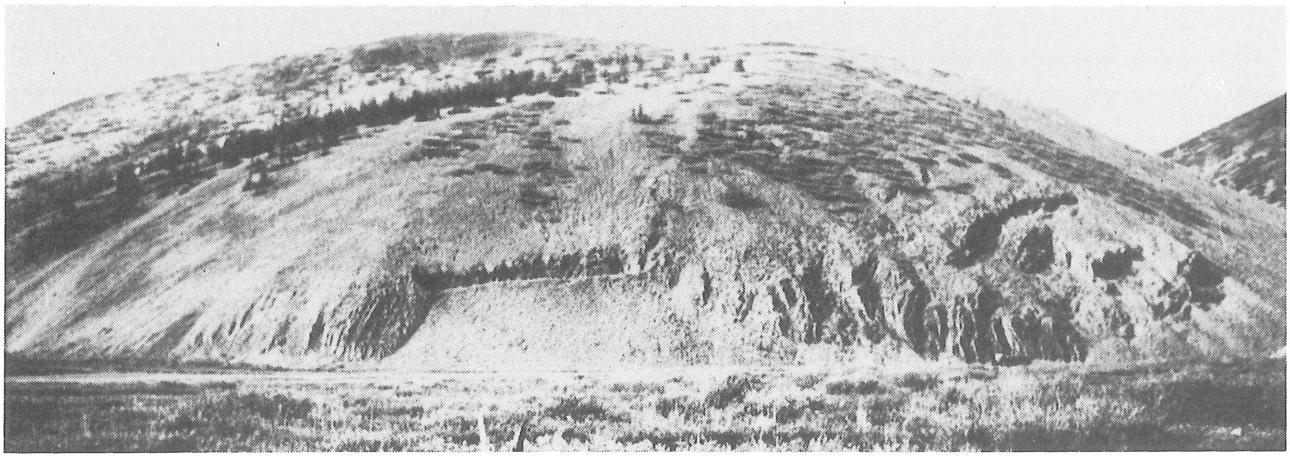

VII-20
VII-16
VII-12
VII-3
VII-1

PLATE 6

View in southern direction from confluence between Pushok Creek and Perevalny Creek showing Ustyevoy (Ustyevoy = "confluence") section (II) with steeply west-ward dipping strata of Elergetkhyn Suite. East of the trench (made in 1983), two more or less continuous outcrops occur which are interrupted by loose debris (corresponding to bed II-7). The lowermost beds (to the left of the picture) consist of nodular, rather fossiliferous limestones (beds II-1/3), which are overlain by dolomites with rare, silicified anhydrite nodules (beds II-4/6). The sequence immediately left (East) of the trench consists again of nodular limestones (beds II-8/11). Dolomites (beds II-12/14) with several intercalated bentonite horizons occur in the trench and in the outcropping rocks to the right (West). Of importance for long-distance correlations with a.o. Western Europe are the limestones (beds II-15/24) in the upper part of the sequence. These have yielded a.o. the conodonts *Siphonodella praesulcata* (beds II-15 and II-23 ; species also recognized in bed II-9) and *Siphonodella sulcata* (bed II-21). This suggests that the Devonian-Carboniferous boundary might be drawn in bed II-21, if the 1979-proposal of the IUGS International Working Group on the Devonian-Carboniferous Boundary is accepted.



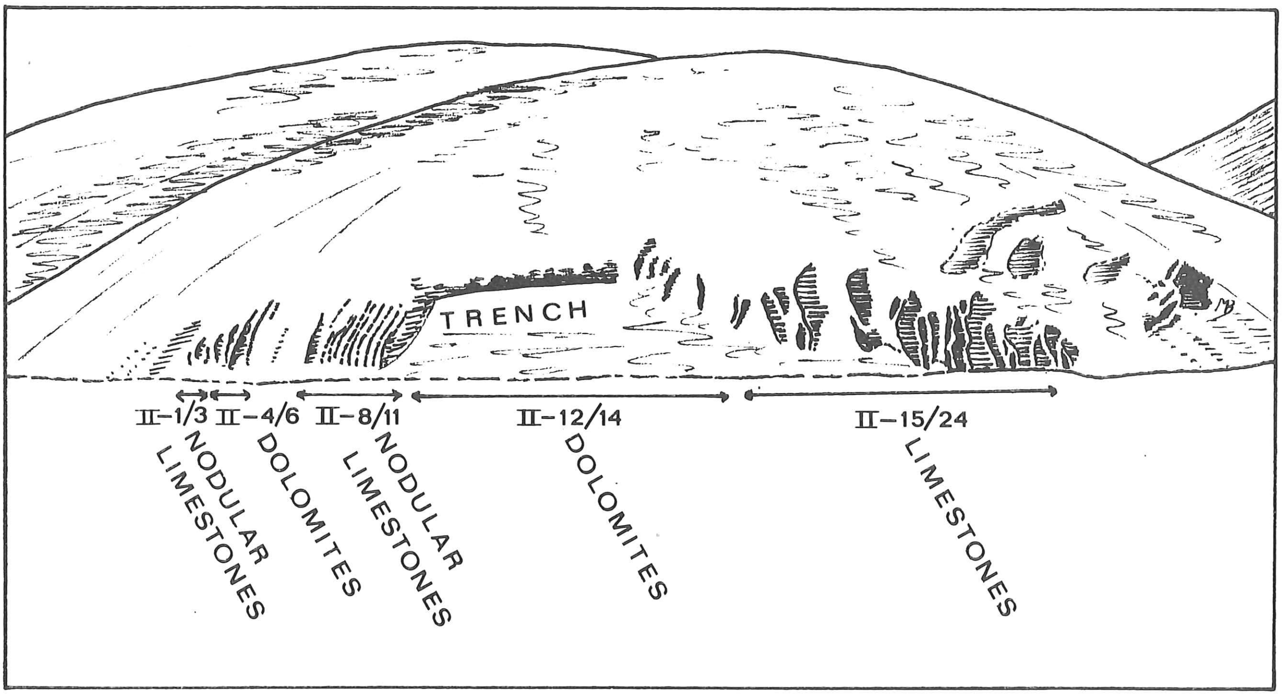
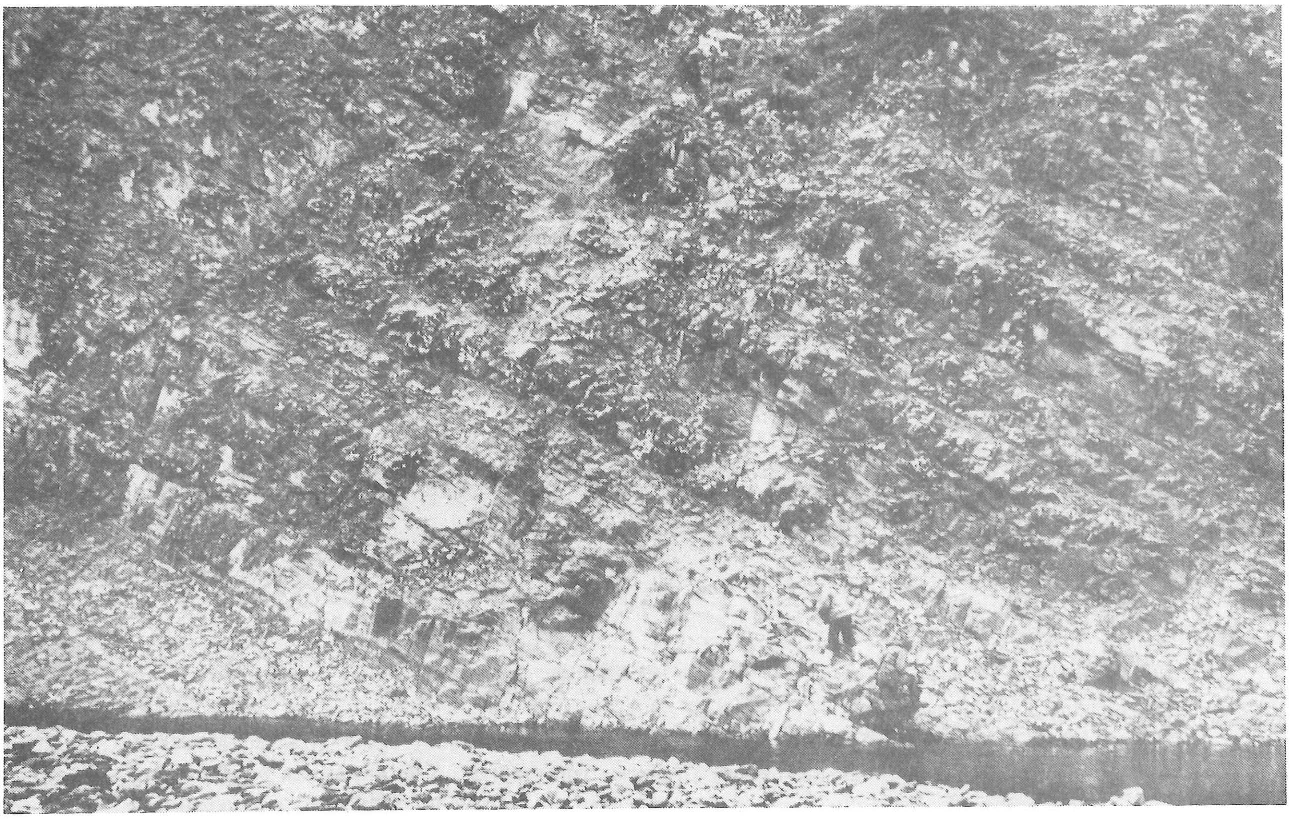

TRENCH
II-1/3
II-4/6
II-8/11
II-12/14
II-15/24
NODULAR LIMESTONES
DOLOMITES
NODULAR LIMESTONES
DOLOMITES
LIMESTONES

PLATE 7

a.- View in southern direction from Uljagan River showing part of the Bazov section (XXIV) roughly west-ward dipping silicified dark-grey to black shales and isolated silicified limestones (phthanites) of "Middle Tournaisian" age. These poorly fossiliferous "Kulm type" deposits suggest sedimentation in an intra-shelf depression environment. A partly silicified limestone bed in the left portion of the picture (bed XXIV-3) has yielded the conodont species *Gnathodus delicatus,* indicating a "Middle Tournaisian" age.

b.- View to the North-North-East showing the Elergetkhyn Lakes. Immediately to the South-West of these lakes, the Livan and Karst Mountains (separated by the Gytgynpylgin Creek) occur. The Elergetkhyn Lakes drain to the North-East. The vegetation in this area is characteristic of the mountain-tundra with predominance of lichen, mosses, dwarf birches and dwarf rhododendrons in the valleys (practical absence of larch). Lichen and mosses (sometimes with surbordinate dwarf rhododendrons) locally persist on the slopes and saddles of the mountains, which are frequently covered by debris due to frost action.



a

b

PLATE 8

View in northern direction from Gytgynpylgin Creek Valley showing Livan Mountain (section XVI) with Gytgynpylgin Creek in foreground. The exposures on the Livan Mountain are generally poor (except for part of the Andylivan Suite) and consist of more or less "in situ" debris (result of frost action) and isolated outcrops of firm rock. The Gytgynpylgin Suite is exposed along both banks of the Gytgynpylgin Creek (section XVII and XVIIA), whereas the Kuluk Suite and base of the Karst Suite can be observed only along the northern bank (section XVIIA).

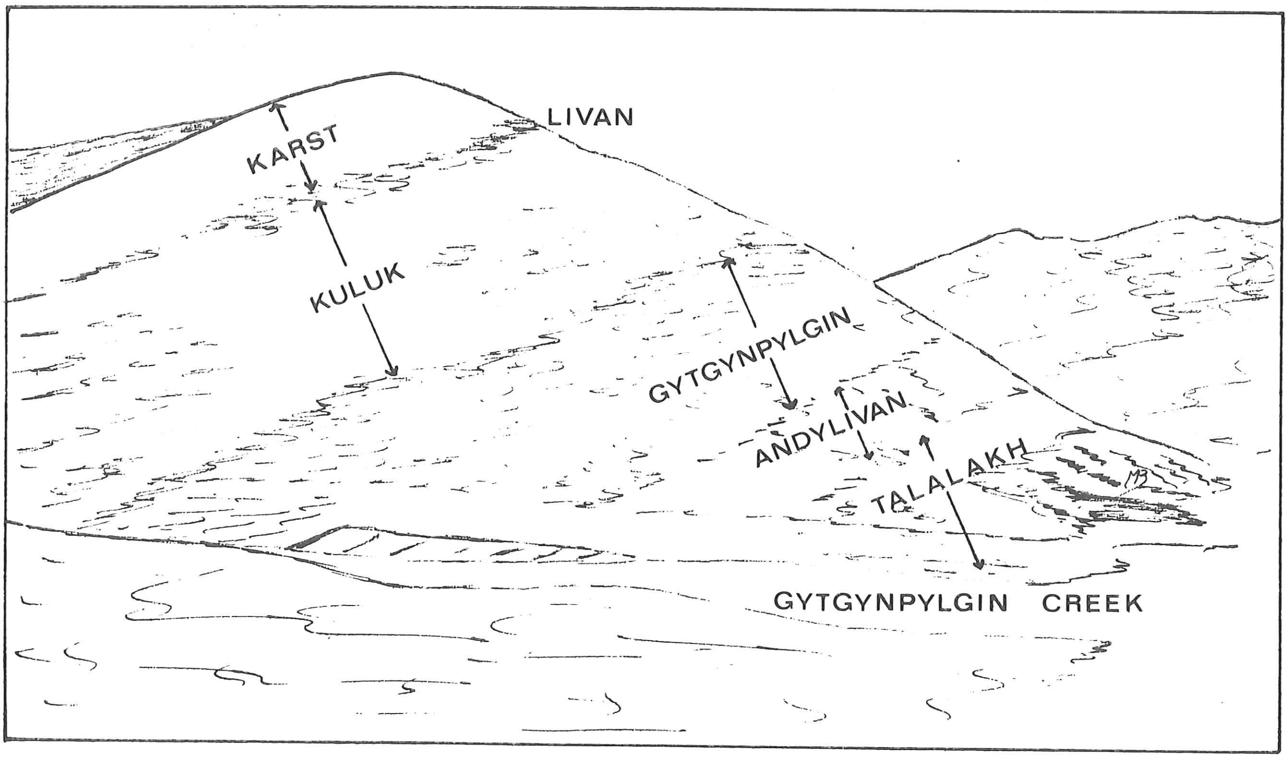
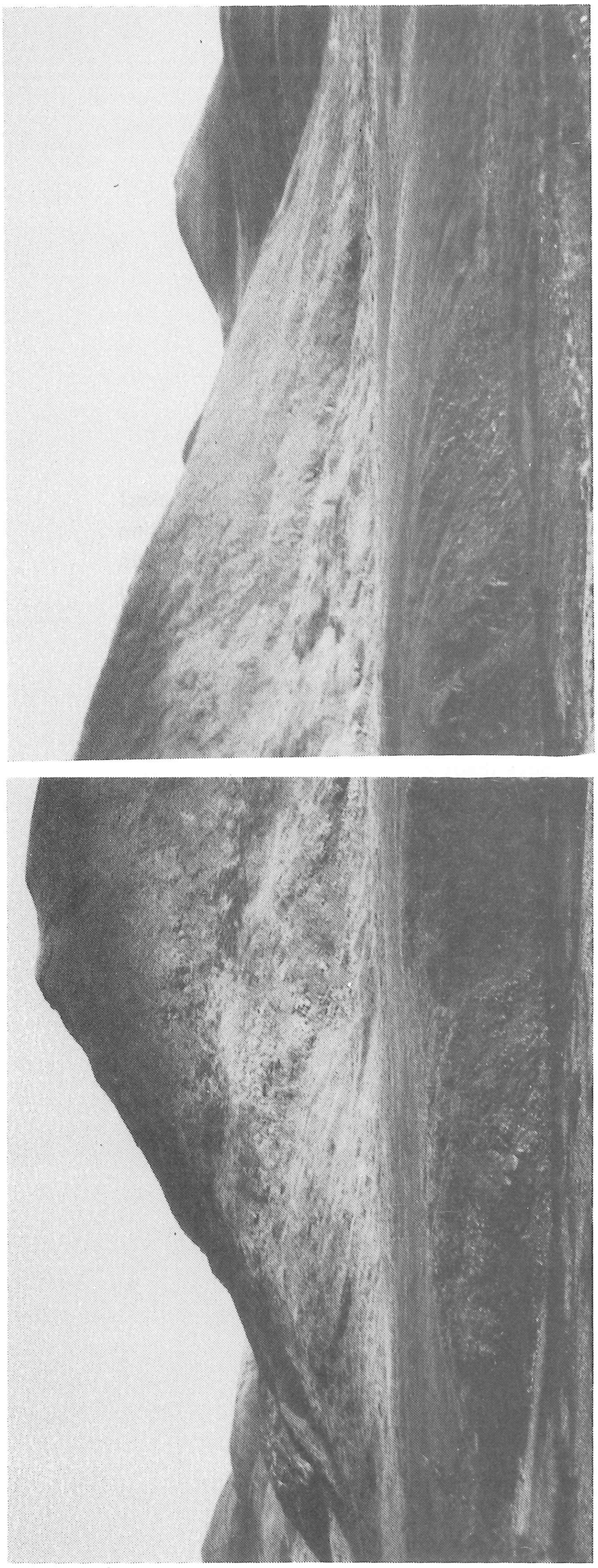

LIVAN
KARST
KULUK
GYTGYNPYLGIN
ANDYLIVAN
TALALAKH
GYTGYNPYLGIN CREEK

PLATE 9

View in southern direction from lower slope of Livan Mountain showing Karst Mountain (section XVIII) with part of Gytgynpylgin section (XVII) in foreground. In contrast to the eastern slope, the (here shown) northern slope of the Karst Mountain almost exclusively consists of more or less "in situ" debris of the Karst Suite and Sikambr Suite with isolated outcrops of firm rock. The Gytgynpylgin Suite is partly exposed along the southern bank of the creek with the same name. In the Lower Gytgynpylgin Suite (left of the dyke on the picture) several horizons with abundant large fragments of presumably floating, marine non-calcareous algae occur. In the Upper Gytgynpylgin deposits (to the right of the dyke on the picture) turbiditic or allodapic limestones occur with well-developed graded bedding. The topmost part of this suite is exposed only on the northern bank of the creek and consists of silicified nodular limestones with cherts.



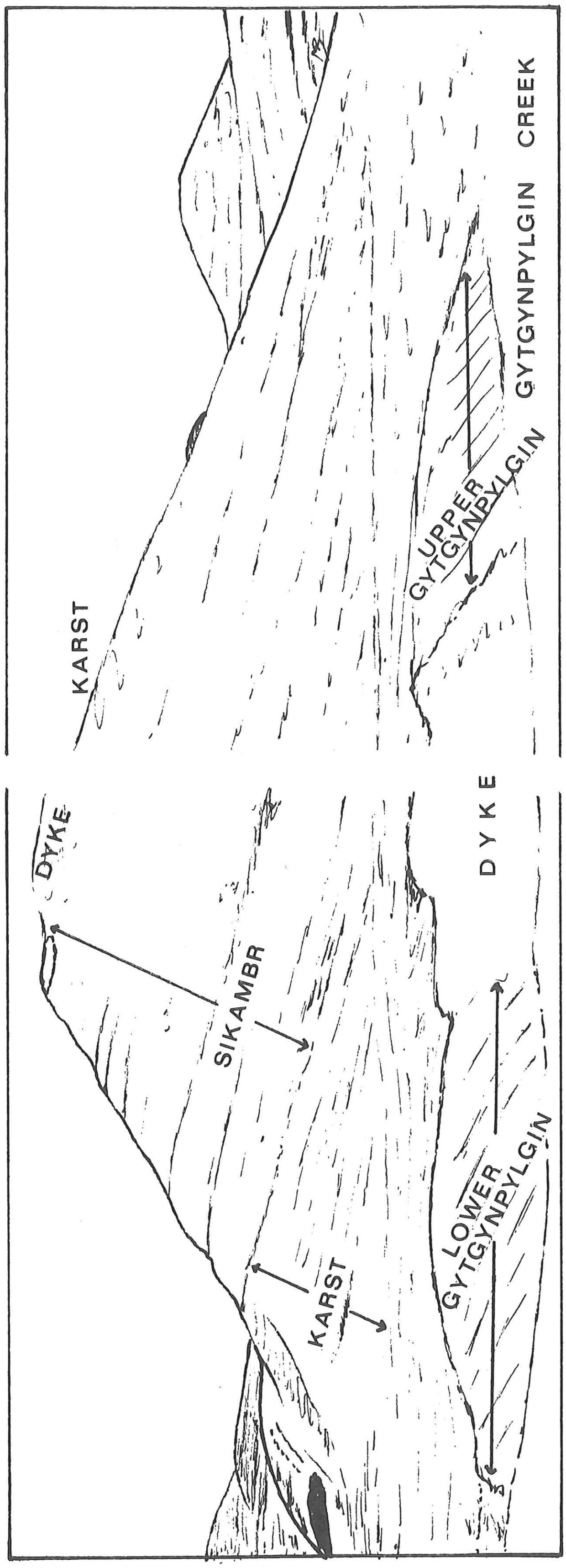
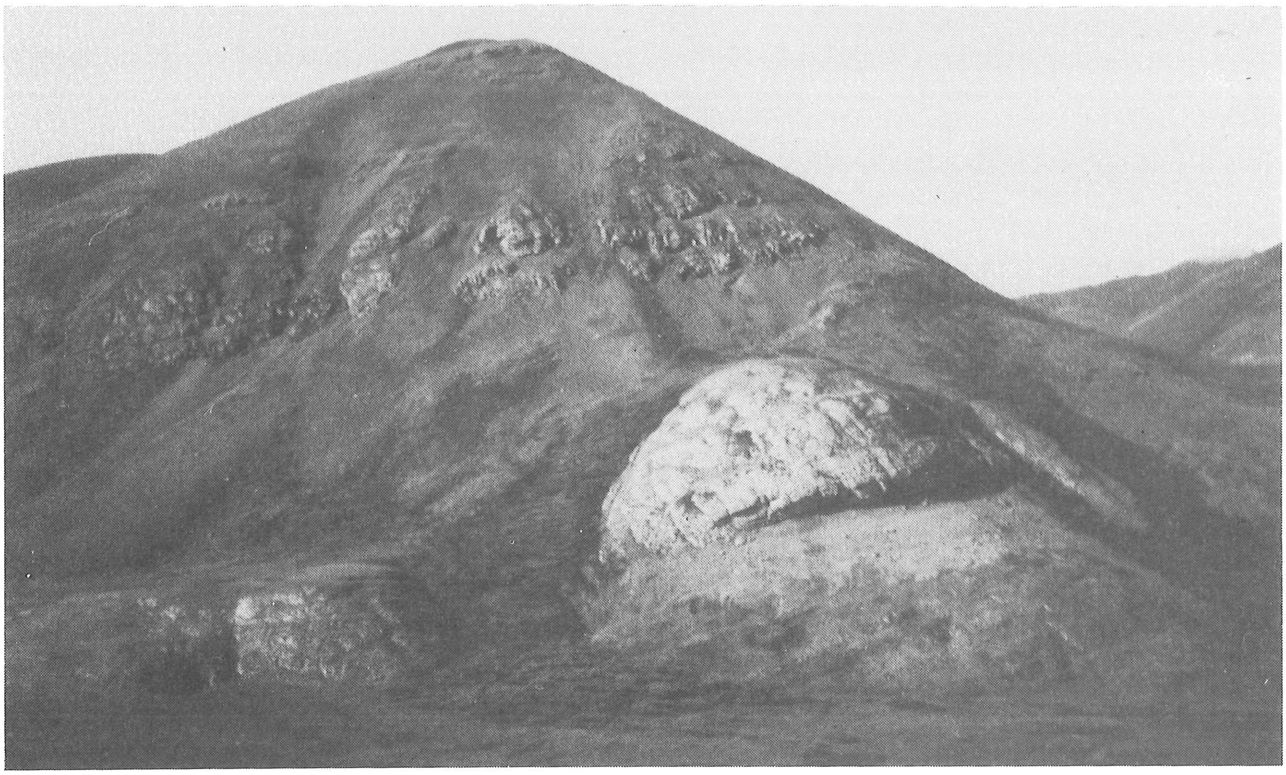

KARST
UPPER GYTGYNPYLGIN
GYTGYNPYLGIN CREEK
DYKE
SIKAMBR
DYKE
KARST
LOWER GYTGYNPYLGIN

PLATE 10

View in western direction from the Elergetkhyn Valley (south of the Elergetkhyn Lakes) showing the Karst Mountain (section XVIII). The lowermost portion of this section possibly consists of dolomites of the Kuluk Suite. However, this part of the section has not been studied during the 1981 and 1983 field work. The measured section starts to the left of a cave with perennial ice (beds XVIII-1/3). The higher portion of the Karst Suite is exposed in a rounded rock with a small wall at the base on the right side of the picture (beds XVIII-4/7). The boundary between the Karst Suite and Sikambr Suite has been drawn at the base of a bed with large oolites (bed XVIII-8) in a small exposure to the top right of this large rock (including beds XVIII-7/9). The debris below (also attributed to bed XVIII-7) and above (beds XVIII-10/11) contains silicified anhydrite nodules suggesting two regressive phases below and above the oolitic (bed XVIII-8) and bioclastic to intraclastic (bed XVIII-9) limestones of the small exposure. The upper portion of the Sikambr Suite is partly poorly exposed (bed XVIII-17) and consists of fossiliferous limestone debris. This part of the sequence is interrupted by two dykes (bed XVIII-18) and (bed XVIII-20), which are largely exposed as "in situ" debris. The top of the Sikambr Suite (a cliff of massive-bedded, fossiliferous limestones with large cherts, bed XVIII-21) is capped by a further dyke on top of the Karst Mountain. In the saddle to the south (left of the picture) of the top, "Middle Visean" limestones with a wealth of corals occur.



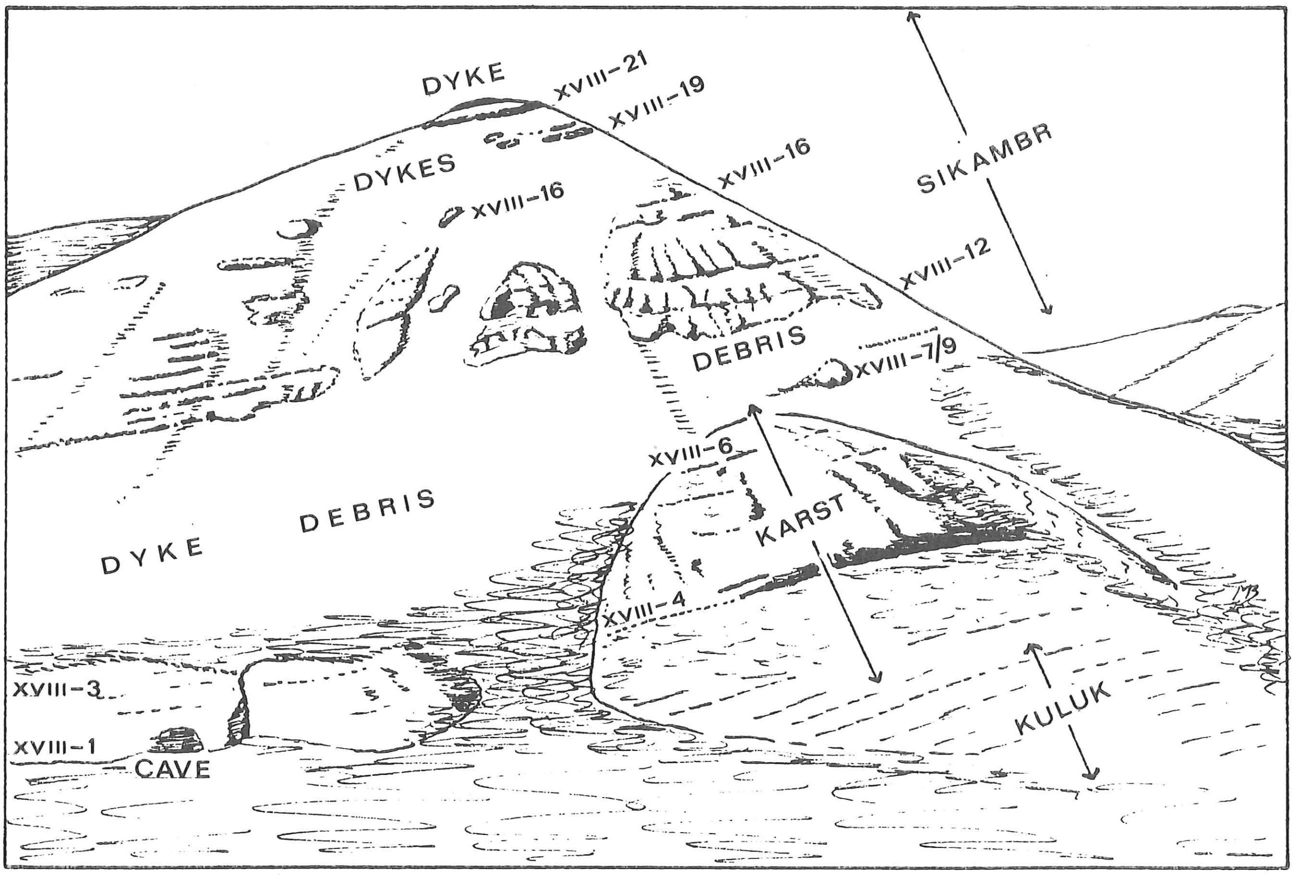

DYKE
XVIII-21
XVIII-19
DYKES
XVIII-16
XVIII-16
SIKAMBR
XVIII-12
DEBRIS
XVIII-7/9
XVIII-6
KARST
DEBRIS
DYKE
XVIII-4
XVIII-3
XVIII-1
CAVE
KULUK

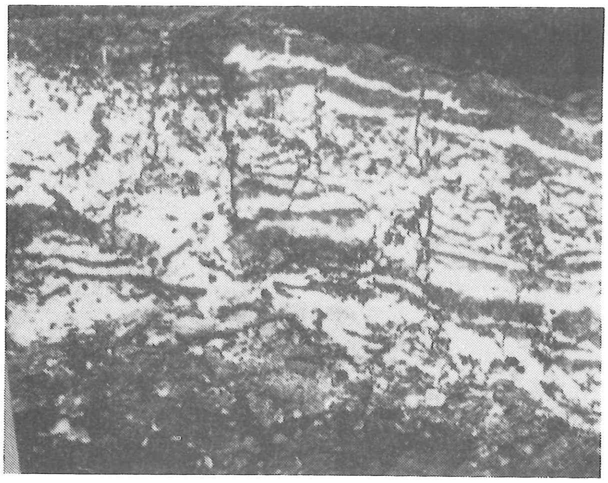
PLATE 11

a.- Zebra limestones, Sikambr Suite, Povorotny section (IV), Perevalny Valley. Scale (10 cm) indicated below photograph.

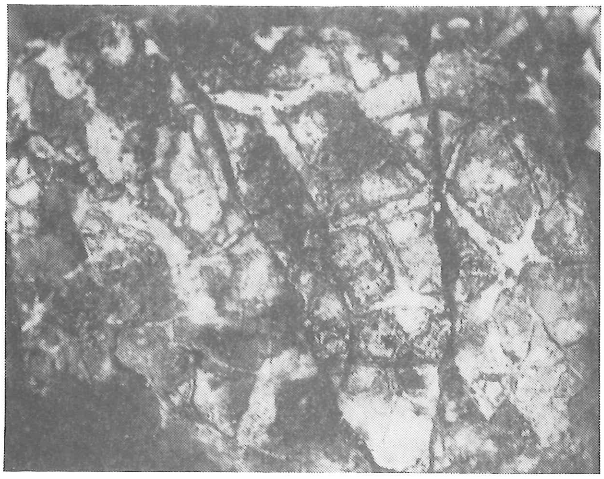
b.- Dissication cracks in top of biostrome in lower portion of Pushok Suite, Pushok section (XV). Scale (10 cm) indicated below photograph. In some cases, the dissication cracks have been filled with anhydrite. Apparently, the reef growth of these coral-stromatoporoid biostromes has been stopped rather abruptly by a lowering of the sea level.

c.- Silicified anhydrite nodules aligned in layers, suggesting repeated occurrence of supratidal environments. Sikambr Suite, Sikambr Section (XXIII), Sikambr Mountain.

d.- Silicified anhydrite nodules. Pushok Suite ; "in situ" debris above outcrop with dolomites in Pushok section (XV). Usually, large silicified anhydrite nodules with a core of calcite crystals have been found. In some cases (not on the photograph) the nodules have been completely silicified and may show an outer rim of silicified pseudomorphs after gypsum.

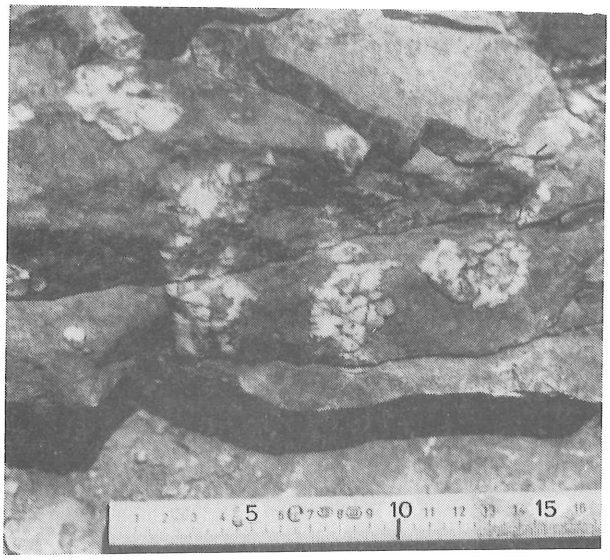


a 10 cm



b 10 cm

c



d

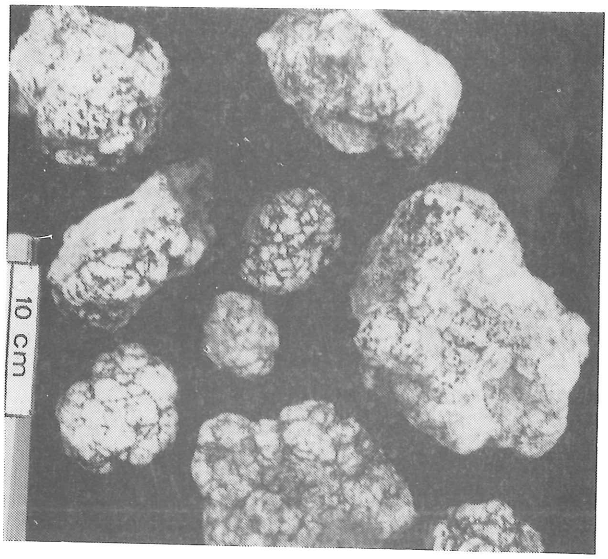
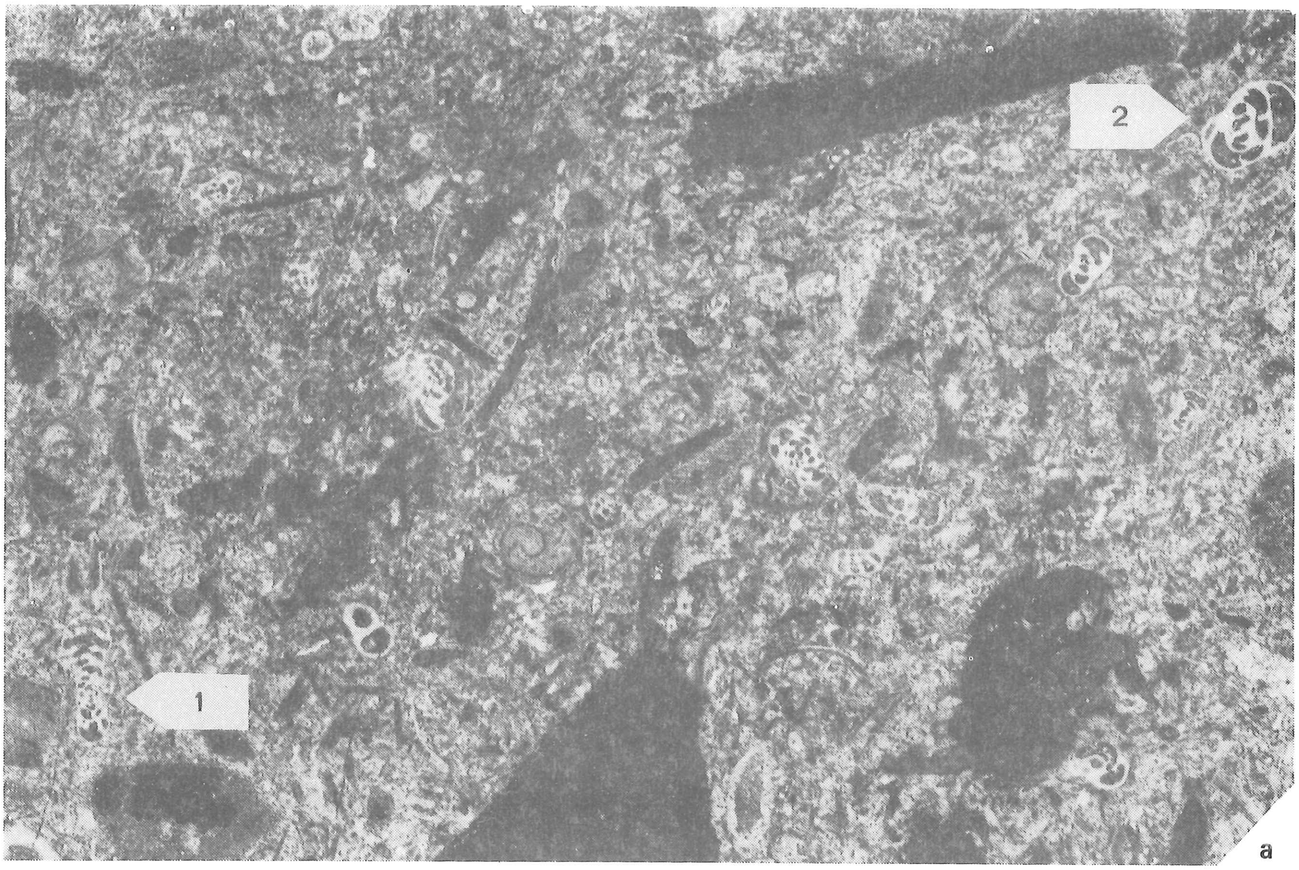


PLATE 12

a.- Biomicrite, bioclastic wackestone. The bioclasts often are silicified (chalcedony). Foraminifers (1 : *Quasiendothyra kobeitusana,* 2 : *Endothyra*), crinoid ossicles, brachiopod and gastropod shell fragments and ostracodes occur. Characteristic of foraminifer assemblage "2" (Foraminifer zone Df3ε of Western Europe). Verkhnenaled section (VII), Perevalny Valley, RC 18517, 1981/250, X 20.

b.- Biomicrite, bioclastic wackestone. Locally many ostracodes and bioclastic debris. Few calcispheres, crinoid debris and algal pieces. Characteristic of foraminifer assemblage "3" (Foraminifer zone Cf1α' of Western Europe).
Sikambr section (XXIII), Sikambr Mountain, RC 18545, 1981/297, X 20.



a

b

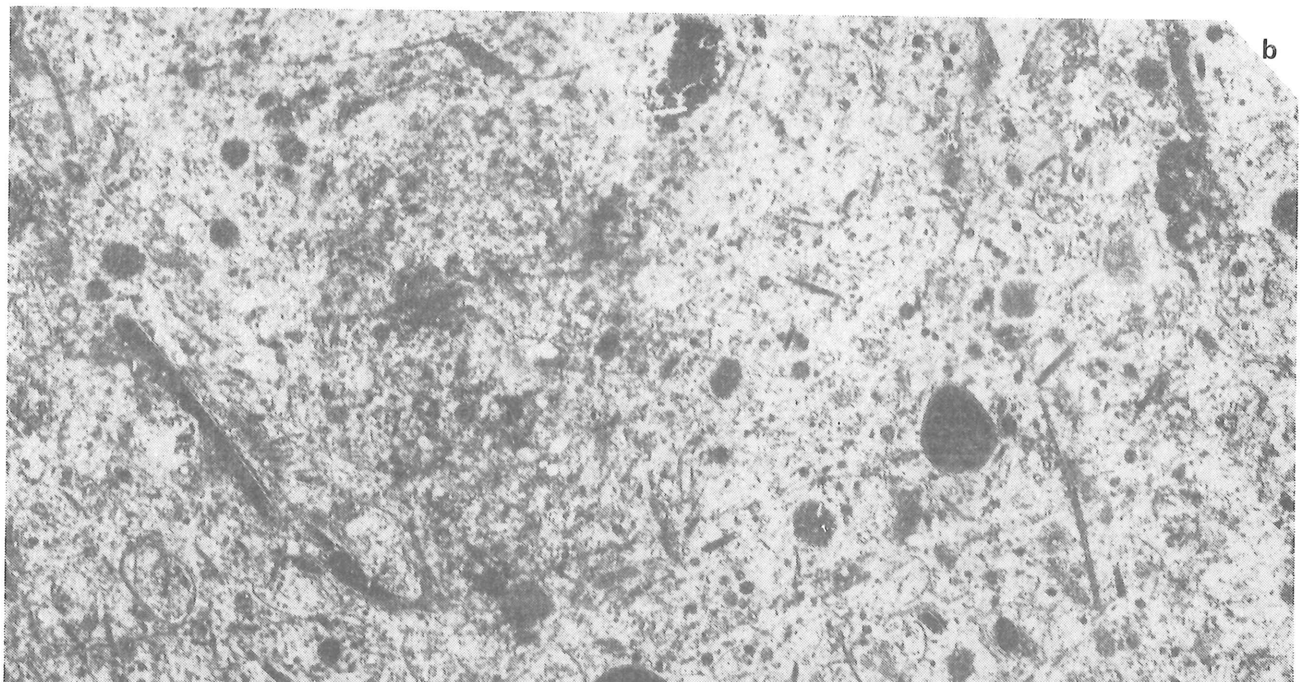


PLATE 13

a.- Intrapelsparite, pelitic packstone with coated grains.
Many foraminifers (arrow : *Palaeospiroplectammina tchernyshinensis*), some crinoid ossicles and calcispheres. Characteristic of foraminifer assemblage "4" (Foraminifer zone Cf1α" of Western Europe). Sikambr section (XXIII), Sikambr Mountain, RC 17445, 1981/314, X 20.

b.- Biosparite, bioclastic grainstone. With debris of crinoidal ossicles, brachiopods and ostracodes. Some foraminifers (arrow : *Latiendothyranopsis*), calcispheres and brachiopod spines occur. Characteristic of foraminifer assemblage "7" (Foraminifer zone Cf2 of Western Europe). Karst section (XVIII), Karst Mountain, Elergetkhyn RC 18348, 1981/137, X 20.

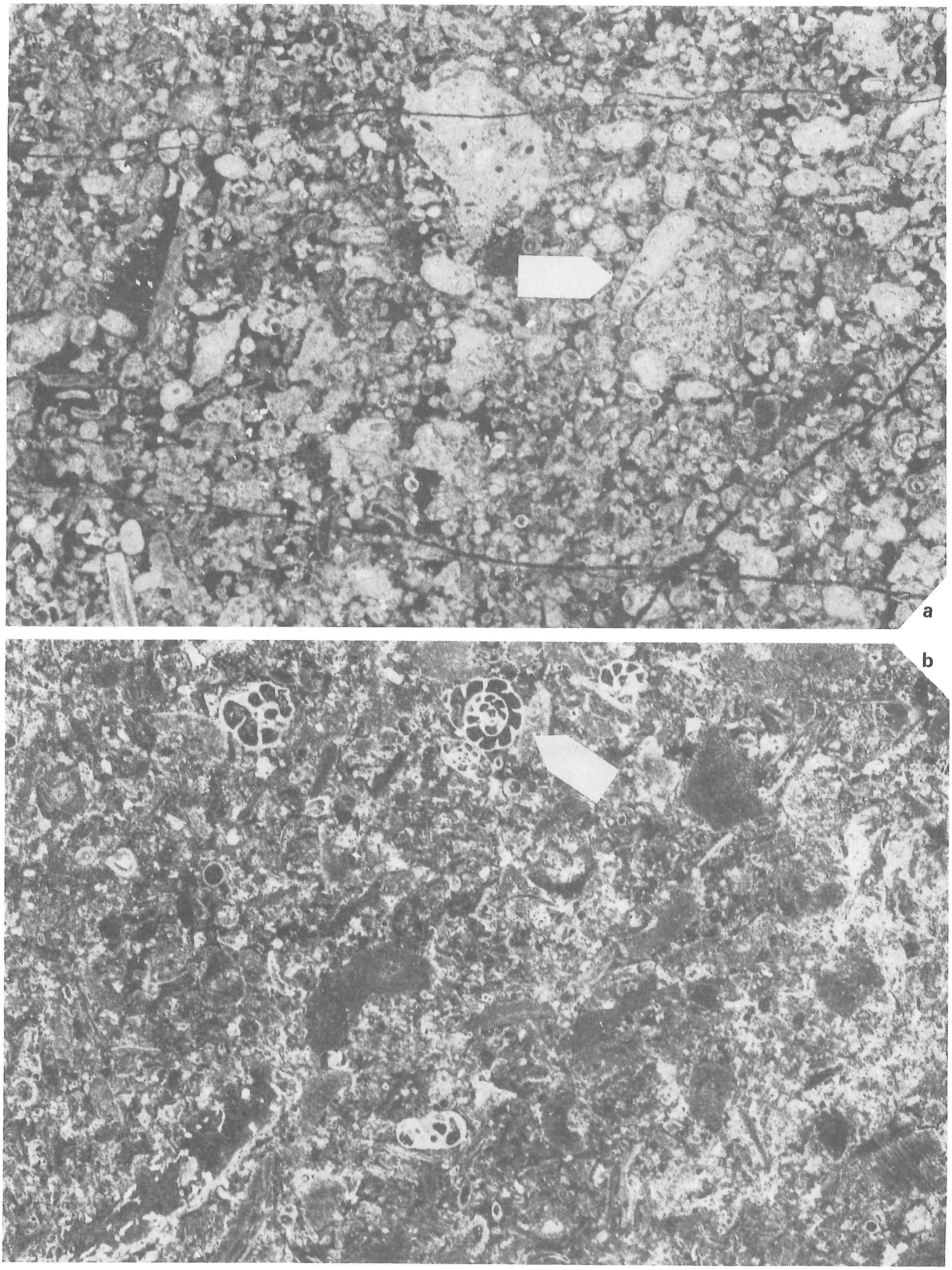
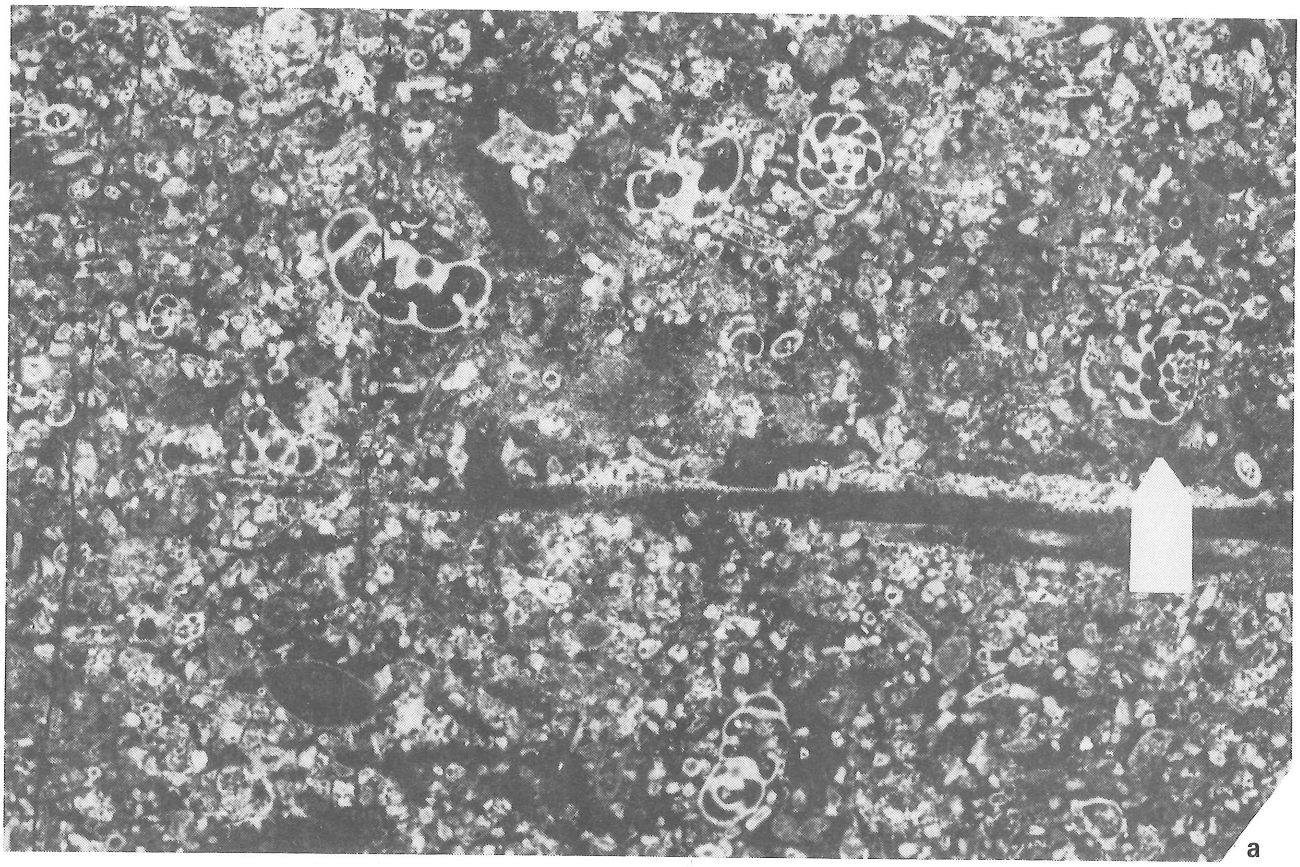

a
b

PLATE 14

a.- Biopelsparite, pelitic to bioclastic packstone. With some subeuhedral dolomite grains. Silicification within the sparitic bioclasts. Calcispheres, ostracodes and brachiopod shell fragments and a few foraminifers (arrow : *Paraendothyra*) occur. Characteristic of foraminifer assemblage "8" (Foraminifer zone Cf2 of Western Europe). Sikambr Suite, Povorotny section (IV), Perevalny Valley, RC 18071, 1981/224, X 20.

b.- Biopelsparite, pelitic packstone. With silicification in the sparitic bioclasts. Calcispheres, foraminifers (arrow : *Tuberendothyra*) and crinoid ossicles occur. Characteristic of foraminifer assemblage "9" (Foraminifer zone Cf2 of Western Europe). Sikambr Suite, Karst section (XVIII), Karst Mountain, Elergetkhyn, RC 18323, 1981/99, X 20.



a

b

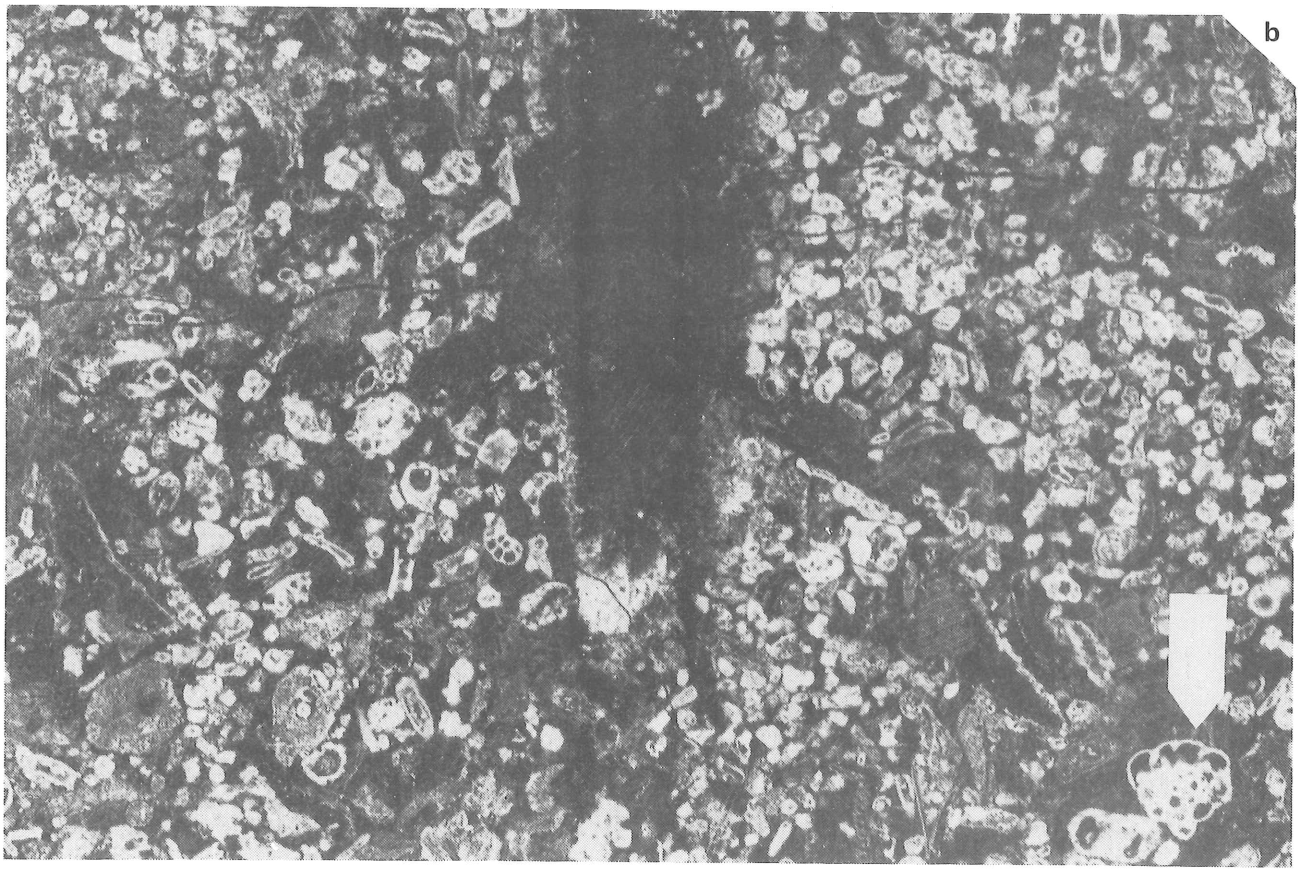


PLATE 16

1, 2. *Campophyllum flexuosum* (Goldfuss 1826).

1. transversal section, x 4. Specimen Kor. 120, Kornelimünster section (Federal Republic of Germany), Strunian (Rugose Coral zone 0).

2. longitudinal section, x 3. Specimen Kor. 133, idem.

3, 4. Undetermined caninomorphic coral.

3. transversal section, x 4. Specimen Omo. 24-10, Ustyevoy section, bed II-21 (first occurrence of *Siphonodella sulcata*), Rugose Coral zone 0.

4. longitudinal section, x 3. Idem.

5. *Caninophyllum* sp. of the "*Caninophyllum patulum* group".

Transversal section, x 2. Specimen Omo. 47-9, Karst Mountain section, Elergetkhyn, Sikambr Suite, Upper Tournaisian (Rugose Coral zone 3).

6. *Melanophyllidium* sp. sensu Hill *in* Moore 1981 (= *Neokeyserlingophyllum* Onoprienko 1979).

Transversal section of a phaceloid colony, x 2. Specimen Omo. 91-5, Perevalny river, probably from the upper part of the Elergetkhyn Suite (Lower Tournaisian).

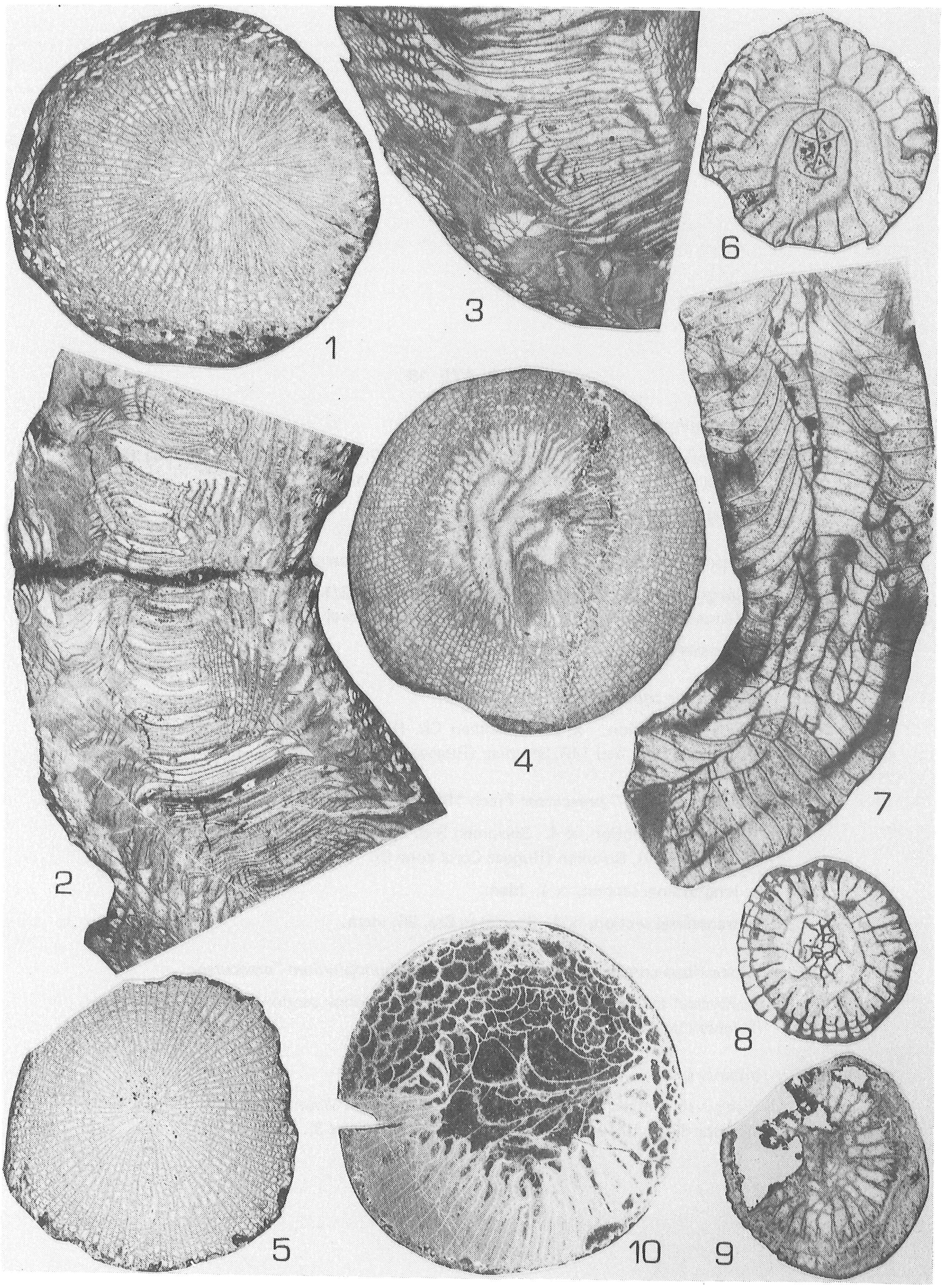

1
2
3
4
5
6
7
8
9
10

PLATE 15

1, 2. "*Tabulophyllum*" sp.

1. transversal section, x 2. Specimen Omo. 23-3, Ustyevoy section, bed II-21 (first occurrence of *Siphonodella sulcata*), Rugose Coral zone 0.
2. longitudinal section, x 2. Idem.

3, 4. Undescribed caninomorphic coral of the "*Palaeosmilia aquisgranensis* group".

3. longitudinal section, x 2. Specimen Av. 142/1, Avesnelles railway cutting (Avesnes, France), bed 142, Strunian (Rugose Coral zone 0).
4. transversal section, x 2. Idem.

5. *Palaeosmilia aquisgranensis* (Frech 1885).

Transversal section, x 2. Specimen Ch. II 149/1, Chanxhe II section (Ourthe valley, Belgium), bed 149, Strunian (Rugose Coral zone 0).

6-8. "*Dibunophyllum*" *praecursor* Frech 1885.

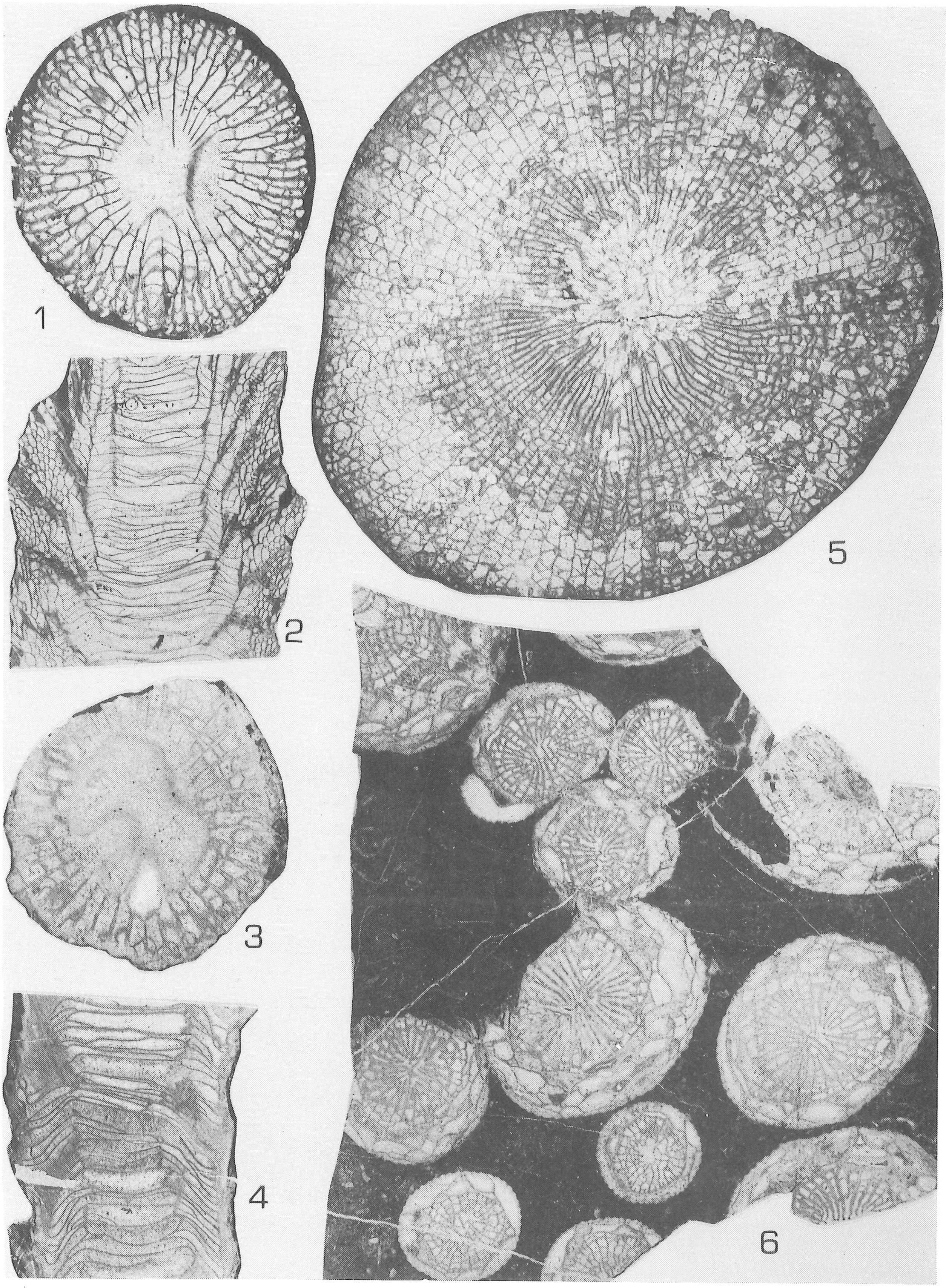
6. transversal section, x 4. Specimen Sto. 66, Stolberg section (Federal Republic of Germany), Strunian (Rugose Coral zone 0).
7. longitudinal section, x 4. Idem.
8. transversal section, x 4. Specimen Sto. 96, idem.

9. Undescribed coral showing affinities with "*Dibunophyllum*" *praecursor*.

Transversal section, x 4. Specimen Omo. 1-1, Pushok section, bed XV-1, Strunian (Rugose Coral zone 0).

10. *Uralinia* sp.

Transversal section, x 2. Specimen Omo. 47-4, Karst Mountain section, Elergetkhyn, Sikambr Suite, Upper Tournaisian (Rugose Coral zone 3). Negative print.


1
2
3
4
5
6