Annales de la Société géologique de Belgique, T. 117, fascicule 1, 1994, pp. 107-121 Février 1996

CONODONTS AND FACIES OF EMSIAN HERCYNIAN LIMESTONES, KLAUSBERG SECTION, HARZ MOUNTAINS, GERMANY

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(2 figures, 3 plates)

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ABSTRACT. The Klausberg Section is one of the isolated Devonian Hercynian Limestone lenses that occur in the Harzgerode Imbrication Zone of the Lower Harz Mountains. These limestone lenses are characterized by tectonic framework as phacoides. Furthermore, lithological fabrics of corresponding shales and chaotic stratification in the surroundings of large limestone blocks as well as in the outer parts of these blocks themselves show evidence of mass flow transport. A synoptic reconstructed carbonatic sequence of Hercynian Limestones allows conclusions on the dynamic history of their primary depositional area. The Devonian facial trend which reflects a stepwise deepening of their primary depositional area is well comparable with sedimentary sequences which document the drowning of carbonate platforms. The Klausberg Section represents an Emsian sequence with a conodont fauna that ranges from the *inversus* Zone into the *inversus/laticostatus* Zone. In some of the conodont samples faunas are dominated by *Polygnathus*. *Belodella*, *Drepanodus* and *Panderodus* are present in small numbers in most samples. The succession of quartz sandstones, crinoid limestones, dacryoconarid sparites and a rhythmic layering of styliolinid rich bioclastic packstones and wackestones are interpreted as sediments of a terrigenous carbonate shelf. The repeated change between grain-supported and mud-supported fabrics indicates a deposition at or somewhat below the fair weather wave base. The occurrence of the questionable dasycladacean algae *Uraloporella* as well as chamositic oncoids points to a shallow marine sedimentation probably in euphotic and coastal settings.

KEYWORDS: Devonian, Emsian, Harz Mountains, limestones, facies, chamosite, conodonts, olistostrom.

RESUME. Conodontes et faciès des calcaires d'âge hercynien emsien de la coupe de Klausberg, Harz, Allemagne. La coupe de Klausberg présente une des lentilles isolées des calcaires hercyniens qui affleurent dans la zone de Harzgerode des monts inférieurs du Harz. Ces lentilles sont de type phacoïde. En outre, la texture lithologique des schistes correspondants et la stratification chaotique des grands blocs de calcaire entre eux, ainsi que dans les parties marginales de ces blocs eux-mêmes, montrent des signes évidents de mouvements de transport en masse. Une reconstruction synoptique de la séquence carbonatée des calcaires hercyniens permet des conclusions sur l'histoire dynamique de leur région de sédimentation primitive. Le faciès du Dévonien qui reflète un approfondissement par saccades de la région de sédimentation primitive est compatible avec les séquences sédimentaires qui illustrent l'enfouissement des plates-formes de carbonates. La coupe de Klausberg représente une séquence de l'Emsien avec une faune de conodontes qui va de la Zone *inversus* jusqu'au sein de la Zone *inversus/laticostatus*. Dans quelques-uns des échantillons de conodontes, les faunes sont dominées par *Polygnathus*. *Belodella, Drepanodus* et *Panderodus* sont aussi présents dans un petit nombre d'échantillons. La succession de grès quartzeux, de calcaires à crinoïdes et un litage rythmique de packstones bioclastiques et de wackestones sont interprétés comme des sédiments de plate-forme terrigène. Le changement répété de textures sableuses et argileuses indique une accumulation juste au niveau de la base des vagues ou juste en-dessous. La présence d'hypothétique algues dasycladacées *Uraloporella* ainsi que d'oncoïdes chamositiques indiquent un milieu marin de sédimentation probablement peu profond en position euphotiques et côtières.

MOTS-CLES: Dévonien, Emsien, Harz, calcaire, faciès, chamosite, conodontes, olistostrome.

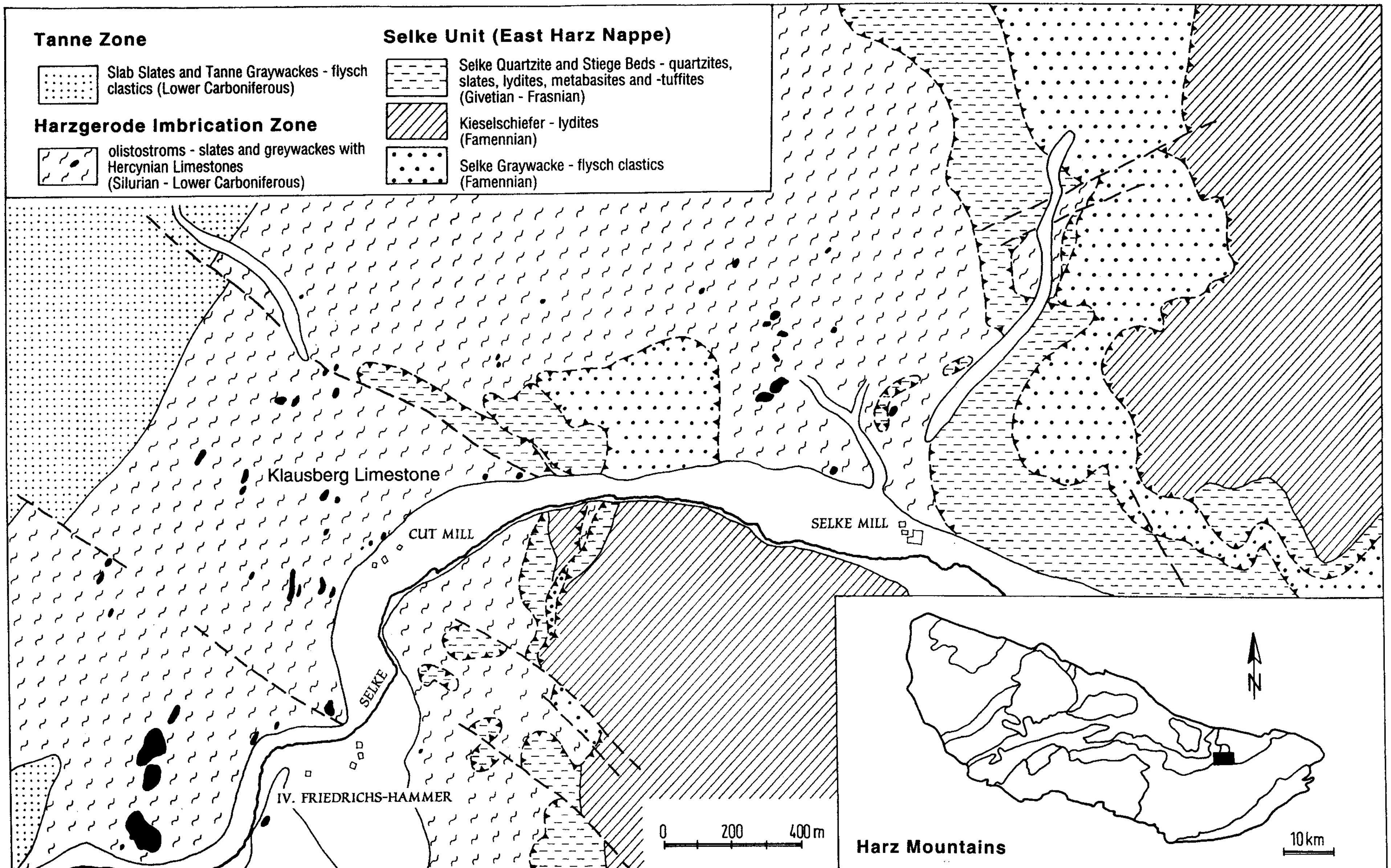

Figure 1. Geological sketch map of the northeastern Harzgerode Imbrication Zone between Tanne Zone and Selke Unit in the middle Selke Valley showing location of Klausberg Limestone Section. Inset map of Harz Mountains (central Germany) shows location of geological sketch map.

KURZFASSUNG. Conodonten und Fazies der unterdevonischen Herzynkalke vom Klausberg, Harz, Deutschland. Die devonischen Herzynkalke vom Klausberg treten wie andere Vorkommen der Harzgeröder Schuppenzone im Unterharz als isolierte, oft linsenförmige Körper auf. Tektonisch sind sie als Scherkörper oder Phacoide, eingeschlichtet in einer tonig-siltigen Matrix, zu beschreiben. Darüber hinaus werden sie von verschiedenen Autoren wenigstens teilweise als Olistolithe einer unterkabonischen Wildflyschserie interpretiert. Eine synoptische Profilrekonstruktion der Herzynkalkentwicklung erlaubt Aussagen zum Herkunftsgebiet, seiner dynamischen Entwicklung und somit zum Ausmaß einer wahrscheinlich gemachten olistostromalen Umlagerung. Die fazielle Entwicklung der Herzynkalke, die eine schrittweise Vertiefung ihres ursprünglichen Ablagerungsraumes während des Devons widerspiegelt, läßt sich gut mit Sedimentabfolgen vergleichen, die das Ertrinken (drowning) von Karbonatplattformen dokumentieren. Das unterdevonische Vorkommen vom Klausberg dokumentiert eine klastisch/karbonatische Abfolge der *inversus* und *inversus/laticostatus* Conodonten-Zonen. Einige Proben führen eine reiche *Polygnathus* Conodontenfauna. *Belodella*, *Drepanodus* und *Panderodus* treten in fast allen Proben auf. Die Profilabfolge aus Quarzsandsteinen, Crinoidenkalken, Dacryoconariden-Spariten und einer rhythmischen Wechselfolge bioklastischer Wackestones und Packstones werden als Ablagerungen eines terrigen beeinflußten Karbonatschelfes interpretiert. Die teils komponententeils matrixgestützten Gefügetypen lassen sich auf eine Akkumulation im Bereich der (Normal-)Wellenbasis zurückführen. Das vereinzelte Auftreten von problematischen Kalkalgen der Gattung *Uraloporella* und die Verbreitung chamositischer Onkoide liefern Hinweise auf eine flachmarine Sedimentation in einem wahrscheinlich euphotischen und küstennahen Milieu.

STICHWORTE: Devon, Emsium, Harz, Fazies, Karbonate, Chamosit, Conodonten, Olistostrom.

1. INTRODUCTION

The term 'Hercynian Limestones' has been applied in the Harz Mountains to a wide range of mostly grey and light grey carbonates of late Silurian to early Carboniferous age. They belong to the Bohemian-Hercynian magnafacies.

The usually thin accumulations of Hercynian Limestones contrast with the reef limestones of Elbingeröder Complex and Iberg. 'Flinz Limestones', another typical carbonatic facies of the Harz Mountains, are allodapic sediments which are distinguished from Hercynian Limestones by a high organic carbon content.

The facies development of Hercynian Limestones during the Devonian period was summarized by Ruchholz (1972) and Lütke (1978) as a general deepening upward trend. A cyclic sedimentation pattern was proposed by Ruchholz (1972) who distinguished an Older Hercyn (Early Emsian), a Younger Hercyn (Late Emsian to Givetian) and a Neo-Hercyn cycle (Frasnian to Famennian) in the Devonian System. Alberti (1994) termed lowermost Devonian Hercynian Limestones as Oldest Hercyn (Lochkovian to Pragian).

Early Emsian shallow-water carbonates (Princeps Limestone, Zorgensis Limestone) of neritic areas, in parts attributed to a high-energy environment on shoals, are overlaid by a thin sequence of Late Emsian and Eifelian subtidal muddy sediments (styliolinid limestones) characterized by bioturbated bioclastic wackestones of shallow water environments with open circulation. Rhythmically bedded Emsian limestones show transitions to clastic sediments. Givetian to lowermost Frasnian Hercynian Limestones are rare or sometimes substituted by extremely condensed phosphatic beds or omission surfaces possibly representing outer shelf or platform edge settings, which, in turn, are blanketed by often condensed Frasnian and Famennian pelagic limestones with numerous corrasion surfaces and hardgrounds. Frasnian styliolinid packstones and typically Upper Devonian cephalopod limestones occur as well. Exposed unconformities, neptunian dykes and cavity systems were described from Givetian and late Frasnian to Hembergian by some authors (Reichstein, 1962; Schriel & Stoppel, 1965; Hüneke, 1994).

2. GEOLOGICAL SETTING

Occurrences of Hercynian Limestones are usually lenslike bodies characterized by tectonic framework as imbricate structures or phacoides (Schwab, 1976; Koll, 1984; Wachendorf, 1986), which are intercalated between shales and shaly greywackes (Fig. 1). Limestone phacoids may reach some tens of metres in diameter but also occur as first-size bodies. Furthermore, lithological fabrics of corresponding shales in the surroundings of large limestone blocks and in the outer parts of these blocks themselves show evidence of mass flow transport. Detailed stratigraphic investigations (Reichstein, 1965) also showed chaotic stratification in the surrounding sediments. These are always

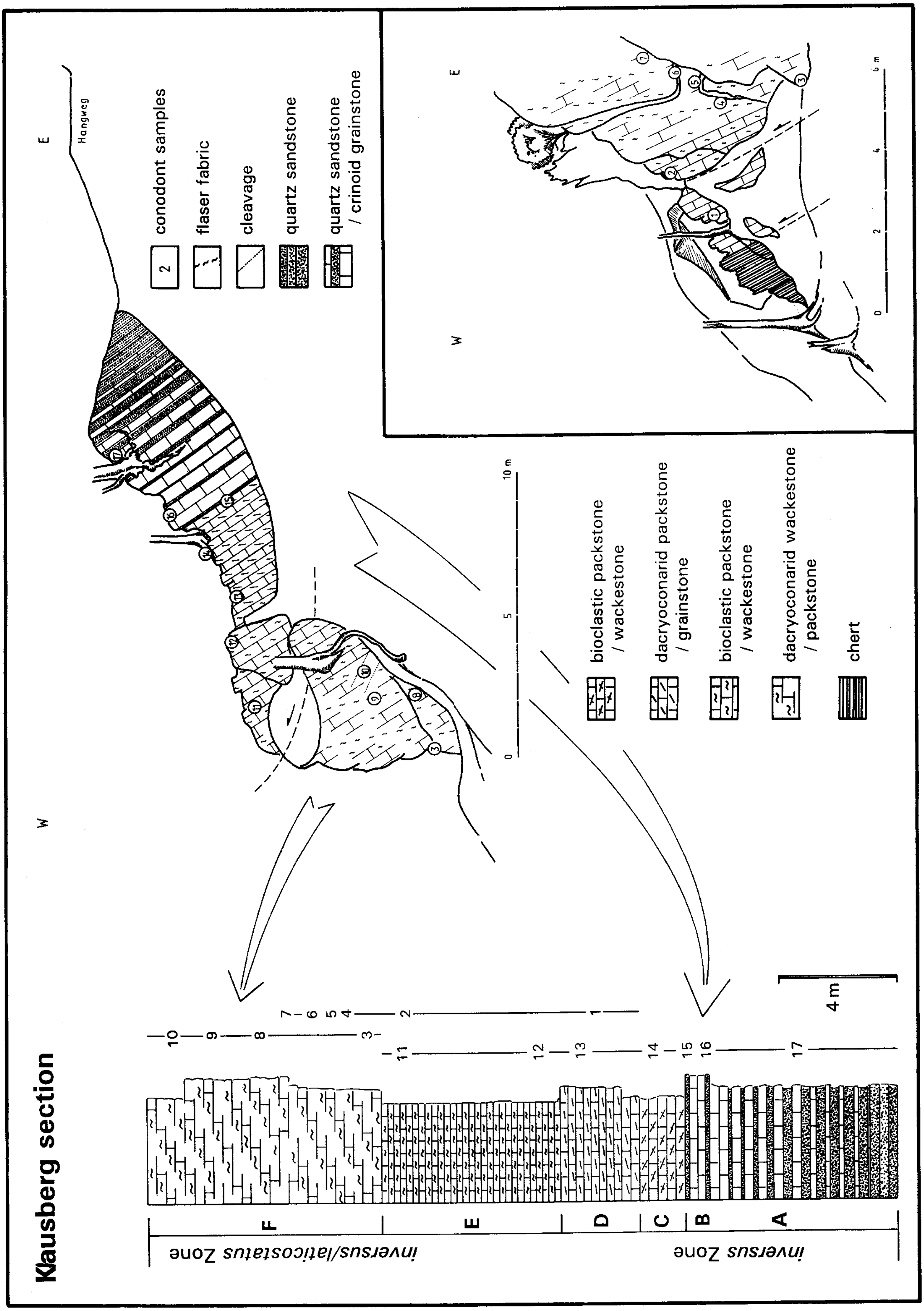

Figure 2. Stratigraphic and lithologic section as well as outcrop plan of the Klausberg profile. Notice that the upper part of the crag is overturned. Circeled numbers indicate positions of conodont samples.

Conodont sample	17	16	14	13	12	1	2	3	5	7	10
Weight dissolved (kg)	11	10	12	16	10	11	11	10	10	12	11
Yield (conodonts)	2	51	126	148	7	20	11	7	7	8	25
Po. dehiscens dehiscens juv.			?	?							
Po. gronbergi			1								
Po. catharinae			5	7							
Po. inversus			?								
Po. gronbergi → *laticostatus*				5	?	1					?
Po. laticostatus				1							
Po. vigierei				?							
Po. sp.										2	
Latericriodus sp.		1				1					2
Icriodus sp.		2		1						1	
Icriodus culicellus					?		2	1			
Icriodus aff. *werneri*					1						
Belodella devonica			3						3		2
Belodella resima		3	>10		2				1	2	4
Belodella triangularis	2	1	5		1	1		1			
Drepanodus sp.				6			1			2	1
Panderodus unicostatus		7			1						
Pan. steinhornensis sp.		4									1

Table 1. Conodont distribution and frequency in section of Klausberg (*Po.=Polygnathus, Pan.=Pandorinellina*). See also Fig. 2.

Devonian and Early Carboniferous sediments, in many cases flyschoid greywackes (Cyclostigma Beds). At many places in the Lower Harz Mountains, bodies of Hercynian Limestones are thus interpreted as olistolites which are embedded in a shaly matrix of olistostroms. One of the basic problems in the geology of the Harz Mountains, however, is the distribution of these allochthonous units and the scale of redeposition. Striking similarities between tectonic and sedimentary fabrics is one reason (Buchholz *et al.*, 1989).

In the parautochthonous concepts of Reichstein (1965), Stoppel (1977) or Lütke (1978, 1990), the occurrences of Hercynian Limestones were considered as resedimented masses derived from topographic heights not far from their final deposition. In most allochthonous explanations limestone blocks are olistolites within olistostroms derived from the Mid-German Rise (Lutzens, 1972; Schwab, 1976) which are connected with the general flysch sedimentation and the orogenetic development of Variscides. Up-to-date reviews of resedimentation in the Harz Mountains can be found in publications by Walliser & Aberti (1983), Buchholz *et al.* (1990) and Lutzens (1991).

3. THE KLAUSBERG SECTION

3.1. STRATIGRAPHY

The Hercynian Limestones at Klausberg were first described by Reichstein (1965), who assumed a Lower to Middle Devonian age for the rocks of the large cliff. The outcrop is exposed at the southwestern slope of hill Klausberg about 250 m to the north-west of the former Cutmill in the Selke Valley, located 3 km E of Mägdesprung (Fig. 1). Lithological profiling and conodont sampling were carried out along the large cliff beneath the slope way. Sampled conodont fauna is shown in Tab. 1. The conodont samples refer to the columnar section of Fig. 2.

The samples 1, 13 and 14 contain *Polygnathus catharinae* and phylogenetic transition forms from *Polygnathus gronbergi* to *Polygnathus laticostatus*. The common occurrence of the two taxa during the Late *gronbergi* Zone, the *inversus* Zone and the Early *inversus/laticostatus* Zone was described by Bultynck (1989) from La Grange Section in the Massif Armorican. Sample 13 from the middle part of the profile yields *Polygnathus laticostatus.* This species may point to an *inversus/laticostatus* Zone stratigraphic age. According to Klapper *et al.* (1978), the *inversus* Zone and the *laticostatus* Zone presumably represent a correlative time interval. In the La Grange Limestone, described by Bultynck (1989), *Polygnathus laticostatus* occurs later than *Polygnathus inversus.* This corresponds to the situation in Nevada (Klapper & Johnson, 1977) where *Polygnathus laticostatus* enters somewhat above the lower boundary of the *inversus* Zone.

Only from some of the conodont samples was it possible to collect a rich fauna with more than hundred conodonts. In these samples, taxa of *polygnathid* biofacies dominate. Conodonts of the genera *Latericriodus* or *Icriodus* occur much more frequently in the quartz sandstones on the base of the section. These elements, however, are not well preserved and difficult to identify. *Belodella*, *Drepanodus* and *Panderodus* are present in small numbers in most samples.

All geopetal fabrics are inversely oriented in the upper part of the Klausberg section starting with sample 11. This fact is critical with respect to the interpretation of the succession. Therefore, the Klausberg crag is affected by faulting. At least two imbricate structures can be distinguished. In both parts of the section dacryoconarid packstone facies (samples 1 and 13) and chamositic onkoid facies (samples 2 and 12 respectively 13) can be correlated. The upper wedge (Fig. 2, samples 11 to 17) rests in inverted order and represents the older stratigraphic part of the section. The lower wedge (samples 1 to 10) rests in the original order and continues the succession into younger beds. The biostratigraphic investigations correspond to this interpretation.

3.2. LITHOLOGY AND MICROFACIES

The reconstructed columnar section shows a maximum thickness of 25 m. Six subunits can be distinguished within the section: (A) lentiform-bedded quartz sandstones and crinoid limestones at the base, (B) a prominent crinoid bank, (C) thin- to medium-bedded limestones, (D) medium-bedded styliolinid limestones, (E) bedded limestones with flaser fabric, and (F) massive limestones with flaser fabric.

Within **subunit A** the succession starts with fine- and medium-sized quartz sandstones cemented by calcite cement. The bulk of clastic particles consists of edge-rounded quartz grains besides a low amount of feldspars (< 5 %). Step by step greater amounts of crinoid ossicles were embedded into quartzite sandstone, forming crinoidal grainstones in some patches. The microfacies of **subunit B** corresponds to crinoidal packstones with abundant crinoids. The size of skeletal grains is smaller than in subunit A. Crinoid ossicles are disarticulated and heavily bored. Two distinctive beds of fine-sized quartz sandstones on the lower and upper margins of subunit B finish the clastic sedimentation.

Beginning with **subunit C** the overlaying carbonatic sequence is characterized by a rhythmic layering of poorly washed biosparites to packed biomicrites (packstone layers) and sparse biomicrites (wackestone interlayers). A rhythmical alternation of grain-supported and mud-supported fabrics is obvious. The thickness of a typical bedding couplet varies between 25 and 70 mm. The two fabric types gradually merge into another without accretion pattern or erosional signs. Primary internal sedimentary lamination and graded bedding do not occur.

The microfacies of packstone layers is characterized by diverse fossil material of neritic biota, mainly benthos besides plankton and nekton. Shells of trilobites, brachiopods and bivalves are almost trachyostraceous and strongly sculptured. Trilobites are concentrated in layers. Rugose solitary corals usually sit upon larger fossil fragments in search of a solid ground. Echinoderms are disarticulated and heavily bored. The size and morphology of the borings argues against algal borings. Gastropods occur sporadically. Shells of planktonic and nektonic organisms such as cephalopods, dacryoconarids or tentaculitids are common too.

Typical of the wackestone interlayers is the predominance of these pelagic fossils. The amount of micrite is higher than in the packstone layers. Shelter pores filled with sparry calcite are common.

Subunit D is characterized by the predominance of dacryoconarids. The thin-skinned cones are randomly oriented and cemented by typical radial fibrous calcite (Kendall, 1985), forming dacryoconarid packstones and grainstones. Fragmentation of shells is nearly missing. Additional biotic elements are bivalves and crinoids.

The microfacies of **subunit E** is comparable to that of subunit C but solitary rugose corals are nearly missing. Packstone layers correspond to poorly washed oncolitic biosparites and packed biomicrites. Wackestone interlayers consist of sparse biomicrites. Subunit E is characterized by the common occurrence of chamosite oncoids and chamositic particles in the micritic groundmass. Typically, chamositic coatings are thick and complete around large carbonate grains, but are thinner and locally incomplete around smaller nuclei such as styliolinid shells. The irregular and usually non-concentric growth pattern of chamositic laminae corresponds to (micro-) oncoids of types C and R (cf. Flügel, 1982), but oolitic envelops also occur. The occurrence of calcareous algae is a rare but conspicuous biotic element. Longitudinal sections of segmented cylindrical thalli have been identified as *Uraloporella variabilis* (Pl. 2). Genera *Uraloporella* is usually classified as dasycladacean algae (Korde, 1950; Chuvashov & Riding, 1984) although there are affinities to foraminiferas (Riding & Jansa, 1976).

The rhythmic layering of packstones and wackestones continues within **subunit F** but the biofacies changes to more and more planktonic and nektonic faunal elements, even in packstone layers. Dacryoconarids and cephalopods dominate. In addition to that, the amount of micrite is higher. Layering is shown by the light-stained and dark-stained matrix which may be locally disturbed by bioturbation.

3.3. CHAMOSITIC ONCOIDS

The green clays of oncolitic envelops were investigated by electron microprobe analysis and x-ray powder diffraction. A high ferrous iron content of oncoids in conjunction with chlorite peaks on x-ray diffraction traces of acid-insoluble residues indicates that they partly consist of iron-rich chlorite, or chamosite in its broad sense. The 001 and 003 reflections are clearly smaller than the 002 and 004 ones.

It has been suggested that the recent verdine facies is a modern equivalent of fossile chamosites (Bhattacharyya, 1983; Odin & Gupta, 1988). In terms of general environment both facies are deposited in nearshore, shallow, tropical, marine waters. Gygi

(1981) concluded that chamositic ooids might well have formed at water depths of up to 100 m. A depth range of 20-60 m seems to be most favourable for the formation and preservation of the green clays specific to the verdine facies (Odin & Gupta, 1988), which is frequently replaced by the glaucony facies at greater depths. The presence of abundant iron is a prerequisite for the development of the characteristic green clays in chamosite and verdine facies. The relation between fluvial influxes and verdine deposits is well documented along the Atlantic coast of Africa (Odin & Gupta, 1988). In the tropical part of this coast, verdine deposits have been identified in the immediate vicinity of the mouths of most large rivers.

3.4. ENVIRONMENTAL INTERPRETATION

The paleoenvironment of Klausberg section limestones can be inferred from the fauna and sediment fabrics.

Crinoidal limestones were frequently described as an intermediate facies which occurs between shallow-water carbonates and cephalopod limestones. Wilson (1975) considered crinoidal limestones as a particular formation of standard microfacies (SMF) type 12. Because there is no evidence of allodapic sediment accumulation, the crinoidal limestones at the base of the section were interpreted as neritic sediment. The predominance of icriodid conodonts points to such an environment, too. The large amount of detrital quartz (50-10 %) indicates the proximity of land.

The **rhythmic layering** of bioclastic packstones and wackestones in higher parts of the section corresponds to SMF type 9 according to Wilson (1975) and Flügel (1972). Differences between facies types of subunits C, E and F result first of all from the composition of bioclastic particles. The accumulation rate seems to be relatively high, because the primary sediment layering was not disturbed and homogenized through bioturbation. Although the formation of chamosite indicates relative low accumulation rates for shallow marine areas (Odin & Gupta, 1988), the hemipelagic limestones at Klausberg do not represent a really condensed facies, like some of the Middle to Upper Devonian cephalopod and styliolinid limestone sections of Western Europe (Tucker, 1973), which are best developed on former submarine highs (swell facies). Sedimentary structures like hardgrounds, corrasional and corrosional surfaces, which would show abundant evidence of early lithification, are completely missing. The predominance of lime mud and the frequency of fine skeletal grains indicate a deposition of the sediment at or somewhat below the fair weather wave base. The rhythmic layering cannot be explained as a result of gravitational sedimentation. Lithologic signs of tempestitic or turbiditic sediment accumulation are missing.

The bioaccumulations of packstone layers with a low content of lime mud (grain-supported fabrics) and a multifarious fauna of benthic biota as well as plankton and nekton can be interpreted as formations of recurrent high hydraulic energy events, possibly caused by frequent storms affecting the sea bottom. More precise limits can be placed upon the limestones, as the chamositic oncoids frequently occur suggesting depths less than 100 m and nearshore marine waters of tropical areas (see 3.3). The (par-)autochthonous character of benthic biota is shown by solitary rugose corals resting in growth position on larger mollusc shells. Therefore, the occurrence of *Uraloporella* most probably shows a sedimentation within the euphotic zone. Typical settings from which *Uraloporella* was described are shallow platform areas, often with restricted circulation (Riding & Jansa, 1974; Riding, 1979). The dominantly pelagic fauna of wackestone layers indicate deposition at depths greater than a few tens of metres, at the base or below the euphotic zone of prolific carbonate production.

The joint occurrence of chamosite and questionable calcareous algae within a carbonatic facies sequence belonging mostly to SMF type 9 according to Wilson (1975) and Flügel (1972) points to an assignment of the Klausberg section to facies belt 7 according to Wilson (1975), which means a shelf lagoon with open circulation but probably in coastal areas. In the Upper Devonian of southern Marocco, cephalopod limestones deposited on platforms are apparently interbedded with birdseye limestones containing tepee structures and vadose diagenetic fabrics, suggesting quite shallow depths of deposition for the pelagic facies (Wendt *et al.*, 1984). Heckel (1973) has described styliolinid-rich bioclastic carbonates sometimes bearing chamositic ooids from the Devonian in New York and Pennsylvania and interpreted the appearance of these Tully Limestones within the detrital regimen of the Catskill Delta as being caused by a more rapidly subsiding basin in front of the clastic influx which served as a clastic trap that caught most of the terrigenous sediments of eastern derivation. Like carbonate sequence at Klausberg, chamosite facies occur between sandy crinoidal limestones and bioclastic wackestones along the delta front.

The dacryoconarid sparites of **subunit D** were deposited in a marine environment, but the extreme reduction in faunal diversity suggests some sort of restriction. They are comparable with SMF type 12 according to Wilson (1975) and Flügel (1972). Only

Styliolina and *Nowakia* shells form bioclastic particles. In principle, this may be caused by sorting or by some kind of environment restriction. Of course, the monomict particle spectrum permits an interpretation of sorting. But the grain-supported fabric and the low amount of lime mud indicates high hydraulic energy during sedimentation. The stratigraphic position of the dacryoconarid sparites between the chamositic bioaccumulations of subunits C and E points to deposition at depths less than 150 m.

In the Frasnian of eastern Anti-Atlas styliolinid 'sand' bodies occur towards the platform margins. These styliolinid microcoquinas may exhibit cross-bedding and preferred parallel orientation as well as common fitting of the shells into each other (Wendt *et al.*, 1984; Wendt & Belka, 1991) suggesting sedimentation on a current-swept shallow pelagic platform. The diagenesis of styliolinid microcoquinas within the Givetian and Frasnian parts of the Cephalopodenkalk sequences in the Rhenish Slate Mountains and Harz Mountains was described by Tucker & Kendall (1973) and Kendall (1985). The styliolinid-rich layers were interpreted as having been lithified on the sea-floor, at a depth probably not exceeding a few 100 m.

4. DISCUSSION

The Emsian carbonate succession at Klausberg is the result of a general deepening upward of a shallow platform area. *Inversus* Zone quartz sandstones and crinoidal grainstones attributed to a neritic terrigenous carbonate shelf facies are overlaid by a rhythmic sequence of *inversus/ laticostatus* Zone chamositic carbonates. The sharp lithological transition from subunit B to C in connection with the invasion of 'pelagic' organisms points to a sudden sea level rise. The following rhythmic sequence of hemipelagic carbonates shows a further but gradual deepening which is documented by a continuous increase of matrix as well as planktonic and nektonic biota.

With the help of isolated occurrences of Hercynian Limestone phacoids it is possible to reconstruct the Devonian carbonatic succession. A synoptic Hercynian Limestone sequence allows conclusions on the dynamic history of their primary depositional area and their probable position within the Rhenohercynian Zone. The Devonian facial trend of Hercynian limestones which reflects a stepwise deepening of their primary depositional area (Ruchholz, 1964) is well comparable with sedimentary sequences documenting the drowning of carbonate platforms (Hüneke, 1994). The Klausberg section appears to set an example of incipient drowning during Emsian time, which shows sedimentation in an shallow water environment at or below wave base under invasion of pelagic biota, and which is caused by stretching and subsidence of the rhenohercynian lithosphere. The joint occurrence of chamositic clays indicates the onset of low accumulation rates, which are most typical of Middle and Upper Devonian sections. As with recent verdine facies, changing currents affecting the sea bottom may have caused the formation and preservation of chamosite. As noted by Franke & Walliser (1983), the term 'pelagic' as used for these limestones is not necessarily related to great water depths, but only implies deposition in any environment below the local wavebase and without clastic input.

5. SYSTEMATIC PALAEONTOLOGY

Incertae Algae
(Dasycladaceen ?)

Genus *Uraloporella* Korde, 1950

*1950 *Uraloporella* n. gen. - Korde, p. 570.
1965 *Uraloporella* Korde. - Rácz, p. 101.
1972 *Kamaena* Antropov. - Petryk & Mamet, p. 777, pars.
1974 *Uraloporella* Korde. - Riding & Jansa, p. 1419.

Uraloporella variabilis Korde, 1950.
(Pl. 2: B & C)

*1950 *Uraloporella variabilis* n. sp. - Korde, p. 570, Text-figs. 3, 4.
1972 *Kamaena sp.* Antropov. - Petryk & Mamet, p. 777, Pl. 3: 10.
1974 *Uraloporella variabilis* Korde. - Riding & Jansa, p. 1421, Pl. 1: 1.

Description. The Klausberg material contains small septate cylindrical skeletons. It shows no branching. Tubes are straight to gently curved and up to 3 mm in length. The external tube diameter is 200-250 µm and the wall thickness 70-90 µm. Septa are straight and regularly spaced at distances nearly equal to the tube diameter. The wall microstructure is speckled, sometimes showing a radially fibrous structure.
Occurrence. The Hercynian Limestones from which *Uraloporella* is reported are shallow subtidal sediments. They are present in packstones and wackestones containing dacryoconarids, bivalves, brachiopods, trilobites and rugose solitary corals. A chamositic oncolite microfacies is characteristic. The section spans the *inversus* and *inversus/laticostatus* Conodont-Zones (Emsian, Lower Devonian).

•*Conodonta*

Genus *Polygnathus* Hinde, 1879

Polygnathus dehiscens dehiscens Philip & Jackson, 1967
(Pl. 3: 1)

*1967 *Polygnathus linguiformis dehiscens* n. subsp. - Philip & Jackson, p. 1265, Text-figs. 2i-k, 3a.
*1987 *Polygnathus dehiscens dehiscens* Philip & Jackson, 1967 - Mawson, pp. 270-272, Pl. 32, Figs. 3-5, ? Figs. 6-10, Pl. 36, Fig. 6.

Remarks. In the Klausberg material small, juvenile *Polygnathus* specimens occur which are characterized by a large basal cavity reaching the posterior end of the platform. Larger, adult specimens are absent. Mawson (1987) distinguished two subspecies on the basis of the profile of the basal cavity. In specimens here assigned to *Polygnathus dehiscens dehiscens* the cavity is in form of a shallow trough at posterior end.

Polygnathus catharinae Bultynck, 1987
(Pl. 3: 8, 10 & ?9)

*1987 *Polygnathus catharinae* n. sp. - Bultynck, p. 183, Pl. 2, Figs. 1-12.

Remarks. Specimens from the Klausberg Section assigned to *Polygnathus catharinae* clearly show the characteristics of the Pa elements of the *Polygnathus mashkovae - Polygnathus catharinae - Polygnathus virgierei/Polygnathus apekinae?* branch as proposed by Bultynck (1987). They have a strongly asymmetric anterior and middle platform because of the more or less angular expansion of the outer platform in its posterior two-thirds. The platform is narrow, strongly constricted and with deep, but narrow adcarinal troughs in its anterior third. The tongue with pointed posterior end bears slightly interrupted transversal ridges. The medium-sized basal cavity is situated anterior of the sharp inward deflection of the platform and is inverted from the beginning of the inward deflection of the posterior platform onwards.

6. ACKNOWLEDGEMENTS

The work was carried out at the Institute of Geology and Paleontology (Fachbereich Geowissenschaften), University Greifswald. Many thanks to Dr. P. Adolphi and Dr. J. Kasbohm for their help in investigating the green clays by electron microprobe analysis and x-ray powder diffraction. Dr. D. Weyer (Magdeburg) determined some of the rugose corals. His counsel and inspiration is gratefully acknowledged. The authors wish to thank Prof. A. Preat (Brussels) and Prof. P. Bultynck (Brussels) for their critical but constructive reviews of the paper. We are grateful to Dr. M. Buckow (Greifswald) for correcting the english manuscript.

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Manuscrit reçu le 25/10/1994; accepté le 15/02/1995.

PLATE 1

Lower Devonian (Emsian) Hercynian Limestones of the Klausberg Section in the Lower Harz Mountains, Germany.

Bedding couplet of poorly washed biosparites and packed biomicrites illustrating the rhythmic layering of subunit F. Bedding runs oblique to the lower right. Densely packed dacryoconarid shells are most frequent. Within packstone layers chamositic oncoids (white envelops in picture) frequently occur. Sample K 3, thin section, negative print.

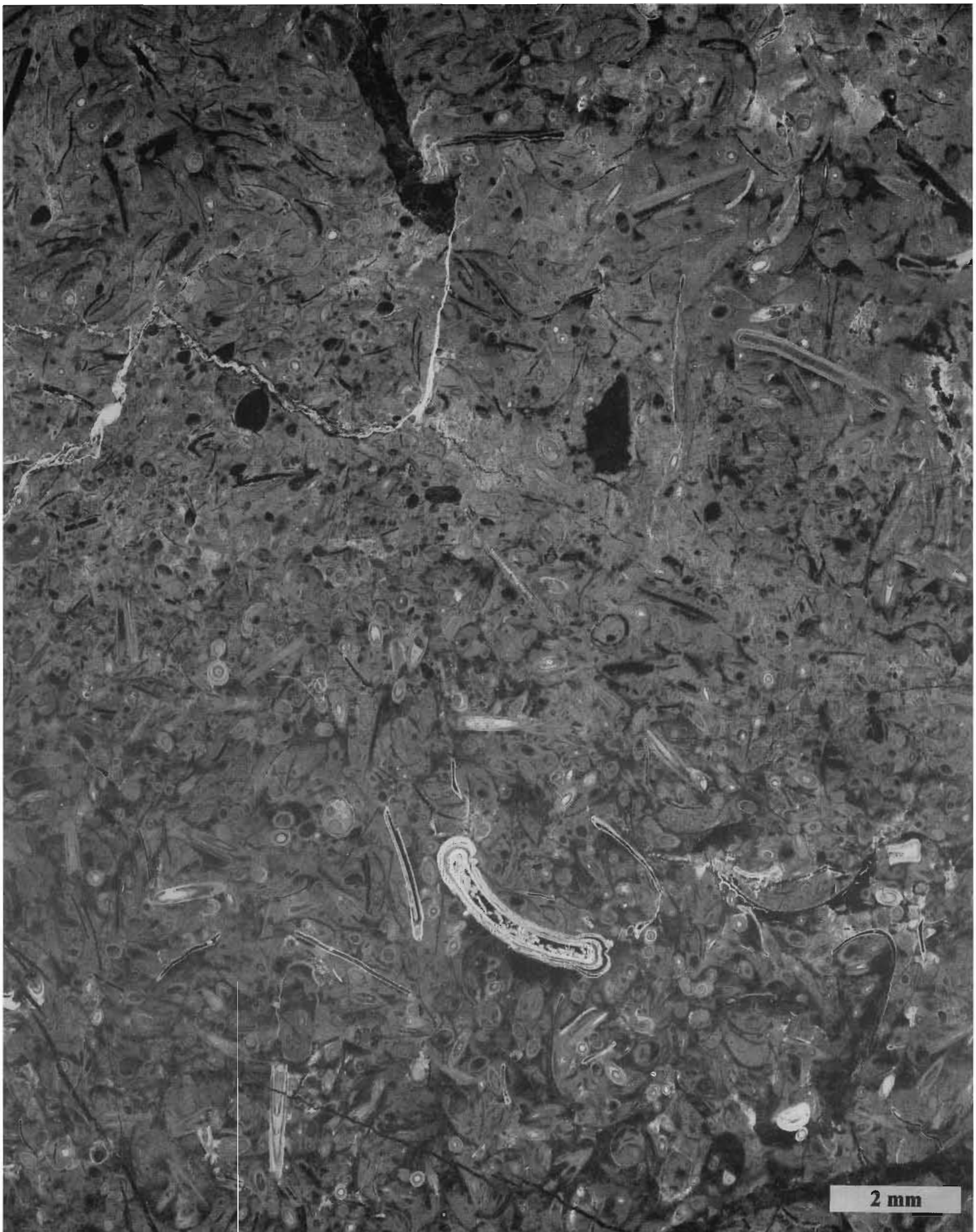
2 mm

PLATE 2

Lower Devonian (Emsian) Hercynian Limestones of the Klausberg Section in the Lower Harz Mountains, Germany. Scale is 1 mm for all figures.

Figure A. Longitudinal section of *Uraloporella* Korde (1950), an incertae dasycladacean algae. Sample K 3, thin section.

Figure B. Specimen of *Uraloporella* from Fig. A. under crossed nicols illustrating chambering of the septate cylindrical tube. Sample K 3, thin section, X nic..

Figure C. Microproblematicum, which is encrusted by chamositic clay (arrow). Sample K 14, thin section.

Figure D. Dacryoconarid wackestone with a broken (top) and a whole (right) chamositic oncoid around a micritic lithoclast. Sample K 11, thin section.

Figure E. Cross section of two cone-in-cone arranged *Styliolina* shells which are overgrown by early marine cements and encrusted by green chamositic clay (arrow). Sample K 2, thin section.

Figure F. Oncolitic laminae around a pseudosparitic recrystallized mollusc shell fragment. Micritic borings are preserved. Sample K 3, thin section.

Figure G. Quartziferous trilobite wackestone with chamositic encrustations (arrow) around some shells. Sample K 14, thin section.

Figure H. Quartziferous crinoid grainstone. Sample K 16, thin section

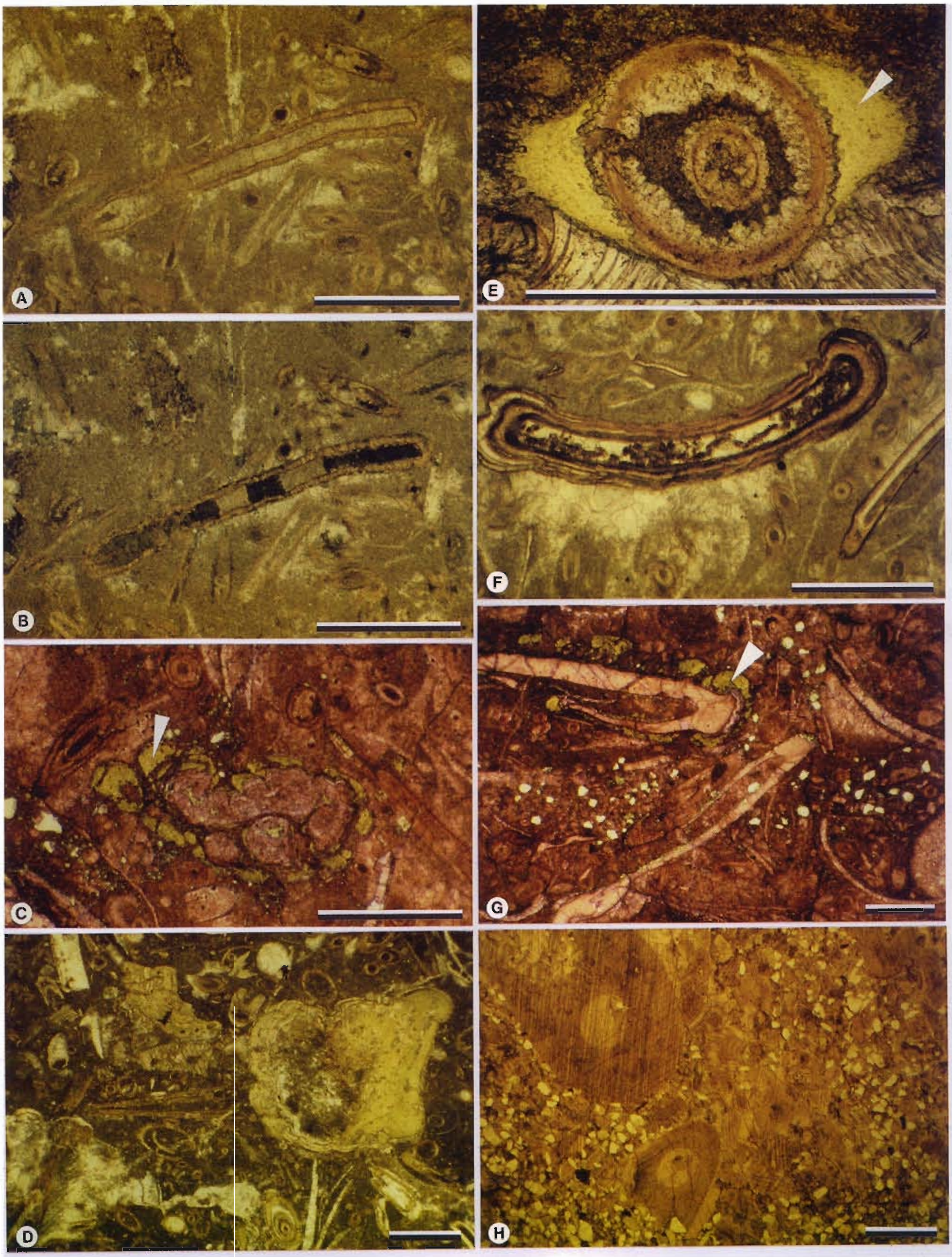
A
B
C
D
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PLATE 3

Lower Devonian (Emsian) Conodonts of the Klausberg Section.

Figure 1. *Polygnathus dehiscens dehiscens* juv. Philip & Jackson, 1967; sample K 12 [0640], x 200.

Figure 2. *Polygnathus gronbergi* Klapper & Johnson, 1975; sample K 13 [0634], x 125.

Figure 3. *olygnathus gronbergi* Klapper & Johnson, 1975 *Polygnathus laticostatus* Klapper & Johnson, 1975; sample K 13 [0631], x 125.

Figure 4. *Polygnathus inversus* Klapper & Johnson, 1975; sample K 13, a: upper view [0615], b: lower view [0809947], x 100.

Figure 5. *Polygnathus laticostatus* Klapper & Johnson, 1975; sample K 13, a: lower view [0620], b: upper view [0809945], x 100.

Figure 6. *Polygnathus gronbergi* Klapper & Johnson, 1975 CARSPECIAUX 174 \f „Symbol" *Polygnathus laticostatus* Klapper & Johnson, 1975; sample K 13, a: upper view [0809948], b: lower view [0632], x 100

Figure 7. *Polygnathus laticostatus* Klapper & Johnson, 1975; sample K 1 [0648], x 150.

Figure 8. *Polygnathus catharinae* Bultynck, 1989; sample K 14 [08099413], x 100.

Figure 9. *Polygnathus* aff. *Poly.* catharinae Bultynck, 1989; sample K 14 [08099415], x 140.

Figure 10. *Polygnathus catharinae* Bultynck, 1989; sample K 14 [08099412], x 150.

Figure 11. *Polygnathus laticostatus* Klapper & Johnson, 1975; sample K 13, a: upper view [0648], b: lower view [0809946], x 125.


1
2
3
a 4 b
a 5 b
a 6 b
7
8
9
10
a 11 b