Field Trip A

CARNIC ALPS

By

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with contributions from

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A contribution to Project „Ecostratigraphy"

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Introduction

The Carnic Alps are an east-west directed 100 km long and 10–20 km broad mountain chain in Southern Austria and Northern Italy. Towards the east they continue to the Karawanken Alps forming the border between Austria and Yugoslavia. The highest peak is Hohe Warte (Mt. Coglians) in the Central Carnic Alps with an altitude of almost 2800 m; most peaks, however, range between 2000 to 2500 m. The mountains are separated by deep valleys and thus form a spectacular landscape, the scenery of which is strongly influenced by repeated alternations from shale dominated areas to rocky limestone regions.

The Carnic Alps represent the Paleozoic basement in parts of the Southern Alps. The area has long been famous for its almost continuous and fossiliferous sequences ranging in age from the Caradocian to the Upper Carboniferous when the Variscan tectonism reached the climax. The intensively folded Lower Paleozoic rocks are unconformably overlain by molasse-type sediments. Transgression started in the Kasimovian Stage (or perhaps even in Moscovian time) and continued during the Permian. These late Paleozoic series are affected by late Variscan tectonism attributed to the Saalic phase. The complicated structure of the Carnic Alps, however, was mainly caused by intense Alpine deformation and produced an imbricate nappe-system, several thrust sheets, and dislocations in both the Variscan and post-Variscan series.

The fossiliferous marine Upper Ordovician to late Dinantian sediments have been studied since the second half of the 19th century, e.g., by G. STACHE, F. FRECH, M. GORTANI, P. VINASSA, F. HERITSCH and H. R. v. GAERTNER, who initiated systematic field work and provided numerous outstanding contributions to stratigraphy on which modern research has been based. Since World War II the nature of the faunas and lithofacies has been analyzed and elaborated to a great extent but yet has not been finished. One of our current goals is, beside others, the publication of a modern geologic map of the Carnic Alps which covers the whole area for the first time.

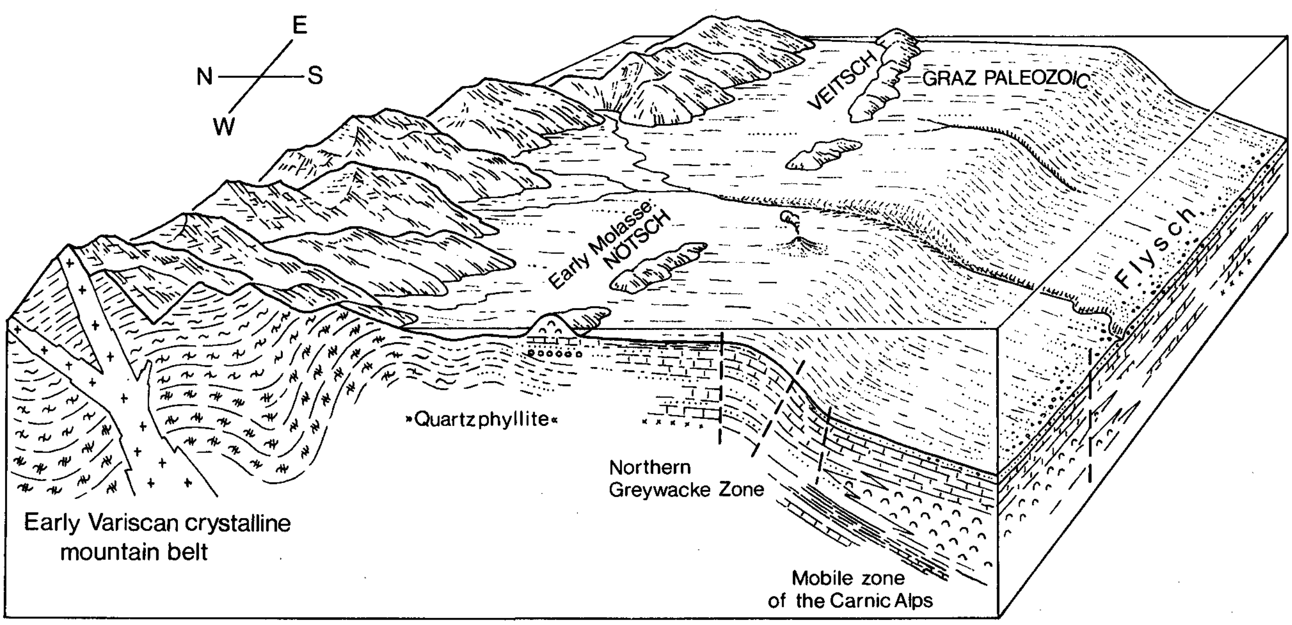


Fig. 1: Paleogeographic sketch of the Eastern Alps Paleozoic in relation to Crystalline Complexes at Lower/Upper Carboniferous time (without scale). From H. P. SCHÖNLAUB 1980.

Towards the south the Carnic Alps are linked with the South Alpine Mesozoic, the so-called Southern Calcareous Alps. Towards the north they end abruptly at the Gail valley which marks a prominent fault zone. North of this fault the Central Eastern Alps form a complex tectonic nappe system caused by the Alpine orogeny (fig. 2). However, correlations across this lineament can be made. For example, for the Paleozoic time the author and others have shown that sedimentary and tectonic evolution, lithofacies and thickness of rocks, rate of subsidence, timing of emersion and deformation, geochronologic events etc., in short, most of the geologic data available indicate a common evolution of the Carnic Alps and other Paleozoic realms in the Eastern Alps, e. g., the Northern Greywacke Zone (see fig. 1).

In terms of Plate Tectonics the Gail Line is part of a major tectonic line in the Periadriatic area. Presumably, it acted as an intraplate geosuture when the Adriatic block, representing an extension of the African Plate („African Promontory") collided with the European Plate in the late Mesozoic and early Tertiary. Subsequently, lateral displacements occured along this structurally important lineament.

Concerning paleobiogeography the fauna and flora of the Carnic Alps exhibit some important features. Upper Ordovician brachiopods show close relationship to Bohemia and the Mediterranean region (Sardinia, Montagne Noire, Northern Africa); the Silurian faunas correspond with the surrounding regions suggesting a uniform development within a transgressing sea and a moderate climate; Lower Devonian trilobites and brachiopods are closely related to Hercynian forms on one side and to elements from the Urals and Tien-Shan on the other. Contrary, algae suggest a connection with the Kusnetz basin and even with the Australian province.

Upper Carboniferous and Permian brachiopods and fusulinids show close affinities to southern and eastern Europe and also to Asiatic faunal realms; the flora of that time resembles West European and Russian floral provinces.

Review of stratigraphy (fig. 3)

The basement of the Carnic Alps is not known. According to recent mapping older strata can be assumed in the western Carnic Alps. This part is mainly composed of clastic rocks in which, however, fossils are lacking.

In the Central Carnic Alps – the area we are visiting during the excursion – the basal strata of the Paleozoic sequence belong to the Caradocian. They are detached from their original basement forming now several E-W striking and south dipping imbricated tectonic slices („Schuppen") of huge dimensions separated by Carboniferous flysch deposits. In many cases the individual zones range from Upper Ordovician to the Carboniferous, i. e., the internal succession mostly has been preserved during mountain building processes.

The Ordovician lithofacies of the Carnic Alps is subdivided into the Uggwa Facies and the Himmelberg Facies, respectively. The first comprises fossiliferous shales with the 5 m thick Uggwa Lst. above, the latter consists of bedded greywackes, sandstones and the Wolayer Lst. on top.

A transitional facies, restricted to more western regions contains various clastic rocks with volcanic debris, quartzites, slates and cystoid limestones („Val Visdende Group").

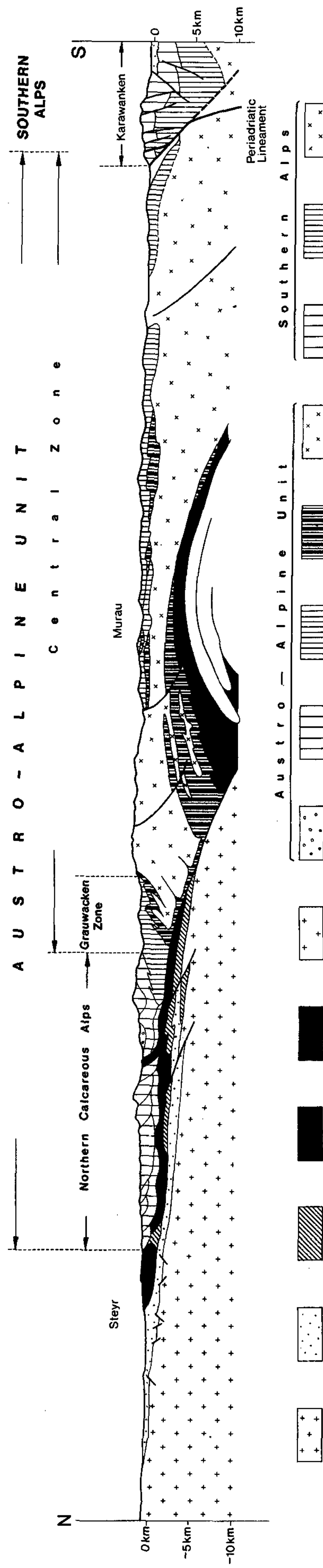


Fig. 2: Schematic cross section of the Eastern Alps along the line Linz–Klagenfurt (modified after S. PREY 1976, from W. JANOSCHEK & A. MATURA 1980).
1 = Extra-Alpine basement of the Bohemian Massif; 2 = Molasse Zone and intra-Alpine Tertiary (post-upper-Eocene); 3 = Helvetic Zone and Klippen Zone; 4 = Flysch Zone; 5 = Metasedimentary rocks of the Penninic Zone; 6 = Crystalline basement of the Penninic Zone; 7–11 = Austro-Alpine Unit: 7 = Gosau Formation; 8 = Permomesozoic (unmetamorphic) in North-Alpine facies; 9 = Palaeozoic (low-grade metamorphic); 10 = Permomesozoic (low-grade metamorphic) in Central Alpine facies; 11 = Crystalline basement („Altkristallin"); 12–14 = Southern Alps: 12 = Permomesozoic; 13 = Palaeozoic; 14 = Crystalline basement.

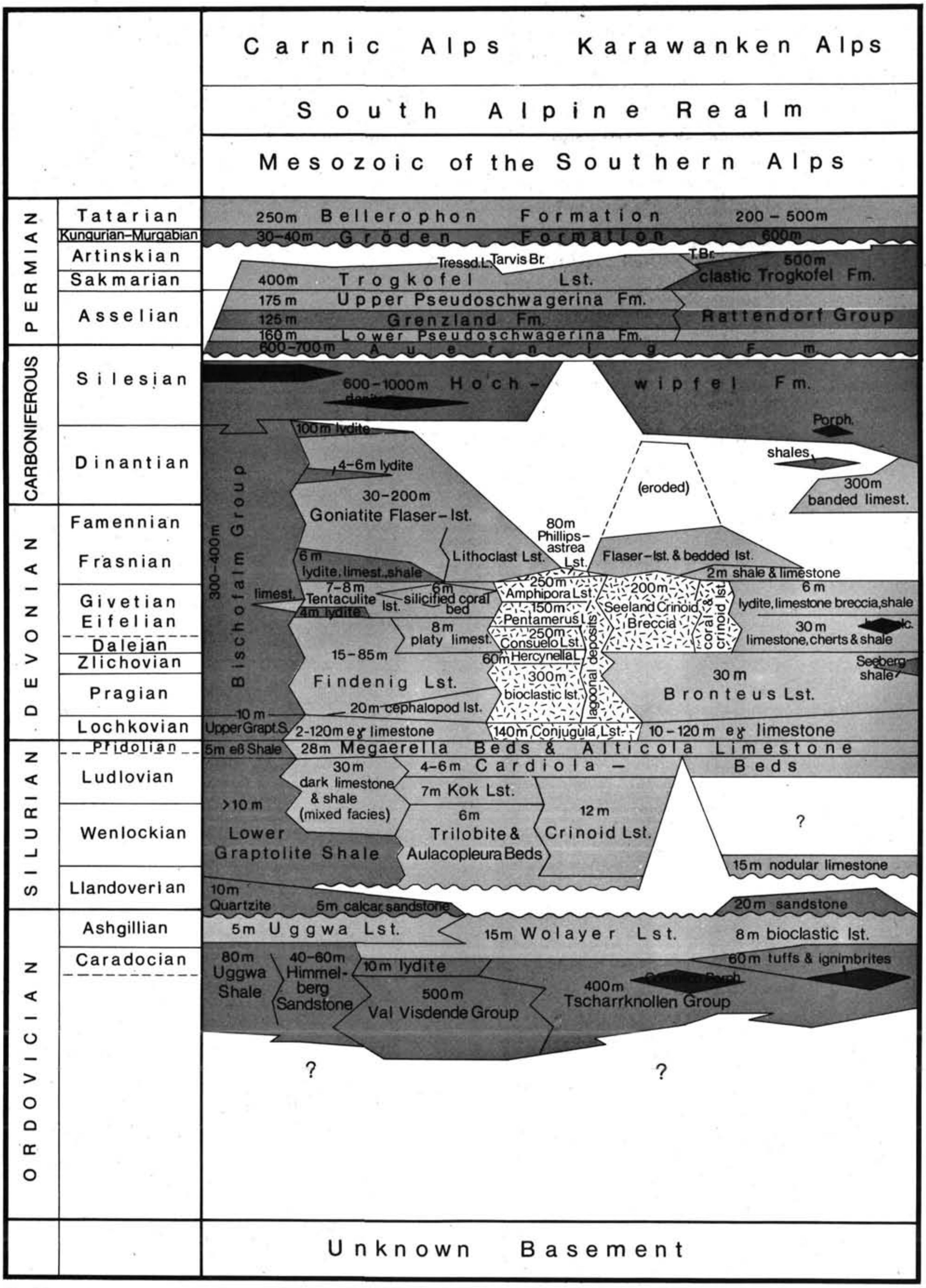


Fig. 3: The Paleozoic sequence of the Carnic Alps and the Karawanken Alps. Modified after H. P. SCHÖNLAUB 1980.

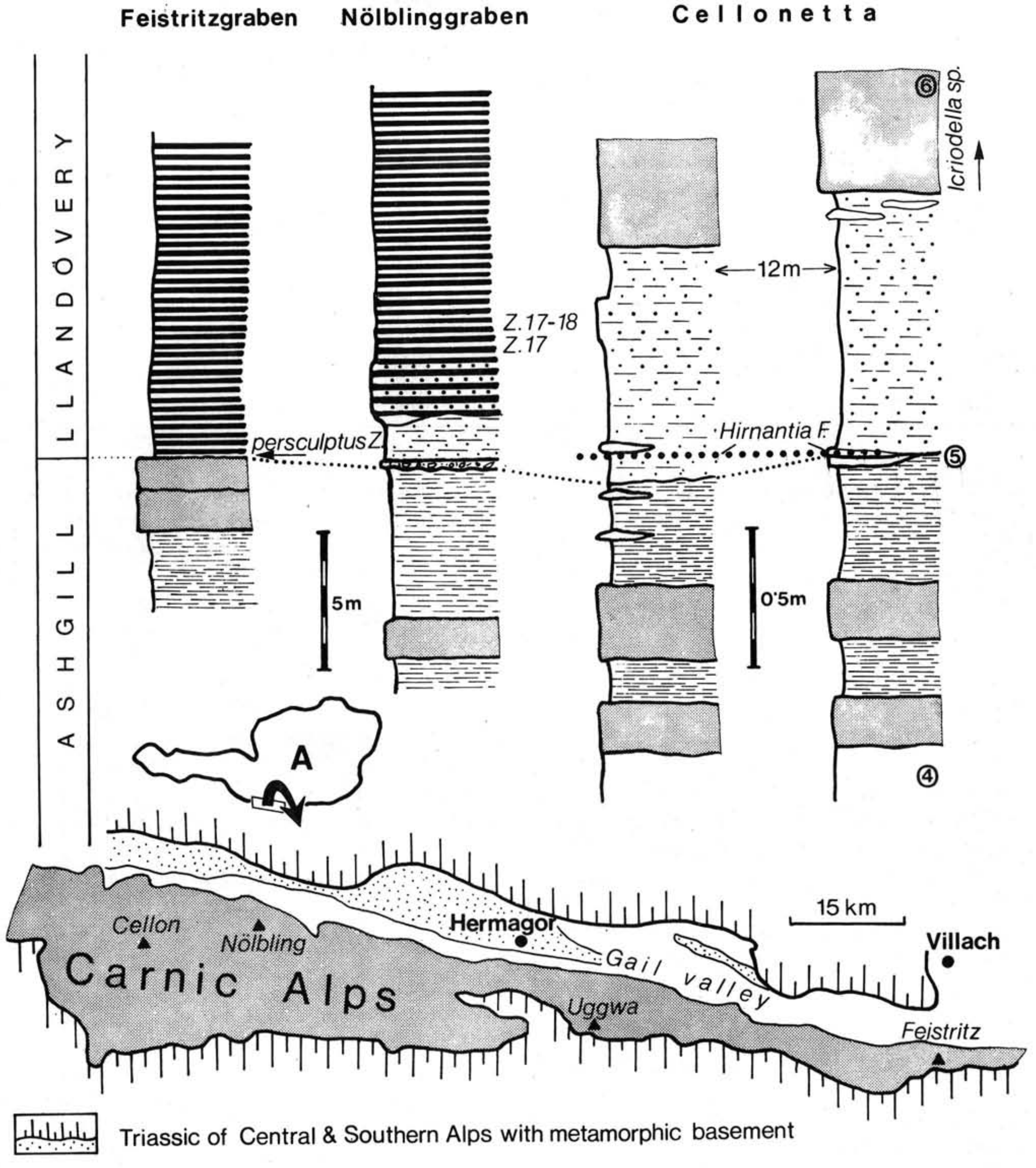


Fig. 4: Ordovician/Silurian boundary sections in the Carnic Alps and the western Karawanken Alps. Note difference in scale (shade = limestones, heavy lines = graptolite shales, thin lines = shales, dots and lines = calcareous sandstones of the „Untere Schichten"). From H. P. SCHÖNLAUB 1979.

Fossils in the two facies mentioned above include bryozoans, brachiopods, cystoids, trilobites, tentaculites, and hyoliths occuring in the shale formation, and abundant conodonts which are derived from the limestones.

Concerning frequency of conodonts, the argillaceous Uggwa Lst. yielded richer faunas than the coarse grained cystoid bearing Wolayer Lst. which suggests a shallower environment.

Chronostratigraphycally, the Upper Ordovician of the Carnic Alps corresponds with the British Caradocian and Ashgillian Series. By comparison with the Barrandian, it is equivalent with the Berounian, the Kralův Dvůrian and the Kosovian.

Recent studies of the Ordovician/Silurian transition beds have revealed a significant disconformity on top of the Ashgillian limestones. Non-deposition and/or erosion was thus, that several Silurian conodont zones may be missing while in other places sedimentation continued. In the Carnic Alps the Silurian transgression began in the graptolite zone of *Gl. persculptus*. Although this index graptolite has not been found together with the Hirnantia-Fauna, there is good evidence to conclude a basal Llandoverian age for its occurrences in the Carnic Alps (fig. 4).

Silurian lithofacies of the Carnic Alps is split up into four major facies which reflect different depths of deposition. A shallow environment can be assumed for the (1) Plöcken facies characterized by limestones and few shale intercalations. Type-section is the 60 m thick famous Cellonetta section, stop 1.

(2) A primarily even shallower environment represents the Wolayer facies which is restricted to the surroundings of Lake Wolayer and the mountain Rauchkofel. This facies is characterized by a long period of non-deposition which may have lasted from the Upper Ordovician to the basal Ludlovian *(sagitta*-Zone). In the Silurian this facies is represented by 10–15 m cephalopod limestones.

(3) An intermediate facies is the so-called Findenig facies representing the transition from carbonate platform deposits of facies 1 and 2 to a starving basinal environment. The Findenig facies comprises alternating dark graptolite shales, marls and limestone beds. Basally, a quartzite member of varying thickness and age can be found.

(4) The basinal graptolite facies in the Carnic Alps is known as Bischofalm facies. It consists of 60–80 m thick black graptolite shale, lydite beds and dark shales which overlie a basal quartzite assigned to the lower and middle (?) Llandovery. During the past 15 years sections of facies 3 and 4 have been thoroughly studied by H. JAEGER. His data are summarized in fig. 5.

A common feature of all 4 Silurian facies in the Carnic Alps is its division into 2 unequal parts suggesting different rates of subsidence. The first part represented by Llandoverian to Ludlovian strata reflects a more or less steadily subsiding basin and hence characterizes a transgression. This tendency decreased and perhaps stopped during the Přidolian. At that time limestones prevailed over shales in facies 1, 2 and in the mixed facies 3; contemporaneously, in the Bischofalm facies black graptolite shale changed into grey-green shale known as eß-shale.

A recurrent facies developed at the beginning of the Devonian when in the Bischofalm facies the graptolite regime was restored. Similarily and contemporaneously, the Lower Devonian carbonate facies changed to a deeper water environment.

In the Silurian deposits the abundance of conodonts varies considerably. They can be found more frequently in rocks of the Plöcken facies occuring predominantly in impure dark limestones of the Trilobite and Aulacopleura Beds and in the Kok Lst. with an average of 50–100 specimens per kg and in some horizons with more than 100 specimens per kg. Generally, the Upper Silurian carbonates yielded less abundant conodont faunas; total numbers only occasionally exceed 50 conodonts in one kg.

Towards the basinal facies conodonts are less diversified than in shallower environments. For example, limestones of the mixed facies at section Oberbuchach 1 intercalated in dark graptolite shale produced only single cones.

As mentioned above, in the basal Devonian a recurrent transgressional sequence has been deposited. The Lochkovian part of this succession includes: 10–120 m thick platy limestones („e-gamma Plattenkalk") on top of the Silurian Plöcken facies which – broadly spoken – also succeeded the mixed facies; some 20 m of cephalopod limestones overlying the Silurian Wolayer facies in the area of Lake Wolayer; and finally, the Upper Graptolite Shale with a thickness of less than 10 meter.

At the end of the Lochkovian bottom mobility increased significantly in the Carnic Alps. As seen in fig. 3 very different facies can be found within short distances indicating a progressive, but not uniform deepening of the basin. They vary from thick reef and near-reef organodetritic limestones (including various lagoonal deposits, e. g., *Amphipora* and gastropod lst., dolomites, laminated algae lst., birdseye lst. etc.) to pelitic deep water shales and cherts of the Bischofalm Group and to 50–100 m thick cepha-

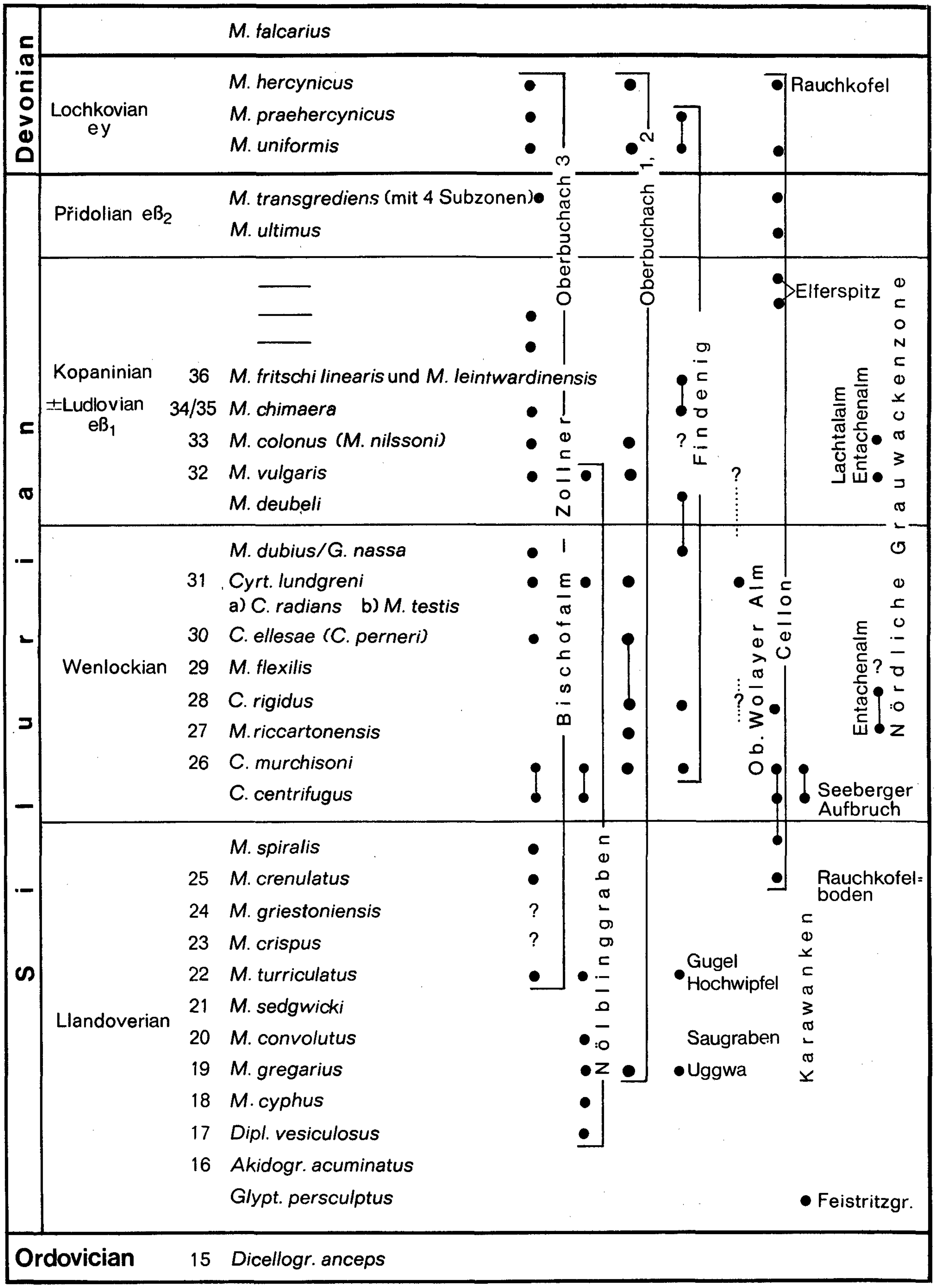


Fig. 5: Age and occurrences of graptolites in Austria (H. JAEGER, modified from H. P. SCHÖNLAUB 1979).

lopod and tentaculite limestones. The latter have been deposited on basinal swells and ridges. The sediments are more or less condensed depending on the distance from shallow water carbonate platforms from which limestone turbidites were supplied into the pelagic realm. Also, bottom currents may have been responsible for the thin Devonian sediments.

In the Carnic Alps conodonts are fairly abundant in the cephalopod and tentaculite Flaser-limestones on which we will concentrate during our excursion. Only a few conodonts have been found in the bioclastic near-reef carbonates and in the lagoonal deposits. In the basinal sequence conodonts occur on bedding planes of greenish and greyish radiolarian cherts. In addition, rich conodont faunas have been discovered in small limestone lenses embedded at various levels in the Bischofalm Group.

The shallow water regime was terminated at the end of the Frasnian when the carbonate platform areas collapsed and subsided. Subsequently, pelagic nodular goniatite limestones were deposited lasting from the Frasnian/Famennian boundary to the Viséan Stage. In some parts, however, sedimentation already ended in the late Frasnian. In the late Devonian no calcarenitic turbidites occur. With varying amount the limestones are composed of pelagic carbonate oozes with locally abundant cephalopods, trilobites, styliolinids, radiolarians, ostracods, forams, fish teeth, conodonts and other sceletal fragments. Phosphatic nodules are restricted to a distinct level in the early Frasnian.

Summarizing, with deposition of various pelagic limestones and radiolarian cherts – which mainly occur in the Tournaisian and early Viséan – the pre-orogenic Paleozoic history of the Carnic Alps came to an end. Yet, not exactly dated, but apparently spanning the same interval of time also pelitic shale-chert sequences have been deposited in the late Devonian and early Carboniferous.

Close to the end of the Viséan, the carbonate platform had been completely collapsed and an extremely mobile trough had been formed instead (fig. 1).

Our present understanding about geodynamic events in the late Devonian and early Carboniferous is almost entirely based on conodont biostratigraphy; conodonts occur in great numbers in continuously exposed limestone sections crossing the Devonian/Carboniferous boundary.

The orogenic flysch sequence of the Carnic Alps is named „Hochwipfel Fm." According to conodonts from basally intercalated limestone lenses the lower limit can be assigned to the Upper Viséan, i. e., the *Gnathodus c. nodosus*-Zone; the same age can also be concluded from plant remains which have been found at many places near the base; furthermore, spores indicate the interval from Namurian B to Westfalian C.

The 600 to 1000 m thick Hochwipfel Fm. comprises alternating sandstones, greywackes and shales at the base, a middle part with abundant chert breccias (the breccias also contain constituents from crystalline rocks) and an upper member with intercalations of acid volcanites. According to Italian geologists in the flysch sequence at different levels olistoliths have been found. Generally, volcanic influence increases towards the top indicating the geosynclinal nature of these deposits.

Sedimentological criteria, heavy mineral analyses and progress in mapping suggest the main source-area for the flysch deposits north of the present Carnic Alps. Clastic material may thus have been supplied from the Old Variscan Mountain Belt of the present Central Eastern Alps in such a way that the rise of this belt simultaneously was compensated by the filling of an adjoining flysch trough (see fig. 1).

In the Carnic Alps the Variscan orogeny reached its paroxysm in the late Westfalian. The following molasse-type sediments rest unconformably on older strata. The main exposures of post-Variscan sediments are in the surroundings of the Naßfeld area, i. e., east of the region we are visiting. They include the 700 m thick fossiliferous Auernig Fm. which exhibits a cyclic alternation of marine fusulinid and algal limestones and shales, coastal and/or deltaic quartz-conglomerates and plant-bearing sandstones.

The Lower Permian comprises the Lower Pseudoschwagerina Lst., the clastic Grenzland Fm., and the Upper Pseudoschwagerina Lst. The latter grades upward into the 400 m thick massive and in part fossiliferous Trogkofel Lst. This formation, in turn, is disconformably overlain by marine sandstones of the Gröden Fm. – with local occurrences of the Tarvis Breccia at the base – and the calcareous, in part evaporitic Bellerophon Fm. which both represent the Upper Permian of the Carnic Alps.

Yet, no systematic search for conodonts in the post-Variscan sequence has been done. Sporadically, however, a few conodonts have been discovered in the limestones of the Auernig Fm. and in the Bellerophon Fm.

For more detailed information about stratigraphy of the post-Variscan sequence of the Carnic Alps the reader is referred to W. BUGGISCH 1975, 1978, W. BUGGISCH et al. 1976, E. FLÜGEL 1975 and the compilation of H. P. SCHÖNLAUB 1979.

Conodonts from the Permian/Triassic boundary beds in the Southern Alps were mentioned by H. W. FLÜGEL 1965 from the Werfen Fm. and W. BUGGISCH 1975 from the Bellerophon Fm., both from the Naßfeld area; U. STAESCHE 1964 and W. C. SWEET 1973 in R. ASSERETO et al. 1973 noted the occurrences of conodonts in the Bellerophon Fm. and the Werfen Fm. of South Tyrol.

Previous conodont work in the Carnic Alps

Conodont discovery in the Carnic Alps dates back to the year 1931 when E. HABERFELNER misidentified conodonts on bedding planes of cherts as graptolites which he named *Rastrites geyeri*. According to W. ZIEGLER in H. FLÜGEL et al. 1959, however, the badly preserved platform types belong to the genus *Polygnathus* and most probably are of Lower Carboniferous age (Pericyclus-Stage). The conodont nature of these enigmatic fossils has already been suspected by A. PŘIBYL 1941.

Systematic conodont studies have been initiated and pioneered by K. J. MÜLLER and O. H. WALLISER. In 1956 K. J. MÜLLER described Famennian conodonts of the genus *Palmatolepis* from 4 localities in the Carnic Alps and in 1959 a Lower Carboniferous fauna based on the occurrences of goniatites. In 1969 the same author drew attention to peculiar shaped „brush-like" Upper Devonian conodonts from the Lake Wolayer area and other places in the Carnic Alps.

O. H. WALLISER first reported in 1957 on Silurian conodonts from the Cellon section and from Rauchkofel and in 1964 he published the famous monograph on Silurian conodonts; previously, the approx. 60 m thick type section („Cellonetta-Lawinenrinne") was thoroughly studied by H. R. v. GAERTNER 1931 and others, who established the biostratigraphical subdivision of the rock sequence. More recently H. JAEGER 1975 added graptolite data from this section for more precise correlations with conodonts.

In the 60ies conodont information has expanded, mainly by the studies of A. PORTI & M. NOCCHI 1963 on Devonian faunas, M. MANZONI 1965, 1966, 1968 on Silurian faunas from the Kok Lst., Lower to Upper Devonian, and Lower Carboniferous conodonts from the Italian part of the Carnic Alps. C. CANTELLI, M. MANZONI & G. B. VAI (1965, 1968) used conodonts to date rocks which were exposed by the transalpine oil pipeline gallery crossing the Central Carnic Alps a few kilometers east of Kötschach; in Austria this study was done by G. FLAJS & P. PÖLSLER 1965 and P. PÖLSLER 1967.

In 1967 E. SERPAGLI finished a comprehensive monograph about conodonts from the Uggwa Lst., i. e., Ashgillian conodonts. This study concentrated on the type locality in the Uggwa valley and on other occurrences of the Uggwa Lst. at Mt. Zermula, Italian Carnic Alps.

At about the same time H. P. SCHÖNLAUB (1968, 1969 a, b), P. PÖLSLER (1969) and W. SKALA (1969) studied Ordovician to Carboniferous sequences in the Austrian Carnic Alps. Due to lack of other fossils, subdivision of rocks was entirely based on conodont biostratigraphy.

Applied conodont biostratigraphy in the past ten years includes studies of Ordovician to Lower Devonian limestones on the southern slope of mountain Rauchkofel (H. P. SCHÖNLAUB 1970, C. MANARA & G. B. VAI 1970); study of a short section at Rauchkofel which exhibits common occurrences of conodonts and graptolites from the Llandovery/Wenlock boundery (H. JAEGER & H. P. SCHÖNLAUB 1970); and a section at the base of mountain Hohe Warte which yielded Ashgillian and early *celloni*-Zone conodonts (H. P. SCHÖNLAUB 1971).

The comprehensive paleoecological study of Devonian and Lower Carboniferous limestones of the Central Carnic Alps, carried out by K. BANDEL 1972 is based on more than 400 conodont samples which enabled precise correlation of 19 individual sections.

Biostratigraphic and correlative value of conodonts has also been demonstrated in tectonically complex areas, as for example, the Elferspitz section which is located little east of Plöcken Pass (F. EBNER 1973 a); upon conodont study, this section easily can be compared with the Cellon stratotype. Also, the Devonian/Carboniferous transition beds which produced an excellent *Protognathodus*-Fauna have been proved on the north side of mountain Elferspitz (F. EBNER 1973 b).

In 1974 I. GEDIK published his results of a dissertation at Bonn University which dealt with Lower Carboniferous conodonts in the Central Carnic Alps. Apart from important geodynamic implications he described 21 conodont genera and 77 subspecies; this fauna is closely related to other Central European occurrences.

In 1977 G. B. VAI (in H. W. FLÜGEL et al. 1977) reported on conodonts from the Lower Devonian of the Seewarte section at Lake Wolayer. The shallow water limestones yielded conodonts which — according to our present knowledge — can be assigned to the Lochkovian and early Pragian.

Finally, it must be stated that conodonts have been widely used for mapping purposes during the past 15 years; very often, they have provided the only information about age in tectonically complex and lithologically uniform limestone and chert sequences in the Lower Paleozoic of the Carnic Alps.

Devonian ammonoid faunas of the Carnic Alps
(A review)

M. R. HOUSE & J. D. PRICE

There has been no systematic study of the sequence of Devonian ammonoids in the Carnic Alps this century. The primary work was done by F. FRECH (summarized by him in 1897). In 1921 O. H. SCHINDEWOLF published a review, largely drawn on by later authors, based on a restudy of F. FRECH's collection at Wroclaw (which we are informed did not survive the second world war) and a study of material in E. KAYSER's collection in Marburg: He also commented on the material described by M. GORTANI (1907) and others. H. R. v. GAERTNER (1931) later added new records and described some sequences incidental to his major study of the geology of the Central Carnic Alps.

This brief review is based almost wholly on published literature and brings terminology up-to-date but it is not based on new systematic collecting which has been planned for summer 1980.

Lower Devonian

F. FRECH recorded a number of forms from the Carnic Alps which he ascribed to the Lower Devonian: The names he gave *'Tornoceras inexpectatum'* and *Beloceras 'praecursor'* show that he was aware of their anomalous nature. These are now thought to be late Devonian records and there is nothing which can certainly be ascribed to the Lower Devonian of which we are aware.

Middle Devonian

The Middle Devonian goniatites reported are few. F. FRECH's record (1897) of *Anarcestes praecursor,* and *Aphyllites* might refer to Emsian or Eifelian types. M. GORTANI described *Anarcestes* cf. *denckmanni* HOLZAPFEL from Casera Primosio, and this species would now be placed in the Givetian genus *Holzapfeloceras,* but M. GORTANI's specimens were small and the specific assignment uncertain. Similar doubt surrounds the forms he assigned to Givetian tornoceratids.

Upper Devonian

It is the Upper Devonian which has the best developed ammonoid faunas and there is evidence for all major genus zones. It is one of half a dozen good and near complete sequences known from Central Europe and faunally is a replication of them. Following W. ZIEGLER (1979, p. 40) the late Devonian ammonoid genus zones are regarded as exactly equivalent to the German Stufen.

Adorfian: *(Manticoceras* genus zone)

Faunas of this level are best described in the region of Lake Wolayer (and also at Steinberg near Graz). The *lunulicosta* Zone (to I alpha) is suggested by records of *Ponticeras pernai* (WEDEKIND) and by common ponticeratids: pharciceratids are not recorded. The *cordatum* Zone (to I beta/gamma) is well developed. *Trimanticoceras retrorsum* (VON BUCH) and *Maternoceras calculiforme* (BEYRICH), recorded by H. R. v. GAERTNER (1931) from near the Wolayer Glacier, suggest to I beta; *Manticoceras cordatum* (G. & F. SANDBERGER), *M. cordatum adorfense* WEDEKIND, *Probeloceras sandbergeri* (WEDEKIND) and *Beloceras sagittarium* (G. & F. SANDBERGER) ? *(=praecursor* FRECH 1897), all from the Wolayer area, indicate to I gamma. Other *cordatum* Zone records include *M. carinatum* (G. & F. SANDBERGER), *M. koeneni* (HOLZAPFEL), *M. intumescens* (BEYRICH) and *Aulatornoceras paucistriatum* (D'ARCHIAC & DE VERNEUIL). There is nothing to indicate the *holzapfeli* Zone (to I delta).

Nehdenian: *(Cheiloceras* genus zone)

Evidence for this level is limited. H. R. v. GAERTNER found *Torleyoceras* (?) *pompeckii* (WEDEKIND) (to II alpha), *Cheiloceras* sp. and *Polonoceras planodorsatum* (MÜNSTER) from the spring at Lake Wolayer and M. GORTANI recorded *Torleyoceras* (?) aff. *lagowiense* (GÜRICH) (? to II beta) from Casera Primosio.

Hembergian: *(Platyclymenia* genus zone)

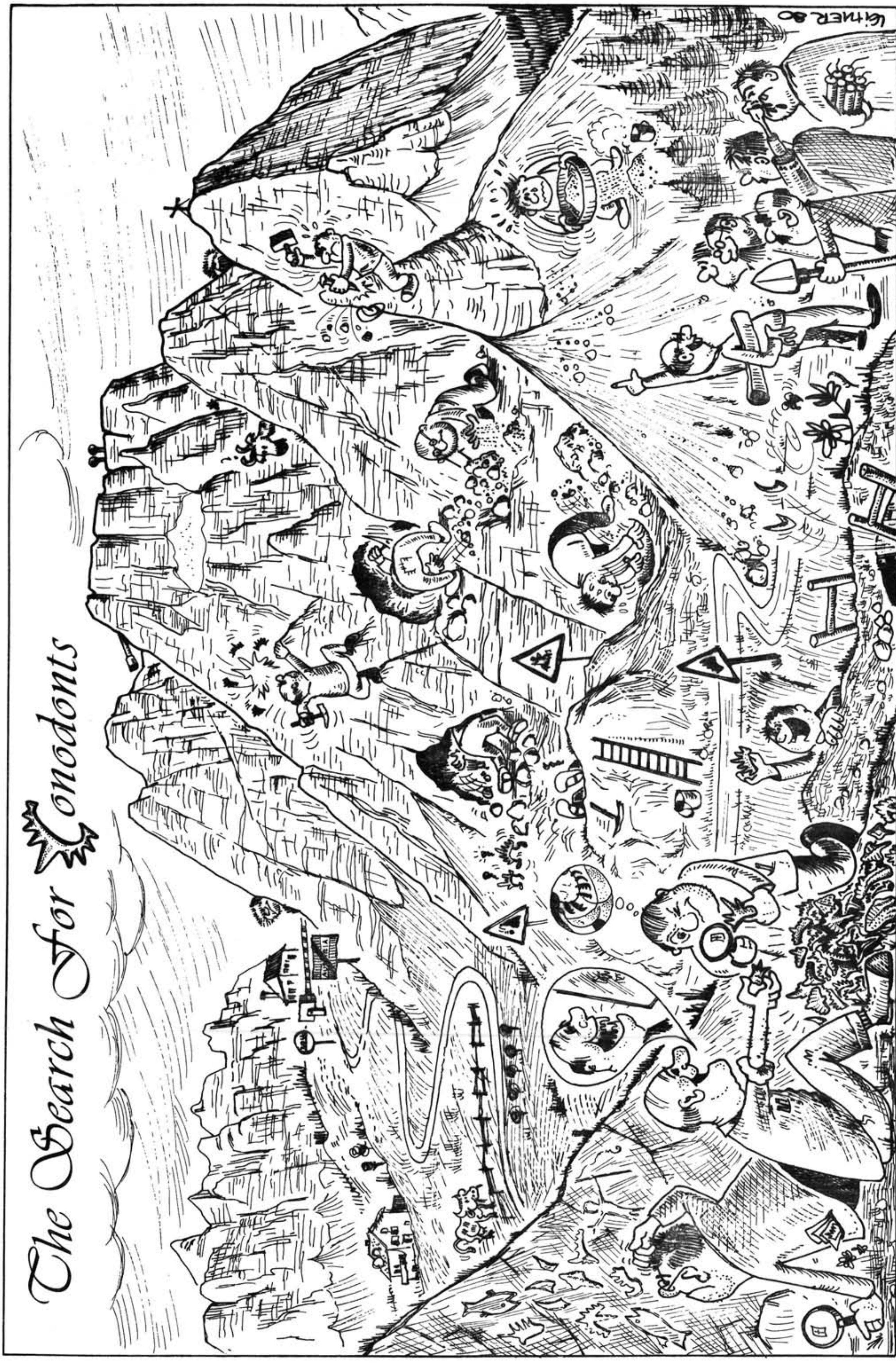
Quite a varied fauna is evident from this division. H. R. v. GAERTNER recorded *Pseudoclymenia* *dillensis* (DREVERMANN) and *Ps. pseudogoniatites* (SANDBERGER) from Valentintörl suggestive of to III alpha/beta levels. From the same locality came a rich to III beta fauna, including: *Prolobites delphinus* (G. & F. SANDBERGER), *Sporadoceras (S.) muensteri* (VON BUCH), *Rectoclymenia rotundata* SCHINDEWOLF, *R. subflexuosa* (MÜNSTER), *R. acuta* (PERNA), *Platyclymenia (Pl.) sandbergeri* (WEDEKIND), *Pl. (Pl.) pompeckii* (WEDEKIND). O. H. SCHINDEWOLF recognised *Lobotornoceras bilobatum* (WEDEKIND) and H. R. v. GAERTNER found *Prolobites mirus* (WEDEKIND) in a loose block. The *annulata* Zone (to IV) is also indicated by good faunas from the Lake Wolayer of *Pl. (Pl.) annulata* (MÜNSTER), *Pl. (Pl.) arieticosta* (SCHINDEWOLF). O. H. SCHINDEWOLF recorded *Prionoceras frechi* (WEDEKIND), *Pr. sulcatum* (MÜNSTER) and *Pr. divisum* (MÜNSTER) and *Falciclymenia falcifera* (MÜNSTER).

Dasbergian: *(Clymenia* genus zone)

At this level ammonoid faunas seem particularly varied and it is unfortunate that detailed successions have not been described. Levels embracing both the usual divisions (to V alpha and beta) seem represented. From the section at the spring at Lake Wolayer a fauna includes *Clymenia laevigata* (MÜNSTER), *Cl. cingulata* GÜMBEL, and *Cl. spiratissima* (SCHINDEWOLF), *Cymaclymenia striata* (MÜNSTER), *Kosmoclymenia subundulata* (WEDEKIND) and others. All the listed species also occur in the Großer Pal section east from Plöckenpaß together with *Discoclymenia cucullata* (VON BUCH), *Pr. sulcatum* (MÜNSTER), *Cyrtoclymenia lata* (MÜNSTER), *Progonioclymenia acuticosta* (MÜNSTER) and *Kosmoclymenia undulata* (MÜNSTER). O. H. SCHINDEWOLF adds *Lobotornoceras escoti* (FRECH), *Imitoceras lineare* (MÜNSTER), *Alpinites kayseri* (SCHINDEWOLF), *Cycloclymenia planorbiformis* (MÜNSTER), *Protoxyclymenia dunkeri* (MÜNSTER), *Kosmoclymenia undulata* (MÜNSTER), *Kosm. bisulcata* (MÜNSTER), *Costaclymenia binodosa* (MÜNSTER) and *Gonioclymenia speciosa* (MÜNSTER).

Wocklumerian: *(Wocklumeria* genus zone)

In the Großer Pal section there is evidence for the presence of both to VI alpha and to VI beta zones but the fauna of the Hangenbergschiefer has not been discriminated. At Grüner Schneid west of Cellon it is clear the sequence goes up into the earliest Carboniferous since *Prolencanites* sp. and *Pseudoarietites* sp. are recorded by H. R. v. GAERTNER. The *subarmata* Zone (to VI alpha) is indicated by *Kalloclymenia subarmata* (MÜNSTER) and the *sphaeroides* Zone (to VI beta) is indicated by *Parawocklumeria distorta* (TIETZE). *Glatziella* is also known, and O. H. SCHINDEWOLF recorded *Cyrtoclymenia agustiseptata* (MÜNSTER).


The Search for Conodonts

The Excursion

DAY 1

During the first day the excursion will visit conodont localities in the area around Plöcken Pass in the Central Carnic Alps. The first part will be spent at Cellon section (Stop 1), in the afternoon the Upper Devonian on top of Großer Pal east of Plöcken Pass will be shown (Stop 2). Stop 3 – 5 are planned along the roadcut from Oberbuchach to Gundersheim Alm to visit Silurian and Lower Devonian graptolite and conodont bearing limestones and shales.

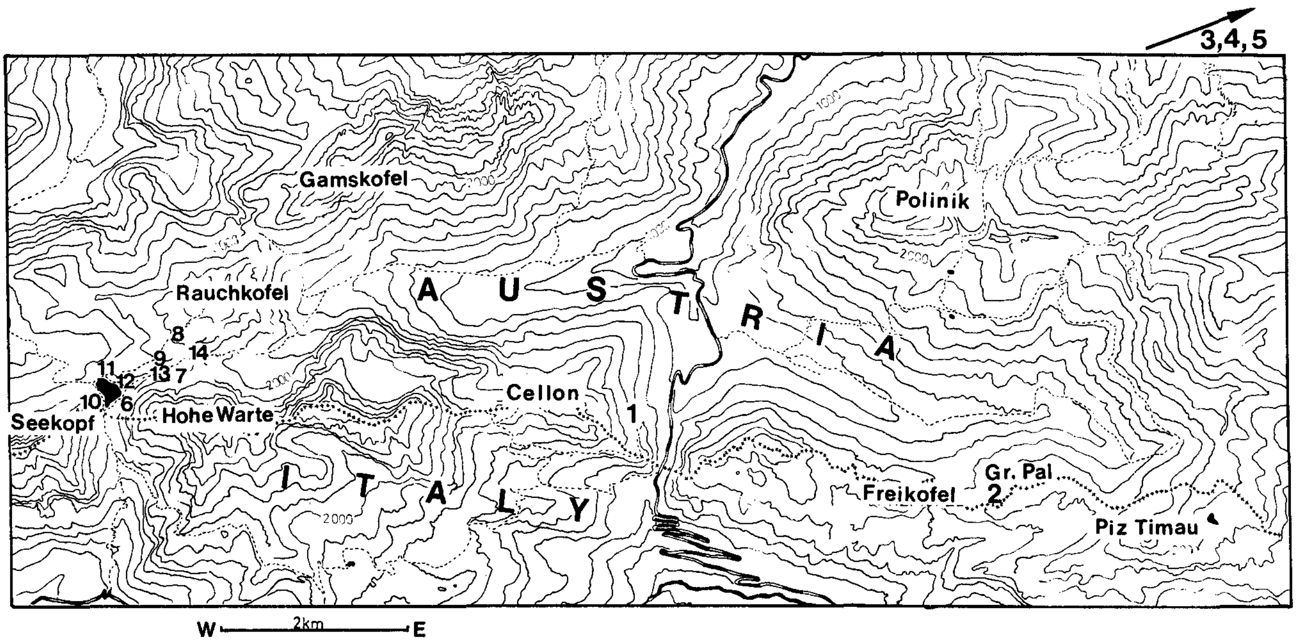


Fig. 6: The excursion route in the Central Carnic Alps.

STOP 1. Cellon Section

The section is located between 1480 and 1560 m on the eastern slope of Mount Cellon, SSW of Kötschach-Mauthen and close to the Austrian/Italian border. It can be reached within a 15 minutes walk from the border where we will leave the coach.

The Silurian portion of the Cellon section is best exposed in a narrow trench made by avalanches. Hence, the proper name for this section is „Cellonetta-Lawinenrinne".

The Cellon section represents the stratotype for the Silurian of the Eastern and Southern Alps. It has been famous since 1903 when G. GEYER first described the rock sequence. According to H. R. v. GAERTNER 1931 who studied fossils and rocks in great detail, the 60 m thick continuously exposed Upper Ordovician to Lower Devonian section can be subdivided into several formations. From bottom to top the following units can be recognized (see figs. 7a–7d):

Top:	80 m	Platy limestones (Lochkovian)
	8 m	Megaerella Beds (light in part fossiliferous limestones)
	20 m	Alticola Limestone (grey and pink nautiloid limestones)
	3,5 m	Cardiola Beds (alternating black limestones and shales)
	7 m	Kok Limestone (brownish ferruginous nodular limestones).
	6 m	Trilobite and Aulacopleura Beds (alternating shales and ferruginous limestone beds)
	5,5 m	Untere Schichten = „Lower Beds" (calcareous sandstones and dark shales)
Base:	7 m	Uggwa Lst. Formation (argillaceous limestones with greenish siltstones on top).

Fig. 7a

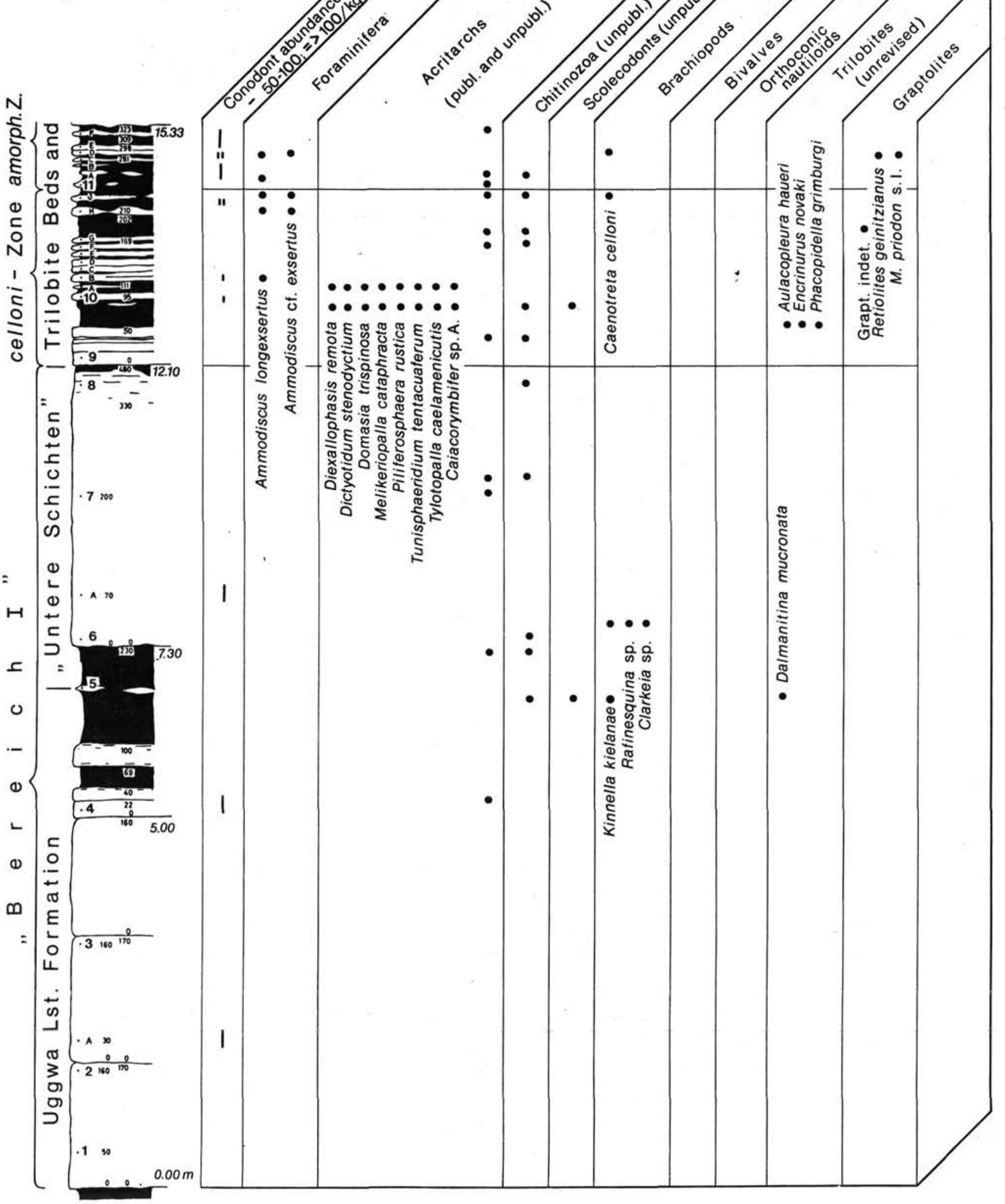
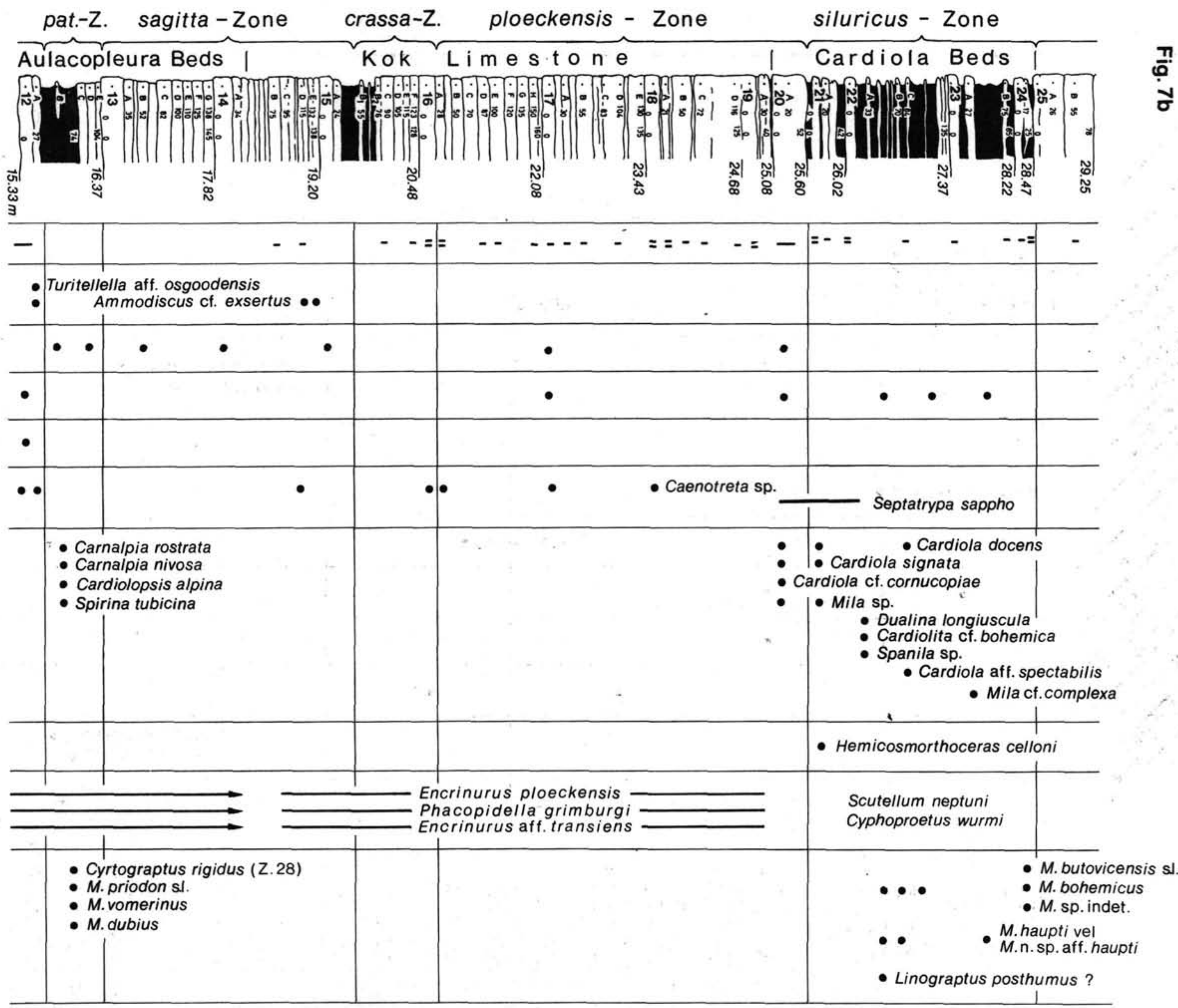
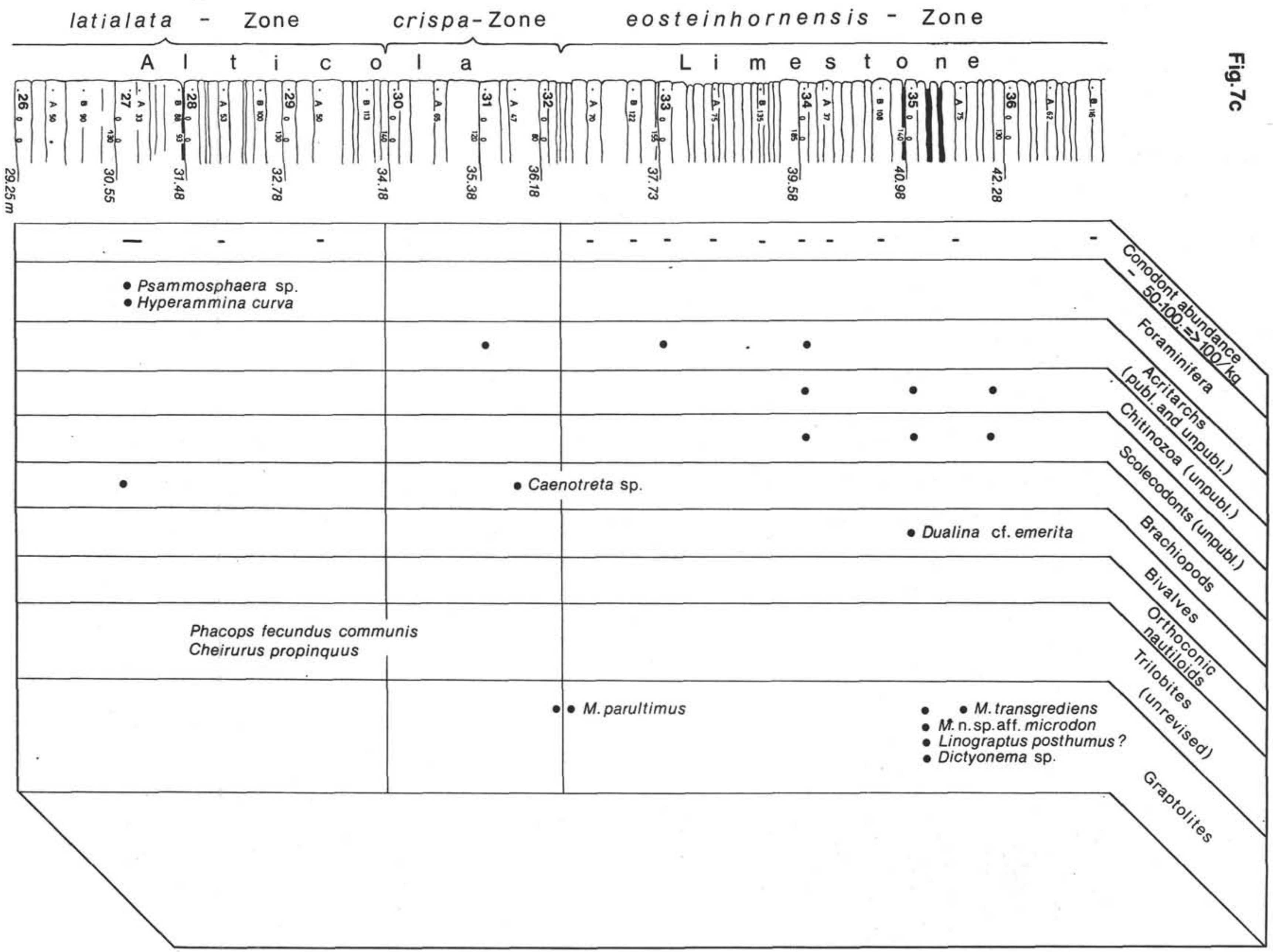


Fig. 7a–d: Stratigraphy and fossil content in the Cellon section (based on O. H. WALLISER 1964 with published and unpublished data provided by H. R. v. GAERTNER 1931, H. RISTEDT 1968, G. PLODOWSKI 1971, 1973, H. JAEGER 1975, E. KRISTAN-TOLLMANN 1971, W. LANGER 1969, F. MARTIN 1978, J. KŘÍŽ 1979 and H. PRIEWALDER).



pat.-Z.
sagitta - Zone
crassa-Z.
ploeckensis - Zone
siluricus - Zone
Aulacopleura Beds
Kok Limestone
Cardiola Beds
15.33 m
16.37
17.82
19.20
20.48
22.08
23.43
24.68
25.08
25.60
26.02
27.37
28.22
28.47
29.25
Turitellella aff. osgoodensis
Ammodiscus cf. exsertus
Caenotreta sp.
Septatrypa sappho
Carnalpia rostrata
Carnalpia nivosa
Cardiolopsis alpina
Spirina tubicina
Cardiola docens
Cardiola signata
Cardiola cf. cornucopiae
Mila sp.
Dualina longiuscula
Cardiolita cf. bohemica
Spanila sp.
Cardiola aff. spectabilis
Mila cf. complexa
Hemicosmorthoceras celloni
Encrinurus ploeckensis
Phacopidella grimburgi
Encrinurus aff. transiens
Scutellum neptuni
Cyphoproetus wurmi
Cyrtograptus rigidus (Z. 28)
M. priodon s.l.
M. vomerinus
M. dubius
M. butovicensis s.l.
M. bohemicus
M. sp. indet.
M. haupti vel
M. n. sp. aff. haupti
Linograptus posthumus ?

Fig. 7b



latialata - Zone
crispa-Zone
eosteinhornensis - Zone
A l t i c o l a
L i m e s t o n e
29.25 m
30.55
31.48
32.78
34.18
35.38
36.18
37.73
39.58
40.98
42.28
Psammosphaera sp.
Hyperammina curva
Caenotreta sp.
Dualina cf. emerita
Phacops fecundus communis
Cheirurus propinquus
M. parultimus
M. transgrediens
M. n.sp.aff. microdon
Linograptus posthumus ?
Dictyonema sp.
Conodont abundance
- 50-100; => 100/kg
Foraminifera
Acritarchs
(publ. and unpubl.)
Chitinozoa (unpubl.)
Scolecodonts (unpubl.)
Brachiopods
Bivalves
Orthoconic nautiloids
Trilobites
(unrevised)
Graptolites

Fig.7c

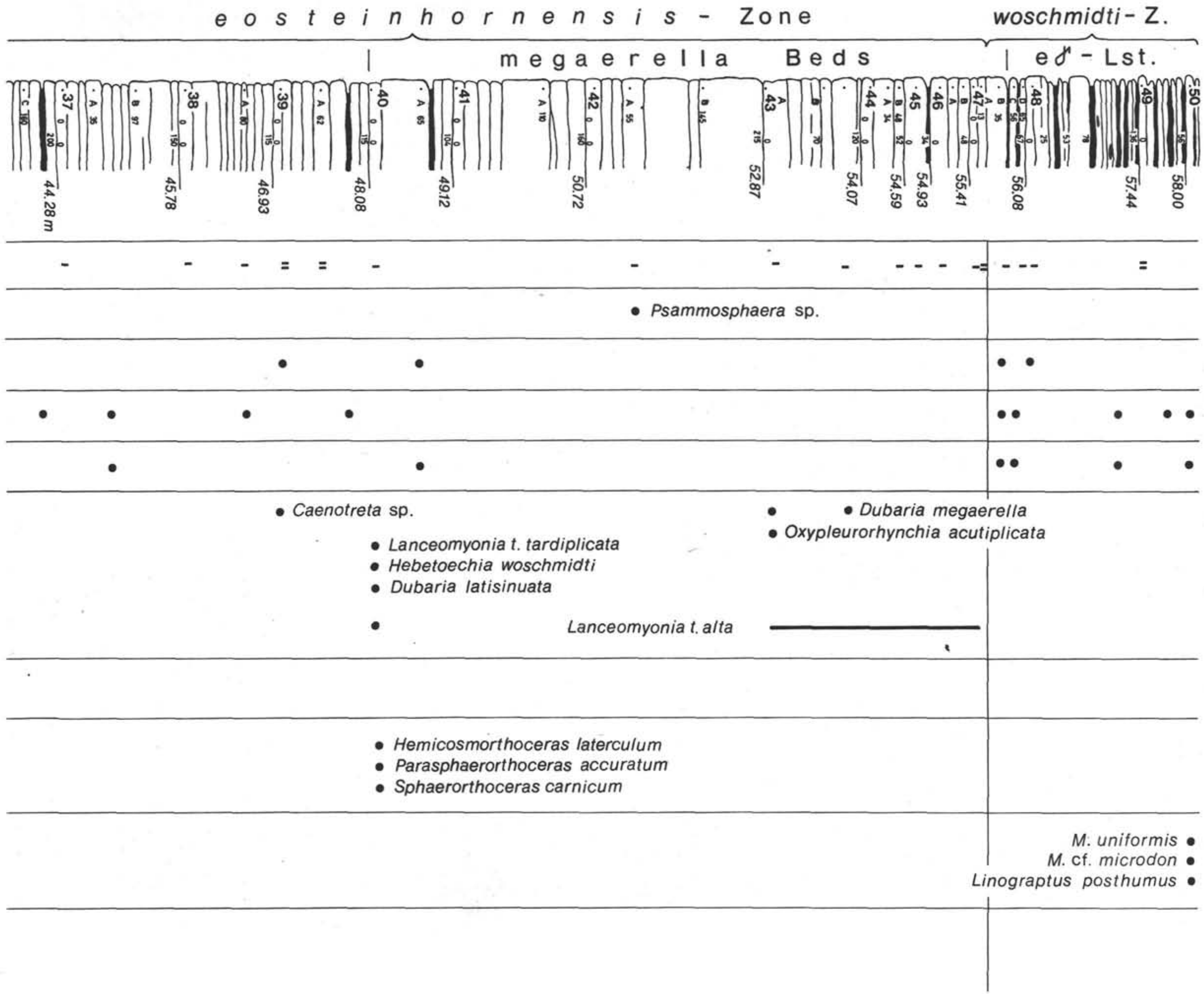

eosteinhornensis - Zone
woschmidti - Z.
megaerella Beds
eδ - Lst.
44.28 m
45.78
46.93
48.08
49.12
50.72
52.87
54.07
54.59
54.93
55.41
56.08
57.44
58.00
Psammosphaera sp.
Caenotreta sp.
Lanceomyonia t. tardiplicata
Hebetoechia woschmidti
Dubaria latisinuata
Lanceomyonia t. alta
Dubaria megaerella
Oxypleurorhynchia acutiplicata
Hemicosmorthoceras laterculum
Parasphaerorthoceras accuratum
Sphaerorthoceras carnicum
M. uniformis
M. cf. microdon
Linograptus posthumus

Fig. 7d

Correlation:

The Ordovician/Silurian boundary is drawn within sample no. 5 of O. H. WALLISER 1964. This limestone lense exhibits a distinct change in facies from grey limestones and greenish shales to dark shales. At the base of the overlying dark shales representatives of the Hirnantia Fauna have been found. By correlation with the section Feistritzgraben which shows a comparable change in facies, the Hirnantia Fauna may be assigned to the basal Llandoverian graptolite zone of *Gl. persculptus*. Conodonts, e. g., *Icriodina irregularis* (which actually may be an *Icriodella)* from sample nos. 6–8 support the conclusion drawn here.

Die Proben enthalten folgende Anzahl von Exemplaren:

- 0 — 20
- • 20 — 50
- •• 50 — 100
- — 100 — 170
- ·— 170 — 300
- ••═ 300 — 500
- ≡ 500 — 700
- ≡·≡ 700 — 1000
- ••≡ < 1000

	Cellon																													
	Bereich I											*celloni*-Zone									*amorphognathoides*-Z.									
	1-4 allg.	1	2	2 A	3	4	5	6-8	6	6 A	7	10 allg.	10 B	10 C	10 D	10C/D	10 E	10 H	10 J	10H/J	11 allg.	11	11 A	11 B	11 C	11 D	11 E	11 F	12	12 A
	·—	—		—		·—		—	•	—		·—	—	•	••	••	••	••	═	••═	—	••	·—	·—	••	—		••		
Ambalodus triangularis	•	•	•	•	•	•	•	•	•	•	•																			
Amorphognathus n. sp.	•	•	•	•	•	•	•	•	•	•	•																			
Carniodus sp.	•	•		•		•																								
Icriodina irregularis								•	•	•																				
? *Neoprioniodus brevirameus*	•	•		•		•		+		•																				
Neoprioniodus planus	+											•	•	•	•	•		•	•	•										•
Ozarkodina sp.		•																												
Roundya truncialata	•	•				•			•																					
? *Roundya prima*	•	•		•		•																								
? *Roundya* n. sp.	•	•		+		•		•																						
Spathognathodus sp.		•																												
gen. indet. n. sp. c		•						•	•	•																				
Ambalodus galerus														•	•	•	•						•	•		•		•		
Apsidognathus tuberculatus												•	•	•	•	•	•				•		•			•		•	•	•
Astrognathus tetractis															•	•										•				
Carniodus carinthiacus													+							•	•	•	•	•	•	•	•	•	•	•
Carniodus carnicus													+									•		•	•	•	•	•	•	•
Carniodus carnus													•						•		•	•	•	•	•	•	•	•	•	•
Carniodus eocarnicus																•			•	•										
Hadrognathus staurognathoides												□	•						•	•	•	•		•	•	•	•			
Ligonodina egregia												•	+				•		•	•			•		•	•	•			
Lonchodina fluegeli												•	•	•	•	•		•	•	•	+								+	
Neoprioniodus costatus paucidentatus												•	•	•	•	•	•		•	•										
Neoprioniodus subcarnus												•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•
Neoprioniodus triangularis tenuirameus													•			•			•	•										
Ozarkodina adiutricis												•	•	•	•	•	•	•	•	•										
Pygodus lyra												•	•	•		•	•						•			•		•		•
Pygodus lenticularis																•														
Roundya brevialata													•	•	•	•	•		•	•		•								
Roundya caudata	+							+		+		•	•				•		•	•					•	•				
Roundya detorta																				•	•	+	•		•	•				
Roundya trichonodelloides																		•		•					•					
Spathognathodus celloni												•	•	•	•	•	•	+	•	•										
Spathognathodus pennatus pennatus																		•	•	•										
Spathognathodus pennatus angulatus													•																	
Spathognathodus ranuliformis																				□				•	•	•				
Synprioniodina silurica															•		•			•										
gen. indet, n. sp. a																				•										
gen. indet, n. sp. b																			•	•										
Carniodus carnulus																					•	•	•	•	•	•	•	•	•	•
Hindeodella equidentata																											•			
Lonchodina greilingi																										•	•			
Neoprioniodus costatus costatus																					•	•	•	•	•	•	•	•	•	•
Neoprioniodus triangularis triangularis																					•	•	•	•	•	•	•	•	•	•
Ozarkodina gaertneri																					•	•	•	•	•	•	•	•	•	•
Pterospathodus amorphognathoides																					•	•	•	•	•	•	•	•	•	•
Roundya latialata																					•	•	•	•	•	•	•	•	•	•
Spathognathodus pennatus procerus																					•					•			+	•

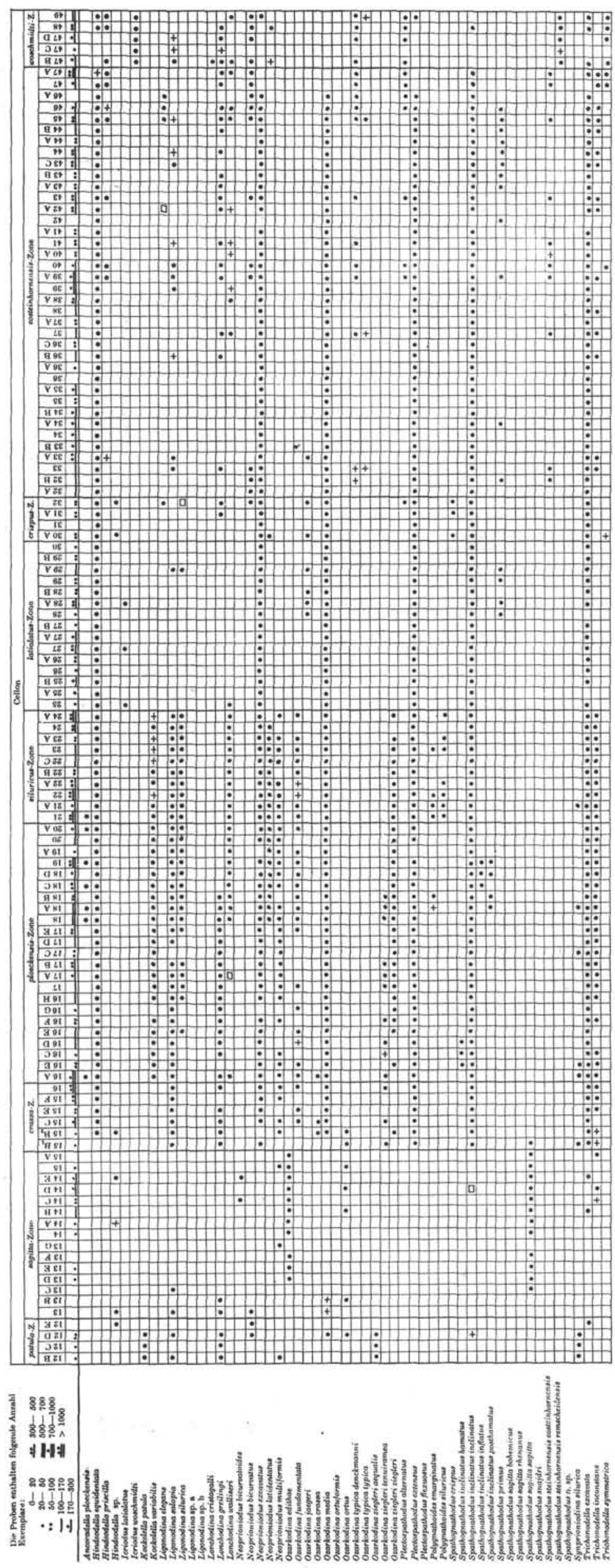
Fig. 8: Conodont distribution in the lowest part of the Cellon section. From O. H. WALLISER 1964.

The precise boundary between Llandovery and Wenlock can not be drawn; by correlation with sections outside the Alps the boundary lies in the basal *amorphognathoides*-Zone.

The Wenlockian/Ludlovian boundary is drawn in the shales above sample no. 15 or slightly above on top of the *sagitta*-Zone provided that the Much Wenlock Limestone defines uppermost Wenlockian.

The base of the Přidolian lies in an interval between the *crispa* and the *eosteinhornensis*-Zone, i. e., approx. 8 m above the base of the Alticola Lst. According to H. JAEGER 1975 who found *M. parulti-*

Fig. 9: Conodont distribution in the Wenlockian to basal Lochkovian part of the Cellon section. From O. H. WALLISER 1964.



mus a few cm above conodont sample no. 32, this graptolite indicates an uppermost Kopaninian or basal Přidolian age. In the Barrandian the *crispa*-Zone appears to be restricted to the uppermost Kopaninian.

At Cellon the Silurian/Devonian boundary is placed at the bedding plane between conodont samples nos. 47 A and 47 B at which the first representatives of *Icriodus woschmidti* occur. It must be emphasized, however, that the first occurrences of diagnostic Lower Devonian graptolites is approx. 1,5 m higher, i. e., in sample no. 50; from that bed H. JAEGER recorded *M. uniformis, M.* cf. *microdon* and *Linograptus posthumus.*

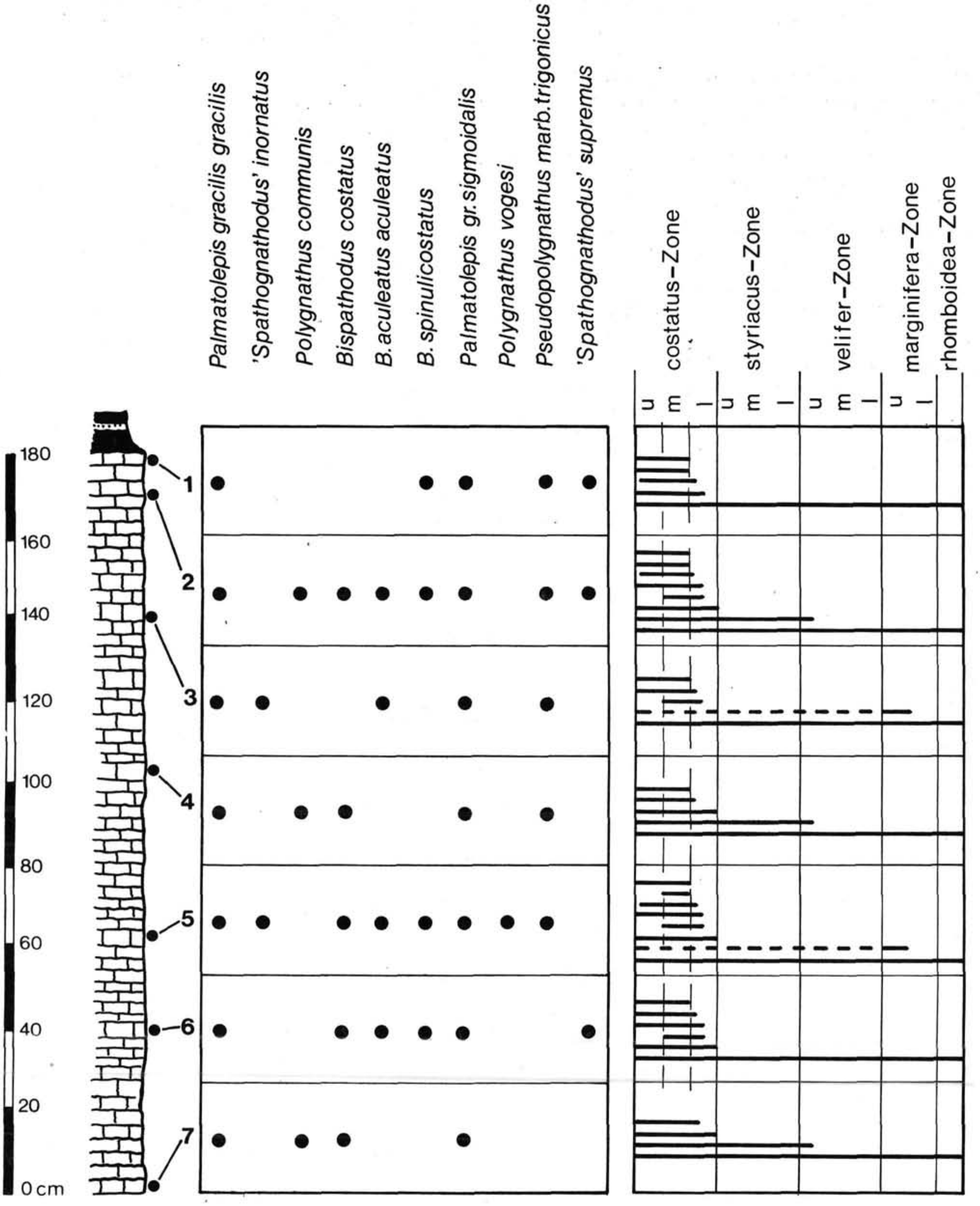


Fig. 10: Section 1, southwest of Großer Pal.

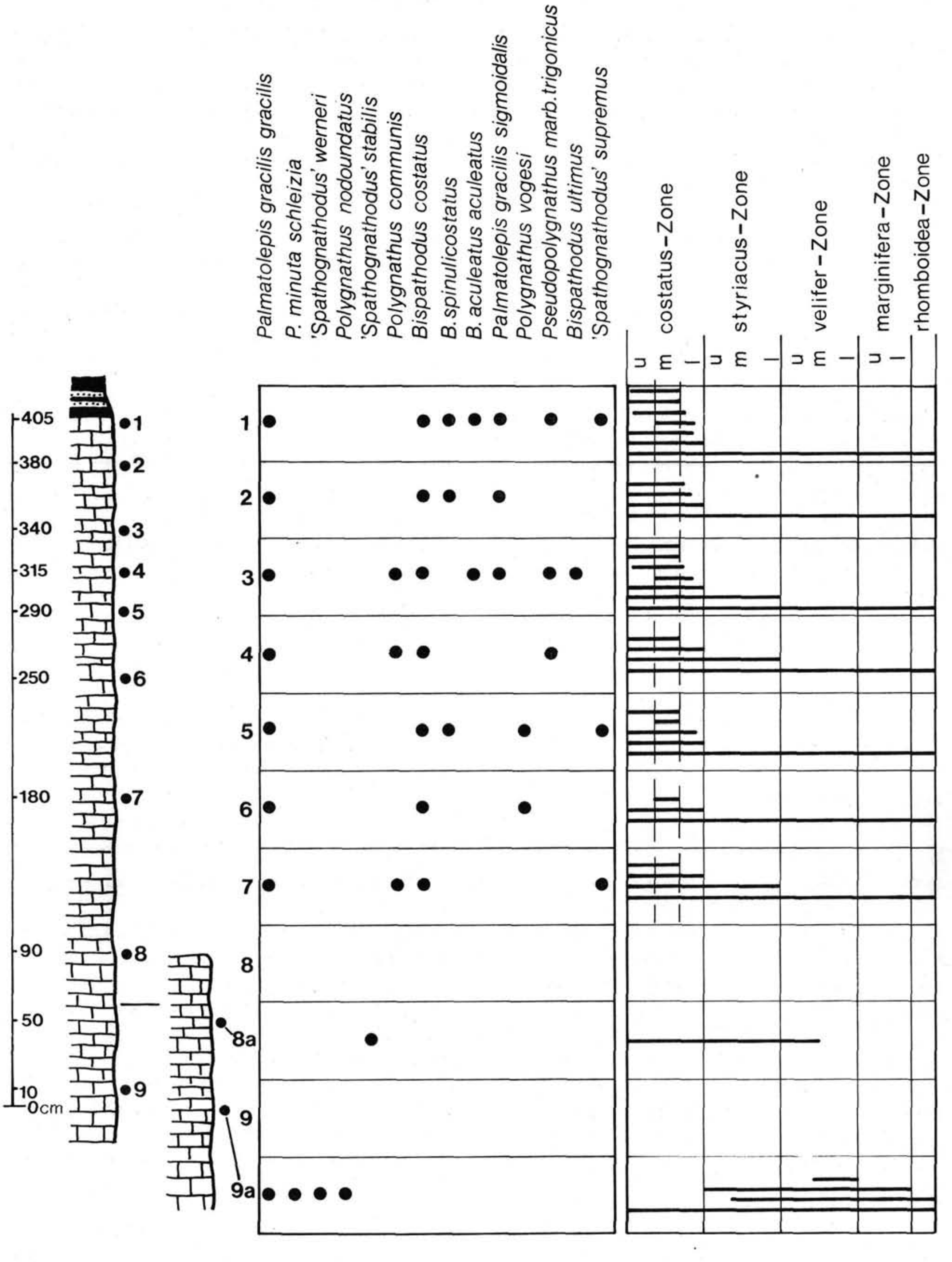


Fig. 11: Section 2: 4 m northwest of section 1 at Großer Pal.

STOP 2. Mount Grosser Pal (figs. 10, 11)

The Grosser Pal section can be reached from Plöcken Pass within 90 minutes. The section is exposed on top of the mountain and runs parallel to the Austrian/Italian border.

At the peak of Grosser Pal (1809 m), some 6 km east from Plöcken Pass, Upper Devonian limestones are excellently exposed. The nodular Flaser-limestones are rich in conodonts, cephalopods, trilobites and foraminifera. The uppermost part of the limestone section is characterized by grey micritic, mostly well bedded limestones. They are overlain by clastic flysch deposits (micaceous sandstones, shales, breccias) forming the base of the Viséan and Namurian Hochwipfel Fm.

Due to earlier studies carried out by F. FRECH in the last century and O. H. SCHINDEWOLF and R. RICHTER at the beginning of this century, Grosser Pal has become one of the classical Devonian localities in the Carnic Alps. For detailed information about ammonoids the reader is referred to the review of M. A. HOUSE & J. PRICE in the introductory part of this guidebook.

Presently, the trilobites first described by R. RICHTER (1913, 1926, 1927), are re-studied by H. ALBERTI, Göttingen. R. RICHTER recognized the following Famennian taxa:

Skemmatocare elegans MÜNSTER
Phacops wocklumeriae RICHTER
Phacops anophthalmus FRECH
Typhloproetus carinthiacus DREVERMANN
Typhloproetus gortanii RICHTER
Drevermannia carnica RICHTER
Caunoproetus pallensis RICHTER

The illustrated section 1 is situated SW of Grosser Pal. The studied part is 180 cm running from SSW to NNE. According to conodonts (H. AUFERBAUER, unpubl.) the uppermost limestone beds can be assigned to the middle part of the *costatus*-Zone (= do VI).

Section 2 is about 4 m NW of section 1. This profile is 405 cm long; the uppermost portion is dated as middle part of the *costatus*-Zone, the base belongs to the *velifer*-Zone (= do IIIß).

A third section located about 300 m W of sections 1 and 2 is 22 m long. The middle portion has yielded conodonts of the *marginifera*-Zone (doII ß – doIII alpha).

Towards the south the Upper Devonian Flaser limestones are underlain by reworked limestones which have been named Lithoclast Lst. Conodonts from various levels indicate an Eifelian to Upper Frasnian age for this formation. On mountain Freikofel, west of Grosser Pal, this type of limestone reaches a thickness of almost 100 m.

STOP 3. Section Oberbuchach 1 (fig. 12)

Section Oberbuchach 1 is exposed in a roadcut at an altitude of 1150 m. The small road runs from the Gail valley near Gundersheim to Gundersheim Alm.

The Silurian exposures represent the mixed argillaceous-calcareous „Findenig-facies". The almost 50 m thick Llandoverian to Ludlovian rocks begin with a basal quartzite. This unit is overlain by interbedded laminated pyritic sandstones, black bedded cherts (lydites) and black argillaceous shales containing a rich graptolite fauna of the zone of *M. gregarius* (= 19), subzone of *M. triangulatus*. This unit is succeeded by a second quartzite; its Llandoverian age is inferred from the occurrence of diagnostic *celloni*-Zone conodonts in limestones immediately above the upper quartzite member.

The limestones are overlain by an alternating sequence of dark argillaceous limestones, black argillaceous graptolite shales and lydites ranging through the Wenlock and lower Ludlow. Basally, the *amorphognathoides*-Zone has been recognized. The conodonts are associated with graptolites of uppermost Llandoverian or early Wenlockian age (zones 25–26). In the shales above graptolites occur at various levels starting off with the zone of *M. riccartonensis* (27) and ending up with the zone of *M. nilssoni* (33), or with a slightly younger horizon.

The dark limestone beds intercalated in the dark graptolite sequence are dominated by single cones, e. g., *Dapsilodus obliquicostatus* and *Decoriconus* sp.; so far only a few ramiform elements have been found.

The late Ludlovian and Přidolian strata consist of lithologically very characteristic 20 m thick grey limestones with a distinctly weathered surface („löchriger Kalk"). Corresponding limestones are known from many areas in the Eastern and Southern Alps; presumably, this unit is coeval with the Thuringian and Sardinian „Ockerkalk."

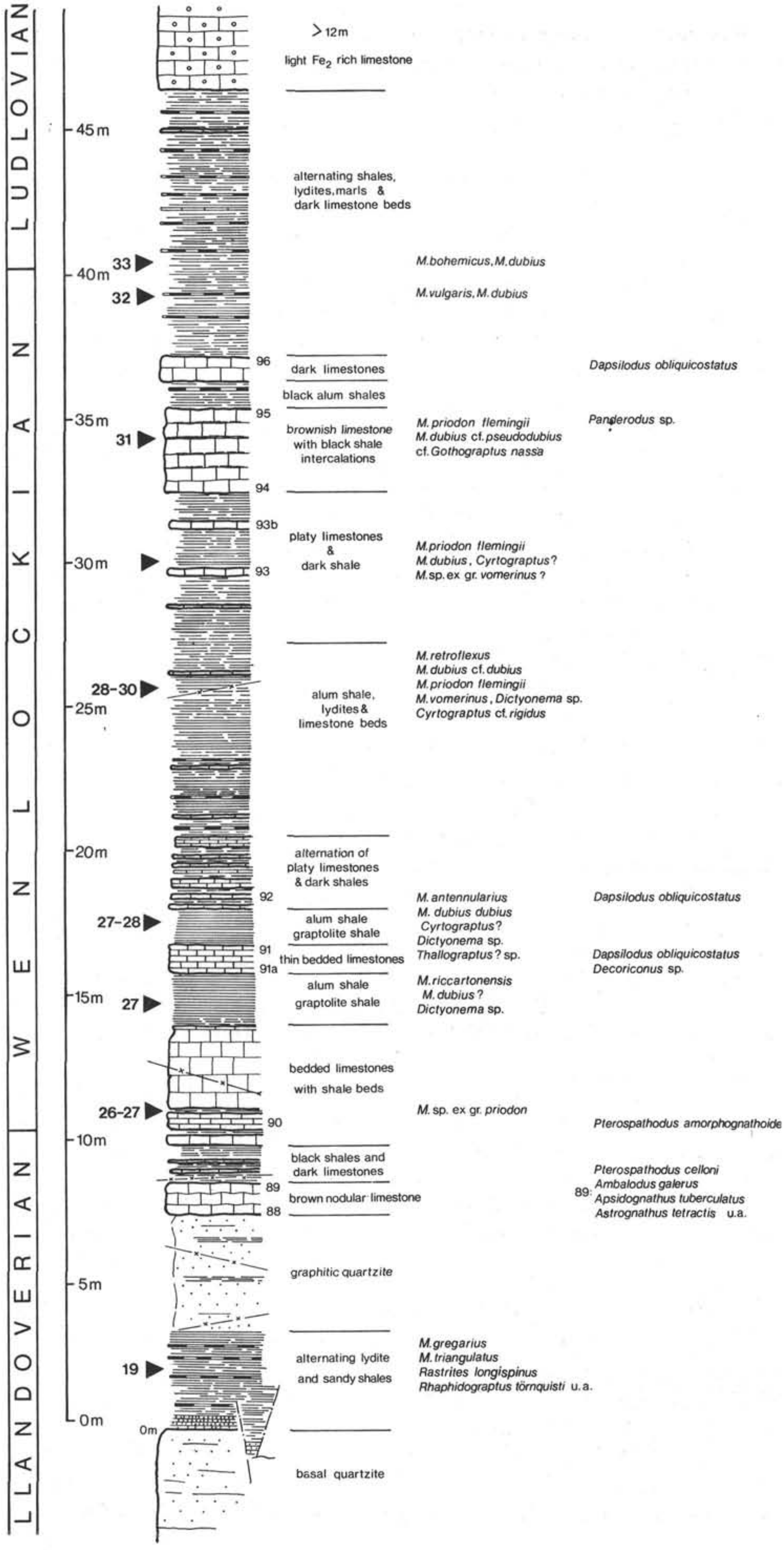


Fig. 12: The Silurian section Oberbuchach 1. From H. JAEGER & H. P. SCHÖNLAUB in press (modified).

In the Lochkovian part of this section only a few conodonts were found (the section continues after the turn). Among others, the fauna includes *Ozarkodina r. remscheidensis* and *Pandorinellina optima*. They are associated with graptolites of the *M. praehercynicus* or *M. hercynicus*-Zone (state of preservation of the graptolites does not permit any precise identification).

STOP 4. Section Oberbuchach 2 (fig. 13)

This section is part of a limestone and shale succession of Upper Ordovician to Carboniferous age which is exposed in a roadcut southwest of Pt. 1294. The rock sequence can be subdivided as follows:

Base:	20 m	sandy bryozoan shales (Upper Ordovician);
	approx. 40 m	alum shales with interbedded limestone lenses and dark limestone beds (Lower–Upper Silurian);
	13 m	well bedded light colored limestone (Upper Silurian);
	11 m	platy limestone, alternating with shale (Lochkovian);
	67 m	red nodular argillaceous limestones with tentaculites (Pragian–Eifelian);
	24 m	grey bedded and nodular limestone with *Polygn. pseudofoliatus* near the base (Eifelian–Givetian);
	2,10 m	black bedded cherts (lydites);
	3,20 m	grey bedded limestone with shale partings. The conodont fauna (*Polygn. ansatus* and *P. l. linguiformis* delta MT) indicates the middle *varcus*-Zone = Upper Givetian);
	0,60 m	shale
	1,50 m	argillaceous limestone
	3,20 m	crinoid-stromatoporoid breccia with silicified corals (upper Givetian);
	6 m	bedded and nodular limestone and calcareous shales of Frasnian age;
Top:		Hochwipfel Fm. (Carboniferous).

The Lochkovian portion of the section on which the present conodont and graptolite study has been concentrated consists of 10–12 m of black platy limestones and interbedded black marly and argillaceous shales. At several levels conodonts and graptolites were discovered which enable further presision of the relationship between conodont and graptolite chronologies in the Lower Devonian. The following Lochkovian index conodonts were found (in ascending order):

In the *M. uniformis* - Zone: *Ozarkodina r. remscheidensis* (ZIEGLER), *Icriodus woschmidti* ZIEGLER, *Pedavis* cf. *biexoramus* MURPHY & MATTI.

In the *M. hercynicus* - Zone: *Oz. r. remscheidensis* (ZIEGLER), *Pandorinellina optima* (MOSKALENKO), *Ozarkodina masara* SCHÖNLAUB (vgl. p. 159!), *P. st. telleri* (SCHULZE), *Oz. stygia* (FLAJS) alpha MT, *Oz. transitans* (BISCHOFF & SANNEMANN), and *Oz. eleanorae* LANE & ORMISTON.

The youngest graptolites occur between sample nos. 47 and 48. According to H. JAEGER this graptolite fauna indicates the lower part of the *M. hercynicus*-Zone; from the upper *hercynicus*-Zone *Linograptus* sp. vel *Abiesgraptus* sp. have not been recorded thus far. Hence, we may assume that the conodont fauna listed in fig. 13 is restricted to the Lochkovian Stage.

Yet, the base of the Pragian in this section is unknown. Recognition of this stage may be enabled by future studies of the tentaculite fauna from the overlying nodular limestones. This study is being planned for summer 1980.

STOP 5. Section Oberbuchach 3

This section is a roadcut some 50 m below Gundersheim Alm. It is a pure shale and chert sequence ranging from the Upper Orodvician to the Devonian. In the Silurian portion, which is intensively faulted, the occurrence of the Upper Llandoverian zones of *M. turriculatus* to *M. crispus* (22/23) and *M. spiralis* (above Z. 25), and of the Ludlovian zones 34/35 or 36 was established. In the Lower Devonian all three Lochkovian zones were recognized, namely those of *M. uniformis, M. praehercynicus* and *M. hercynicus*. The black shales and lydites of the latter zone are conformably overlain by a sequence of interbedded light siliceous shales and bedded cherts of the so-called Bischofalm Group.

The section Oberbuchach 3 is the first outcrop in the Carnic Alps where the transition from black graptolitic shales of the Lochkovian to a younger chert sequence was established.

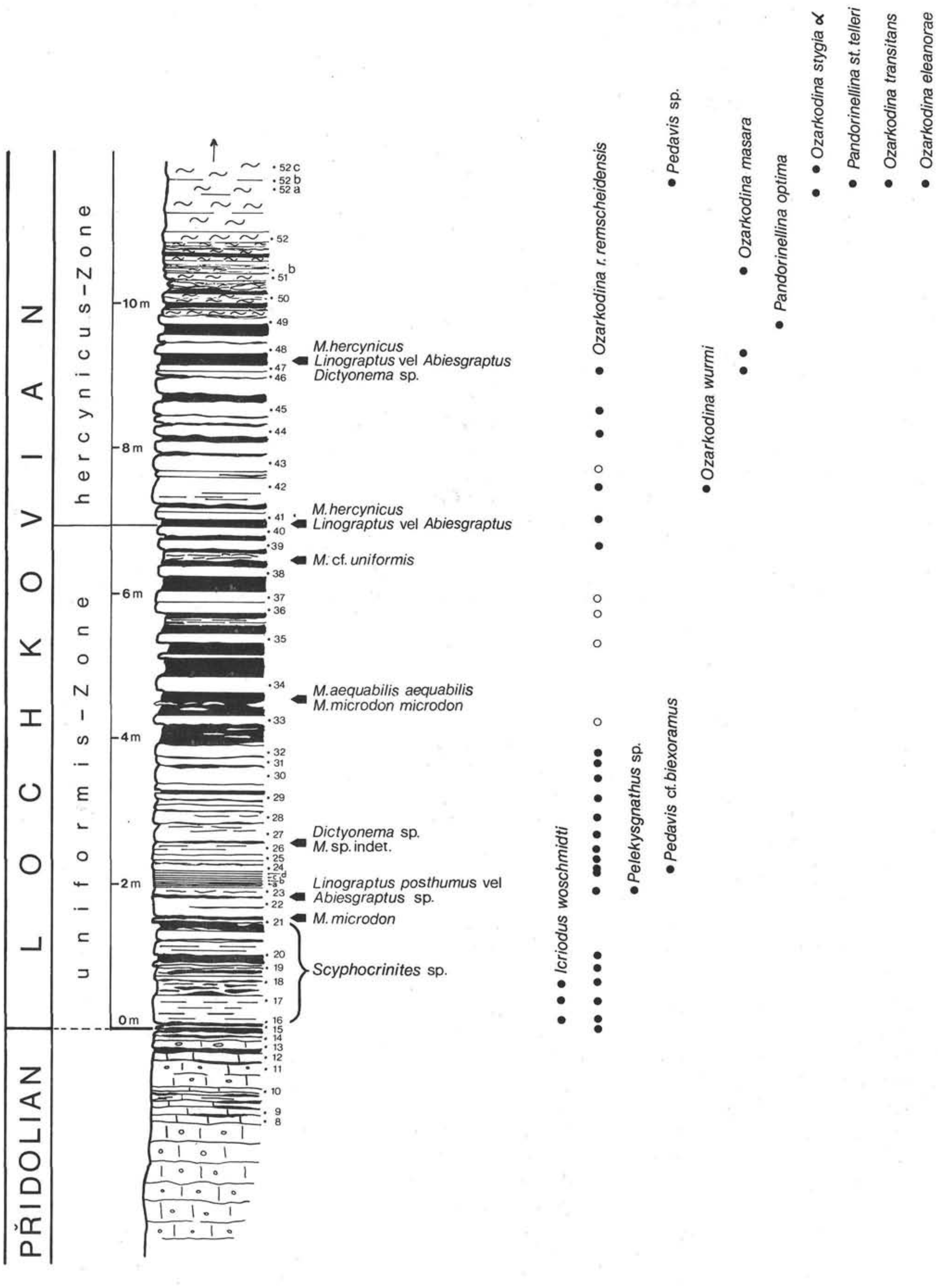


Fig. 13: The Přidolian to Lochkovian section Oberbuchach 2. After H. JAEGER & H. P. SCHÖNLAUB in press (modified).

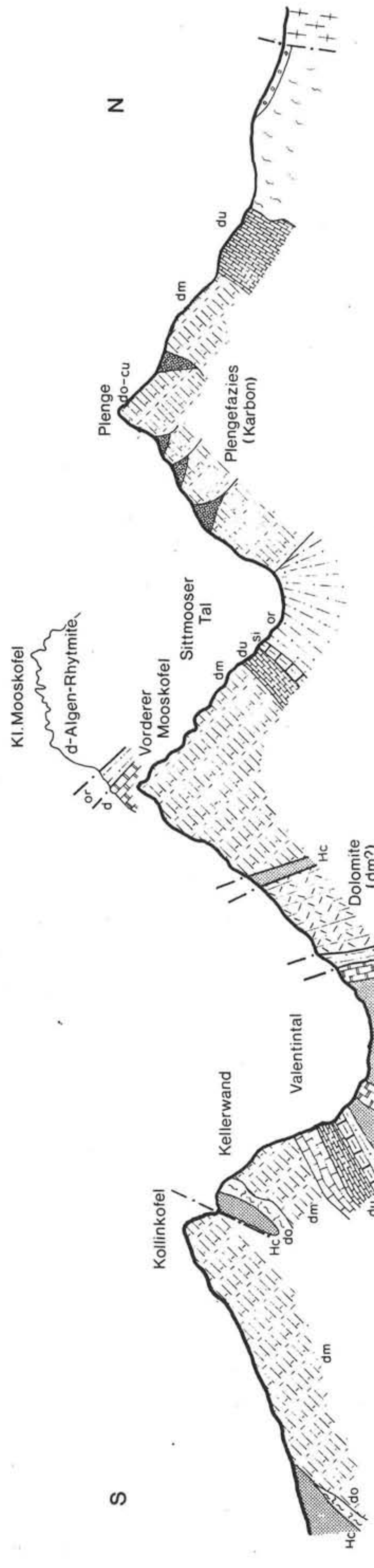


Fig. 14: Cross section in the Central. Carnic Alps from the Gail valley to Plenge, Mooskofel and Kellerwand.
From H. P. SCHÖNLAUB 1979.

DAY 2 – 3

On the second day the field trip to the Lake Wolayer region west of Plöcken Pass is planned. We will leave the bus close to the cemetery of World War II at „Kreuztratte" (or perhaps at „Untere Valentin Alm"). From there the foot walk starts to „Obere Valentin Alm" (1540 m), where a general outline of the geology will be given (see fig. 14):

Towards north and east the Gamskofel-Polinik zone consists of lagoonal sediments of Devonian age (algal laminites, birdseye dolomites, dolomites, crinoidal limestones); they are separated from cephalopod limestones forming the base of this mountain chain by several faults.

Towards the northwest the Flaser and cephalopod limestones culminate in the structurally complicated Mount Rauchkofel which consists of Ordovician to Carboniferous rocks; later the day we will better see part of the sequence.

Towards the south and southwest the Cellon-Kellerwand zone forms a prominent cliff. From top to bottom the section can be briefly summarized as follows:

6. Flysch deposits of the Hochwipfel Fm. (Carboniferous);
5. Flaser limestones and cephalopod lst. (Upper Devonian);
4. Massive shallow water carbonates (bioclastic crinoidal-corallinacean-stromatoporoid lst.) with lateral transitions into reef limestones (± Middle Devonian);
3. Alternation of yellowish tentaculite limestones and greyish crinoidal limestones (Pragian – Zlichovian ?)
2. Dark platy limestones with interbedded coarse organodetritic limestone beds (Lochkovian);
1. Silurian and Ordovician limestones and shales, in part strongly faulted (the facies resembles the Cellon section).

Climbing up to Valentin Törl at an altitude of 2138 m we will pass Ordovician to Lower Devonian rocks which form the southern flank of Mount Rauchkofel. This part is tectonically duplicated. Lithologically, the rocks are almost identical with the Cellon section at Plöcken Pass.

The section across Valentin Törl is shown in fig. 15. In this profile the complicated geology and stratigraphy is best demonstrated. Note the stratigraphic gap between the *ordovicicus*-Zone (Ashgillian) and the *sagitta*-Zone (uppermost Wenlockian). Before use of conodonts the age relationships of these limestones (and others in the Lake Wolayer region) were poorly understood.

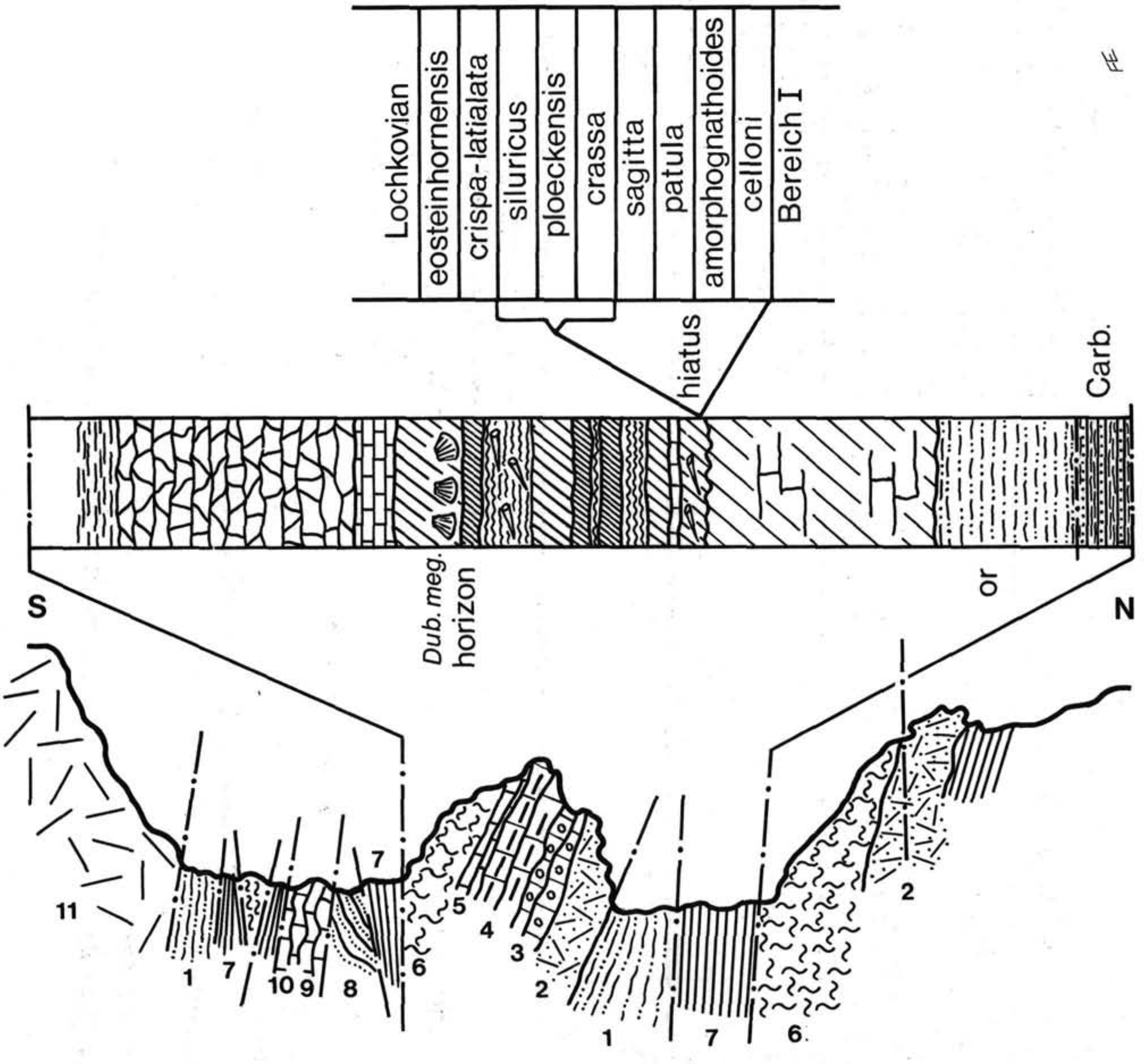


Fig. 15: Valentin Törl section. Note the stratigraphic hiatus in the Lower and Middle Silurian. From O. H. WALLISER & H. P. SCHÖNLAUB 1971.

1, 2, 8: Ordovician shales, sandstones and limestones (Wolayer Lst.);
3, 4: Silurian (Ludlovian) Orthoceras Lst. and crinoidal limestones;
5, 6: e-gamma platy limestone and reddish nodular limestone respectively (Lochkovian + Pragian);
7: Hochwipfel Fm. (Carboniferous);
9: Crinoidal limestones of the Kok Lst.-level (Wenlockian);
10: Flaser limestones of unknown age (Devonian);
11: Organodetritic limestones of Mount Seewarte and Hohe Warte (Lower Devonian, mainly Pragian).

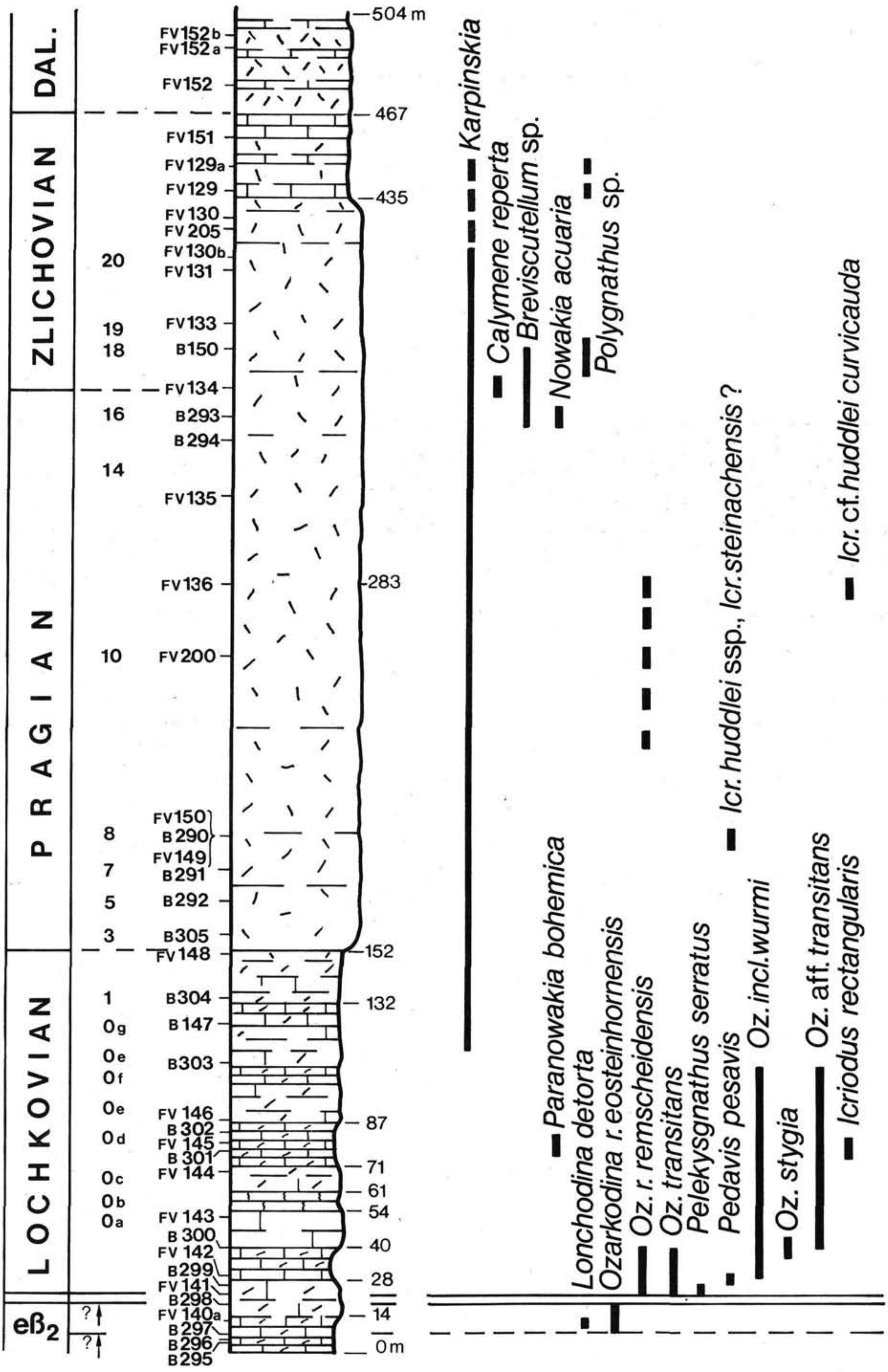


Fig. 16: The Lower Devonian section along the northwestern slope of Mount Seewarte. From G. B. VAI 1973 (modified).

STOP 6. The lower Seewarte Section (1973 m; fig. 16).

This section is located at the northwestern and western base of Mount Seewarte (= Mt. Coglians) just opposite to the alpine refugee at Lake Wolayer (fig. 16).

The complete section ranges from the Upper Caradocian to the Dinantian. The basal part (Upper Ordovician to Wenlockian) will be visited during stop 7. Here the Silurian/Devonian transition beds and Lower Devonian strata will be shown.

According to K. BANDEL 1969 and G. B. VAI 1967, 1971, 1977 (in H. W. FLÜGEL et al. 1977) the Silurian/Devonian boundary beds are lithologically very uniform. The boundary interval is defined on paleontological evidence (conodonts, brachiopods and trilobites).

The Přidolian (eß$_2$) Megaerella Beds consist of greyish-blackish, medium to well bedded crinoidal limestones which are more or less dolomitized. Fossil content is rather poor. Marker fossils include *Oz. r. eosteinhornensis, Dubaria megaerella* and *Gracianella umbra.*

Based on conodonts and brachiopods the boundary interval can be drawn within a seven meter interval between sample nos. B 298 and FV 140.

The Lochkovian is dominated by massive bedded, light grey, partly dolomitized fossiliferous crinoidal limestones which are intercalated in the matrix sediment, i. e., grey to black, thinner and well bedded pelletoidal limestones. Locally, within the first type small patch reefs may occur. The Lochkovian fauna is listed in fig. 16.

The approx. 150 m thick platy and crinoidal limestones grade into a 300 m thick Pragian to Zlichovian (?) sequence of massive light grey bioclastic to biohermal limestones of fore-reef or reef-core environment. This unit is extremely fossiliferous (see K. BANDEL 1969). For continuation of the sequence the reader is referred to the stratigraphic table (fig. 3).

STOP 7. Base of Seewarte (figs. 17, 18)

The oldest rocks of the Seewarte section are best exposed near the Valentin Törl, a few meters to the west of the southern pass at an altitude of 2.100 m. Very recently, rocks and conodonts were outlined by H. P. SCHÖNLAUB 1971.

The Ashgillian and Silurian part of the section represents a transitional facies between the Plöcken facies and the Wolayer facies. In the Ashgillian neither typical Uggwa Lst. nor typical Wolayer Lst. are developed. Similarly, the Silurian is characterized by an intermediate facies of crinoid-brachiopod limestones instead of brownish Kok Lst.

At the base of the Silurian iron-manganese bearing black shales and Fe-Mn enriched hardground layers occur suggesting a condensation level which also can be inferred from the basal Silurian conodont fauna.

The Ashgillian conodont fauna comprises 17 form taxa representing 13 genera. They correspond with conodonts described from the Bereich I at Cellon and from the Uggwa Lst. in Italy (E. SERPAGLI 1967). The following taxa have been identified:

Multielement *Amorphognathus ordovicicus* s. SWEET & BERGSTRÖM (consisting of form taxa *A. ordovicicus, Ambalodus triangularis, Hibbardella ? diminuta, Ligonodina delicata)*
Plectodina breviramea (WALLISER)
Zygognathus paularoi SERPAGLI
Acodus similaris RHODES
Acontiodus procerus (ETHINGTON) ?
Distomodus europaeus SERPAGLI
Drepanodus altipes HENNINGSMOEN
Drepanodus amplissimus SERPAGLI
Oistodus niger SERPAGLI
Panderodus costulatus REXROAD
Panderodus gracilis (BRANSON & MEHL)
Panderodus unicostatus (BRANSON & MEHL)
Walliserodus debolti (REXROAD)

This fauna is dominated by single cones, e. g., *Acodus similaris, Oistodus niger* and *Distomodus europaeus.*

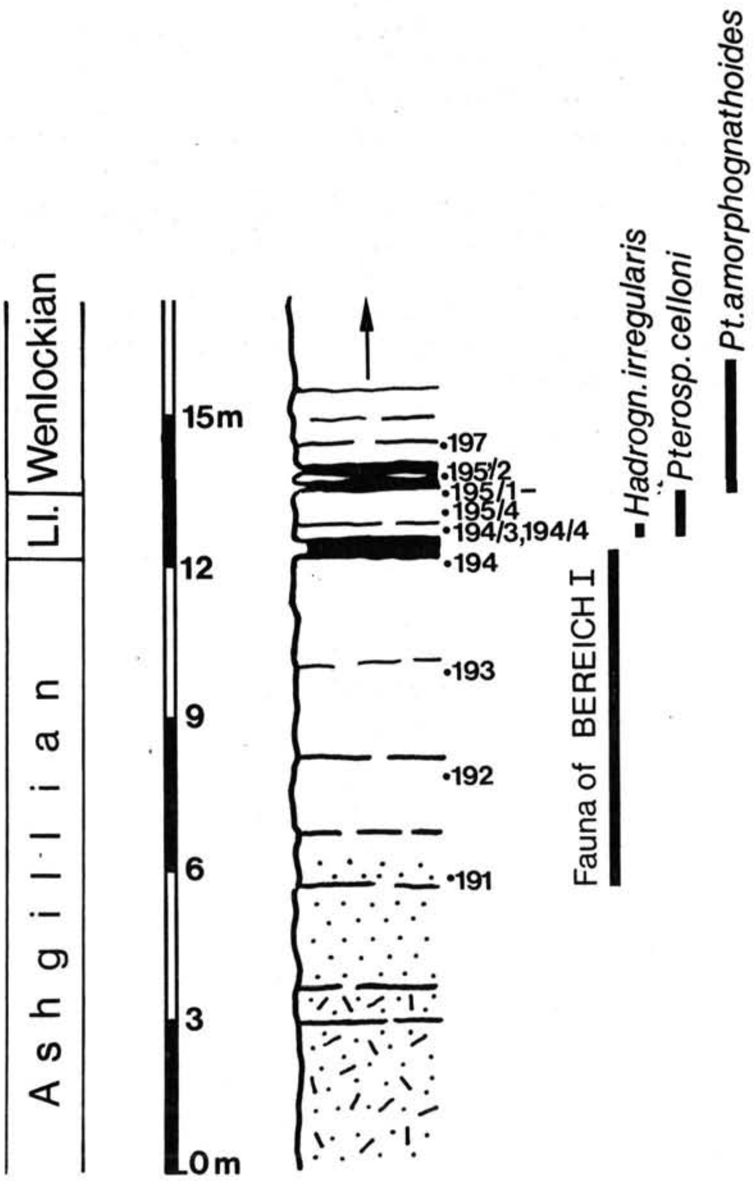


Fig. 17: Ordovician/Silurian boundary section at the base of Mount Seewarte–Valentin Törl. From H. P. SCHÖNLAUB 1971.

The basal Silurian conodont fauna is listed in fig. 18. Diagnostic elements indicate the *celloni*-Zone (upper Llandovery, Telychian) and the *amorphognathoides*-Zone (upper Llandovery – lower Wenlock). Hence, lower and middle Llandovery (and perhaps upper Ashgillian) equivalents are missing in this section.

The best horizon to collect a rich *amorphognathoides*-Zone fauna is sample no. 196 at the base of the coarse grained grey crinoid limestone.

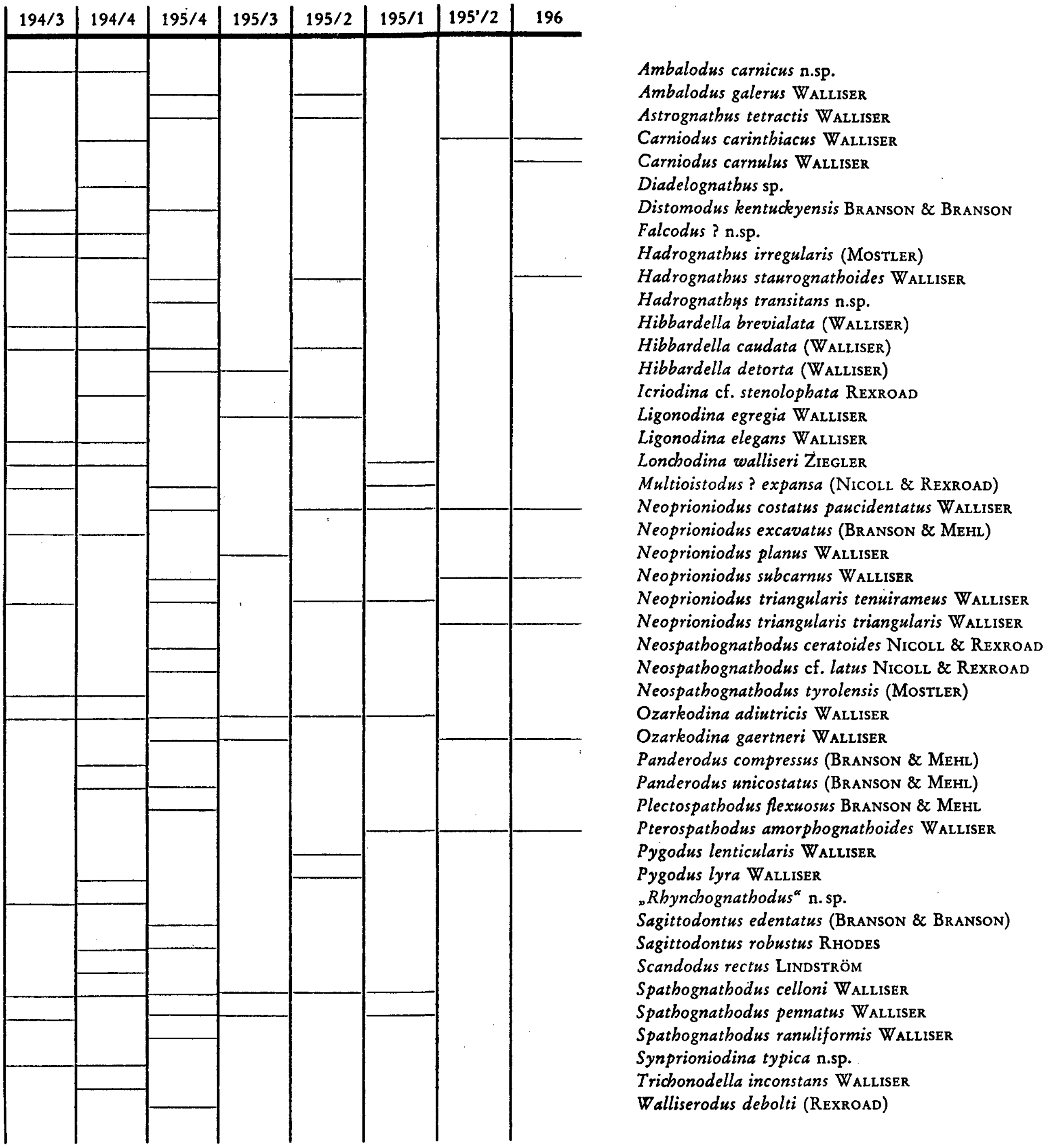


Fig. 18: Conodonts of the *celloni* and *amorphognathoides*-Zones in the section at base of Mount Seewarte–Valentin Törl. From H. P. SCHÖNLAUB 1971.

How old is Lake Wolayer – the history

During the time of maximum glaciation („Würm Period") Lake Wolayer was covered by a 70 to 100 m thick icesheet. In this area the upper limit of the main glaciation was at an altitude of approx. 2000 m. The peak of Mt. Rauchkofel, Seekopf, Seewarte, Hohe Warte, and Biegengebirge formed the frame for the glacier.

The oldest pollen found in sediments of Lake Wolayer (E. SCHULTZE 1979) apparently reflect a Younger Dryas age (10 900 – 10 000 b. p.). In the following times successive floral communities are: ***Pinus*** – ***Petula*** (birch tree) – ***Picea*** (fir). Less significant are linden, elm and oak pollen. In the Boreal (approx. 8 000 b. p.) pollen from *Picea* are dominating.

In the Atlantic period (7 000 – 5 000 b. p.) they are succeeded by *Alnus* pollen which are accompanied by *Fagus* (beech tree) and in particular, by *Abies* (fir) pollen.

The last period in the Younger Subatlantic time (last 1000 years) is characterized at the beginning by a higher content of *Picea* (pine).

R e f e r e n c e : SCHULTZE, E. (1979): Pollenanalytische Untersuchungen an einem Seebohrkern aus dem Wolayersee in den Karnischen Alpen, Kärnten. – Carinthia II, 169/89, 427–435, Klagenfurt.

STOP 8. Rauchkofel Bodentörl (2200 m; fig. 19)

The section at Bodentörl is exposed on the path from Lake Wolayer to Mount Rauchkofel; it can also be reached from Valentin Törl. The short section comprises the Trilobite-Aulacopleura Beds of the stratotype at Cellon (fig. 19).

The section has been famous for the common occurrences of graptolites, trilobites and conodonts. The graptolite fauna, found 1,30 m above the base, includes *M. curvus, M. priodon, M. retroversus, M. spiralis, M. grobsdorfiensis* ?, *M. vomerinus* ssp. indet. and *Ret. geinitzianus* cf. *angustidens*. According to H. JAEGER (in H. JAEGER & H. P. SCHÖNLAUB 1970) this fauna indicates the upper part of the *crenulatus*-Zone (= 25).

The trilobites are poorly preserved. W. HAAS identified *Scharyia* n. sp., *Otarion* sp., *Phacops* sp., *Encrinurus* sp., *Dalmanites* sp. and n. gen. ex aff. *Eodrevermannia.*

Diagnostic *celloni*-Zone conodonts were found in the lower part of the section (sample nos. 16–11). They are associated with the above mentioned macrofauna of Upper Llandovery age. The succeeding *amorphognathoides*-Zone occurs in sample 7–2.

In summary, graptolite and conodont data from section Bodentörl led to the conclusion that the boundary between the *celloni*- and the *amorphognathoides*-Zone comes near to the Llandoverian/Wenlockian boundary. This is in accordance with British sections.

STOP 9. Rauchkofel Boden (figs. 20, 21)

This section is exposed on the southwestern slope of Mount Rauchkofel west of p. 2175 m. It represents a continuously exposed limestone succession ranging from the Ashgillian to the Lower Devonian (Pragian). Lower and Middle Silurian strata, however, are missing.

The Rauchkofel Boden section is one of the best known and most fossiliferous Upper Silurian sections of the Carnic Alps corresponding to the „Wolayer facies". A detailed description was published by H. R. v. GAERTNER 1931 and H. P. SCHÖNLAUB 1970. The fauna was studied by H. RISTEDT 1968 (orthoconic nautiloids), W. HAAS (trilobites, in prep.), J. KŘIŽ 1979 (bivalves), and H. P. SCHÖNLAUB (conodonts).

The Upper Ordovician is represented by a 8.60 m thick cystoid bearing massive limestone horizon, the so-called Wolayer Lst. Conodonts correspond to the Bereich I fauna of the Uggwa Lst. at Cellon section. The fauna is dominated by single cones; less abundant are ramiform or platform elements. 1 kg of rock produced 20–40 conodonts. For reference material sample no. 318 may be recommended (apparatus of *Amorphognathus ordovicicus* a. o.).

The Wolayer Lst. is conformably overlain by 3.90 m thick grey fossiliferous cephalopod limestones („Orthoceras Lst."). The macrofauna includes the following nautiloids and bivalves (sample nos. 310–315, 319–324):

Michelinoceras (?) sp.
Sphaerorthoceras n. sp.
Merocycloceras declivis RISTEDT
Parasphaerorthoceras sp.

Isiola lyra KŘIŽ (nos. 319, 322, 325–65 cm)
Slava fibrosa (no. 325–105 cm)
Slava sp. (nos 319–325)
Cardiola aff. *signata* BARR. (322)

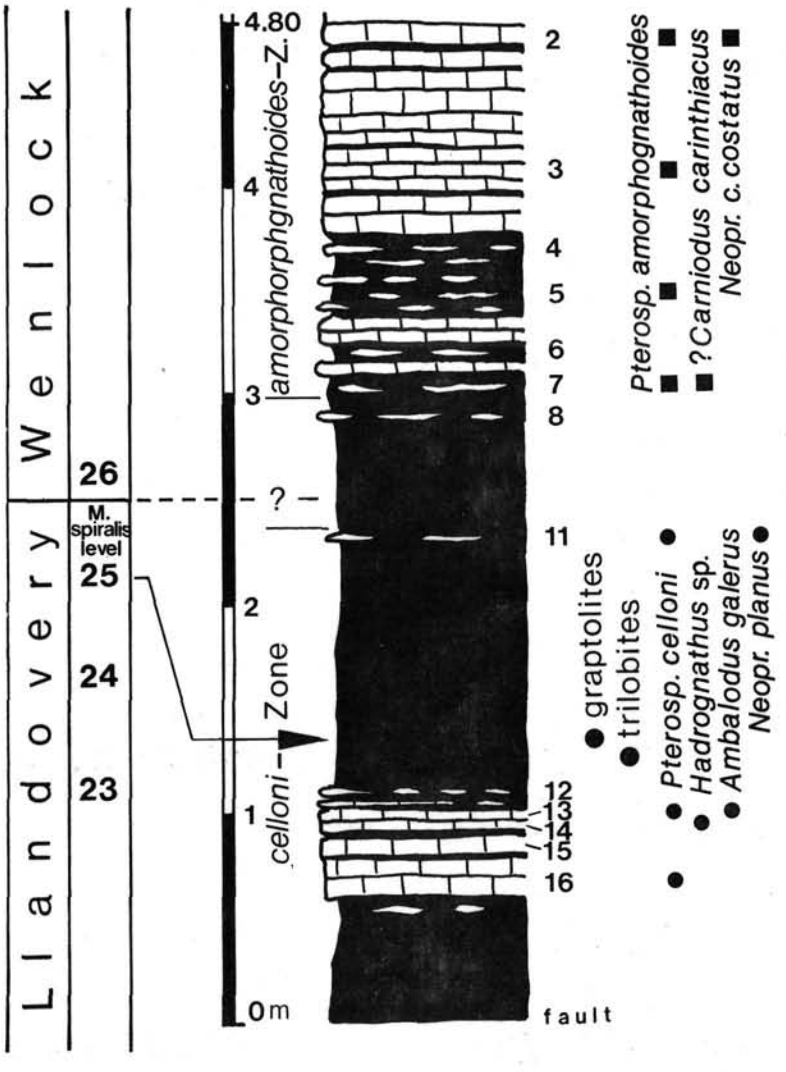


Fig. 19: Rauchkofel Bodentörl section. After H. JAEGER & H. P. SCHÖNLAUB 1970 (modified).

Cardiola contrastans (no. 325–105 cm)
Spanila sp. (no. 322)

W. HAAS from Bonn University reports the following trilobites from the basal part (approx. 1,5 m) of the cephalopod limestone:
Aulacopleura haueri
Kielania n. sp.
„Odontopleura" ovata
Eodrevermannia n. sg. n. sp.
Otarion (O.) sp.
Scharyia n. sp.
Leonaspis cf. *minuta*
Xanionurus n. sp.
Koneprusia n. sp.

In the middle part he found:
Kosovopeltis n. sp.
Eodrevermannia n. sg. n. sp.
Otarion (O.) sp.
Leonaspis cf. *minuta*
Raphiophorus rouaulti

The upper part of the cephalopod limestone contains:
Raphiophorus rouaulti
Prionopeltis striatus
Otarion (O.) sp.
Leonaspis cf. *minuta*

The 10 cm thick black limestone bed above no. 325 (now badly exposed in the trench of the war) yielded the following bivalves:

Cardiola docens BARR.
Cardiola consanguis BARR.
Cardiola cf. *signata* BARR.
Mila complexa BARR.
Spanila aspirans BARR.

W. HAAS reports from the Cardiola Beds *Aulacopleura* cf. *münsteri.*

The fauna above the Cardiola Beds have not been re-studied in very detail yet. H. R. v. GAERTNER and F. HERITSCH identified the following taxa:

Base of Alticola Lst. (nos. 326–328):

Spirigera canaliculata BARR.
Spirigera obovata SOW.
Retzia ? umbra BARR.
Maminca italica GORTANI
Dualina plicata MSTR.
Dualina cf. *sedens* BARR.
Tenka cf. *bohemica* BARR.
Loxonema commutatum PER.
Holopella compressa MSTR.
Holopella trochleata MSTR.
Platyceras otiosum BARR.
Platyceras praepriscum BARR.

Nos. 329–332:

Encrinurus transiens BARR.
Proetus romanicus GAERTNER
Petraia laevis POČTA
Holopella subcompressa MSTR.
Orthoceras tiro BARR.
Scyphocrinus sp.

According to W. HAAS (in prep.) the following trilobites occur at the edge of the steep slope (sample no. R 5):

Goldillaenus nilssoni
Cornuproetus (C.) cf. *vertumnus*
Encrinurus subvariolaris
Encrinurus ploeckensis

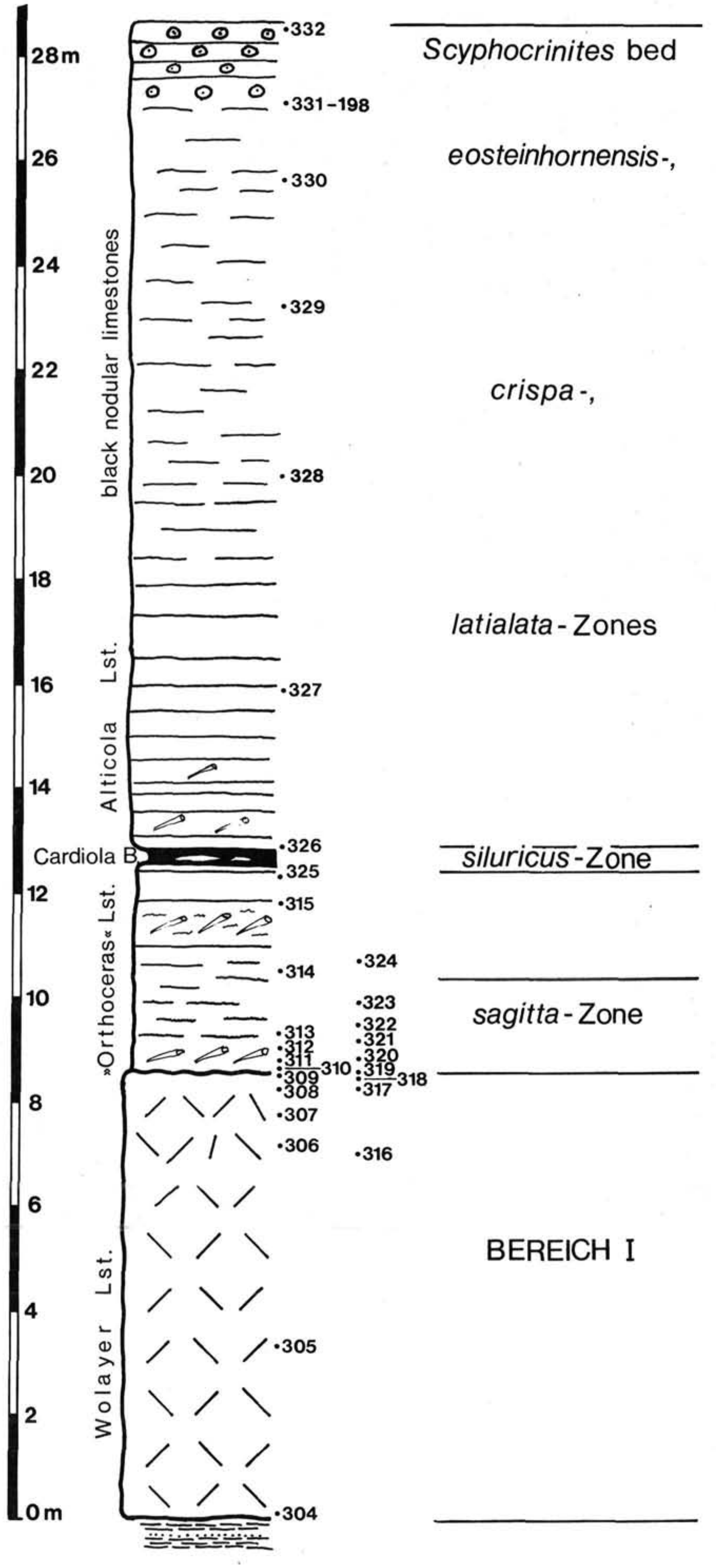


Fig. 20: The Upper Ordovician and Silurian portion of section Rauchkofel Boden.

Bohemoharpes n. sp.
Bohemoharpes cf. *crassifrons*
Cerauroides cf. *propinquus*
Phacopidella n. sp.
Ananaspis grimburgi
Ceratonurus sp.

In the Upper Silurian portion of the section conodonts are fairly abundant. Rich fauna representing the *sagitta*-Zone *(Oz. s. sagitta, Oz. s. rhenana)* occur from the base of the Orthoceras Lst. up to sample no. 313; the latter can be recommended for reference material.

In sample no. 314 *Kockelella variabilis* occurs suggesting a somewhat younger age *(crassa* to *siluricus*-Zone).

The Cardiola Beds correspond to the *siluricus*-Zone of the stratotype at Cellon.

Conodonts in the uppermost part of the black nodular limestones (nos. 330, 331) belong to the apparatus of *Oz. r. eosteinhornensis*. Furthermore, *Oz. ortuformis* and *Oz. jaegeri* occur in that interval.

The Silurian/Devonian boundary is drawn at the base of grey and dark platy crinoidal limestone beds with *Scyphocrinites* sp. (sample no. 331 = 198). At this horizon abundant loboliths of *Scyphocrinites* can be found. Bed no. 198 as well as the overlying sample no. 199 yielded common occurrences of *Oz. r. eosteinhornensis* and – more frequently – *Oz. r. remscheidensis.*

The Lower Devonian portion of section Rauchkofel Boden exhibits some stratigraphic peculiarities which have not been recognized previously. Based on almost 70 conodont samples (and repeated sampling campaigns) a very detailed conodont range chart has been established. By comparison with the graptolite-bearing Lochkovian section Oberbuchach 2

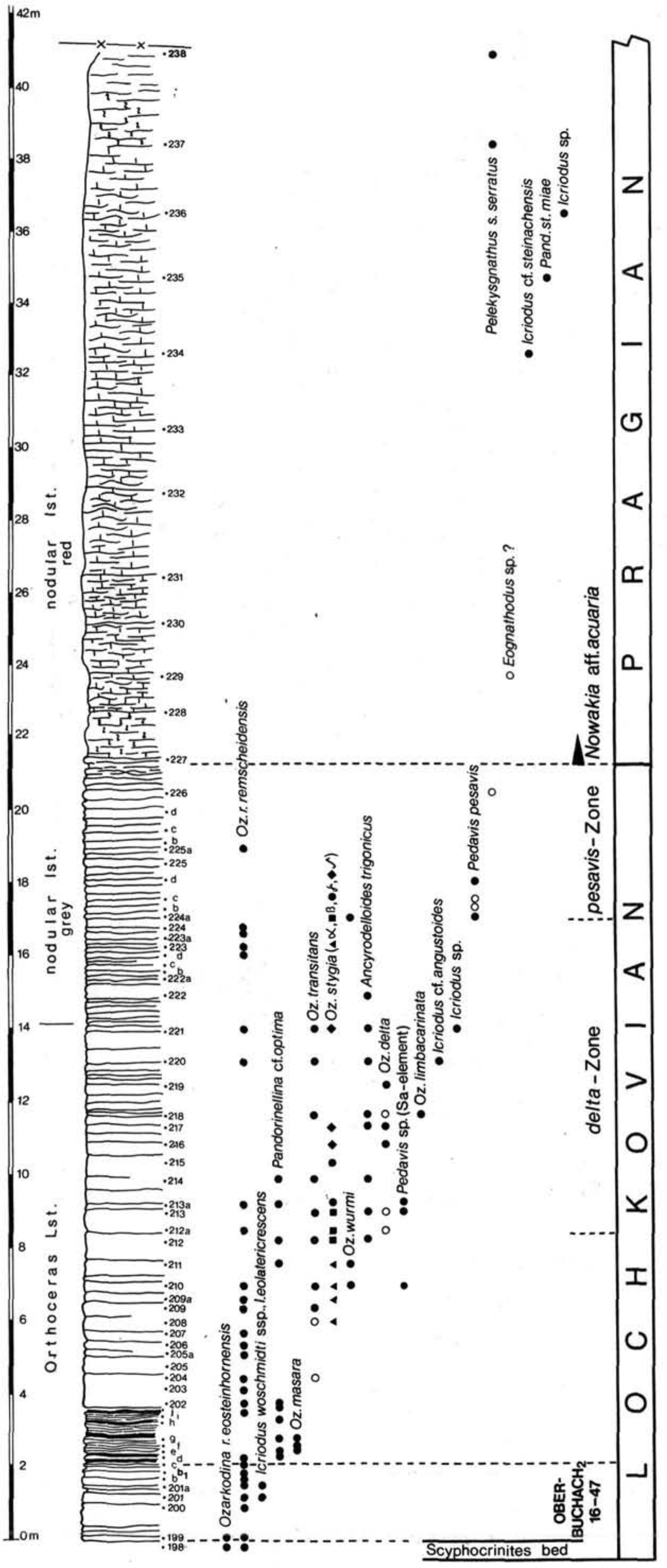


Fig. 21: The Lochkovian and Pragian portion of section Rauchkofel Boden.

(Stop 4) the following stratigraphic conclusions can be drawn:

(1) Obviously, the basal Lochkovian is extremely condensed. This part is characterized by thin bedded limestone beds with shale intercalations (nos. 201 b – 201 j).

(2) *Icriodus woschmidti* ssp. occurs in sample nos. 201 and 201 a. The juvenile and incomplete specimen of no. 201 a resembles *Icr. eolatericrescens* MASHKOVA. It has two large denticles at the posterior end of the median row. According to T. V. MASHKOVA 1970 the lower range of the species is associated with the upper range of *M. uniformis*.

(3) *Pandorinellina* cf. *optima* and *Oz. masara* SCHÖNLAUB, both present in the succeeding sampling interval from 201 d to 201 j, have also been found at section Oberbuchach 2. They are associated with graptolites of the lower *M. hercynicus*-Zone. If the correlation between both sections is correct (and there is no reason why it should not be), the lower Lochkovian at Rauchkofel Boden is represented by a 2 m horizon corresponding with sample nos. 16–47 at Oberbuchach 2!

(4) In both sections *Oz. masara* is followed by *Oz. transitans* (B. & S.) and *Oz. stygia* (FLAJS). The latter shows an evolutionary sequence from straight forms with an expanded basal cavity (alpha) to moderately sigmoidal units (beta), strong sigmoidal units (gamma) and finally to those in which the free blade gradually rises in height (delta). This sequence varies from the one described by H. R. LANE & A. R. ORMISTON 1979.

(5) In several layers *Oz. transitans* and *Oz. stygia* are associated with *Ancyrodelloides trigonicus* BISCHOFF & SANNEMANN, *Pedavis* sp. (Sa-element), *Oz. limba-*

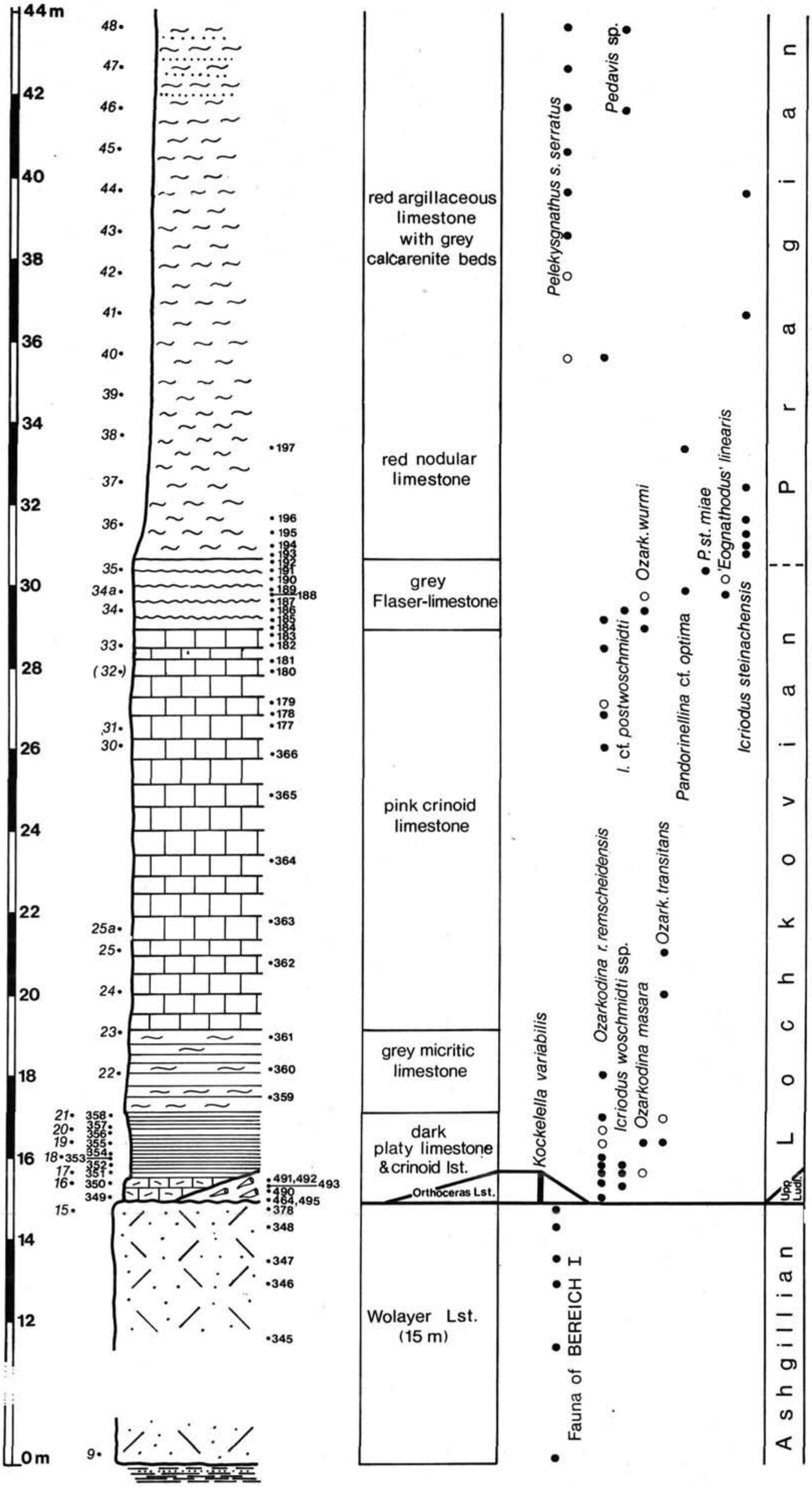


Fig. 22: The Upper Ordovician to Pragian section Seekopf Sockel.

carinata KLAPPER & MURPHY, *Icriodus* cf. *angustoides* CARLS & GANDL, and – most important – also with *Oz. delta* KLAPPER & MURPHY, the former *Oz.* n. sp. D of G. KLAPPER. This form indicates the *Oz. delta* conodont zone.

(6) The succeeding *pesavis*-Zone is proved in sample nos. 224 a, 224 b, 224 c and 224 d.

(7) The base of the Pragian is tentatively drawn at sample no. 227, i. e., the transition from grey nodular limestones to red argillaceous limestones. According to G. ALBERTI (preliminary identifications of tentaculite bearing samples collected by the author) this level represents the first appearance of *Nowakia* aff. *acuaria*. Hopefully, we can present additional information on the tentaculite distribution during this field trip.

(8) Although in this section the Pragian fauna is very poor, several index conodonts have been found, e. g., *Pelekysgnathus s. serratus* JENTZSCH, *Icriodus* cf. *steinachensis* AL RAWI (fragmentary) and *Pandorinellina st. miae* (BULTYNCK).

In sample no. 229 an incomplete specimen has been referred to *Eognathodus* sp. ? because the single row of denticles shows a tendency to develop transverse ridges.

Sample no. 238 is the uppermost sample in this undisturbed section; it is separated by a fault zone from the overlying limestones.

Recommendations for reference material: 198–199, 201, 201 g, 208, 209, 212, 213, 216, 218, 220, 221, 224 a, 234, 237, 238.

STOP 10. Seekopf Sockel (fig. 22)

The Seekopf Sockel section is exposed on the slope a few meters northwest of Wolayer Pass. The section treated here comprises the basal cystoid bearing massive Wolayer Lst. of Upper Ordovician (Ashgillian) age and the overlying Silurian and Lower Devonian limestones. Concerning lithofacies this profile belongs to the Wolayer facies. Recently, rocks and fauna were studied by O. H. WALLISER 1967 (unpubl.), H. P. SCHÖNLAUB 1970, G. B. VAI 1971 and A. FENNINGER & H. P. SCHÖNLAUB 1972.

The Seekopf Sockel section was repeatedly sampled for conodonts. The data presented here are based on the author's collections from two sampling campaigns and O. H. WALLISER's collection of 1967. In fig. 22 sample numbers of WALLISER are drawn in italics (nos. 9–48). H. P. SCHÖNLAUB is much indebted to Prof. O. H. WALLISER/Göttingen who kindly made available his collection for publication.

The coarse grained cystoid bearing Wolayer Lst. („Helle Bank" in the past) reaches a thickness of 15 m. Conodonts prove an Upper Ordovician age corresponding to the Bereich I fauna of other sections in the Carnic Alps.

Locally, the Wolayer Lst. is disconformably overlain by a thin horizon of Upper Silurian limestones (pink nautiloid-trilobite lumachelle limestones); in other places, however, the Ashgillian Wolayer Lst. is succeeded by limestones of Lower Devonian age.

The transgressive Silurian limestone will be shown on the ascent to the section proper which is located near the war fortifications. The small outcrop below is next to the trench where the bedding plane of the Wolayer Lst. is exposed on a large scale. The surface of this grey limestone is covered with irregularly shaped pink laminated limestone patches which laterally pass into a continuous limestone horizon of 1 m thickness. This horizon is very fossiliferous (nautiloids and trilobites). Unfortunately, amateur collectors have already destroyed the bigger part of the small outcrop.

From this limestone the following trilobites have been recorded:

Otarion burmeisteri BARRANDE
Aulacopleura (A.) konincki haueri FRECH
Ceratocephala ovata EMMRICH
Harpes sp.

The index conodont *Kockelella variabilis* WALLISER indicates an Upper Ludlovian age *(crassa-siluricus*-Zone) for this thin limestone horizon.

At the fortifications from World War I (trench and cavern) the complete section is continuously exposed. 0.50 m below its top the massive limestone bed is disconformably overlain by younger strata (nos. 349, 350). This horizon, in turn, is succeeded by thin bedded dark grey to black limestone beds (sample nos. 351–358) which pass upwards into micritic limestones and pink crinoid limestones, respectively. These limestones are followed by grey Flaser limestones, forming the transition to red argillaceous tentaculite limestones.

Conodonts from the dark platy limestones above the Ashgillian Wolayer Lst. indicate a Lower Devonian age (nos. 349–358 and nos. 16–21 respectively). Important taxa are *Icriodus woschmidti hesperius, Icr. postwoschmidti, Ozarkodina r. remscheidensis, Oz. masara* SCHÖNLAUB and *Oz. transitans.*

A comparable conodont fauna occurs in lithologically similar limestone beds in the Rauchkofel Boden section (Stop 9, fig. 21) suggesting the same age for both horizons. Hence, for the Seekopf Sockel section we may also conclude, that lowermost Devonian strata are either missing or extremely condensed.

In the figured section which runs along the trench, an interesting conodont fauna was found in sample no. 25, i. e., *Oz. transitans* associated with *Oz.* n. sp. B. The latter may represent an ancestor of *Oz. stygia* (FLAJS) alpha-morphotype!

Sample nos. 34 a and 190 produced conodonts which have been identified as *'Eognathodus' linearis* PHILIP. Apparently the illustrated specimens are intermediate forms and fill the morphologic gap between *Ozarkodina* and *Eognathodus.* The longitudinal row of nodes shows a tendency towards irregularly distributed and merged nodes. Juvenile specimens on the other hand have a very distinct asymmetrical basal cavity.

Beginning with sample no. 193 *Icriodus steinachensis* AL-RAWI occurs fairly abundant. In particular, sample no. 37 can be recommended for reference material. From no. 40 upwards it is associated with *Pelekysgnathus s. serratus* JENTZSCH. This distribution is in excellent accordance with Pragian sections in the Barrandian. Provisionally we draw the Lochkovian/Pragian boundary between the last occurrence of *'Eognathodus' linearis* and the first occurrence of *Icriodus steinachensis,* i. e., between sample nos. 34 a and 193.

In the Pragian portion of the section two horizons with *Pedavis* sp. were found (nos. 46, 48). This occurrence agrees with data from Nevada, Alaska and the Barrandian (G. KLAPPER 1969, 1977, H. R. LANE & A. R. ORMISTON 1979, M. A. MURPHY et al., in press, H. P. SCHÖNLAUB, this Guidebook).

The section continues upwards into the Middle Devonian and ends in the Frasnian. Yet, no detailed study has been carried out in this part (see summary remarks in K. BANDEL 1972).

The biostratigraphic data presented above and in fig. 22 are confirmed and extended in a second profile which runs over the crest on the Austrian side, some 40 m to the north of the „border section". It was also sampled and studied by O. H. WALLISER 1967. His results can be summarized as follows:

The Ashgillian Wolayer Lst. (which presumably is not completely exposed) is disconformably overlain by coarse grained grey limestones of Lower Devonian age. Sample no. 290, 9 m above the base of the exposed limestone section, yielded *Ozarkodina r. remscheidensis* and icriodids which most probably can be assigned to *I. postwoschmidti* MASHKOVA.

Pandorinellina cf. *optima* is derived from the base of 1,50 m thick dark limestones, some 14 m above the base; they can be correlated with the platy limestone horizon in section 1.

This unit is overlain by 11,50 m thick and mostly grey limestones, which in turn are succeeded by distinct nodular tentaculite limestones which we have already seen in section 1 and during previous stops.

In this part of the section *Ozarkodina stygia* (FLAJS) alpha morphotype occurs in sample no. 312, i. e., 18,20 m above the base of the section; *'Eognathodus' linearis* PHILIP was found 7 m above this level which is exactly 25,20 m above the base of the exposed section or 0,80 m below the top of the grey limestones (sample no. 315). As in section 1 the first representatives of *Icriodus steinachensis* AL-RAWI occur at the base of the overlying red nodular limestones (no. 297, level 26 m above base); they were also found in several samples above (nos. 298, 339, 299). Finally, *Pelekysgnathus s. serratus* JENTZSCH was proved in sample no. 333, i. e., 6,10 m above the beginning of the red limestones.

STOP 11. Clymeniid limestones near E. Pichl-Hütte

Close to that place where the outlet of Lake Wolayer disappears in the cavernous Devonian limestones north of the refugee, Upper Devonian clymeniid limestones have been preserved in a 80 cm thick, tectonically isolated small outcrop. This locality has been famous since the days of H. R. v. GAERTNER (1927, 1931) who recorded the following ammonoids from that place (see list of M. R. HOUSE & J. PRICE in the introductory part of this guide):

Clymenia laevigata (MÜNSTER)
Clymenia cingulata GÜMBEL

Clymenia spiratissima (SCHINDEWOLF)
Cymaclymenia striata (MÜNSTER)
Kosmoclymenia subundulata (WEDEKIND)
Platyclymenia annulata MÜNSTER
Platyclymenia arieticosta SCHINDEWOLF a. o.

The ammonoid fauna proves a do V alpha and beta age. It should be noted that these limestones represent the youngest Devonian strata in the surroundings of Lake Wolayer and Mount Rauchkofel.

The conodont fauna includes the following taxa (F. EBNER):

Pandorinellina sp.
Palmatolepis gracilis gracilis BRANSON & MEHL
P. perlobata helmsi ZIEGLER
P. perlobata maxima MÜLLER
P. perlobata postera ZIEGLER
P. perlobata schindewolfi MÜLLER
P. rugosa rugosa BRANSON & MEHL
Polygnathus hassi HELMS
P. praehassi SCHÄFFER
P. znepolensis SPASSOV
div. ramiform elements

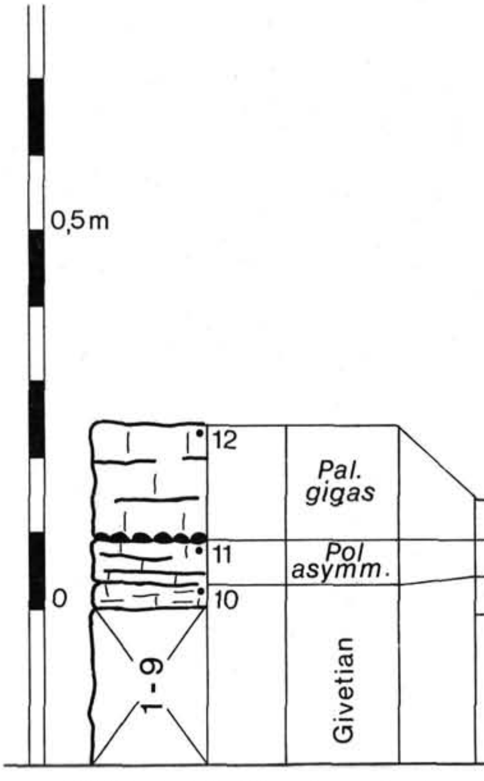
Age: Upper *Polygnathus styriacus*-Zone (= do V alpha–beta).

STOP 12. Middle/Upper Devonian boundary at the edge of Lake Wolayer (fig. 23)

A Lower to Upper Devonian limestone section is exposed on the northern edge of Lake Wolayer and will be shown along the path which runs around the lake. The south dipping limestone sequence mostly composed of Flaser limestones is overlain by sediments of the Carboniferous Hochwipfel Fm. (greywackes, sandstones and shales).

The Middle/Upper Devonian boundary is being studied by B. GÖDDERTZ from Bonn University. His results are summarized in fig. 23. The critical boundary plane is just below a thin horizon of black phosphorite or phosphorite nodules at the base of the *asymmetricus*-Zone, considering that this zone wholly is regarded as Upper Devonian.

Obviously, the Middle/Upper Devonian boundary interval in this section is very much condensed.



	Polygnathus decorosus	P. cf. linguiformis ssp.	P. asymmetricus asymmetricus	Polygnathus webbi	Palmatolepis punctata	Palmatolepis gigas	Palmatolepis proversa	Palmatolepis subrecta	Icriodus symmetricus	Ancyrodella lobata	Ancyrodella buckeyensis	Nothognathella brevidonta	Ancyrodella gigas	Ancyrognathus asymmetricus	Nothognathella iowaensis	Palmatolepis hassi	Ancyrognathus triangularis	Ancyrodella nodosa
12	●			●	●	●	●		●				●	●	●	●	●	●
11			●	●	●		●	●	●	●	●	●						
10	●	●																
1-9																		

Fig. 23. The Middle/Upper Devonian boundary section at the edge of Lake Wolayer (B. GÖDDERTZ).

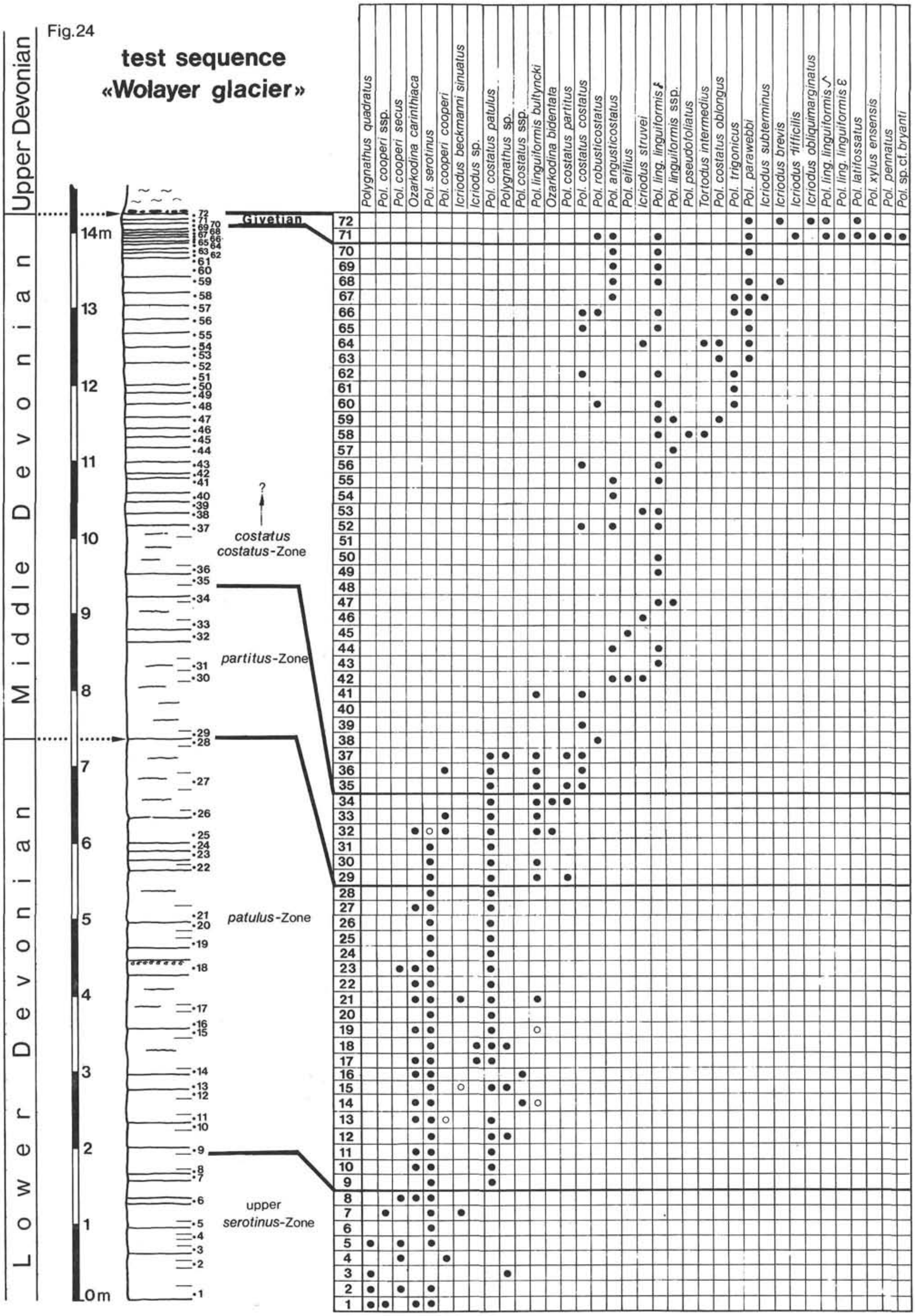


Fig.24 test sequence «Wolayer glacier»

STOP 13. „Wolayer glacier" (fig. 24)

This locality is at about half distance from Lake Wolayer to Valentin Törl (altitude 2 130 m) where the southeast dipping rocks of Rauchkofel Boden form a 20 m high cliff.

The section was chosen as test sequence to demonstrate whether or not the currently used *Polygnathus* zonal sequence across the Lower/Middle Devonian boundary – as defined by the Subcommission on Devonian Stratigraphy – can be applied to pelagic rocks of the Carnic Alps. Other than in the Eifelian hills or in the Barrandian, in the Carnic Alps the presumed boundary interval is not characterized by any lithologic changes and hence, Lower and Middle Devonian have not been subdivided in terms of formations.

The 14 m thick limestone section is being studied by H. P. SCHÖNLAUB who sampled from the base to no. 37 and by B. GÖDDERTZ studying the upper part. The continuously exposed profile comprises grey, mostly well bedded Flaser limestones with tentaculites and goniatites. Particularly on the bedding plane of sample no. 18 the latter are very frequent. According to I. CHLUPÁČ, due to the state of preservation the goniatite fauna can not be identified; they may belong to the family Anarcestidae or Werneroceratidae.

Fig. 24 shows distribution of diagnostic conodonts. In the lowermost part and in the upper part conodonts are not very abundant; furthermore, up to no. 8 juvenile specimens often occur making it difficult to discriminate *Polygnathus serotinus* TELFORD from *Polygnathus quadratus* KLAPPER, ZIEGLER & MASHKOVA. Based on the association of *Pol. quadratus, Pol. serotinus, Pol. cooperi secus* KLAPPER, ZIEGLER & MASHKOVA and *Ozarkodina carinthiaca* (SCHULZE) the upper *serotinus*-Zone has been recognized (nos. 1–8).

The succeeding *patulus*-Zone ranges from sample no. 8 to no. 28. Conodonts are more abundant than in the portion below (20–50/kg). In particular, *Pol. costatus patulus* KLAPPER, *Pol. serotinus* and *Ozarkodina carinthiaca* can be found in almost every sample. Less frequent, although very significant, is the occurrence of *Icriodus beckmanni sinuatus* KLAPPER, ZIEGLER & MASHKOVA, *Pol. linguiformis bultyncki* WEDDIGE and *Pol. cooperi secus.* In the chart polygnathids are listed without specific assignment; considering the small and reduced platform these specimens resemble very much *Pol. angustipennatus* BISCHOFF & ZIEGLER or *Pol. angusticostatus* WITTEKINDT. More probably, however, they represent juvenile forms of *Polygnathus cooperi.*

For reference material of the *patulus*-Zone we recommend the interval from no. 20 to no. 23.

The equivalents of the *partitus*-Zone are 2 m thick. This horizon is characterized by the joint occurrences of the name bearer, *Pol. costatus partitus,* together with *Pol. costatus patulus, Pol. cooperi, Pol. ling. bultyncki* and *Ozarkodina bidentata; Pol. serotinus* and *Ozarkodina carinthiaca* proceed from the *patulus*-Zone into the lower part of the *partitus*-Zone. In sample no. 33 this fauna is replaced by ramiform elements which now dominate the conodont fauna.

Good reference material can be obtained from sample nos. 31 and 34.

The *costatus*-Zone is identified on the appearance of the nominal subspecies *Pol. c. costatus* KLAPPER in sample no. 35. *Pol. costatus patulus, Pol. ling. bultyncki* and *Pol. costatus partitus* extend into the basal part of this zone from which sample no. 36 can be recommended for reference material.

The upper limit of the *costatus*-Zone, i. e., the base of the succeeding *australis*-Zone has not been traced by index conodonts yet; indirectly younger zones were proved by diagnostic conodonts of the Eifelian such as *Pol. angusticostatus* or. *Pol. eiflius.* The latter already indicates the *kockelianus*-Zone. This portion of the section, however, is very poor in conodonts.

The Eifelian/Givetian boundary is tentatively drawn between sample nos. 70 and 71. At this level a sudden increase of conodonts can be observed. Typical *varcus*-Zone conodonts are *Pol. latifossatus* WIRTH, *Pol. ling. linguiformis* epsilon morphotype, delta morphotype and icriodids listed in the chart.

Sample nos. 70 and 71 are recommended for collectors.

The top of the bed with sample no. 72 is marked by a very distinct phosphorite layer separating limestones of Givetian age (*varcus*-Zone) and Frasnian limestones. At this horizon many big and easily recognizable conodonts can be found. A sample from near the base of the 1,3 m thick Frasnian yielded the following fauna of toI ß (gamma) age:

Polygnathus asymmetricus ovalis ZIEGLER & KLAPPER
Palmatolepis transitans MÜLLER
Ancyrodella rot. rotundiloba (BRYANT)
Palmatolepis punctata (HINDE)
Ancyrodella gigas YOUNGQUIST

Ancyrodella buckeyensis STAUFFER
Ancyrognathus triangularis YOUNGQUIST
Age: *Asymmetricus*-Zone and *Anc. triangularis*-Zone.

The reason for this „mixed" fauna may be very simple: Different from the sampling procedure today this more than 10 year old conodont sample apparently came from a more than 10 cm thick horizon which may embrace two successive conodont zones; another explanation may be the extrem thinning and condensation that affected all Frasnian rocks in the Carnic Alps. In any case, contrary to stop 12, there is clear evidence of the *asymmetricus*-Zone above the phosphorite layer.

Comparison: Conodont distribution in Lower/Middle Devonian boundary beds of section „Wolayer glacier" exhibits remarkable similarities with data from coeval strata in the Barrandian (see G. KLAPPER et al. 1978, figs. 1, 3):

(1) In both regions *Pol. quadratus* is restricted to the upper *serotinus*-Zone;

(2) *Ozarkodina carinthiaca* occurs in both areas in the *serotinus* and in the *patulus*-Zone. However, in the Carnic Alps the range of this species extends to the *partitus*-Zone which accords with unpublished data from the basal Choteč Lst. (H. P. SCHÖNLAUB);

(3) *Icriodus beckmanni sinuatus* occurs in the Barrandian in the *laticostatus* and *serotinus*-Zones. In the Carnic Alps this species extends to the *patulus*-Zone;

(4) In the Barrandian, the Eifelian hills, and in the Carnic Alps the last occurrence of *Pol. serotinus* has been proved in the lower part of the *partitus*-Zone;

(5) *Ozarkodina bidentata* first appears slightly above the first occurrence of *Pol. costatus partitus*;

(6) In both regions *Pol. ling. bultyncki* has a long range: In our section this form has been proved in the *patulus, partitus,* and *costatus costatus*-Zones, in the Barrandian also in the *serotinus*-Zone;

(7) Similarly to the Barrandian in the *costatus costatus*-Zone the nominal subspecies occurs together with its subspecies, i. e., *Pol. costatus patulus* and *Pol. costatus partitus.*

In conclusion, the comparison of the Lower/Middle Devonian test sequence „Wolayer glacier" with the Barrandian type sections revealed an almost identical distribution of conodonts. Hence, the Lower/ Middle Devonian boundary – as drawn in fig. 24 – approximates very closely with the lowest occurrence of *Polygnathus costatus partitus* in the roof of the Třebotov Lst. of the Barrandian and with the traditional Heisdorf/Lauch boundary in the Eifelian hills.

STOP 14. Middle/Upper Devonian boundary west of Valentin Törl (fig. 25)

Stop 14 exhibits the uppermost limestone beds at the southern flank of Mount Rauchkofel west of Valentin Törl. The visited section is exposed a few meters to the left of the path running from Lake Wolayer to Valentin Törl. From this locality a rich ammonoid fauna was described by H. R. v. GAERTNER 1931 suggesting a doIII alpha/beta level:*

Sporodoceras (S.) muensteri V. BUCH
Pseudoclymenia dillensis (DREVERMANN)
Pseudoclymenia pseudogoniatites (SANDBERGER)
Rectoclymenia rotundata SCHINDEWOLF
Rectoclymenia subflexuosa (MÜNSTER)
Rectoclymenia acuta (PERNA)
Platyclymenia (Pl.) sandbergeri (WEDEKIND)
Platyclymenia (Pl.) pompeckii (WEDEKIND)

However, conodonts from the uppermost limestone beds (B. GÖDDERTZ) proved the middle *Pol. asymmetricus*-Zone. Hence, based on conodonts, a maximum age of post-doI delta or doII alpha can be concluded for the youngest limestone beds.

Provisionally, the Middle/Upper Devonian boundary level is drawn at the phosphorite horizon. A sample 30 cm above produced index conodonts of the lower *Pal. triangularis*-Zone. During summer 1980 it is intented to reduce the „big" sampling interval from no. 28 to no. 29 and to examine whether or not doI alpha to doI gamma strata are present at the base of the Upper Devonian.

Summarizing the available data from three boundary sections west of Valentin Törl it may be concluded that the Middle/Upper Devonian boundary interval is extremely condensed and incomplete. Conodont data suggest that the phosphorite horizon reflects a significant stratigraphic break in the basal Frasnian. Apparently in one section (Stop 12) continuous sedimentation took place from the *asym-*

metricus-Zone to the *gigas*-Zone; from two other sections (Stop 13, 14) it can be inferred that a local phase of non-deposition (or erosion) occurred in the *asymmetricus*-Zone and perhaps in the uppermost Givetian. In fact, at other places in the Carnic Alps similar phenomena have been known (see for example Stop 4).

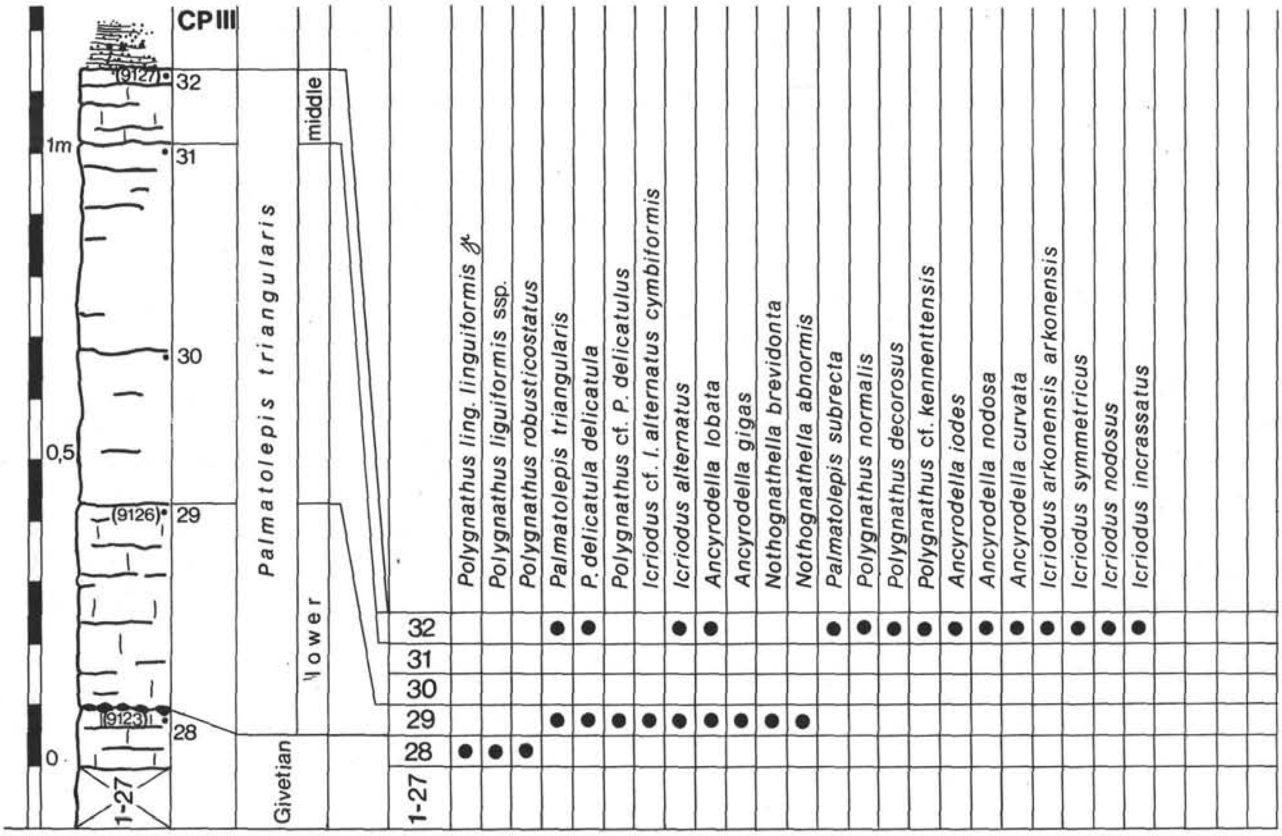


Fig. 25: The Middle/Upper Devonian boundary section northwest of Valentin Törl (B. GÖDDERTZ).

* Recent investigations showed that the ammonoids were derived from a different locality than the conodonts, i. e., some 50 m to the east of the conodont section. The small and tectonically limited locality is close to Valentin Törl and near the deviation of the path to Hohe Warte.

Appendix

In addition to the sections in the Central Carnic Alps in the following chapter three localities are described (Uggwa section, Hoher Trieb section, Feistritz valley section) which only will be visited by members of the Ordovician/Silurian Boundary Working Group. Furthermore, we add two stops to show on the way back from Kötschach to Villach.

1. The Uggwa section (G. B. VAI & C. SPALETTA)

IGM 14 I SE Camporosso in Valcanale 1:25.000 topographic map. Uqua creek (= Uggwa Graben), 200 m NNE of Rifugio Fratelli Nordio (Udine, Friuli-Venezia Giulia, Italy).

The section is illustrated in fig. 26. The following units can be distinguished from the bottom.

Base: Thrust contact over Silesian Flysch (Hochwipfel Formation).

I. Uqua Formation

1) Siltstone and sandstone member of the Uqua Fm.: 22.7 m

Grey-green, yellowish-brown weathering, very fine grained sandstones and shales with pervasive cleavage. Grains of quartz with minor feldspar, mica, heavy minerals, chert, and other rock fragments. Matrix usually abundant. Wavy- and flaser-lamination quite common, though disturbed by the slaty cleavage. Fossil fragments disseminated throughout the section with coquinitic lenticular enrichments in the upper part of the unit resulting in biocalcarenitic to biocalcruditic siltstones. More than 70 % of the disarticulated brachiopod valves are convex upwards. Decalcification largely affects the outcrop.

Fossils. Bryozoans *(Chasmatoporella, Hallopora, Monotrypa,* etc.), brachiopods *(N. actoniae,* Orthacea, Dalmanellidae, *Drabovia, Drabovinella, Heterorthina, H.* aff. *retrorsistria, Onniella, S.* cf. *inclyta,* Plectambonitacea, *Anisopleurella, A. aquila* ssp. ind., *K. nuntius, Strophomena, Rafinesquina, Leptaena, P. sardous, P.* cf. *platystrophoides,* etc.), *Tentaculites,* cephalopods, trilobites (Dalmanitacea, *D. proaeva, Onnia,* etc.), pelmatozoans, etc.

Age. The fossil list includes mainly upper Caradocian as well as lower Ashgillian (Kralův Dvůr) or even Upper Ashgillian forms, some of them in the same sample (e. g. *S. inclyta, D. proaeva, K. nuntius* and *P.* cf. *platystrophoides);* only one broken fragment of *D. proaeva* as well as a couple of *P.* cf. *platystrophoides* were found, so that more material is needed to ensure determination; however, *K. nuntius* is very common. According to VAI 1971 *K. nuntius* might appear in the Carnic Alps earlier than in Bohemia. It is also possible, however, that *K. nuntius* is coeval in both Bohemia and the Carnic Alps. This would imply that the age of most of this member is already lower Ashgill and not upper Caradoc, or that the Bohemian stage Kralův Dvůr is partly overlapping with the Caradocian.

Environment. Flat, shallow water, sub-littoral shelf with clastic, partly immature sedimentation.

2) Sandy calcarenite: 1 m

Grey, brown weathering, bioruditic, silty-sandy calcarenite with cherty-phyllosilicatic and calcareous-dolomitic matrix. The calcarenite passes to medium to fine grained bioruditic sandstone with abundant matrix enclosing (or enveloping) globular to tabular biomicritic intraclasts. Decalcification and ochre weathering common on exposed surface. Bioclasts mostly deriving from pelmatozoans and trilobites and, more rarely, brachiopods and bryozoans.

Fossils. Tentaculites and conodonts. Sample 304 = 1426 of SERPAGLI 1967 (1 on the field): *A. similaris, A. triangularis, A. ordovicicus, „O." niger, Hibbardella,* etc.

Sample 303 = 1427 of SERPAGLI 1967 (2 on the field): *D. europaeus, H. prima, P. breviramea* in addition to the forms of sample 304.

3) Nodular limestone member of the Uqua Fm.: 1.1 m

Thin discontinuous lenses of grey, nodular biomicritic limestone fractured by small-scale neptunian dykes filled with ochre weathering sandstone or calcarenite containing flat, angular, biomicritic intraclasts. These lenses alternate with fine-grained, poorly sorted lithic calcarenites with floating biomicritic „nodules" actually representing intraclastic fragments sometimes fractured and filled with sandy material. The biomicrite contains uniformly scattered, silt-sized quartz grains and abundant pelmatozoans and trilobite fragments; some of them, usually larger than 1 mm, are deeply micritized and encrusted by Fe and Mn laminae suggesting reworking from a hard-ground-like top surface of a submarine high.

Fossils. Sample 302 = 1428 of SERPAGLI 1967 (3 on the field), 301 = 1429 (4) and 301 t.:

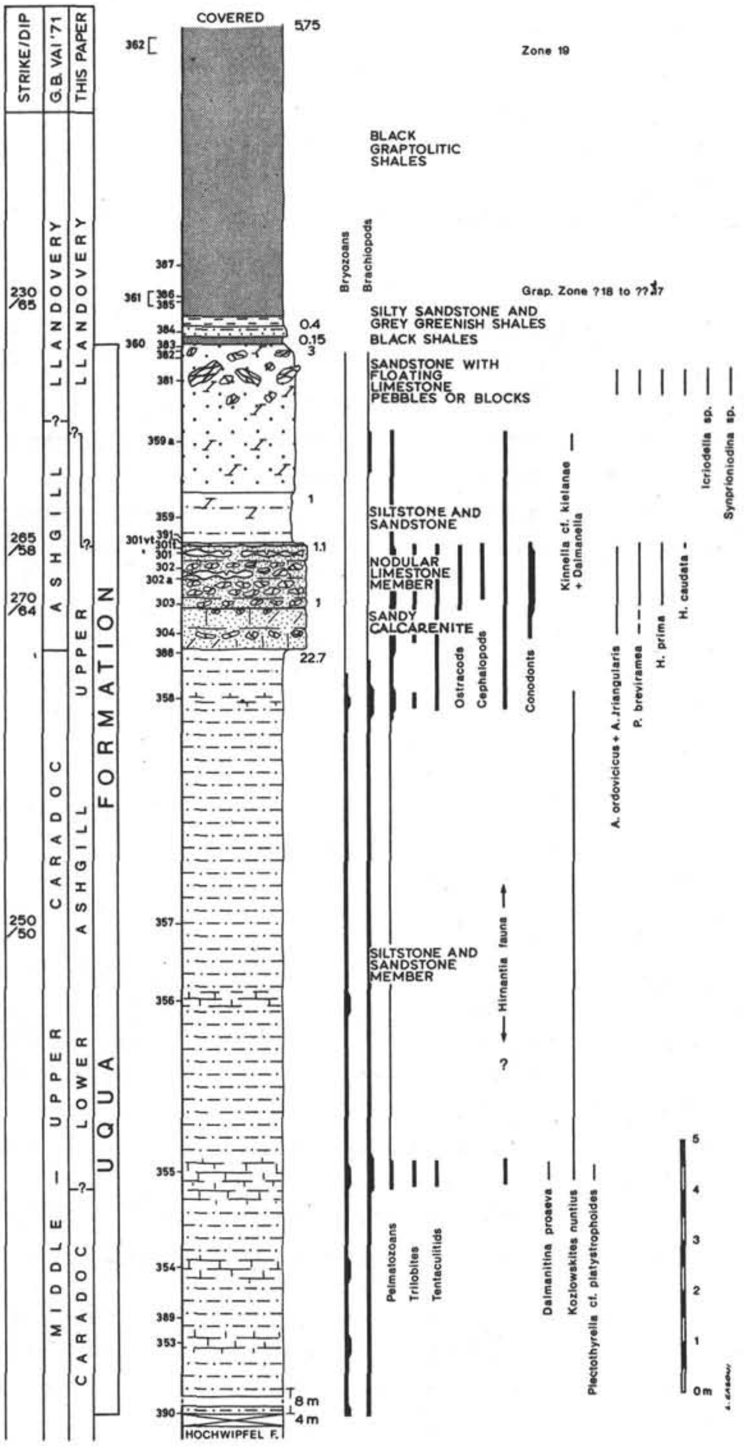


Fig. 26: The Uggwa Stratotype (Italian Carnic Alps). From G. B. VAI, 1971.

A. trigonius, A. procerus, „Carniodus", C. erectus, D. ? altipes, N. italicus, P. furcata, T. superbus, W. debolti in addition to the forms of samples 304 and 303.

Sample 301 v. t.: *H. caudata, H.* cf. *brevialata* in addition to previous forms.

Age. According to SERPAGLI 1967 the conodont fauna is dated as lower Ashgillian.

4) **Siltstone and fine grained sandstone:** 1 m

Quite similar to unit 1) with slightly increasing maturity of the terrigenous supply.

5) **Sandstone with floating limestone pebbles or blocks:** 3 m

Dark grey, brown weathering, sometimes bioclastic, massive to thick bedded, coarse grained sandstones. Grains more or less sorted and rounded, made of quartz and lithic fragments (chert and quartzites prevailing); abundant siliceous-phyllosilicatic matrix with dolomitic cement; isolated clasts up to 2 mm are present. Bioclasts and rare biosomata include pelmatozoans, brachiopods, and trilobites.

The upper half of the unit contains floating limestone pebbles or tabular blocks, ranging from 2 to 30 cm in width, usually inclined to the bedding plane. Sligthly different types of „Tonflaserkalk" as well as minor amount of „Cystoideenkalk" are represented in the limestone clasts of this part of the unit, which is made of typical slump deposits.

Fossils. The sandstone contains small brachiopods of the **Hirnantia** fauna, including *Kinnella* and *Dalmanella.* Three different clasts of limestone yielded the following conodonts:

Sample 381 d: *Icriodella, „Carniodus", A. similaris, A. triangularis, A. ordovicicus, D. europaeus, H. prima, H. caudata, „O." niger, P. unicostatus, P. breviramea, Z. paularoi.*

Sample 381 A: *A. similaris, A. triangularis, „Carniodus", P. unicostatus, Synprioniodina.*

Age. The poor **Hirnantia** fauna should indicate the upper Ashgill, but *Icriodella* and *Synprioniodina,* though yielded in exotic blocks, point out to a Llandovery age (cfr. JAEGER et al., 1975). This is a further possible evidence in favour to the overlapping of upper Ashgillian **Hirnantia** fauna with the lowermost Silurian *persculptus*-Zone.

II. Black shale formation

6) **Black graptolitic shales** with a 40 cm thick intercalation of silty sandstone and grey-greenish shale close to the base: more than 6 m exposed along an artificial trench.

Fossils. The sampling intervals 361 and 362 contain fairly abundant graptolites. The graptolite zone 19, probably 18 and possibly 18–17 transition are represented in the samples of this unit according to preliminary identification of H. JAEGER (see JAEGER et al., 1975; JAEGER & SCHÖNLAUB 1977).

2. Section Hoher Trieb (fig. 27)

This section is located south of Obere Bischofalm on an altitude of approx. 1830 m. It is accessible from „Dr. Steinwender Hütte" or from „Obere Bischofalm" to pt. 1847 and further to pt. 1771 („Oberes Trieb Kar"; see H. P. SCHÖNLAUB 1969 a).

On the slope from pt. 1771 to pt. 1889 south dipping rocks are exposed which in its lower part comprise the following shales and limestones (fig. 27):

(a) Some 40 m thick greenish sandy shales with abundant bryozoans and brachiopods and less frequently cystoids, gastropods and trilobites. Fossils suggest a Caradocian age.

(b) Approx. 35 m thick coarse bedded quartzites with dolomitic matrix; vertically they pass into a 18 m thick alternating sequence of calcareous sandstones and pelmatozoan limestones.

(c) The Upper Ordovician ends with the 6 m thick grey argillaceous Uggwa Limestone. As far as thickness, microfacies, and fossil content are concerned this horizon corresponds with the Uggwa Lst. at Cellon.

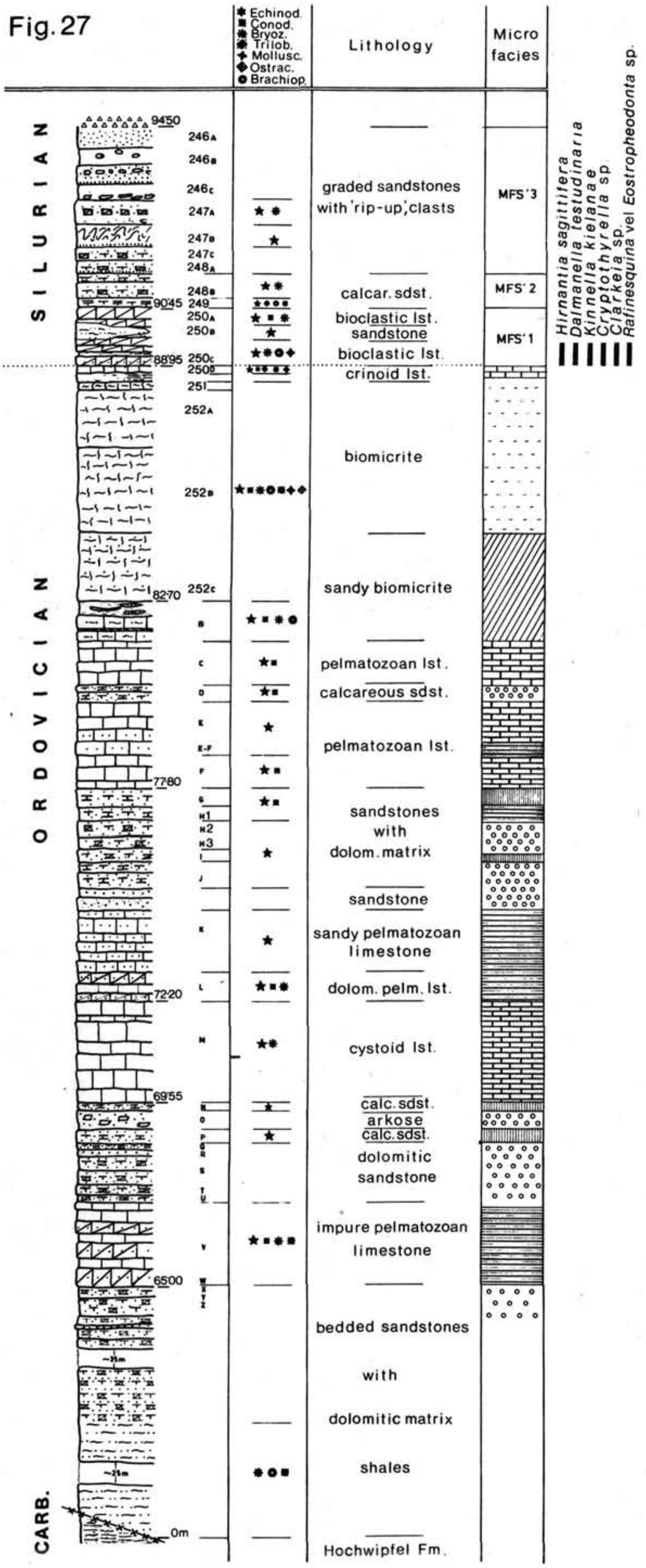
(d) The uppermost micritic bed of the Uggwa Lst. (bed. no. 250 D) is conformably overlain by a 5 m thick exposed sequence consisting of bioclastic limestones, calcareous sandstones, graded sandstones, and contorted sandstone beds.

Litho- and biostratigraphically this horizon can be correlated with the clastic „Untere Schichten" at the Cellon section. At its base the Hirnantia Fauna was proved by V. HAVLIČEK (in H. JAEGER et al., 1975). In the same bed the Silurian index species *Clarkeia* sp. was found (see fossil list in fig. 27). The fauna is badly preserved and collecting is very difficult.

The Ordovician/Silurian boundary is drawn between sample nos. 250 D and 250 C.

ORDOVICIAN/SILURIAN BOUNDARY BEDS AT HOHER TRIEB

Fig. 27



3. Feistritz valley section (fig. 28).

This section is exposed in the western Karawanken Alps south of Villach. It is accessible by car as far as the beginning of the north directed valley and then after a 20 minutes walk until the junction of two gorges on an altitude of approx. 900 m, south of pt. 800. In more detail the exposure was described by H. JAEGER et al., 1975. For the geology of the surroundings contact the new geological map by N. ANDERLE published by the Austrian Geological Survey in 1977.

From base to top the section treated here can be subdivided into the following units:

(a) Forming the base of the section 3 m of greyish and brownish slates are exposed in the rivulet. So far fossils have not been found in this unit.

(b) 6,50 m thick nodular and argillaceous Uggwa Lst. In thin sections many fossils can be observed, e. g., cephalopods, tentaculites, bryozoans, trilobites and ostracods. The conodont fauna comprises such forms like *Amorphognathus ordovicicus* BR. & M., *Ambalodus triangularis* BR. & M. and *Plectodina breviramea* (WALL.). They suggest a coeval age with the stratotype in the Uggwa valley.

(c) With a marked lithologic change the Uggwa Lst. is conformably overlain by 3 m of black graptolite and alum shales containing many pyritic nodules and pyritic layers.

(d) The black shales are succeeded by some 7 m thick dark siltstones and fine grained sandstones. The latter are separated from Upper Silurian limestones – forming the cascade – by a fault.

In the lowermost 60 cm of unit (c) graptolites are locally very abundant and cover the bedding planes over and over. However, preservation is generally poor depending on the degree of tectonic deformation and weathering. All graptolites are more or less washed out.

According to H. JAEGER the rich fauna apparently represents one single species, *Glyptograptus* cf. *persculptus* (SALTER). A few other fossils also occur but a specific assignment is not possible.

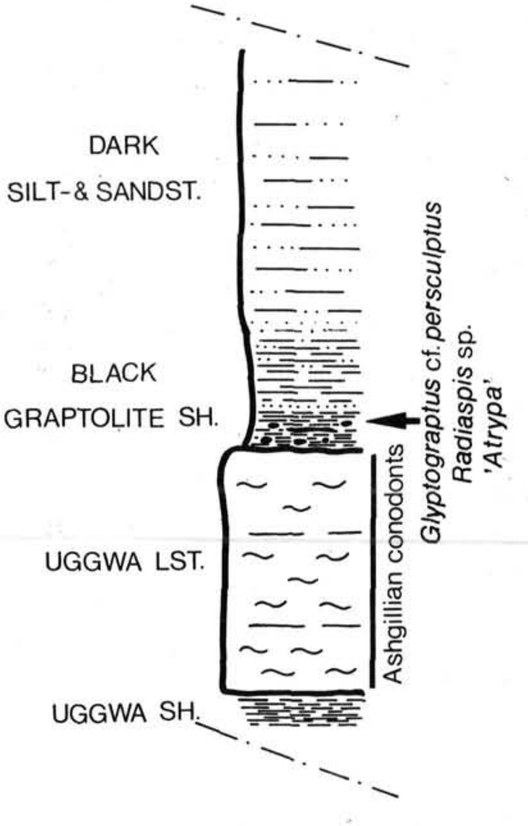


Fig. 28: The Ordovician/Silurian boundary at Feistritz Graben (Western Karawanken Alps).

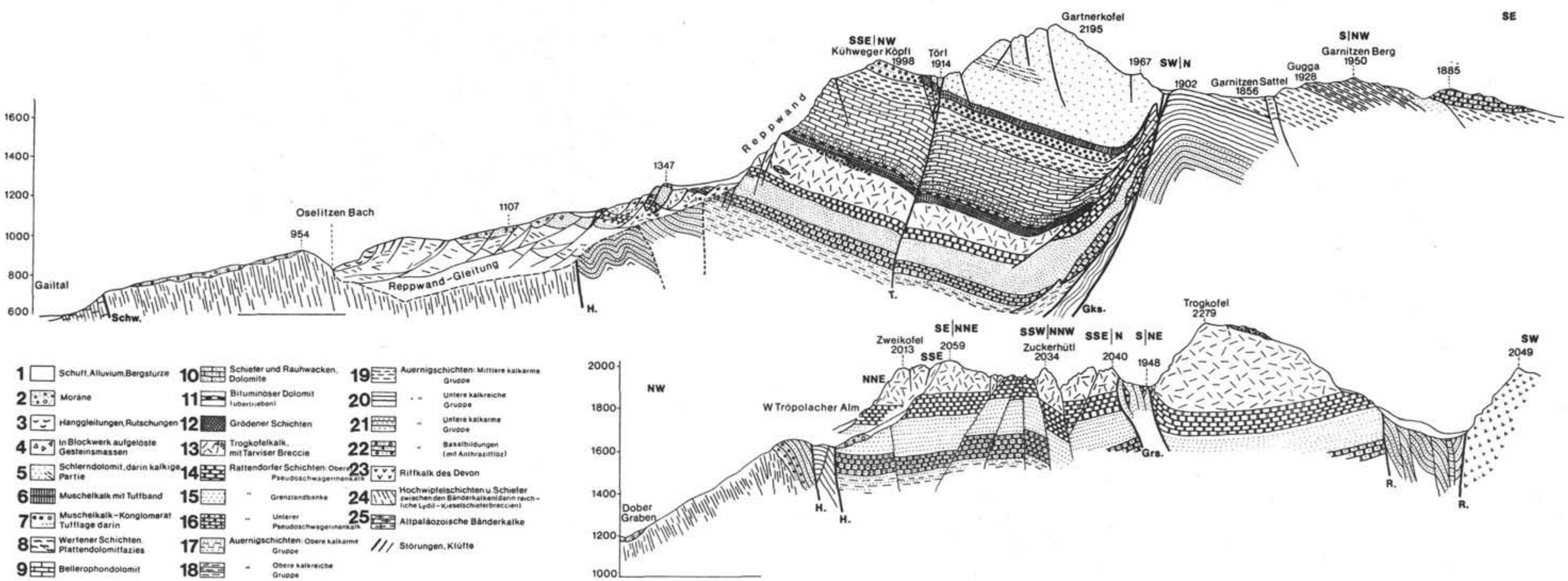


Fig. 29: Reppwand-Gartnerkofel section, Carnic Alps (after F. KAHLER & S. PREY, 1963). Explanation of legend: 1 = talus, landslip debris; 2 = moraines; 3 = landslides; 4 = boulder masses; 5 = Schlern Dolomite with calcareous layers; 6 = Muschelkalk with tuff layers; 7 = Muschelkalk conglomerate with tuffs; 8 = Werfen Fm.; 9 = Bellerophon Fm.; 10 = slates, rauhwackes and dolomites; 11 = bituminous dolomite; 12 = Gröden Fm.; 13 = Trogkofel Lst. and Tarvis Breccia; 14–16 = Rattendorf Group; 17–22 = Auernig Group; 17 = Upper limestone poor fm., 18 = Upper limestone rich fm.; 19 = Middle limestone poor fm.; 20 = Lower limestone rich fm.; 21 = Lower limestone poor fm.; 22 = basal formations; 23 = Devonian limestone (organodetritic); 24 = Hochwipfel Fm.; 25 = Lower Paleozoic banded limestones; faults, joints.
Schw = Schwarzwipfel Fault; H = Hochwipfel Fault; T = Törl Fault; Gks = Gartnerkofel South Fault.

The graptolite bearing horizon has been equated with strata at Cellon and Hoher Trieb that contain the Hirnantia Fauna. In all three sections this horizon represents the base of the transgressive Silurian sediments.

Junction Naßfeld road/Gailtal road, west of Hermagor

This stop provides the best view for the famous Permian/Triassic section of Reppwand and Gartnerkofel (fig. 29).

In the area around Naßfeld Pass and west of it the Late Paleozoic of the Carnic Alps shows its widest extent. The transgressive post-Variscan series include the Upper Carboniferous Auernig Group and Permian to Triassic sequences as shown in the stratigraphic scheme of fig. 3 in this guide. For general information the reader is referred to the chapter „Review of stratigraphy".

Gailtal Crystalline Complex N of Nötsch, pt. 719 at bridge

If time permits a conodont locality within quartzphyllites of the Gailtal Crystalline Complex will be visited. The small outcrop has been described recently by the author (1979).

At this locality the boundary between granites of presumably Variscan age and amphibolites to the north and quatzphyllites to the south can be seen. Interestingly, in the quartzphyllites up to 30 m thick graphitic slates with intercalations of Fe-dolomites and dark limestones occur. The small exposure near the bridge yielded single cones and ramiform conodont elements which according to H. P. SCHÖNLAUB 1979 indicate an Upper Silurian or Lower Devonian age. Two conodonts have been identified, *Neopanderodus* sp. and *Ozarkodina remscheidensis* ssp. For reference material at least 2 kg of rocks are needed.

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GEOLOGISCHE KARTE VC

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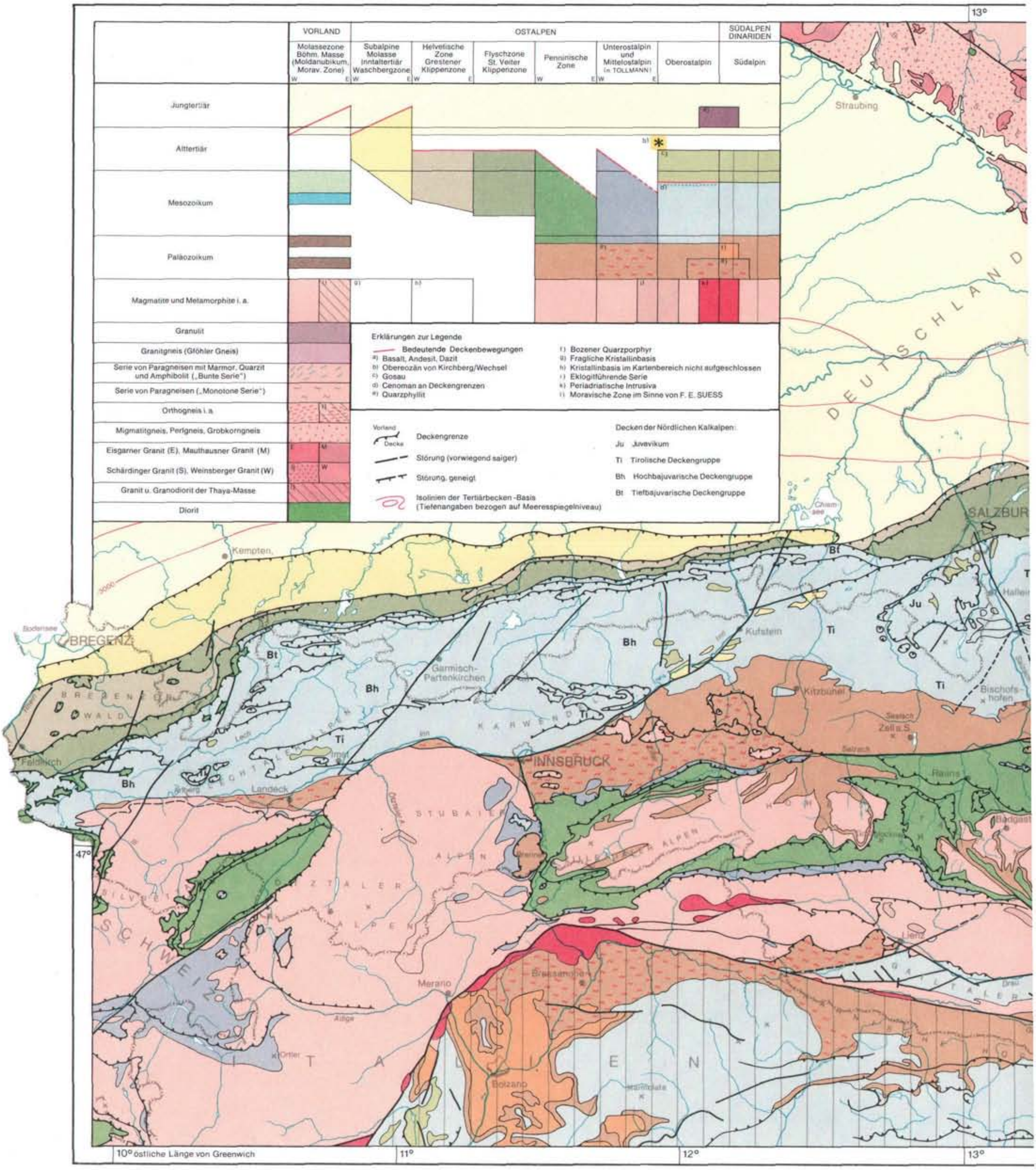

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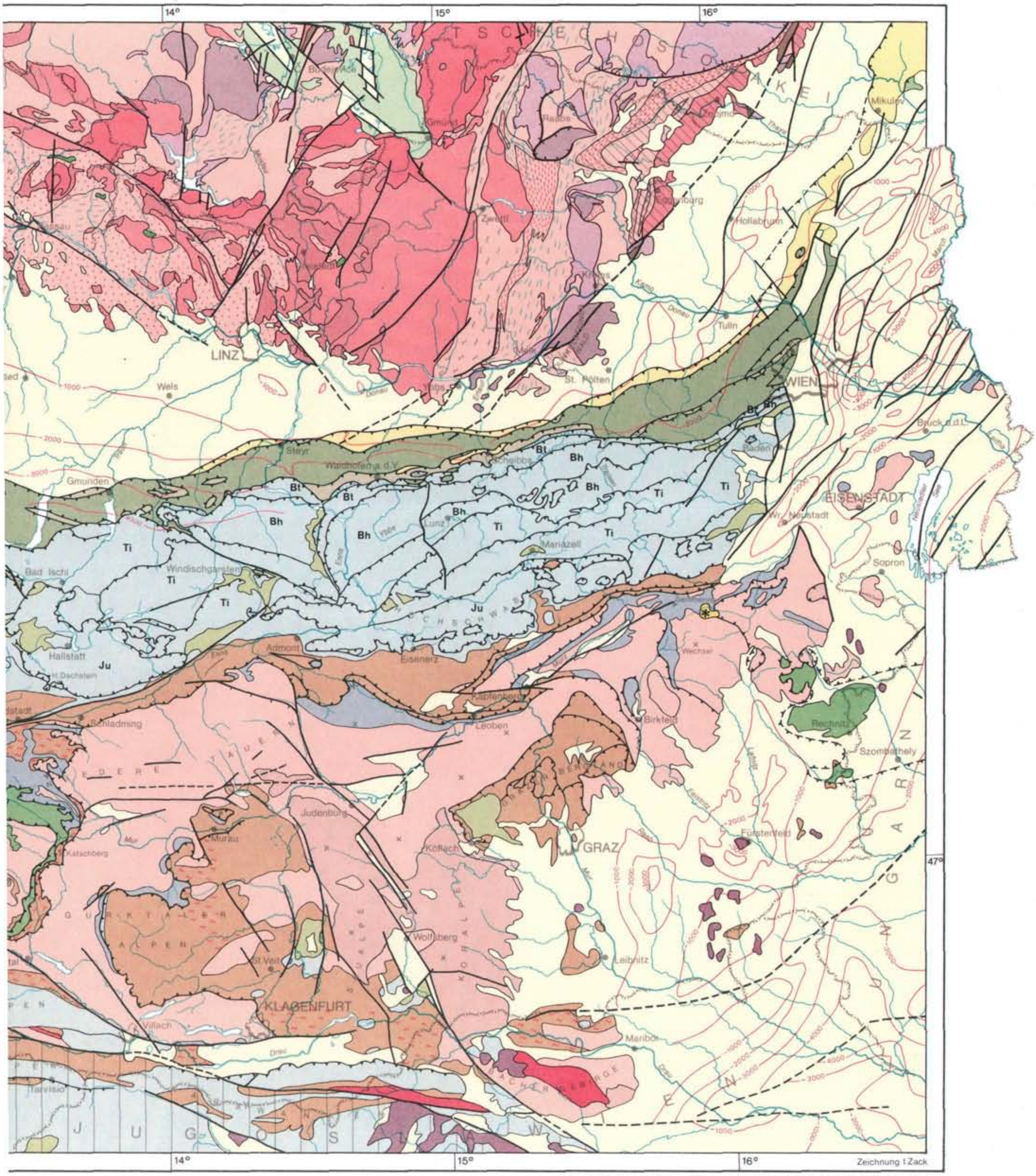

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Plate 1

Section Oberbuchach 2, Lochkovian (Stop 4)

(Second number indicates sample no.)

Figs. 1/16, 2–3/16, 8/17, 9/17, 10/20, 12/24, 13/24, 15/25, 16/25, 18/29, 20/29, 21/29: *Ozarkodina r. remscheidensis* (ZIEGLER).
Figs. 2, 3 resemble *Oz. r. eosteinhornensis* (WALLISER). *Uniformis*-Zone. Fig. 1: 0,98 mm, fig. 2: 1,06 mm, fig. 8: 0,87 mm, fig. 9: 0,7 mm, fig. 10: 0,67 mm, fig. 12: 0,7 mm, fig. 13: 0,71 mm, fig. 15: 0,9 mm, fig. 16: 0,64 mm, fig. 18: 0,84 mm, fig. 20: 0,69 mm, fig. 21: 0,43 mm.

Fig. 17/25: *Ozarkodina* cf. *remscheidensis* (ZIEGLER). The specimen resembles *Oz. eurekaensis* KLAPPER & MURPHY. *Uniformis*-Zone. 0,64 mm.

Figs. 4–5/16, 6/16: *Icriodus woschmidti woschmidti* ZIEGLER. A juvenile and an adult specimen from the base of the *Scyphocrinites* horizon. Figs. 4, 5: 0,73 mm, fig. 6: 0,7 mm.

Fig. 7/23: *Ozarkodina* n. sp. A. 0,68 mm.

Fig. 11/23: *Panderodus* cf. *semicostatus* ZIEGLER & LINDSTRÖM. Length of cone: 0,64 mm.

Fig. 14/24: *Pedavis* cf. *biexoramus* MURPHY et al. A single specimen from the *uniformis*-Zone with a short lateral process. Length of main axis: 0,9 mm.

Figs. 19/23, 22/23: *Pelekysgnathus* sp. Lateral and upper views of an undescribed species. 0,54 mm.

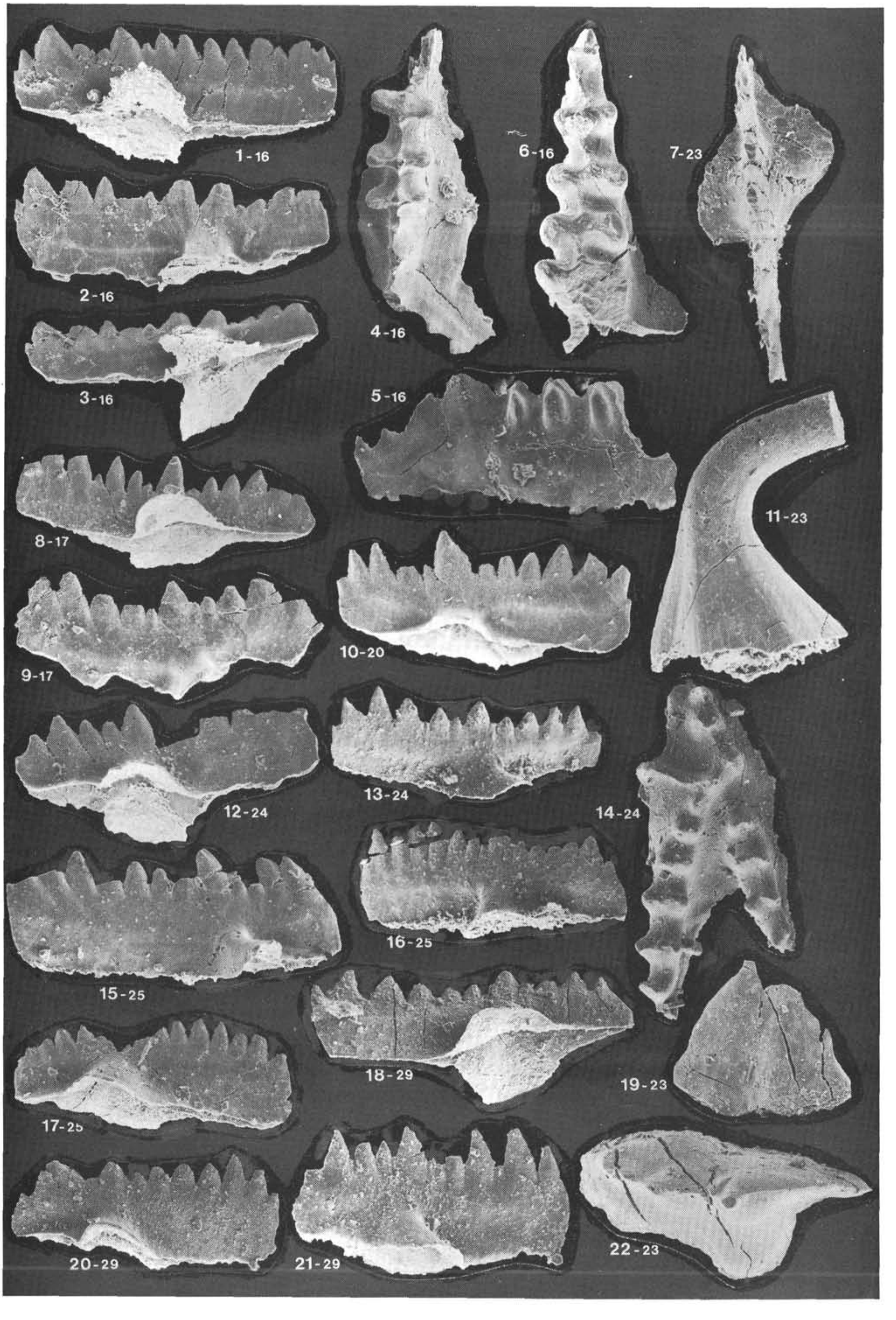
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Plate 2

Section Oberbuchach 2, Lochkovian (Stop 4, cont'd)

(Second number indicates sample no.)

Figs. 1/32, 2/31, 3/44: *Ozarkodina r. remscheidensis* (ZIEGLER).
Fig. 1: 0,54 mm, fig. 2: 0,7 mm, fig. 3: 0,83 mm.

Figs. 4/49, 5/49: *Pandorinellina optima* (MOSKALENKO).
Fig. 4 is fragmentary. 1,01 mm, 0,95 mm. *Hercynicus*-Zone.

Figs. 6–7/51 b, 8–9/48, 11/48, 15/48: *Ozarkodina* n. sp. A.
Figs. 6, 7: Lateral and upper views, figs. 8, 9: Upper and lateral views. Note merged denticles at the posterior part of the blade in figs. 6–7. Figs. 6, 7: 0,56 mm, figs. 8,9: 0,53 mm, fig. 11: 0,62 mm, fig. 15: 1,19 mm. *Hercynicus*-Zone.

Figs. 10/51 b, 16–17/51 b: *Ozarkodina masara* SCHÖNLAUB.
Fig. 10 fragmentary; Figs. 16, 17: Upper and lateral views. Fig. 10: 0,5 mm, figs. 16–17: 0,98 mm. *Hercynicus*-Zone.

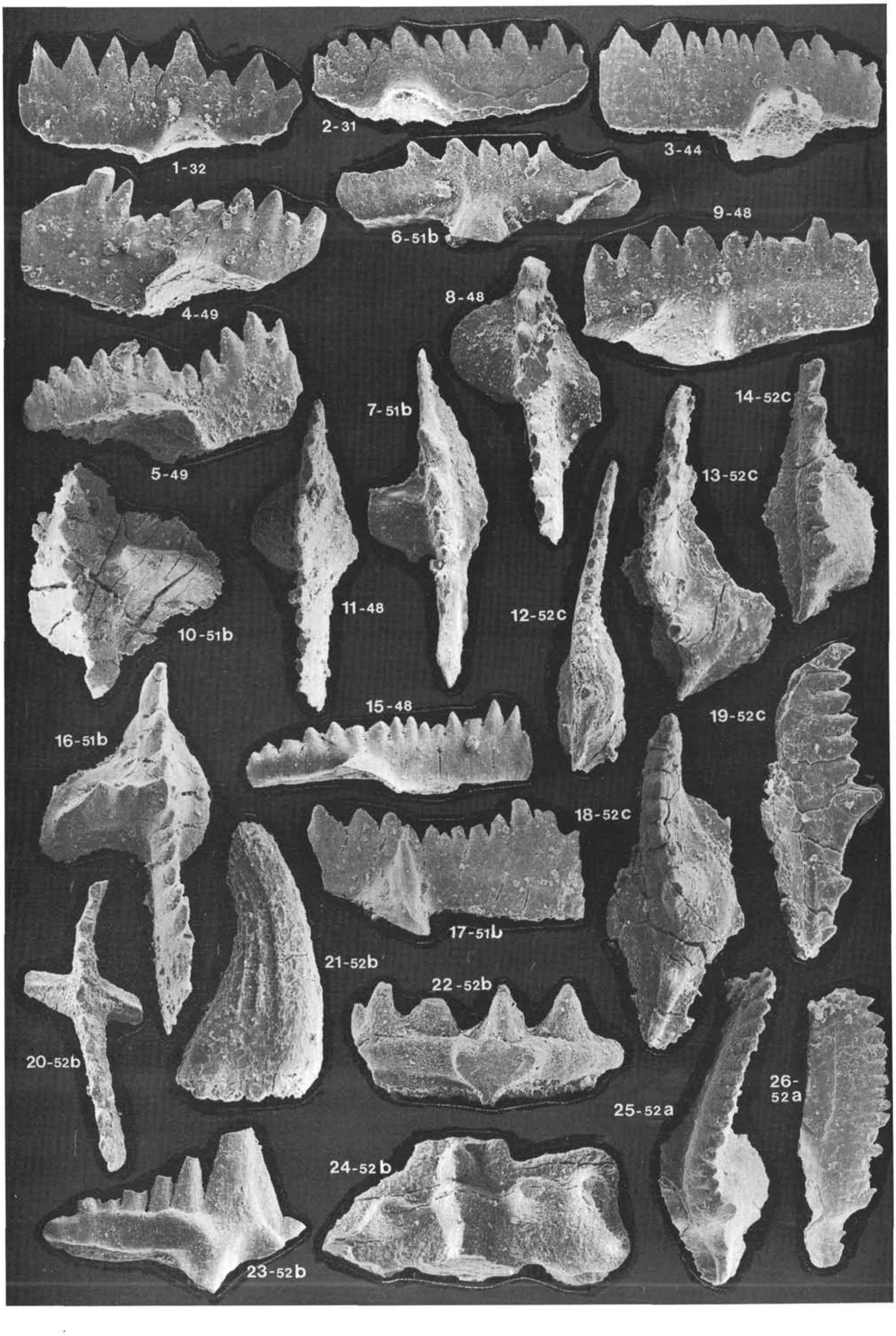
Figs. 12/52 c, 13/52 c, 14/52 c, 18–19/52 c, 25–26/52 c: *Ozarkodina stygia* (FLAJS). Upper and lateral views of phylogenetically early representatives with straight carina (except fig. 12 which belongs to the beta morphotype).
Fig. 12: 0,59 mm, fig. 13: 0,41 mm, fig. 14: 0,51 mm, figs. 18–19: 0,44 mm, figs. 25–26: 0,68 mm. *Hercynicus*-Zone.

Fig. 20/52 b: *Pandorinellina steinhornensis telleri* (SCHULZE). Upper view. 0,58 mm. *Hercynicus*-Zone.

Fig. 21/52 b: *Pedavis* sp. M 2 element (simple cone). Length of the cusp : 0, 37 mm. *Hercynicus*-Zone.

Figs. 22/52 b, 24/52 b: *Ozarkodina transitans* (BISCHOFF & SANNEMANN). Fragments of the middle part. Width of the lobes: 0,61 mm. *Hercynicus*-Zone.

Fig. 23/52 b: *Ozarkodina eleanorae* LANE & ORMISTON. A fragmentary Pa element with tongue like extension of the basal cavity. 0,71 mm. *Hercynicus*-Zone.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13-52c
14-52c
15-48
16-51b
17-51b
18-52c
19-52c
20-52b
21-52b
22-52b
23-52b
24-52b
25-52a
26-52a

Plate 3

Rauchkofel Boden section, Ordovician to Lower Devonian (Stop 9)

Figs. 1–4: *Amorphognathus* cf. *ordovicicus* BRANSON & MEHL (s. SWEET & BERGSTRÖM 1969). Ambalodiform and amorphognathiform elements, the latter incomplete. Upper views, sample no. 318.
Fig. 1: 0,43 mm, fig. 2: 0,42 mm, fig. 3: 0,63 mm (length of main process), fig. 4: 0,98 mm.

Figs. 5–7: *Ozarkodina s. sagitta* (WALLISER). Upper and lateral views from sample no. 313, Orthoceras lst. 0,81 mm.
Fig. 7: Ozarkodiniform element (in form taxonomy: „*Oz. edithae*") from sample no. 312. 0,51 mm.

Fig. 8: *Ozarkodina s. rhenana* (WALLISER). Upper view, sample no. 313. 0,69 mm.

Fig. 9: *Kockelella variabilis* WALLISER. Incomplete P element from sample no. 314. Length of figured specimen 0,88 mm.

Figs. 10–13: *Ozarkodina r. eosteinhornensis* (WALLISER). Lateral views, sample no. 198.
Fig. 10: 0,77 mm, fig. 11: 0,9 mm, fig. 12: 0,78 mm, fig. 13: 0,88 mm.

Fig. 14: *Ozarkodina r. remscheidensis* (ZIEGLER). Lateral view of a specimen from sample no. 198. 0,89 mm.

Figs. 15, 16: *Ozarkodina r. eosteinhornensis* (WALLISER). Lateral view of 2 specimens from sample no. 199.
Fig. 15: 0,73 mm, fig. 16: 0,88 mm.

Figs. 17, 18, 20, 21: *Ozarkodina r. remscheidensis* (ZIEGLER). Lateral view.
Fig. 17: no. 199, 0,87 mm, fig. 18: no. 200, 0,81 mm, fig. 20: no. 201, 0,56 mm, fig. 21: no. 201 A, 1,35 mm.

Fig. 19: *Icriodus woschmidti* ssp. Upper view of a juvenile specimen from sample no. 201. 0,45 mm.

Fig. 22: *Pandorinellina optima* (MOSKALENKO). Lateral view, sample no. 201 B 1. 1,1 mm.

Fig. 23: *Pandorinellina* cf. *optima* (MASKALENKO). Lateral view, sample no. 201 D. 0,69 mm.

Figs. 24–30: *Ozarkodina masara*. Upper and lateral views of 5 specimens from sample no.201 G.
Fig. 24: 0,81 mm, fig. 26: 0,65 mm, fig. 28: 0,95 mm, fig. 29: 0,53 mm, fig. 30: 0,55 mm.
Figs. 25, 27 are lateral views of figs. 24, 26.

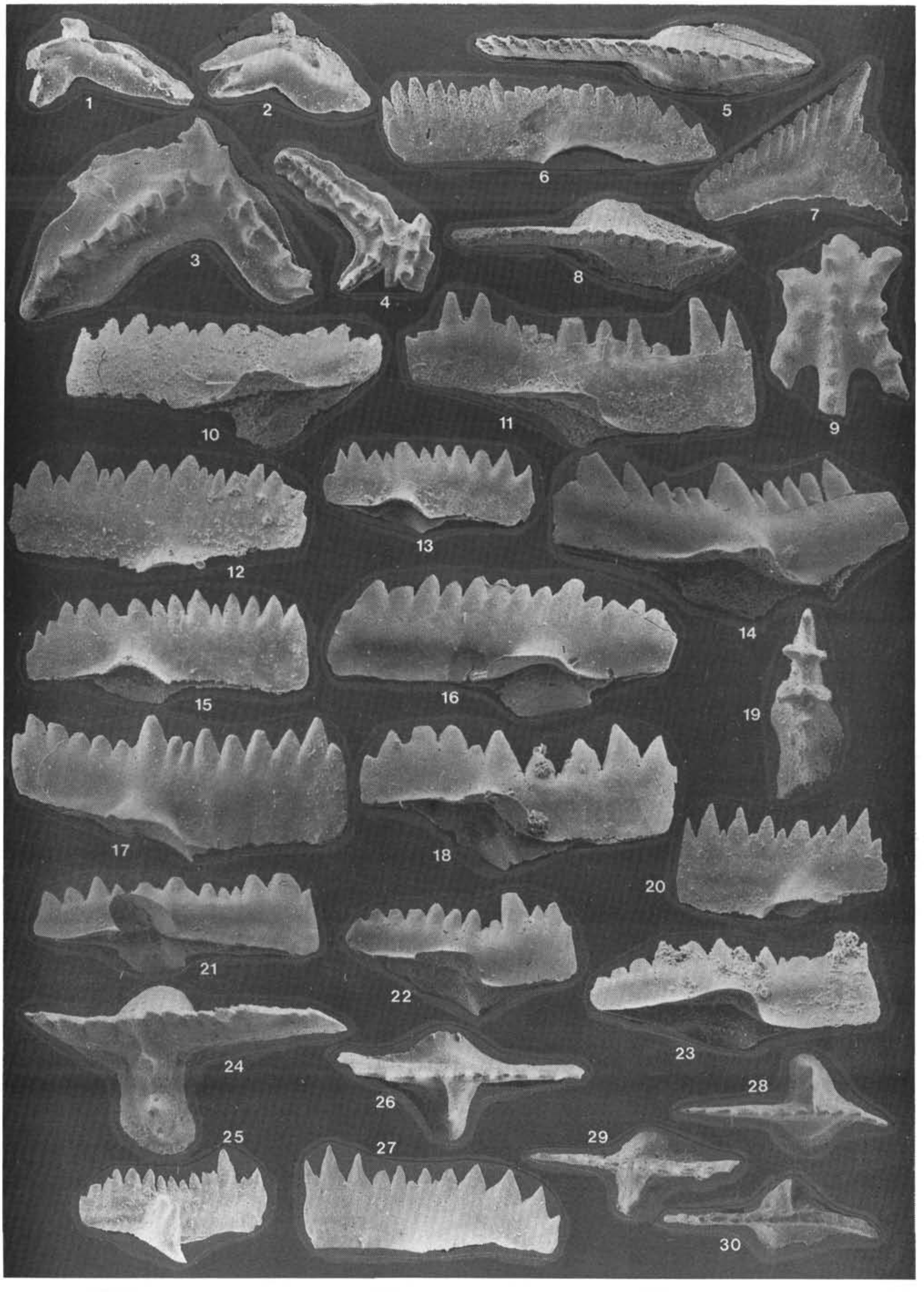
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Plate 4

Rauchkofel Boden section, Lower Devonian (cont'd)

Figs. 1, 2: *Ozarkodina r. remscheidensis* (ZIEGLER). Lateral view, sample no. 204.
Fig. 1: 0,74 mm, fig. 2: 0,71 mm.

Figs. 3–4: *Ozarkodina* cf. *asymmetrica* (BISCHOFF & SANNEMANN). Upper and lateral views, sample no. 208. 1,18 mm.

Figs. 5–6, 7–8: *Ozarkodina stygia* (FLAJS), alpha morphotype. Upper and lateral views of 2 specimens from sample no. 208.
Fig. 5: 0,62 mm, fig. 7: 0,63 mm.

Figs. 9–10, 13–14, 18: *Ozarkodina stygia* (FLAJS), beta morphotype. Lateral and upper views of 3 specimens from sample nos. 211 (figs. 13–14), 212 (figs. 9–10) and 213 (fig. 18).
Fig. 9: 0,72 mm, fig. 13: 0,63 mm, fig. 18: 0,71 mm.

Figs. 11, 16, 17: *Ozarkodina transitans* (BISCHOFF & SANNEMANN). Upper and lower views.
Fig. 11: no. 209, 0,98 mm; fig. 16: no. 213, 0,54 mm; fig. 17: no. 213, 0,64 mm.

Fig. 12: *Pedavis* sp. M 2 b element (complex cone) of MURPHY et al. (in press). Sample no. 210. Length of cone 0,54 mm.

Fig. 15: *Ancyrodelloides trigonicus* BISCHOFF & SANNEMANN. Sample no. 212. 1,02 mm.

Fig. 19: *Pedavis* sp. M 2 d element (simple cone) of MURPHY et al. (in press). Sample no. 213. Length of cone 0,70 mm.

Figs. 20, 27–28, 29: *Ozarkodina delta* KLAPPER & MURPHY (former named *Oz.* n. sp. D).
Fig. 20: *Oz.* cf. *delta* (fragmentary). Lateral and upper views. Fig. 20: no. 213, 0,79 mm; fig. 27: no. 216, 0,86 mm; fig. 29: no. 216, 0,77 mm.

Figs. 21–22, 23, 24–25: *Ozarkodina stygia* (FLAJS), gamma morphotype. Upper and lateral views.
Fig. 21: no. 213 a, 0,55 mm; fig. 23: no. 215, 0,36 mm; fig. 24: no. 215, 0,65 mm.

Fig. 26: *Ozarkodina stygia* (FLAJS), delta morphotype. Upper view from sample no. 217. 0,52 mm.

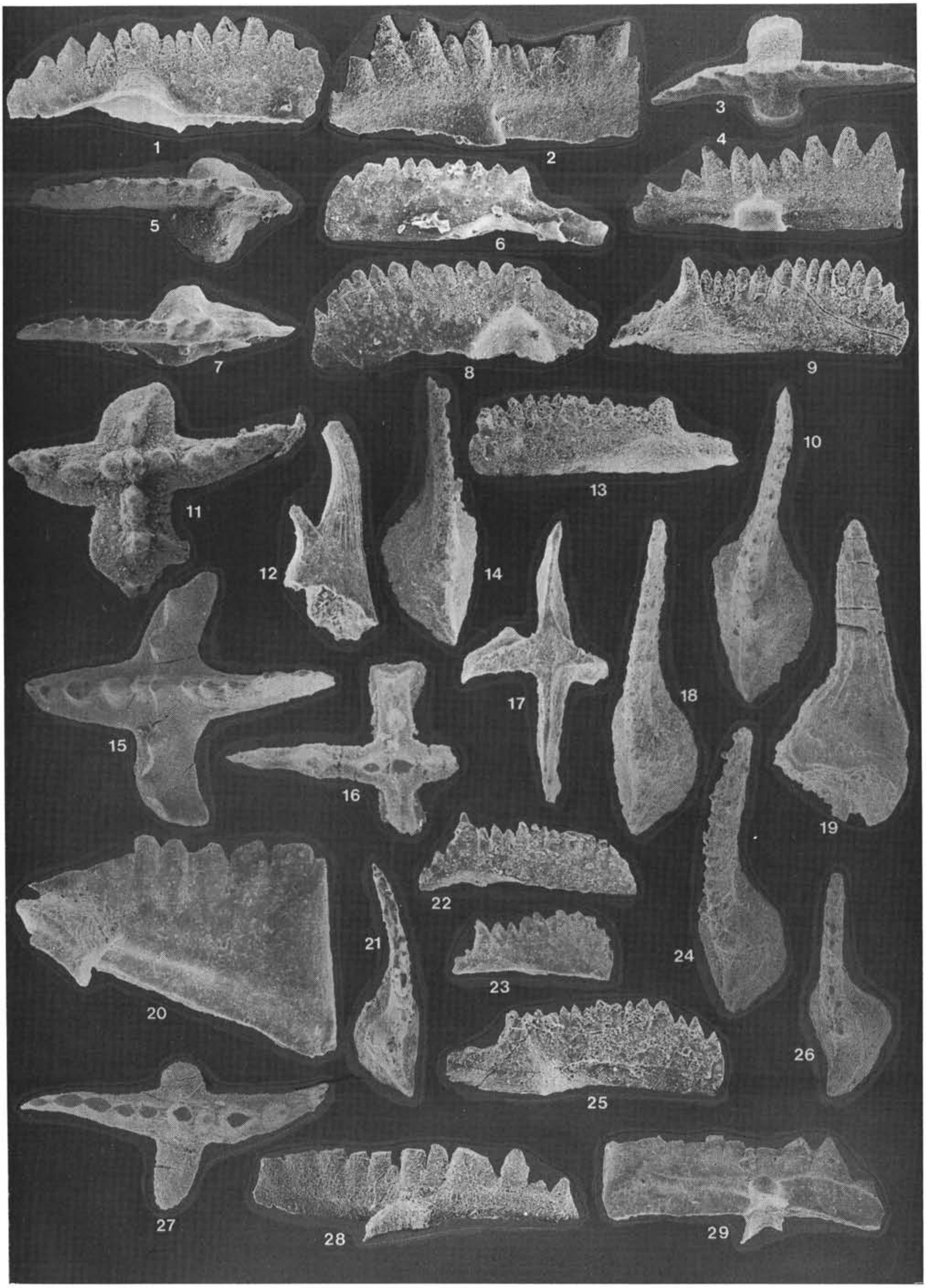
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Plate 5

Rauchkofel Boden section, Lower Devonian (cont'd)

Figs. 1–2, 3, 4, 5: *Ozarkodina limbacarinata* KLAPPER & MURPHY. Upper and lateral views.
Fig. 1: no. 218, 0,74 mm; fig. 3: no. 218, 0,6 mm; fig. 4: no. 218, 0,73 mm.

Fig. 6: *Ozarkodina* sp. Oblique view. Sample no. 220. 0,48 mm.

Fig. 7: *Ozarkodina stygia* (FLAJS), delta morphotype. Lateral view of a specimen from sample no. 221. 0,76 mm.

Figs. 8, 10, 11, 12–13: *Ozarkodina transitans* (BISCHOFF & SANNEMANN). Upper and lateral views of 4 specimens.
Fig. 8: no. 220, 0,71 mm; fig. 10: no. 220, 0,63 mm; fig. 11: no. 220, 0,84 mm; fig. 12: no. 220, 0,81 mm.

Fig. 9: *Icriodus angustoides* CARLS & GANDL. Fragmentary specimen. Sample no. 220, 0,74 mm.

Fig. 14: *Ancyrodelloides trigonicus* BISCHOFF & SANNEMANN. Sample no. 222. 1,04 mm.

Figs. 15, 16, 17, 19: *Pedavis pesavis* (BISCHOFF & SANNEMANN).
Fig. 17: M element. Figs. 15, 16: fragmentary, sample no. 224 a; fig. 17: no. 224 b; fig. 19: no. 224 d. Fig. 15: approx. 1 mm, fig. 16: 0,93 mm (length of the posterior and lateral process), fig. 17: 0,42 (diameter of base), fig. 19: 0,52 mm (length of main axis of a juvenile specimen).

Fig. 20: *Icriodus* cf. *steinachensis* AL-RAWI. Upper view. Sample no. 234 (red nodular limestone, Pragian). 0,63 mm.

Fig. 21: *Pelekysgnathus s. serratus* JENTZSCH. Lateral view. Sample no. 238. 0,81 mm.

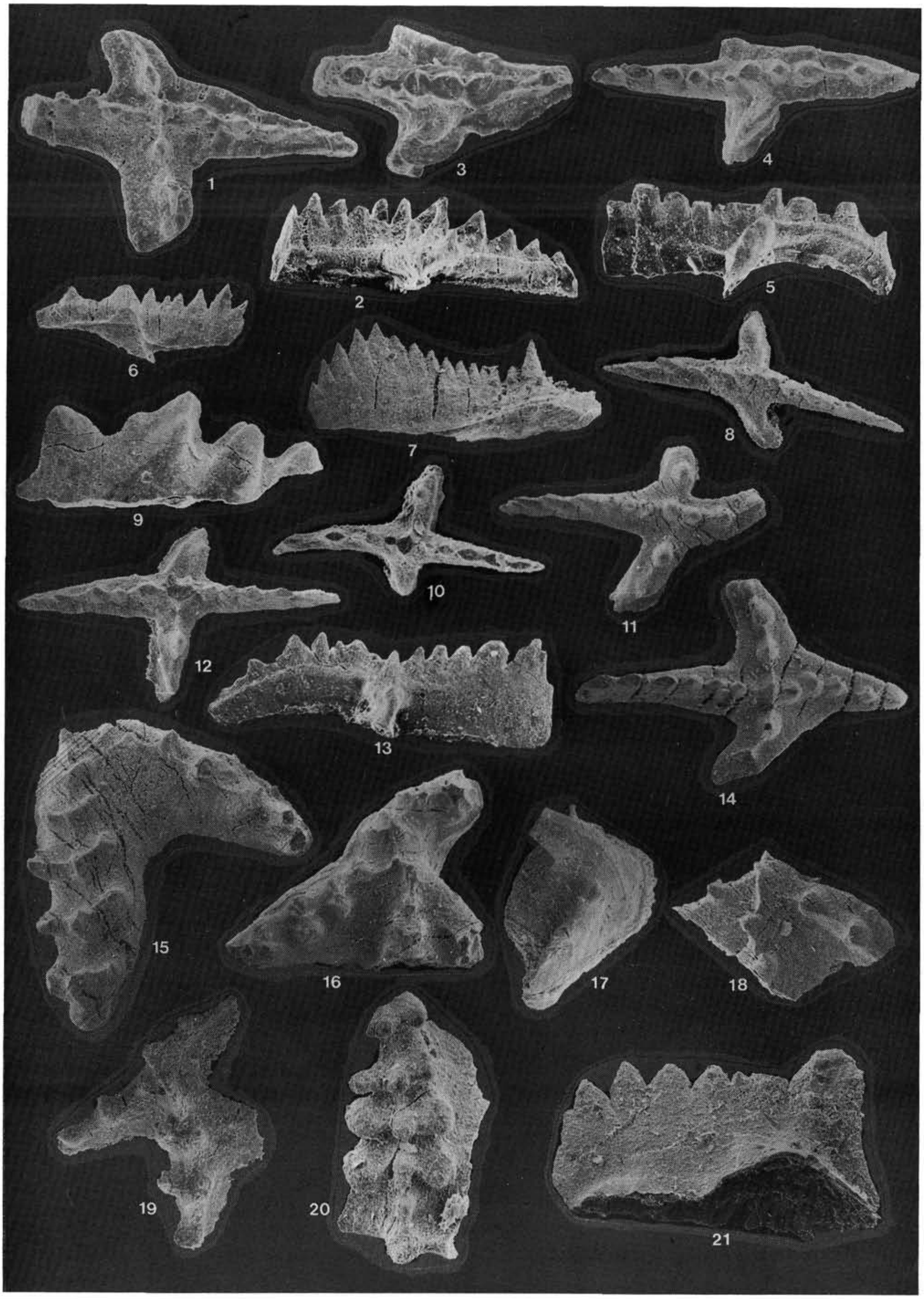
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Plate 6

Seekopfsockel section, Ludlovian to Pragian (Stop 10).

Fig. 1: *Kockelella variabilis* WALLISER. Upper view from sample no. 464. 0,67 mm (length of blade).

Figs. 2–3: *Ozarkodina* cf. *eurekaensis* KLAPPER & MURPHY. Oblique and lateral view of a specimen from the black platy limestone horizon, sample no. 350. 0,65 mm.

Figs. 4, 6–7, 9, 11: *Ozarkodina r. remscheidensis* (ZIEGLER). Lateral and upper views.
Fig. 4: no. 349, 0,94 mm; fig. 6: no. 351, 0,64 mm; fig. 9: no. 352, 0,65 mm; fig. 11: no. 190, 0,49 mm.

Fig. 5: *Icriodus woschmidti hesperius* KLAPPER & MURPHY. A juvenile specimen from sample no. 351, platy limestones. 1,1 mm.

Fig. 8: *Icriodus* cf. *postwoschmidti* MASHKOVA. Sample no. 186. 0,57 mm.

Fig. 10: *Ozarkodina wurmi* (BISCHOFF & SANNEMANN). Sample no. 186. 1, 2 mm.

Fig. 12: '*Eognathodus*' *linearis* PHILIP. Lateral view. Sample no. 190. 0,99 mm.

Fig. 13: *Pandorinellina* sp. Fragmentary specimen from sample no. 197. 0,82 mm.

Figs. 14, 15, 16, 17: *Icriodus steinachensis* AL-RAWI. Upper view of 4 specimens from sample nos. 195 (fig. 14), 193 (fig. 15), 194 (fig. 16), 196 (fig. 17).
Fig. 14: 0,63 mm, fig. 15: 0,59 mm, fig. 16: 0,71 mm, fig. 17: 0,59 mm.

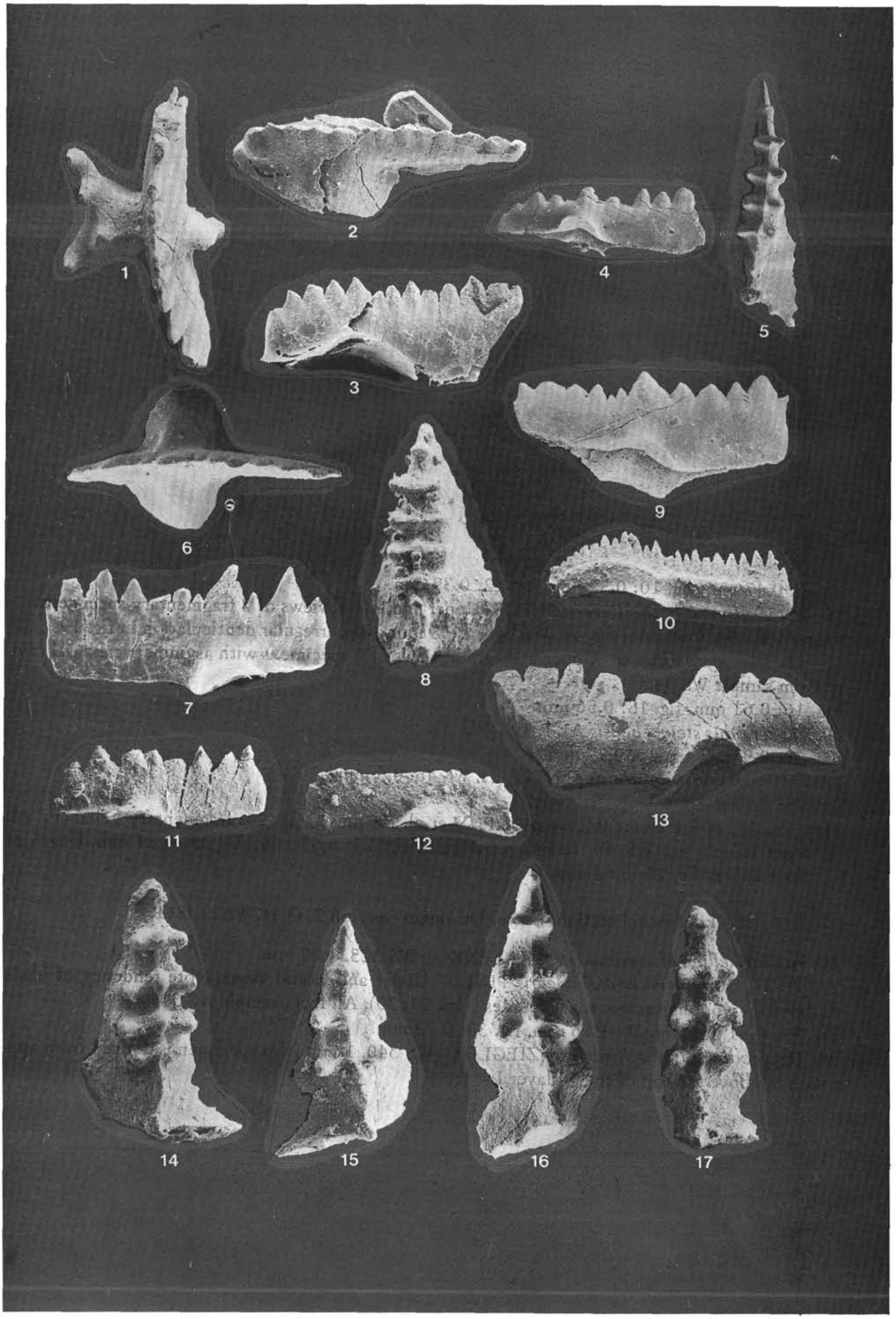
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Plate 7

Seekopfsockel section, Lower Devonian (collection O. H. WALLISER)

Fig. 1: *Icriodus postwoschmidti* MASHKOVA. Sample WS 16. 0,64 mm.

Figs. 2, 7: *Ozarkodina r. remscheidensis* (ZIEGLER). Lateral view.
Fig. 2: Sample WS 18, 0,67 mm; fig. 7: WS 33, 0,59 mm.

Fig. 3: *Ozarkodina masara*. Upper view of a specimen from WS 19.
0,69 mm. (Compare with plate 3, figs. 24–30).

Fig. 4: *Ozarkodina transitans* (BISCHOFF & SANNEMANN). Upper view. WS 24. 0,51 mm.

Fig. 5: *Ozarkodina* cf. *masara* SCHÖNLAUB. Upper view, WS 25. 0,63 mm.

Fig. 6: *Ancyrodelloides trigonicus* BISCHOFF & SANNEMANN. The anterior process is missing in the figured specimen. WS 24. 0,55 mm.

Figs. 8–9, 10–11, 12–13: *Ozarkodina* n. sp. B. Upper and lateral views of 3 undescribed specimens from sample no. WS 25.
Fig. 8: 0,47 mm, fig. 10: 0,52 mm, fig. 12: 0,39 mm.

Figs. 14–15, 19: *'Eognathodus' linearis* PHILIP. Upper and lateral views of 2 fragmentary specimens.
Fig. 14: WS 34, 0,66 mm; fig. 19: WS 34 a, 0,38 mm. Note irregular denticulation in fig. 19.

Figs. 16–17, 18: *Ozarkodina* sp. Upper and lateral views of 2 specimens with asymmetrical basal cavity from sample WS 34 a.
Fig. 16: 0,61 mm, fig. 18: 0,56 mm.

Figs. 20, 21: *Icriodus steinachensis* AL-RAWI. WS 37.
Fig. 20: 0,9 mm, fig. 21: 0,77 mm.

Fig. 22: *Pelekysgnathus s. serratus* JENTZSCH. WS 46. 0,5 mm.

Figs. 23–25: *Pedavis* sp.
Figs. 23, 25: M 2 c element after MURPHY et al. (in press), fig. 24: fragmentary I element. All from sample no. WS 46. Length of cone in fig. 23: 0,57 mm, fig. 25: 0,39 mm; length of main axis in fig. 24: 0,62 mm.

Seekopfsockel section, Lower Devonian (section 2, O. H. WALLISER)

Fig. 26: *Pandorinellina* cf. *optima* (MOSKALENKO). WS 325. 1,02 mm.

Figs. 27, 28/31, 30: *'Eognathodus' linearis* PHILIP. Upper and lateral views. Note tendency of blade to develop two longitudinal row of nodes (figs. 27, 30). All from sample WS 314.
Fig. 27: 0,81 mm, fig. 28: 1,16 mm, fig. 30: 0,72 mm.

Fig. 29: *Ozarkodina r. remscheidensis* (ZIEGLER). WS 340. 1 mm (this specimen is derived from approx. 8 m above the top of the Wolayer Lst.).

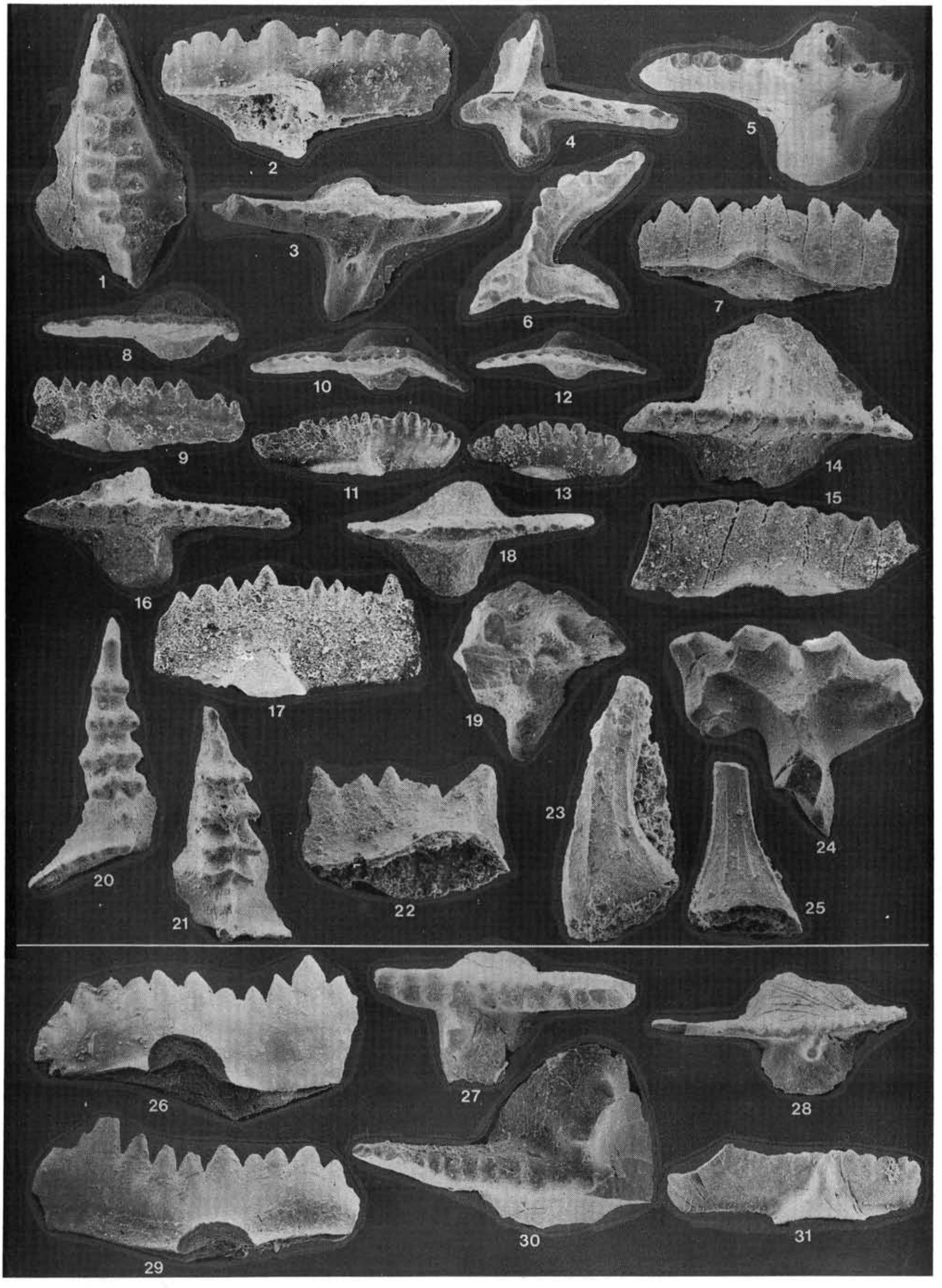
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Plate 8

Lower/Middle Devonian boundary at „Wolayer Glacier" (Stop 13)

Figs. 1, 2: *Polygnathus cooperi secus* KLAPPER et al. Lower and upper views from sample 98/2.
Fig. 1: 0,87 mm, fig. 2: 1,1 mm.

Fig. 3: *Polygnathus quadratus* KLAPPER et al. Sample no. 99/3. 0,52 mm.

Figs. 4, 8, 9, 10, 23, 24: *Polygnathus serotinus* TELFORD.
Fig. 4: Lower view, sample no. 103/7; 0,57 mm. Fig. 8: Oblique view, sample no. 107/11; 0,55 mm. Fig. 9: Upper view, sample no. 114/18; 0,72 mm. Fig. 10: Lower view, sample no. 115/19; 0,46 mm. Fig. 23: Upper view, sample no. 126/30; 0,52 mm. Fig. 24: Lower view, sample no. 126/30; 0,77 mm.

Fig. 5: *Polygnathus* sp. An apparently juvenile representative of *Polygnathus* from sample no. 108/12 resembling *Pol. angustipennatus* BISCHOFF & ZIEGLER. 0,46 mm.

Figs. 6, 17, 18: *Ozarkodina carinthiaca* (SCHULZE). Fig. 18 is regarded as oz-element within the apparatus of this species.
Fig. 6: Sample no. 109/13; 0,59 mm. Fig. 17: Sample no. 118/22; 0,6 mm. Fig. 18: Sample no. 119/23; 0,56 mm.

Fig. 7: *Polygnathus cooperi* ? Upper view of an apparently juvenile specimen in which the specific characteristics of the platform are not fully developed. Sample no. 108/12; 0,65 mm.

Figs. 11, 12, 13, 14, 19, 27, 28: *Polygnathus costatus patulus* KLAPPER. Upper and oblique views.
Fig. 11: Sample no. 116/20; 1,3 mm. Fig. 12: Sample no. 116/20; 1,1 mm. Fig. 13: Sample no. 117/21; 1 mm. Fig. 14: Sample no. 116/20; 1,1 mm. Fig. 19: Sample no. 119/23; 0,83 mm. Fig. 27: Sample no. 126/30; 1,2 mm. Fig. 28: Sample no. 127/31; 0,87 mm.

Figs. 15, 16: *Icriodus beckmanni sinuatus* KLAPPER et al. Fig. 16 represents a juvenile specimen. Both figured specimens are from sample no. 117/21.
Fig. 15: 1,03 mm; fig. 16: 0,63 mm.

Figs. 22, 26: *Polygnathus linguiformis bultyncki* WEDDIGE. Oblique views.
Fig. 22: Sample no. 126/30; 1,1 mm. Fig. 26: Sample no. 129/33; 0,85 mm.

Fig. 25: *Ozarkodina bidentata* (BISCHOFF & ZIEGLER). Lateral view. Sample no. 128/32; 0,4 mm.

Figs. 20–21, 29: *Polygnathus costatus partitus* KLAPPER et al.
Figs. 20–21: Upper and oblique views of the specimen from sample no. 125/29; 1,2 mm. Fig. 29: Sample no. 130/34; 0,84 mm.

Figs. 30, 31, 32: *Polygnathus costatus costatus* KLAPPER. The three illustrated specimens come from sample no. 132/36.
Fig. 30: 0,84 mm; fig. 31: 0,77 mm; fig. 32: 0,96 mm.

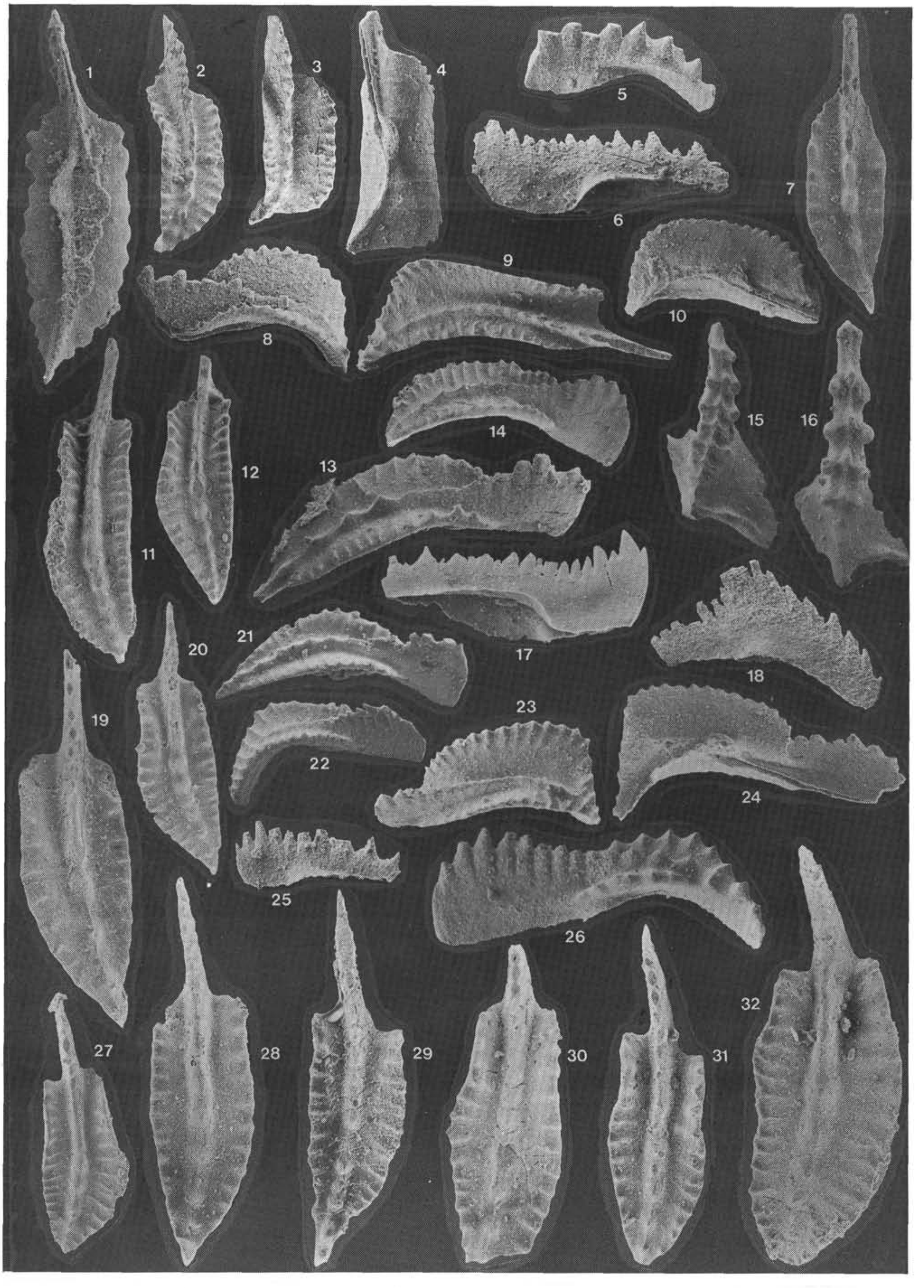
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Plate 9

Stop 13 (Wolayer glacier); Stop 12 (Lake Wolayer); Stop 14 (Valentin Törl)

Fig. 1: *Polygnathus ling. linguiformis* HINDE gamma MT. Upper view, Wolayer glacier, sample no. 41; x 40.

Fig. 2: *Polygnathus eiflius* BISCHOFF & ZIEGLER. Upper view, Wolayer glacier, sample no. 42: x 44.

Figs. 3, 4: *Polygnathus angusticostatus* WITTEKINDT. Lateral views.
Fig. 3: Wolayer glacier, sample no. 54; x 85. Fig. 4: Wolayer glacier, sample no. 67; x 96.

Fig. 5: *Icriodus struvei* WEDDIGE. Upper view, Wolayer glacier, sample no. 46; x 50.

Fig. 6: *Polygnathus robusticostatus* BISCHOFF & ZIEGLER. Upper view, Wolayer glacier, sample no. 65; x 50.

Fig. 7: *Polygnathus costatus costatus* KLAPPER. Upper view, Wolayer glacier, sample no. 66; x 47.

Fig. 8: *Icriodus difficilis* ZIEGLER & KLAPPER. Upper view, Wolayer glacier, sample no. 71; x 44.

Figs. 9–10: *Icriodus obliquimarginatus* BISCHOFF & ZIEGLER. Lateral and upper views, Wolayer glacier, sample no. 72; x 61 (fig. 9), x 49 (fig. 10).

Figs. 11–12: *Icriodus brevis* STAUFFER. Upper and lateral views, Wolayer glacier, sample no. 72; x 76.

Fig. 13: *Polygnathus costatus oblongus* WEDDIGE. Upper view, Wolayer glacier, sample no. 63; x 50.

Figs. 14–15: *Tortodus intermedius* (BULTYNCK). Upper and lateral views, Wolayer glacier, sample no. 64; x 44 (fig. 14), x 48 (fig. 15).

Figs. 16–17: *Polygnathus ling. linguiformis* HINDE gamma MT. Upper and lower views, Wolayer glacier, sample no. 71; x 36 (fig. 16), x 42 (fig. 17).

Figs. 18–19: *Polygnathus ling. linguiformis* HINDE delta MT. Oblique and lower views, Wolayer glacier, sample no. 71; x 57 (fig. 18), x 72 (fig. 19).

Figs. 20, 21: *Polygnathus latifossatus* WIRTH. Upper and lower views of 2 specimens from sample nos. 71 (fig. 20) and 72 (fig. 21), Wolayer glacier; x 40.

Fig. 22: *Polygnathus xylus ensensis* ZIEGLER & KLAPPER. Upper view, Wolayer glacier, sample no. 71; x 70.

Fig. 23: *Polygnathus ling. linguiformis* HINDE epsilon MT. Upper view, Wolayer glacier, sample no. 71; x 30.

Fig. 24: *Polygnathus parawebbi* CHATTERTON. Oblique view, Wolayer glacier, sample no. 68; x 56.

Fig. 25: *Ancyrodella buckeyensis* STAUFFER. Upper view, Lake Wolayer, sample no. 12; x 63.

Fig. 26: *Ancyrognathus triangularis* YOUNGQUIST. Upper view, Lake Wolayer, sample no. 12; x 42.

Fig. 27: *Ancyrognathus asymmetricus* ULRICH & BASSLER. Upper view, Lake Wolayer, sample no. 12; x 42.

Figs. 28–29: *Polygnathus webbi* STAUFFER. Oblique and lower views, Lake Wolayer, sample no. 11; x 63 (fig. 28), x 75 (fig. 29).

Figs. 30–31: *Ancyrodella nodosa* ULRICH & BASSLER. Upper and lower views, Valentin Törl, sample no. 32; x 63.

Figs. 32–33: *Ancyrodella lobata* BRANSON & MEHL. Upper and lower views, Valentin Törl, sample no. 32; x 63 (fig. 32), x 70 (fig. 33).

Figs. 34–35: *Polygnathus normalis* MILLER & YOUNGQUIST. Upper and lower views, Valentin Törl, sample no. 32; x 75 (fig. 34), x 45 (fig. 35).

Fig. 36: *Icriodus* cf. *I. alternatus cymbiformis* BRANSON & MEHL. Upper view, Valentin Törl, sample no. 29; x 95.

Fig. 37: *Icriodus arkonensis arkonensis* STAUFFER. Upper view, Valentin Törl, sample no. 32; x 60.

Fig. 38: *Icriodus* cf. *I. incrassatus* YOUNGQUIST & PET. Upper view, Valentin Törl, sample no. 32; x 60.

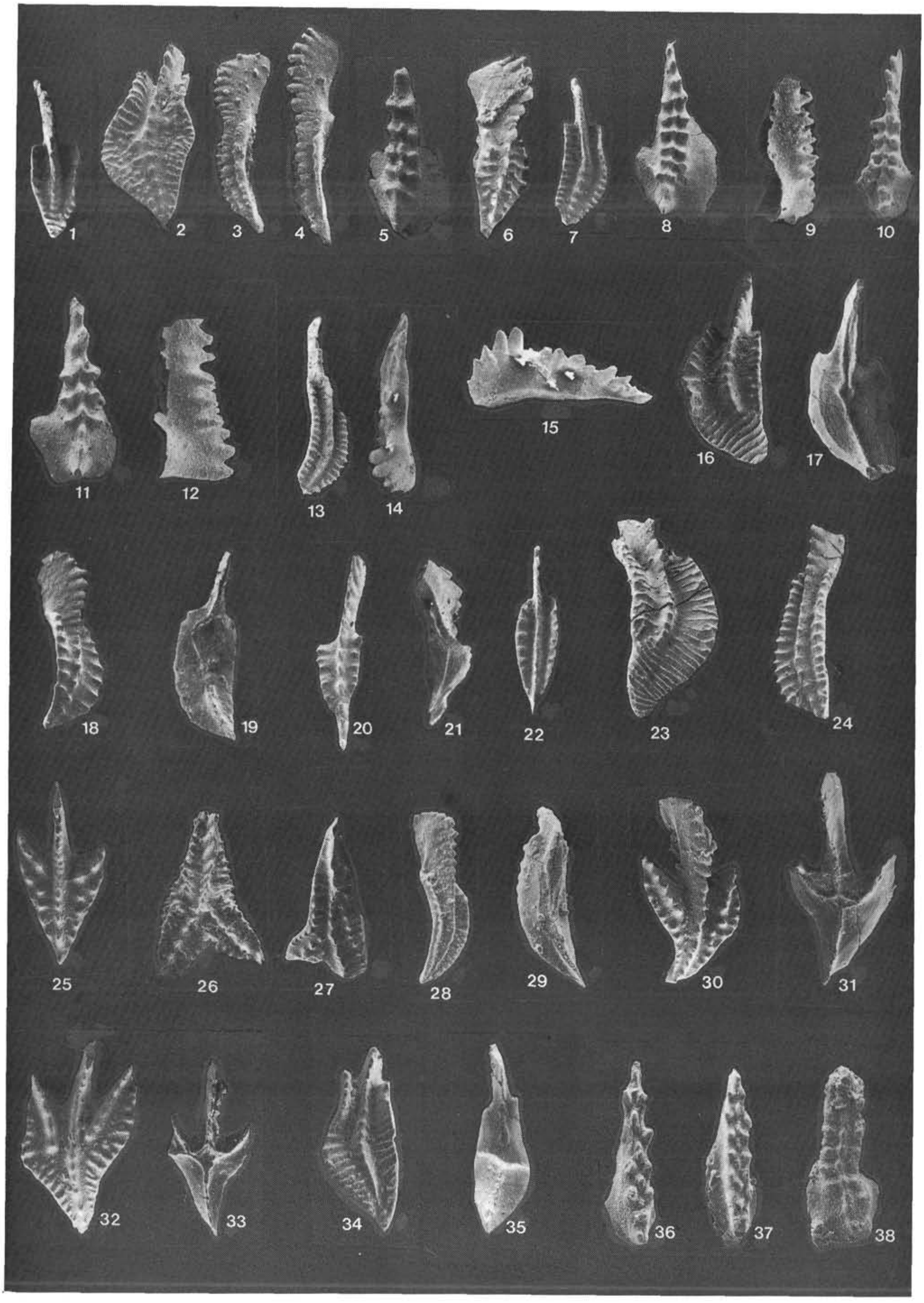
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Plate 10

Stop 12 (Lake Wolayer) and Stop 14 (Valentin Törl)

Figs. 1–3: *Palmatolepis subrecta* MILLER & YOUNGQUIST. Upper and lateral views,Lake Wolayer, sample no. 11; x 58 (figs. 1–2), x 50 (fig. 3).

Figs. 4, 5, 6: *Palmatolepis proversa* ZIEGLER. Upper an lower views, Lake Wolayer, sample nos. 11 (fig. 4) and 12 (figs. 5, 6); x 47 (fig. 4), x 63 (fig. 5), x 76 (fig. 6).

Figs. 7–8, 9: *Palmatolepis punctata* (HINDE). Upper and lower views, Lake Wolayer, sample nos. 12 (figs. 7–8) and 11 (fig. 9); x 32 (fig. 7), x 51 (fig. 8), x 39 (fig. 9).

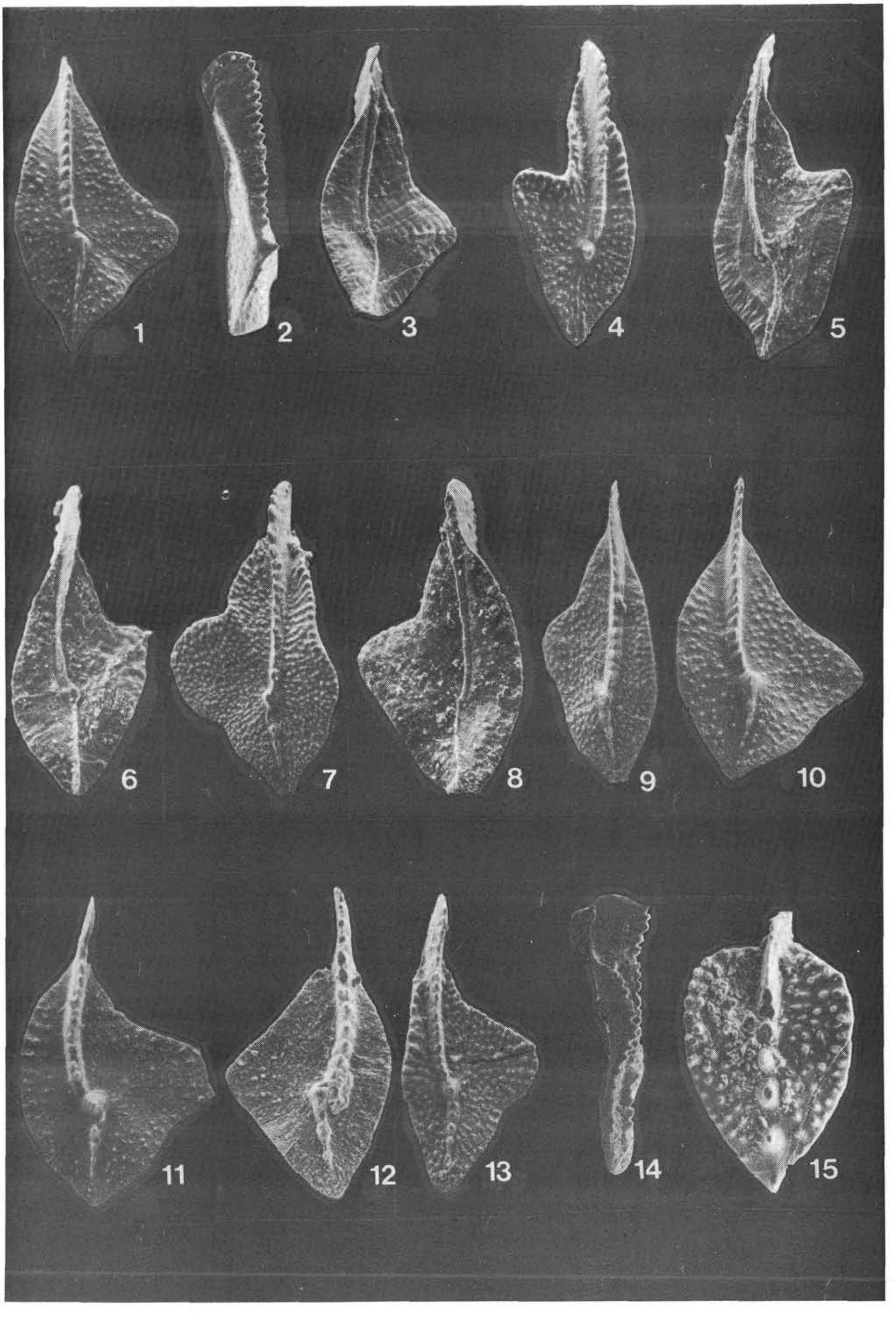
Fig. 10: *Palmatolepis hassi* MÜLLER & MÜLLER. Upper view, Lake Wolayer, sample no. 12; x 57.

Fig. 11: *Palmatolepis gigas* MILLER & YOUNGQUIST. Upper view, Lake Wolayer, sample no. 12; x 47.

Fig. 12: *Palmatolepis d. delicatula* BRANSON & MEHL. Upper view, Valentin Törl, sample no. 32; x 84.

Figs. 13–14: *Palmatolepis triangularis* SANNEMANN. Upper and lateral views, Valentin Törl, sample no. 29; x 38.

Fig. 15: *Polygnathus asymm. asymmetricus* BISCHOFF & ZIEGLER. Upper view, Valentin Törl, sample no. 29; x 73.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