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[1] **There are some new indications that this taxon has a longer range and may well reach the (?Middle) Norian.**

Abstrakt

Nové výskumy v tisovskom lome, teda na typovej lokalite rovnomenných tisovských vápencov, považovaných za karnské, priniesli prekvapujúci poznatok o ich spodno- a stredno-norickom veku. Dostatočne to preukazuje fauna konodontov a amonitov.

Z litologického hľadiska je možné v lome odkryté vápence zaradiť do dvoch hlavných faciálnych zón: k svahovej fácii a k rífovému vývoju v širšom zmysle.

Z litologického ako aj stratigrafického hľadiska v tisovskom lome odkryté masívne norické vápence zodpovedajú východoalpskému dachsteinskému vápencu a v dôsledku toho by sa tak mali aj nazývať (obr. 6). Označenie „tisovský" vápenec by sa teda na označovanie takýchto vápencov nemalo používať.

Z toho dôvodu je na označenie skutočných vrchnokarnských riasových vápencov, ktoré boli dosiaľ v literatúre týkajúcej sa vápencových Álp označované ako „tisovské", potrebné zaviesť nové pomenovanie. Navrhuje sa pre ne pomenovanie waxenecké vápence (Waxeneck-Kalk) (typový profil Kleines Waxeneck, mürzalpský príkrov, obr. 2).

Zusammenfassung

Die Bearbeitung des Steinbruches in Tisovec, der Typuslokalität des gleichnamigen, für karnisch gehaltenen Kalkes, erbrachte das überraschende Ergebnis eines norischen Alters. Dieses ist durch Conodonten und Ammoniten hinreichend abgesichert.

In lithologischer Hinsicht können die im Steinbruch aufgeschlossenen Gesteine zwei Hauptfaziesbereichen zugeordnet werden: einer Slope-Fazies und einer Riffentwicklung im weitesten Sinne.

In lithologischer wie auch in stratigraphischer Hinsicht entsprechen die im Steinbruch Tisovec aufgeschlossenen massigen norischen Kalke vollkommen dem ostalpinen Dachsteinkalk und sind folglich auch so zu benennen (Abb. 6). Die Bezeichnung „Tisovec-Kalk" ist dagegen einzuziehen.

Aus diesem Grund war eine Neubenennung jener echten oberkarnischen Algenkalke nötig, die bisher in der Literatur über die Kalkalpen unter der Bezeichnung „Tisovec-Kalk" geführt wurden. Für sie wird die Bezeichnung Waxeneck-Kalk (Typusprofil Kleines Waxeneck, Mürzalpendecke, Abb.2) vorgeschlagen.

COMPARATIVE STUDY OF WETTERSTEIN CARBONATE PLATFORMS OF THE EASTERNMOST NORTHERN CALCAREOUS ALPS AND WEST CARPATHIAN MOUNTAINS: PRELIMINARY RESULTS

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Introduction

Most of the fieldwork on which this paper is based was carried out in the frame of the respective Austrian and Slovak regional mapping programmes. Field mapping is still in progress and detailed paleontological work will be a future task. The calcisponges collected so far in the Austrian working area (leg. LOBITZER) at present are under study by colleagues from Erlangen University. The comparatively scarce and often poorly preserved coral fauna will be evaluated by Mrs. Doc. E. Roniewicz, Warsaw. Therefore, in order not to confuse the literature by inadequate fossil determinations, we do not refer to our preliminary determinations in the frame of this paper.

We also have to state that all the poor English in this paper is in the responsibility of the Austrian/Slovak authors, Sal Mazzullo did not forget his mother language!

For the sake of brevity, in the remainder of this paper we often refer to the Anisian to Cordevolian sequence as "Middle Triassic". In the study area, Middle Triassic rocks include diverse lithologic types, each with a distinct faunal assemblage.

Wetterstein carbonate platforms of the easternmost Northern Calcareous Alps

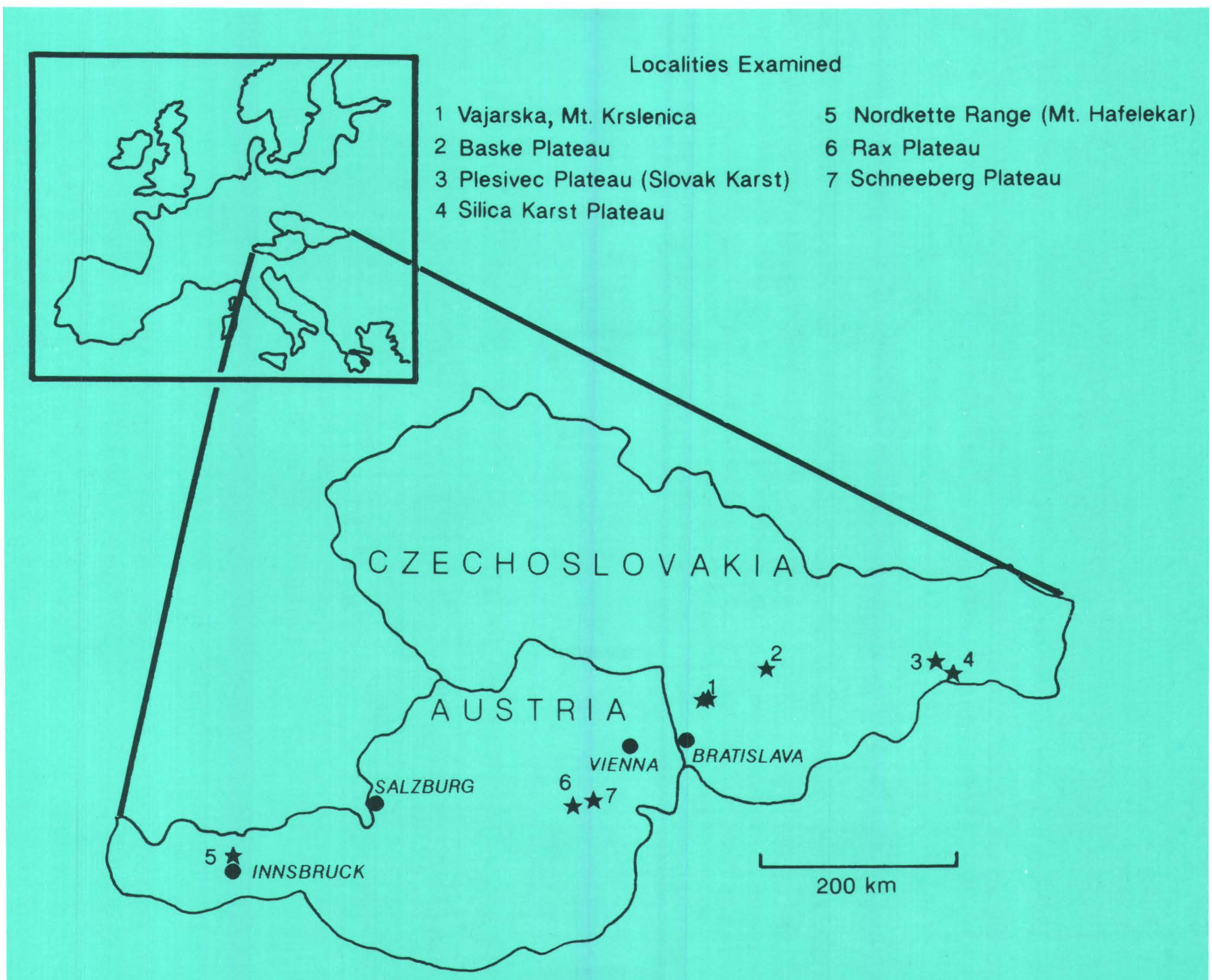
Published data on the facies distribution in the Wetterstein Limestone of the easternmost Northern Calcareous Alps are scarce and the only documentation so far is the unpublished map in the PhD-Thesis by LOBITZER (1971), followed by several short accounts by LOBITZER (1972—1988) and MANDL (1985—1987). In the following paragraphs we shortly summarize the results of our field investigations concerning Wetterstein Limestone in the Schneeberg nappe.

Details on the biota and their communities will be worked out in a joint effort with colleagues from Erlangen University (particularly the calcisponges) in cooperation with experts from various other institutions.

The Schneeberg nappe as part of the Higher Alpine Nappe System provides excellent exposures both on larger karst plateaus (Rax and Schneeberg) and in scattered smaller exposures, isolated either by tectonics or erosion, which stretch eastward towards the easternmost margins of the Northern Calcareous Alps (Figs. 2,3). Equivalents of the Schneeberg nappe have been cored also in the subsurface of the Vienna Basin (e.g. Tattendorf drill hole with Wetterstein reef-facies) by ÖMV AG.

The Rax Plateau provides excellent exposures of a prograding carbonate platform over slope sediments. In the southwest an extensive platform edge reef (the Heukuppe-Predigtstuhl reef complex) interfingers in its lower parts towards the south with upper slope limestones and towards the northeast with near-reef lagoonal, in part peritidal, limestones. The slope sediments (Plate 1, Figs. 6,8,9; Plate 2, Figs. 1,2,6) comprise various allodapic limestones and variegated micrites, often with pronounced deeper water biota, including ammonites, conodonts, „filaments" and radiolarians. The „reef-belt" clearly stretches from the uppermost slope to a considerable distance into the platform. In the field the intensive cementation by radiaxial fibrous calcite, often of grossolithic character, is most conspicuous. Larger biota are rather scarce and maximum in the decimeter size range. A variety of calcisponges (inozoans and sphinctozoans), *Tubiphytes* and more scarcely corals predominante. Brachiopods are the most important reef-dwellers. Small lenses of pinkish micritic limestone of Hallstatt-type, occasionally with „zebra"-neptunian dykes or stromatactis-shaped fabrics occur within the reef. They clearly show deeper-water biota (Plate 2, Figs. 3,4,5) and also contain stratigraphically valuable conodonts and foraminifera (LOBITZER 1986, LOBITZER et al. 1988). Towards the north, or northeast, the reef belt interfingers either with grainstones or with birdseye limestones, both of them contain the characteristic dasycladacean alga *Teutloporella herculea* and very often abundant solenoporaceans and/or porostromate algae. In a transitional zone „mixed" biota, such as *Teutloporella*, solenoporaceans/porostromate algae and sphinctozoans and/or corals may occur together. Patchy dolomitization affects as well the reef and also the lagoonal sediments.

Fig. 1. Situation map of studied exposures



Location map of Wetterstein carbonate platforms and coeval basin deposits in the eastern part of the Northern Calcareous Alps, Austria. Compiled from AMPFERER & SPENGLER 1931, CORNELIUS 1936, 1951, PLÖCHINGER 1982, TOLLMANN 1976, WESSELY 1983, FUCHS 1984 and own mapping (MANDL 1983 - 1986 unpubl.).

Northern Calcareous Alps:

- Cretaceous
- mainly Triassic, local Jurassic
- Wetterstein dolomite
- Wetterstein limestone
- H Hallstatt limestones
- Reifling Formation

(Wetterstein dolomite to Reifling Formation: Lower Carnian to Upper Anisian)

- Main nappe boundaries
- LF Lunz/Frankenfels nappe system
- R Reisalpen nappe
- U Unterberg nappe
- G Göller nappe
- HW Hohe Wand / Mürzalpen nappe
- S Schneeberg nappe

Fig.

Towards the east, respectively northeast the plateaus of the Schneeberg and Gahns (Fig. 3) show again a complex patchwork of various carbonate platform sediments which are very similar to the Rax plateau. The reefs interfinger in their lower parts with various slope sediments (MANDL 1987, LOBITZER 1986). One gets the impression, that deeper water steep fjord-like channels cut into the carbonate platforms.

Also further towards the east (Fig. 3) Wetterstein Limestone in reef-facies (Schacherberg, Asandberg, Kehr) and lagoonal environments (Hinterberg, Dürrenberg, Talberg, Kienberg) are well exposed as documented by LOBITZER 1986; LOBITZER-PIROS 1987; MANDL 1985, 1986).

Many excellent papers on the Wetterstein depositional system of the western Northern Calcareous Alps have been published, among them BRANDNER-RESCH (1981), DONOFRIO et al. (1979), FLÜGEL (1982), GERMANN (1960,1971), HENRICH (1982), OTT (1967,1973), SARNTHEIN (1965,1967), SCHNEIDER (1964), TOSCHEK (1968), and WOLFF (1973).

Wetterstein carbonate platforms (WCP) of the Inner West Carpathians (IWC)

The WCP are the most widespread in the eastern part of the IWC (Fig. 6), less in the western part (Fig. 5) and relatively scarce are in the central portion of the IWC (not illustrated). This is due to the fact that WCP are mainly bind with Silicic (before „Gemeric") tectonic unit which is preserved mainly in these two areas. In the middle part of the IWC the Silicic unit is present only in small overliers, but encroaching of the WCP into tectonic and paleogeographic area of Hronic (the Choč nappe) is of interest.

In the western part of IWC however still remains the problem if WCP are really part of higher nappes of Silicic, or presence of WCP is due to facial change of Hronic (the Choč nappe) in westward direction.

WCP of the western part of IWC (Fig. 5)

If we push aside occurrences of Wetterstein limestones in deep drillings of Vienna basin, the nearest outcrops of WCP to Northern Calcareous Alps (NCA) in IWC are in White Hills of Malé Karpaty Mts. between Vajarská and Trstín (Fig. 5, Fig. 8) and in neighbouring Brezovské Karpaty Mts. (the Veterling, Havranica and Jablonica nappes).

Structural correlation with NCA is rather controversial, because distinguished tectonic units (the Choč and higher nappes) are older than Gosau sediments, while in NCA tectonic units are upper Jurassic to Paleogene in age.

On the other hand, there are no problems in facial and lithostratigraphic correlation - it is a direct continuation and prolongation of facial zones from NCA with analogical sequences in the underlier and overlier.

Further to the North rests of WCP are preserved in Čachtické Karpaty Mts. and Strážovská hornatina Mts. in higher nappes (Nedzov and Strážov nappe) with interference to the Choč nappe (into Bebrava Group of M. Mahel' 1979a).

Wetterstein carbonate platforms are here mostly of prograding (regressive) type - they are growing towards the basins over basinal sediments. These are mostly represented by the Reifling, less by the Schreyeralm limestones. Higher up slope facies of the Raming limestones, often with turbidites, forereef breccias, limestones of reef barrier follow and the cycle is terminated with back-reef and lagoonal facies, often dolomitized.

More detailed data about individual Wetterstein carbonate platforms of this region may be found mainly in the works by M. Mahel' (1979a, 1979), J. Bystrický (1972, 1973, 1982), J. Bystrický — M. Mahel' (1970), J. Michalík (1984), J. Hanáček (1976), G. Kolosvary (1958—1967), E. Jablonský (1973), M. Peržel (1966), S. Buček (1988), P. Masaryk (in press) and J. Salaj et al. (1987).

For more detailed illustration of the Wetterstein limestone facies two areas have been chosen: Baske reef complex S of Omšenie in Strážovská hornatina Mts. (Fig. 7) and Veterlin and Havranica nappes in Malé Karpaty Mts. (Fig. 8).

Mt. Baske is rest of a huge reef area: back-reef and lagoonal parts of complex are scattered amidst dolomites. In Veterlín nappe almost exclusively reefal limestones and fore-reef breccias (demonstrated kindly by J. Michalík) are represented, for Havranica nappe lagoonal Wetterstein limestones are typical (J. Bystrický 1973, S. Buček 1988).

Wetterstein carbonate platforms in the inner part of the West Carpathians, eastern Slovakia (Fig. 6).

In this region Wetterstein limestones form widespread karst plateaus of Slovak Karst, Muráň plateau and Stratenská hornatina Mts. The most detailed data on facies distribution of Wetterstein carbonate platforms are available from the Slovak Karst (J. Bystrický 1964, 1972, J. Mello 1974, 1975a, 1975b, 1975b, 1977, Ľ. Gaál 1982, E. Jablonský 1973a, 1973b, 1973c, M. Kochanová-J. Mello-M. Siblík 1975). On Muráň plateau mainly dasycladacean zones of back-reef and lagoonal area were studied (J. Bystrický 1986). In Stratenská hornatina Mts. both reefal (Veľký Sokol, Geravy) and lagoonal (Pelc, Glac) facies of Wetterstein limestones are richly represented, but they have not been studied in detail until now.

For illustration of facial relations of this region WCP of Silica nappe on Zádiel and Jasov karst plateau (of Slovak karst) have been chosen (Fig. 9). WCP is cut here in two partial units which are dipping slightly to the south. Basinal facies are represented on the northern side by Nádaska and Reifling limestones. Reefs are concentrated also near to the northern margin of the plateaus (in the overlier of the basinal facies) in both subunits. Back-reef and lagoonal facies are developed in overlying parts of reef (with some patch-reefs) southwards.

Middle Triassic depositional system in the area studied

Sedimentary facies

Four principal depositional facies units are recognized in platform carbonates of the Wetterstein Limestone: (1) peritidal, (2) lagoonal, (3) reef, and (4) associated grossoolite-breccia facies. Distal-slope and basin deposits comprise fore-platform facies.

Accordingly, a brief treatment of Middle Triassic facies is presented herein as background for the sections on depositional systems and diagenesis that follow.

Peritidal facies. This facies includes rocks deposited in intertidal and supratidal environments.

Syndepositional marine cements are characteristic features of these rocks. Evidence of periodic hypersalinity and locally, subaerial exposure, during the deposition of these beds is indicated in several outcrop sections, particularly in central and western Austria (BRANDNER & RESCH 1981). Similar facies are known in Tethyan Upper Triassic (i.e., LOBITZER 1974) as well as Permian rocks in the Guadalupe Mountains of New Mexico-Texas (MAZZULLO & HEDRICK 1985), the United Kingdom (SMITH 1981; HARWOOD 1986; KALDI 1986) and Southern Alps (NOE 1987).

Lagoonal facies. Rocks of this facies are generally massive bedded, locally bioturbated and partly dolomitic limestones with a diverse biota of various dasycladacean (prominently including the genus Teutloporella), solenoporacean and codiacean algae, molluscs, echinoderms, sponges, corals, brachiopods, bryozoans, foraminifera and ostracods. Textures vary from wackestone to grainstone, the latter lithology being particularly abundant in transitional zones between lagoonal and reef facies (the „reefflat calcarenite" facies of BRANDNER & RESCH 1981). Patch reefs up to approximately one cubicmeter in size occur very

Facies distribution within the Wetterstein limestone of Schneeberg nappe. Compiled after CORNELIUS 1936, 1951
LOBITZER 1971 - 1988, MANDL 1984 - 1987.

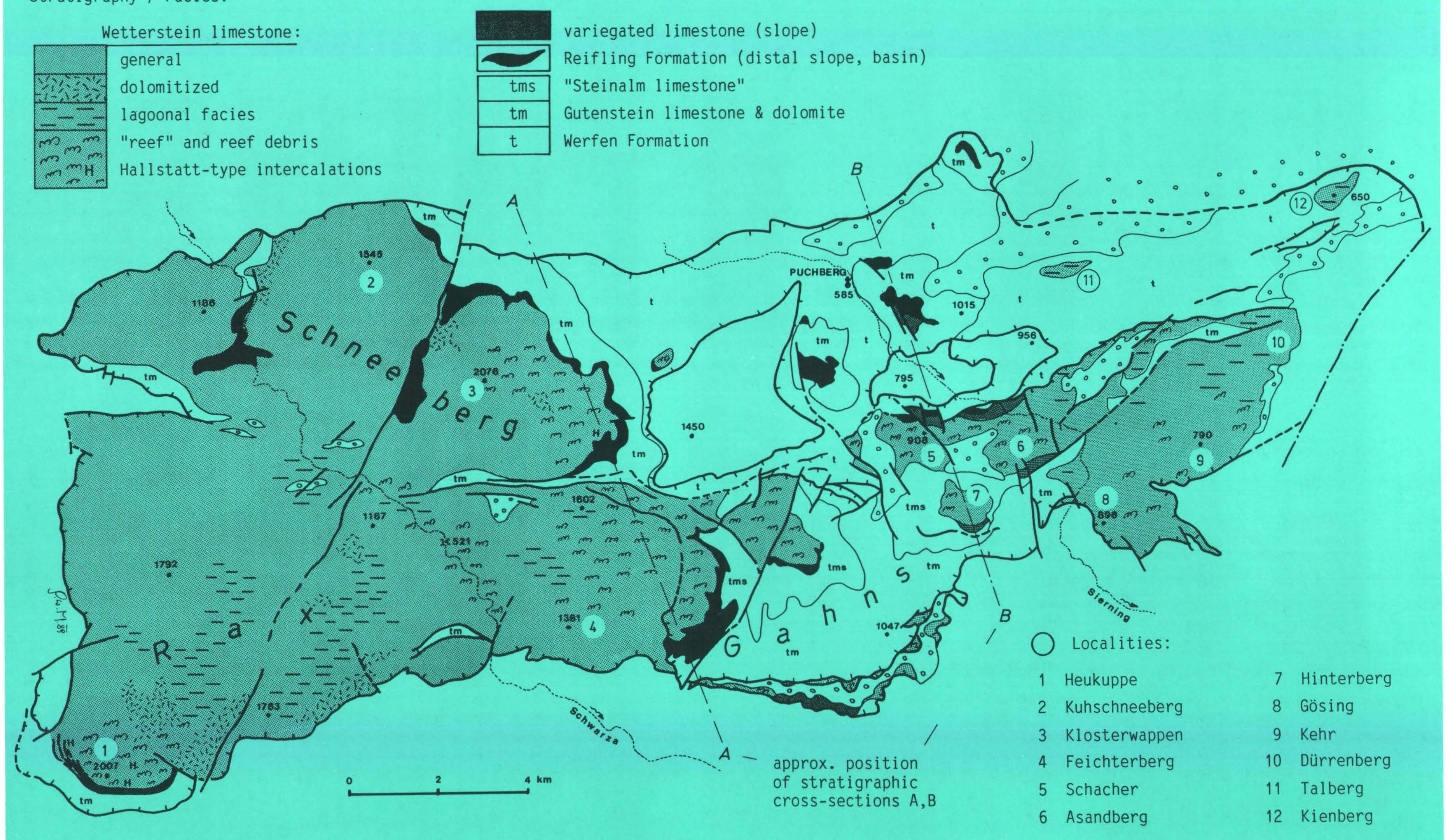


Fig. 3.

scarcely in the lagoon. They consist of buildups made up by branching corals of „Thecosmilia"-type. Brachiopods are conspicuous reef dwellers, their clams can be observed in considerable quantity entrapped between the coral branches. The immediate transitional area „behind" the reef — the near-reef lagoon platform — is often characterized by grainstones, boundstones or birdseye-limestones with mixed biota consisting of reef debris and *Teutloporella* as typical element of the near reef lagoon. In some cases flats with abundant in situ growth of solenoporaceans are most characteristic; they are either represented by grainstones or by birdseye-limestones.

Reef facies. The most intensely studied facies of the Wetterstein is by far, reefal limestones (Plate 1, Fig. 3). These buildups are composed of diverse biotic assemblages of sphinctozoan and other calcisponges, corals (*„Thecosmilia", „Montlivaltia", „Thamnasteria"), Tubiphytes,* bryozoans, codiacean and solenoporacean algae (and possible squamariaceans), foraminifera, echinoderms, molluscs, and brachiopods (MELLO 1975a; BRANDNER & RESCH 1981). *Tubiphytes* alone locally occurs as relatively thick platform-margin reef buildups such as in the Vajarska-Mt. Krslenica outcrops area of Slovakia (Fig. 5). This organism similarly is a major faunal constituent of Permian rocks throughout the world (MAZZULLO & CYS 1977; FLÜGEL 1981a; SMITH 1981). Rock textures of reefal deposits generally are wackestones and packstones; boundstones resulting in large part, from syndepositional marine cementation, are also very common in this facies.

MAZZULLO & LOBITZER (1988) compared the biotic compositions, settings, and diagenetic attributes of Upper Permian (Guadalupian, Capitan) and Tethyan Triassic reefs, noting the persistence and similarity of major reef-forming organisms in these Permian and Middle Triassic limestones.

Notwithstanding evolutionary changes in specific taxa, the biotic compositions of the Capitan (and other Permian sections in the world: FLÜGEL 1981a; SMITH 1981; HARWOOD 1986; KALDI 1986; NOE 1987) and Middle Triassic reefs are very similar at several phyllogenetic levels, and are clearly distinct from those of Tethyan Upper Triassic reefs. Both the Permian and Middle Triassic reefs are composed mainly of calcisponges, *Tubiphytes* and lesser numbers of corals (rugosans in the Permian, scleractinians in the Triassic). Spongiostromata and possible squamariacean algae are important contributors to the Middle Triassic reefs, whereas organisms of similar encrusting habit, namely the problematical alga *Archaeolithoporella,* apparently occupied the same ecologic niche in the Capitan (MAZZULLO & CYS 1978) and other Permian reefs (FLÜGEL 1981a; SMITH 1981). In contrast, Tethyan Upper Triassic reefs are dominated by scleractinian corals (*Thecosmilia* types). Phylloid algae are known as a minor constituent in the Capitan reef (BABCOCK 1977), and REID (1986) noted their persistence into the Mesozoic, describing occurrences in Upper Triassic (Norian) reef carbonates in Canada. To date, however, we have not found phylloid algae in any of the Triassic reefs examined in the study area. In addition to their biologic makeup, Permian and Middle Triassic reefs are also similar in terms of their diagenetic histories, both having been extensively syndepositionally cemented in the marine environment (MAZZULLO & CYS 1977, 1978; FLÜGEL 1981a; SMITH 1981). In Upper Triassic reefs, syndepositional marine cements are relatively uncommon (MAZZULLO & LOBITZER 1988).

According to our opinion a biogenic reef framework in the sense of a wave-breaking structure- as e.g. in the Latest Triassic Steinplatte reef crest — did not exist in the Wetterstein reefs of the eastern Northern Calcareous Alps. Practically all „reef"-organism are of comparatively small dimensions of several centimeters only. Coral-buildups of giant dimensions are missing as well as also other potential wave breaking organisms. One gets the impression, however, that a rigid „framework" could be constructed by a combination of pervasive submarine early diagenetic cementation and various encrusting organisms. The remarkable fact of immediate interfingering of the „reef"-proper with lagoonal birdseye limestones is considered as prove for platform-edge reefs and not an upper slope situation. Typical assemblages of a deeper water slope, as silicisponges, ammonites, radiolarians and relevant foraminifera are missing. Scattered very small lenses of variegated — pinkish, yellowish or grey — micritic limestones with conspicuous cement growth of „zebra"-type and stromatactis-like features can be seen within the reef of Heukuppe on Rax-Plateau and even more scarcely on Schneeberg-Plateau as well. We call them „lenses of Hallstatt-type limestone". Similar features are well documented also in the Dachsteinkalk reefs (Hoher Göll: Zankl 1969; Mitteralpe/Hochschwab-Plateau: Lobitzer 1971, Hohenegger- Lobitzer 1971; and Gosaukamm/Dachstein-Plateau). The biofacies indicates a deeper water environment and in many cases also allows a stratigraphic dating. The biota comprise conodonts, „filaments" (thin pelecypod shells), spicules of siliceous sponges, and ammonites.

Grossoolite facies. A conspicuous feature of platform-edge facies in the Wetterstein Limestone is the development of coarse breccias (Plate 1, Fig. 5) and locally, in reef and outer-lagoonal (reef-flat aprons) sand facies, coarse skeletal rudites with interparticle „grossoolite" cements. The term „grossoolite" (or „grossoolith") refers to thick, laminated, isopachous coatings of coarsely crystalline calcite cement (generally radiaxial-fibrous fabrics) and calcite-replacive dolomite around lithoclasts and skeletal particles (LEUCHS 1928; SANDER 1936 [and 1951 translation]; GERMANN 1971). Although SANDER (1936) initially interpreted these crystalline coatings as being of organic origin, they are now regarded as inorganic cements (GERMANN, 1971; MCKENZIE & LISTER 1983). The term „grossoolite facies" is herein also applied in the textural sense, to those coarse, reef-associated breccias („grossoolite-breccias") and skeletal calcirudites that are lithified by grossoolitic cements. The component clasts in the grossoolite-breccia facies are commonly angular and generally poorly sorted through a vertical section of such rocks, ranging in size from a few centimeters to several decimeters in diameter. Within individual beds, however, the clasts typically are relatively well sorted such that the interparticle matrix is occluded nearly entirely by coarse crystalline cements rather than fine particulate detritus (Plate 1, Fig. 4). In the outcrops examined, the clasts within the grossoolite-breccia facies are composed exclusively of shelf-margin reefal lithologies (Plate 1, Fig. 4); reefal and some lagoonal organisms similarly comprise the associated calcirudites lithified by grossolitic cements. In places, grossoolite-breccias are the only remaining evidence of the former presence of in-situ, shelf-margin reefs.

We concur with BRANDNER & RESCH (1981) in interpreting the grossoolite-breccias to have been deposited in both shelf-margin as well as uppermost slope environments, although we believe they are best developed on the shelf margin throughout most of the study area. Although the origin of these breccias in the Nordkette Range of Tyrol has been attributed by BRANDNER & RESCH (1981) to syndepositional block-faulting of the underlying Goetheweg reef, equivocal evidence of similar faulting has not been noted by us in other outcrop areas. However, it is likely that syndepositional tectonism, oversteepening of the platform margin, slope instability, or combinations of these processes, must have been causative factors in the formation of such widespread breccia deposits in this region.

Slope and basin facies. Rocks of transitional nature between Middle Triassic platforms and basins are relatively rarely exposed in the Northern Calcareous Alps and West Carpathians due to structural complexities. Basinal facies often are tectonically isolated from formerly contiguous platform deposits.

In general we know two different types of Anisian to Cordevolian carbonatic basinal sediments, the Reifling Formation and Hallstatt Formation. The Reifling Fm. consists of light to dark grey, well bedded, nodular micritic limestone with chert nodules, occasionally green tuffits and a sparse fauna dominated by radiolarians, filaments, conodonts and locally ammonites. In central and western part of NCA it passes lateraly into the dark shales of Partnach Formation. The Hallstatt Formation comprises a lot of different lithologies mostly of variegated (violet, red, pink, yellowish-grey, white) micritic limestones with abundant conodonts and ammonites. Hallstatt Limestones are almost restricted to the uppermost respectively southernmost tectonic units and represent the sediment of outer shelf and/or local uplifts, far away from continental influences and may pass into oceanic conditions (Meliata Fm. in Slovak Karst area).

Transitional strata between Wetterstein and Reifling Limestone is known as Raming Limestone (TOLLMANN 1976). It is a sequence of medium bedded, light coloured micritic limestone with graded lithoclastic beds and occasionally chert nodules. Clasts are mainly slope-derived semiconsolidated micritic sediments, locally platform debris occurs too.

Investigations of the last 15 years have shown much more types of slope and basin facies (HOHENEGGER &LEIN 1977, MELLO 1975) which do not fit very well to the established formations mentioned above. This should be a main topic of further comparative investigations. Therefore we use in this article preferably descriptive lithological terms.

Basinal facies and eventually distal slope too is represented in the Schneeberg area by grey nodular limestone of Reifling type and black even bedded cherty limestone with fine grained graded allodapic composition. The latter has been named Grafensteig Limestone by HOHENEGGER & LEIN 1977. It is overlain at Mt. Schneeberg by grossoolite-breccia facies of upper slope.

A second type of transitional facies is a variegated limestone which resembles Hallstatt Limestone at a macroscopic view. But gradual transition into Wetterstein reef limestone, resedimentation structures, „stromatactis"-cavities and fine grained platform debris do not fit to typical Hallstatt facies in a strict sense. It contains lenticular cavities lined with alternating generations of isopachous, radiaxial-fibrous calcite cements and red, internal sediments. Whether these filled cavities represent the products of marine or meteoric diagenesis is presently uncertain. These textures and crystalline fabrics of these rocks are the focus of a detailed study by MAZZULLO, who notes their resemblance to similar features described by KENDALL (1985) from Devonian fore-reef carbonates in Australia.

A variegated limestone of slope origin has also been described by BALOGH & KOVACS 1981 as „Nadaska" Limestone. But as far as published, influence of a nearby reef has not been noticed and therefore it does not show the special characteristics of our slope type.

Another type of transitional facies has been reported from the Slovak Karst as „Wetterstein bedded limestone" by MELLO 1975. Similar lithology is known from Northern Calcareous Alps, Dachstein region (MANDL et al. 1987) in position between Hallstatt Limestones and Wetterstein reef limestone.

Slope and basinal facies of the Tethyan Upper Triassic and Permian (such as in the southwestern United States and the United Kingdom) do not differ greatly from those in the Middle Triassic. Upper Triassic fore-platform deposits in the study area are variously lithoclastic (Aflenz Limestone: LOBITZER 1974), calcarenitic (Steinplatte reef complex: PILLER 1981) or micritic (LOBITZER 1974, 1980).

Analogous Permian distal-slope and basinal facies in the United States and United Kingdom similarly consist variously of lithoclastic (non-grossoolitic), calcarenitic, and micritic limestones as well as sandstones, shales, and evaporites (KING 1948; HARWOOD 1986).

The foraminifera assemblages of the Wettersteinkalk and age-equivalent slope- and basin facies are much lesser diverse and poorer in individuals compared to the Norian/„Rhaetian" Dachstein Limestone (HOHENEGGER — LOBITZER 1971). In addition the ecologic distribution of taxa assemblages is not yet studied in sufficient detail though some preliminary results are already available (BRANDNER-RESCH 1981, LOBITZER et al. 1988).

In Carnian time a conspicuous break in biotic distribution is evident. Most of the Permian/Mid-Triassic holdovers disappear and new highly diverse faunas bloom. Land floras show extreme generic diversity and pronounced provincialism (DOBRUSKINA in LOBITZER et al. 1988). The reason for this regressive Carnian event is still unclear (STANLEY 1988). And as pointed out by KRYSTYN et al. (this volume), the Tisovec Limestone at its classical locality cannot be longer considered as „missing link" between the reef developments of the Wetterstein and Dachstein Formations.

Depositional Models

Interpreted platform-to-basin depositional models of the Middle Triassic are generally similar throughout the study area (Figures 3 and 4). Platforms in Austria and Slovakia both evolved from incipient shallow-shelf and skeletal bank deposits of the subjacent Steinalm Limestone (Fig. 2). Likewise, the Middle Triassic everywhere in the study area accreted rapidly into thick, basinward progradational sequences (MELLO 1974; BRANDNER & RESCH 1981). The ubiquitous occurrence of coarse grossoolite-breccias in Austria (Figures 3A and B), and deposition of coarse, dolomitized reef-derived megabreccias in Czechoslovakia (Fig. 4A), suggest that platform-edges in these areas were, at least periodically, destructional. Insofar as the Tethyan region was structurally active during the Triassic (BRANDNER & RESCH 1981), it is likely that these destructional phases of platform development were related, at least in part, to periodic tectonism. Except for some areas on the platforms in Austria (sand-shoal and peritidal facies in the Hafelekar complex: BRANDNER & RESCH 1981) and Czechoslovakia (Plesivec Plateau), we have not found evidence of subaerial exposure of the Middle Triassic reefs in the study area. Upper Triassic reefs particularly those of the Norian-Rhaetian in Austria, however, contain abundant evidence for repeated episodes of subaerial exposure and meteoric diagenesis related presumably, to eustatic fluctuations (MAZZULLO, in prep.).

A major aspect of facies systems development in the Middle Triassic concerns the nature of the platform-to-basin depositional profile (i.e., READ 1985). In this regard, the depositional setting of the reefs is critical in interpreting platform profiles.

A depositional setting mainly in upper slope environments is considerd for the Late Permian Capitan reef (PRAY 1977, MAZZULLO & LOBITZER 1988). Of course, ecologic displacement in the Late Triassic of calcisponges by scleractinian corals, from shallow platform-marginal to reef-slope environments, must also be considered as an alternative interpretation for such biotic variations in Middle to Upper Triassic depositional systems. Notwithstanding this alternative explanation, there is some apparent sedimentological corroboration for an upper slope interpretation for Middle Triassic calcispongal reefs, as suggested by the distribution of facies in these rocks. This evidence is predicated on the following three assumptions: (1) that shallow, seaward facing shelf-margin environments are areas of maximum wave and current energy and therefore, (2) shelf-margin deposits should be dominated by carbonate sands or mud-poor reefs (although the latter is not necessarily a valid assumption for all reef buildups: FRIEDMAN 1985), and; (3) that syndepositional marine cementation in many modern and ancient platform-margin environments is most pervasive in upper fore-reef deposits and the seawardfacing margins of reefs (GINSBURG & JAMES 1973; GOREAU & LAND 1974; MAZZULLO & CYS 1977;

Stratigraphic scheme (Anisian to Lower Carnian) of Schneeberg nappe. Note lateral variability of platform to basin transition. For location of cross-sections A,B see textfigure of facies distribution.

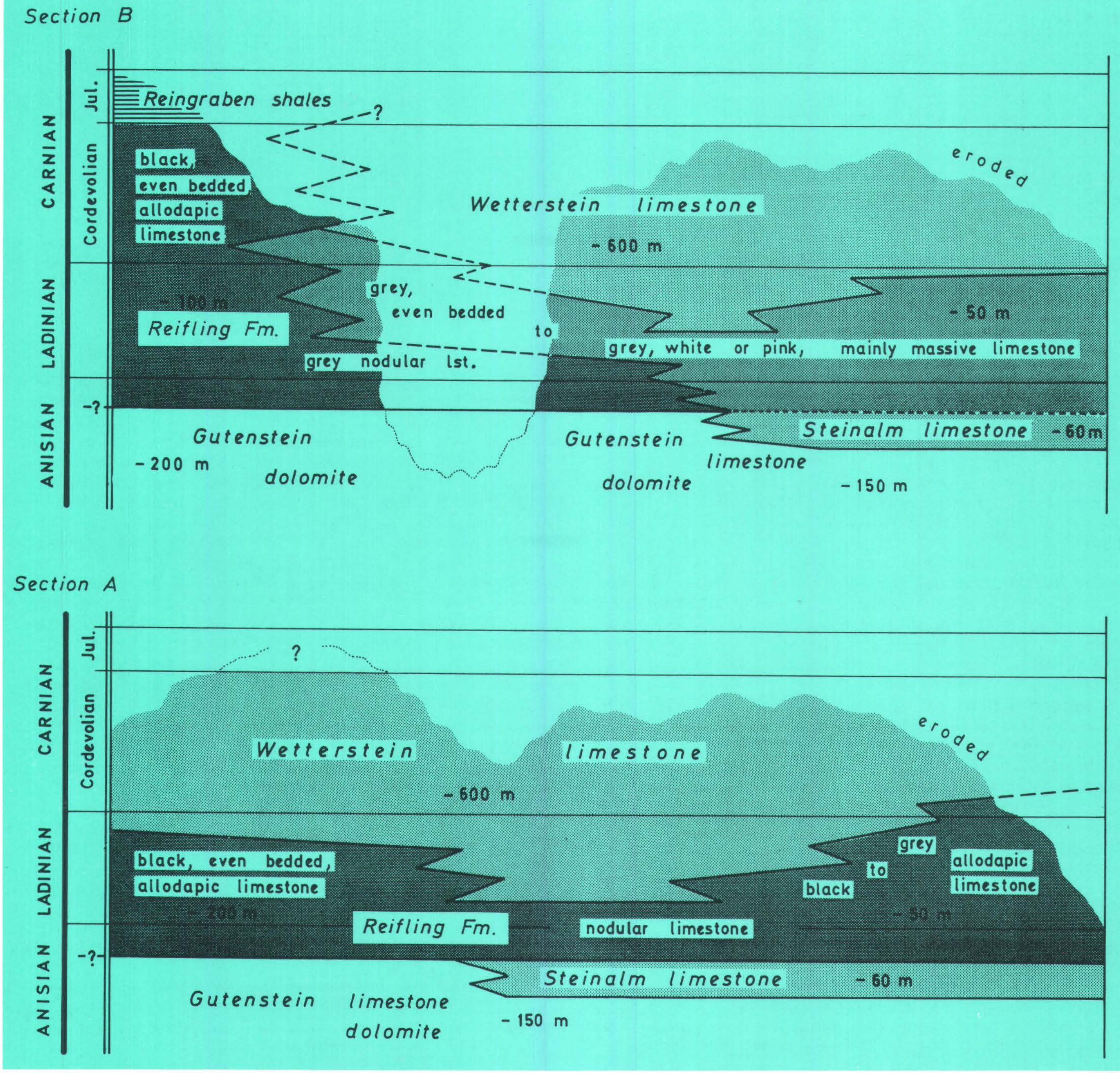


Fig. 4.

JAMES & GINSBURG 1979; PURSER & SCHROEDER 1986).

On the Schneeberg Plateau in Austria (Fig. 2), for example, in-situ calcisponge reef facies are poorly represented, occurring mostly as small lenses within middle and lower beds of the grossoolite-breccias. Pervasively cemented grossoolite-breccias not only comprise most of the upper slope facies of the present platform-margin, but they pass directly into outer-lagoonal, marine-cemented biograinstones without an intervening in-situ reef buildup. These grainstones contain conspicuous *Teutloporella,* and locally associated with only small, marine-cemented calcispongal patch-reefs. These facies pass further shelfward into micritic limestones with a typical quiet-water lagoonal biota. A similar belt of biograinstones occurs updip of the extensively marine-cemented Upper Permian Capitan sponge-algal reef (MAZZULLO & HEDRICK 1985); these grainstones are composed of typical outer-shelf rather than reef biotic assemblages. In the Hafelekar complex of the Nordkette Range in Tyrol the grossoolite-breccias similarly comprise much of the upper slope and shelf-margin facies. In-situ calcispongal reefs make up only a minor portion of this depositional environment, instead occurring most notably in distal-slope settings. The platformedge facies here pass updip into high-energy, reef-flat and skeletal sands composed of a mixed reefal and lagoonal biota (BRANDNER & RESCH 1981). Middle Triassic reefs in Czechoslovakia also appear to have been deposited in similar environments. In the Plesivec-Silica Karst Plateau area for example, micritic reef facies seemingly occur between basinal facies of the

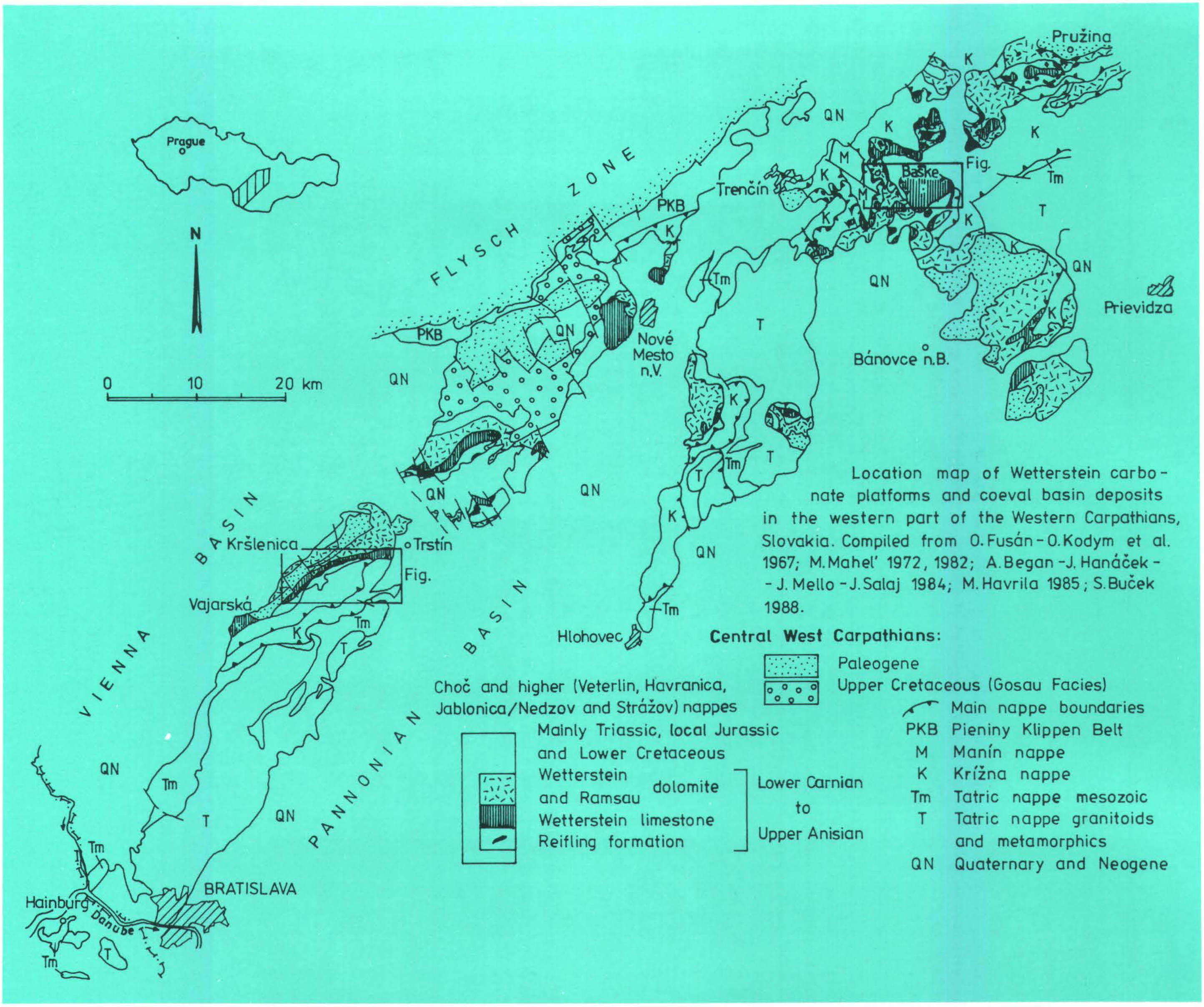


Fig. 5.

Reifling and an updip belt of biograinstones that define the zone of maximum depositional energy.

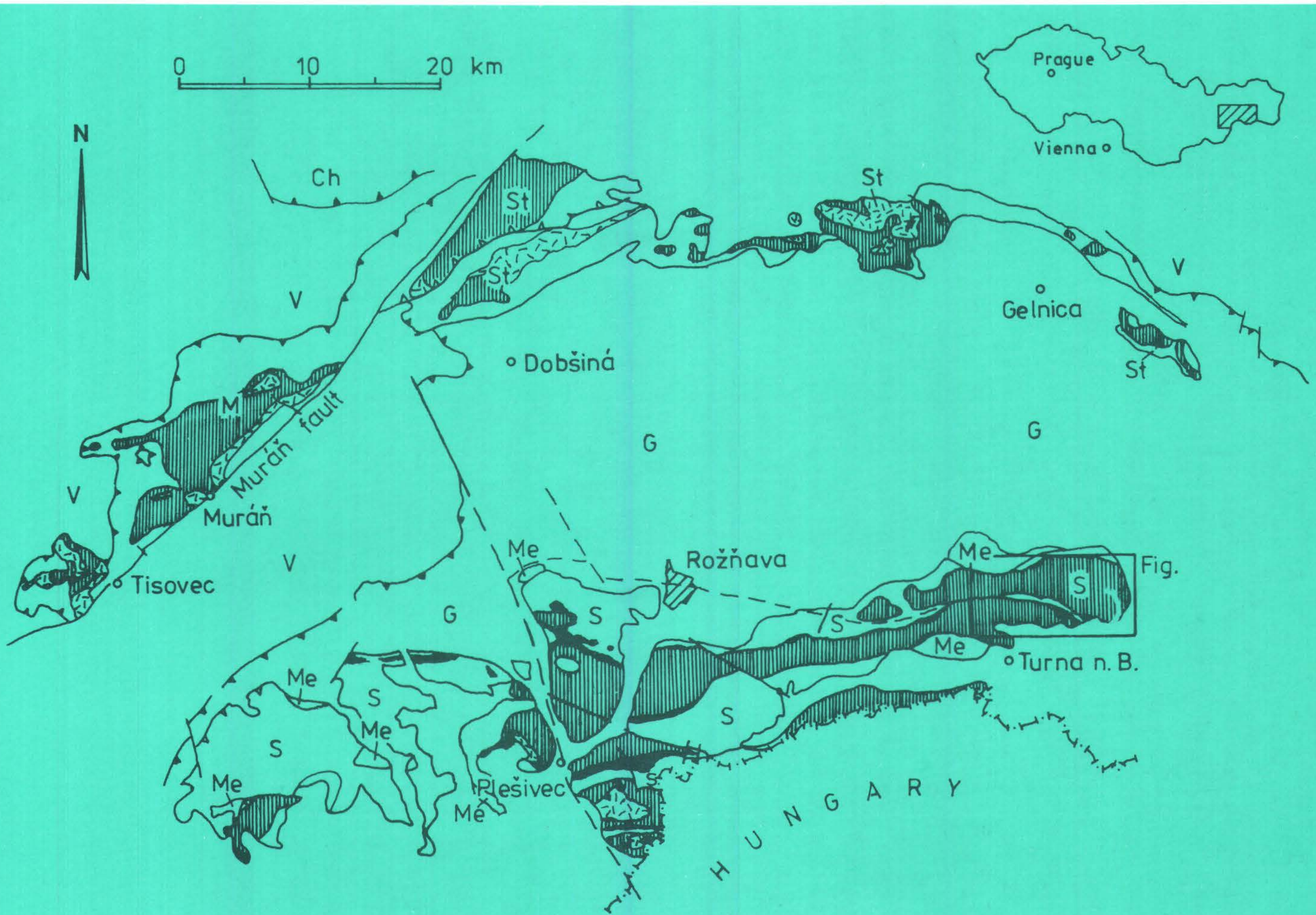
Diagenesis of Middle Triassic carbonates

The diagenetic history of Middle Triassic platform carbonates is similar throughout the study area, and is analogous in many respects to those of the Capitan reef complex and other Permian platform carbonates. Syndepositional marine cementation of platform deposits appears to have been a pervasive theme in both the Permian and Middle Triassic (MAZZULLO & CYS 1977, 1978; FLÜGEL 1981; SMITH 1981). Peritidal, lagoonal, and reef facies in the Wettersteinkalk all typically contain abundant marine cements represented principally by isopachous rims of radiaxial-fibrous calcite surrounding component allochems in the rocks (Plate 6, Figures 1—3). KENDALL & TUCKER (1973) originally interpreted radiaxial-fibrous crystalline fabrics as being replacive of aragonite, although current studies (KENDALL 1985) suggest that it may instead be a primary fabric of precursor marine high-magnesian calcite or possibly, calcite cements. The Capitan reef and some associated shelf grainstones also were pervasively marine-cemented, but apparently by aragonite in most cases rather than calcite (MAZZULLO & CYS 1977, 1978). A similar precursor mineralogy is considered for Permian reefs elsewhere (FLÜGEL 1981; SMITH 1981). The reasons for apparent changing marine cement mineralogies in the Permian and Triassic are unknown, although they may relate to differences in seawater chemistry through time. The Upper Triassic platform carbonates that we have examined in the study area contain little to no readily recognizable syndepositional marine cement fabrics (MAZZULLO & LOBITZER 1988; MAZZULLO in prep.). Because of the micritic texture of the rocks, we are unable to recognize with any certainty, marine cements in the distal-slope and basinal deposits of the Middle Triassic.

The coarse crystalline calcite cements in the grossoolite-breccia facies in Austria are similarly composed of radiaxial-fibrous calcite and locally, some replacive dolomite (Plate 6, Fig. 4). That these cements were not precipitated during actual subaerial exposure of the breccias is suggested by the lack of corroborative evidence in the rocks of such exposure. BRANDNER & RESCH (1981) and MCKENZIE & LISTER (1983) suggested that lithification of the grossoolite-breccias in Tyrol occurred in the early burial environment as a consequence of interaction with refluxing meteoric and hypersaline fluids. We don't entirely agree with a burial-diagenetic origin for these cements everywhere in the study area for the following reasons: (1) in the other Austrian grossoolite occurrences that we've examined, there is ample evidence of multiple episodes of cementation, brecciation and resedimentation (Plate 6, Fig. 4), some of which may suggest pre-burial lithification; (2) coarse crystalline, radiaxial-fibrous cements in reefal limestones associated with the breccias represent syndepositional lithification, and these cements are identical petrographically to those in the grossoolite-breccia deposits (Plate 6, Fig. 3); (3) grossoolitic cements are characteristically laminated and contain numerous internal discontinuities (Plate 6, Figure 4), indicating long-term cement precipitation. It is therefore possible that cementation of the grossoolite-breccia deposits was initiated syndepositionally, and that it continued into the shallow-burial environment; accordingly, the nature of the precipitating fluids would likely have changed during the course of cementation. MAZZULLO and his colleagues are presently studying the petrography and geochemistry of these cement fabrics in order to identify their precursor mineralogy, timing and sites of lithification, and geochemistry of involved waters.

In the Wetterstein rocks examined, neither we nor BRANDNER & RESCH (1981) have found any evidence of

Fig. 6.



Location map of Wetterstein carbonate platforms and coeval basin deposits in the inner part of the West Carpathians, eastern Slovakia.
Compiled from O. Fusán - O. Kodym et al. 1967; J. Bystrický 1964, 1982, 1986; Ľ. Gaál 1982; M. Mahel' 1957; J. Mello 1988; Š. Bajaník et al. 1984.

Central and Inner West Carpathians:

Silica (S), Muráň (M) and Stratená (St) nappe
Mainly Triassic, local Jurassic
- Wetterstein dolomite
- Wetterstein limestone
- Reifling, Schreyeralm and Nádaska formation

(Lower Carnian to Upper Anisian)

- Main nappe boundaries
- Partial nappe boundaries
- G Gemeric unit
- Me Meliata unit
- V Veporic unit
- Ch Choč nappe

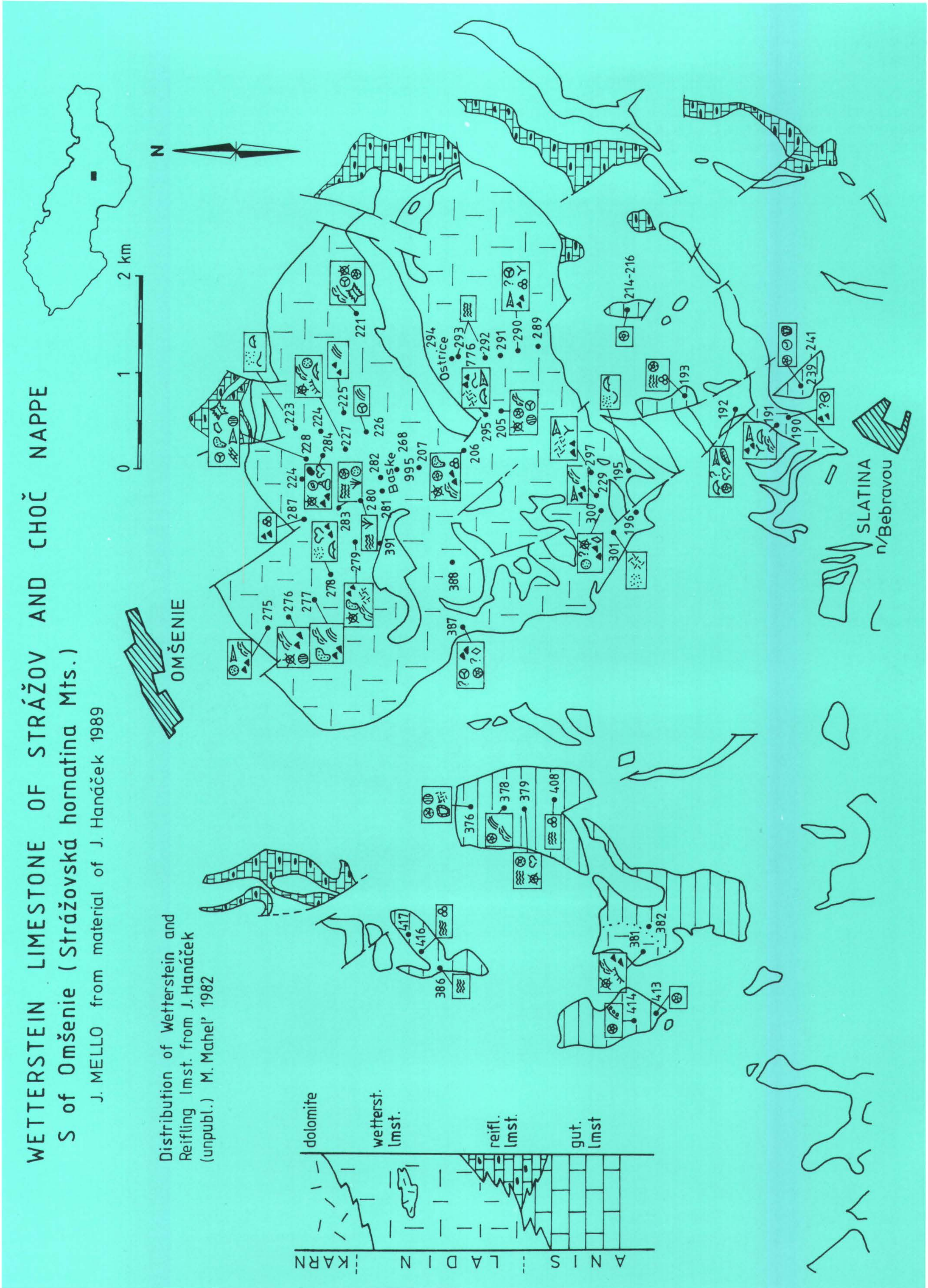
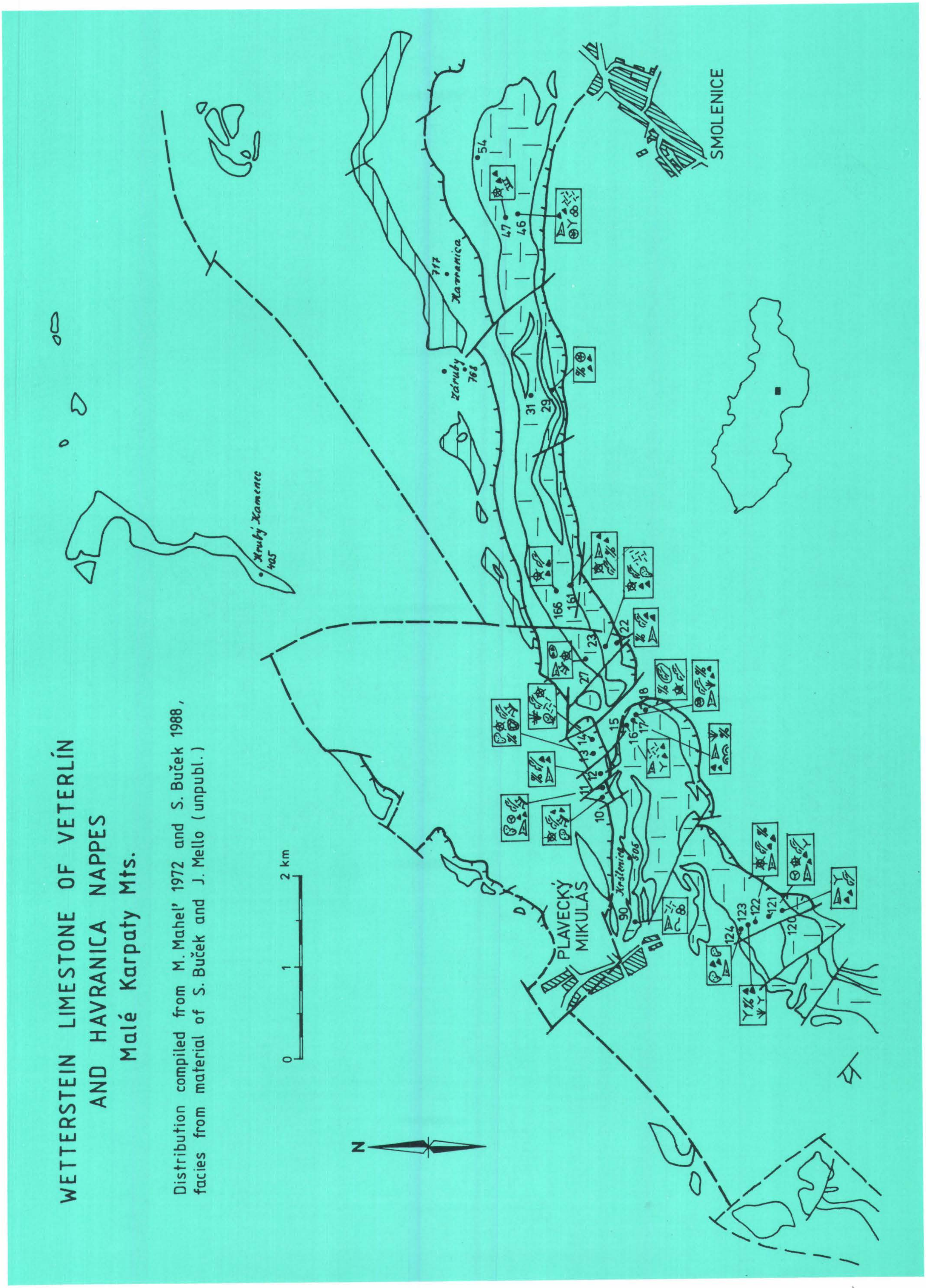

WETTERSTEIN LIMESTONE OF STRÁŽOV AND CHOČ NAPPE
S of Omšenie (Strážovská hornatina Mts.)
J. MELLO from material of J. Hanáček 1989
Distribution of Wetterstein and Reifling lmst. from J. Hanáček (unpubl.) M. Mahel' 1982
dolomite
wetterst. lmst.
reifl. lmst.
gut. lmst
KARN
LADIN
ANIS
N
0 1 2 km
OMŠENIE
Ostrice
Baske
SLATINA n/Bebravou

Fig. 7.

Fig. 8.


WETTERSTEIN LIMESTONE OF VETERLÍN
AND HAVRANICA NAPPES
Malé Karpaty Mts.
Distribution compiled from M. Mahel' 1972 and S. Buček 1988,
facies from material of S. Buček and J. Mello (unpubl.)
0
1
2 km
N
SMOLENICE
PLAVECKÝ MIKULÁŠ
Havranica
717
Záruby
768

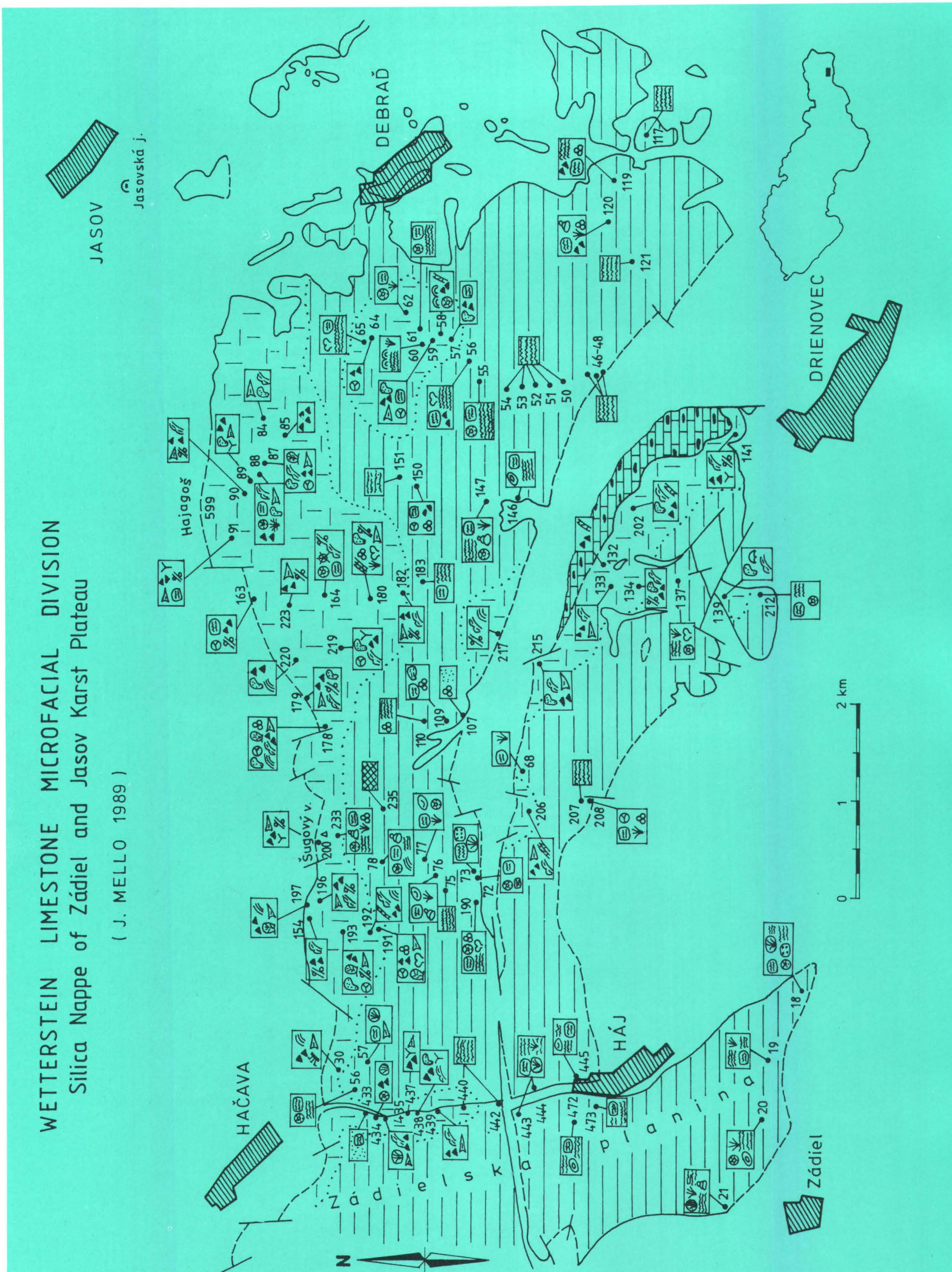

WETTERSTEIN LIMESTONE MICROFACIAL DIVISION
Silica Nappe of Zádiel and Jasov Karst Plateau
(J. MELLO 1989)
JASOV
Jasovská j.
DEBRAĎ
DRIENOVEC
HAČAVA
Hajagoš
Šugový v.
HÁJ
Zádiel
Zádielska planina
0
1
2 km
N

Fig. 9.

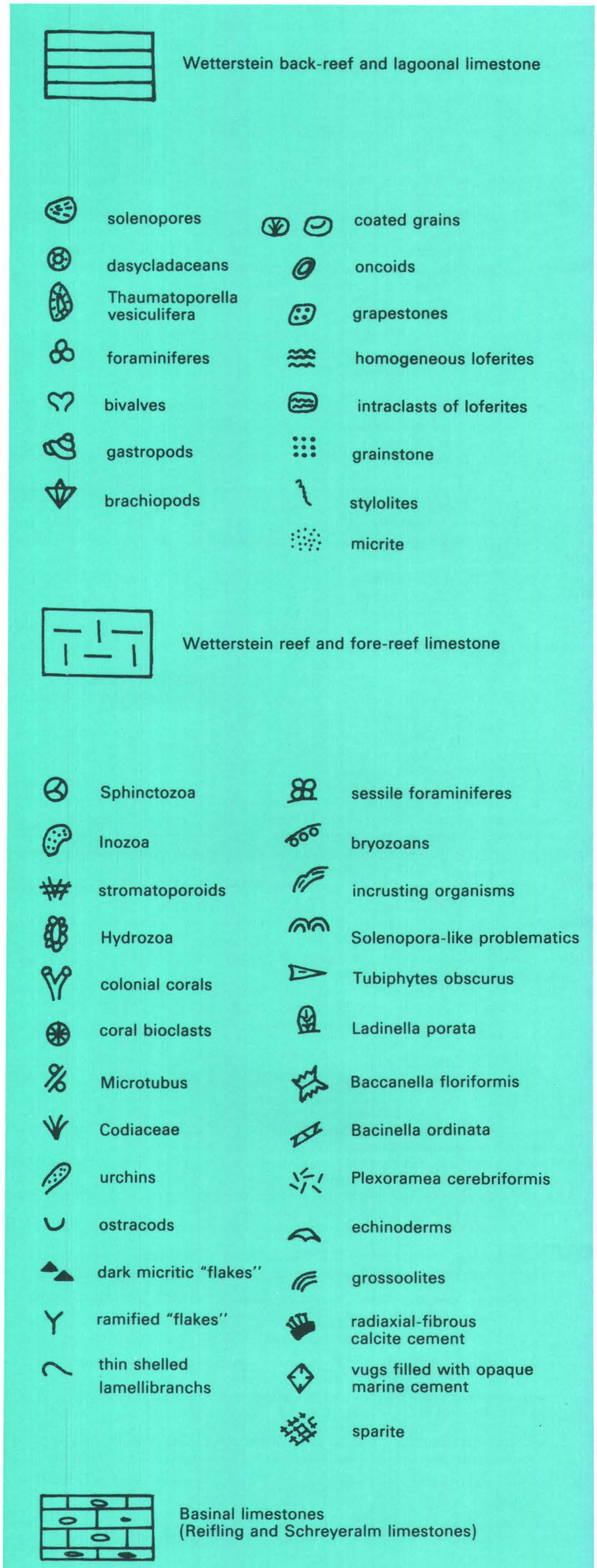


Fig. 10.

subaerial meteoric diagenesis of reef facies, except for scattered zones with red internal sediment on the Plesivec Plateau of Slovakia. BRANDNER & RESCH (1981) did, however, recognize subaerial diagenetic textures and fabrics in lagoonal facies of the Hafelekar reef complex in Tyrol, and similar evidence of exposure is known to us in Wetterstein peritidal facies at several localities in the study area. The apparent lack of subaerial exposure of these Wetterstein reefs throughout most of Austria and Czechoslovakia compares with that of the Upper Permian Capitan reef, but contrasts with the Tethyan Upper Triassic reef and platform sections we've examined (i.e., the Norian-Rhaetian Steinplatte reef complex near Salzburg: MAZZULLO in prep.), which contain abundant solution molds filled with red internal sediments and cements.

The possible relationships between sealevel changes and diagenesis in Triassic rocks are presently important unresolved topics in Tethyan sedimentology, and warrant further study.

Particularities of Wetterstein reefs in comparison with Late Permian and Late Triassic ones

Summarizing it simply can be stated, that biota-wise the Wetterstein Formation still shows an extremely intensive connection with the Late Permian Capitan Formation (LOBITZER 1971, FLÜGEL 1981, MAZZULLO & LOBITZER 1988, STANLEY 1988). This statement is also particularly true for the diagenetic aspects. The shelf profile, however, seems to have changed from prevailing upper slope reefs in the Late Permian to predominatly shelf margin location of reefs in the Middle Triassic. This development marks the transition to the „modern" reef-rimmed platforms of the Tethyan Dachstein Limestone in the Norian/„Rhaetian".

Compared to the biota of the Capitan Formation the diversity after the Early Triassic break in reef growth in the early stages of Wetterstein reef development was very low. However all important groups survived as „Lazarus" (STANLEY 1988) and constructed buildups in the Middle Triassic very much similar to the Permian ones. Archaeolithoporella, however, up to present has not yet been identified in European Middle Triassic reefs. In the Middle Triassic reefs and in part in the associated grossoolites we do recognize abundant syndepositional marine cement, in particular radiaxial fibrous calcite (see, however, critical evaluation in the chapter on „grossoolite facies").

Following the strongly clastic influenced Carnian extinction-event and reorganization the „modern" types of reef-rimmed platforms with tremendous framework of scleractinian corals evolved (Hoher Göll: ZANKL 1969; Steinplatte: OHLEN 1959, LOBITZER 1980, PILLER 1981, a.o.). Also we feel difficulties in following the ideas expressed by STANTON & FLÜGEL 1981, in particular that a biogenic framework should be absent even in the Latest Triassic reefs and other statements by these authors which were already discussed by STANLEY (1988).

Also on the platforms the change between the Wetterstein and Dachstein Formations is most remarkable as evidenced by the Lofer cyclothems (FISCHER 1964) and the dominant role of the megalodonts. In general, marine cements are present in much lesser amounts than in the Middle Triassic and unconformities are very abundant (e.g. Steinplatte). In the Wetterstein Limestone the near reef lagoon with its peritidal sediments indicates sedimentation repeatedly interrupted by sea level low stands of short duration.

CONCLUSIONS

Tethyan Middle Triassic carbonates in Austria and Czechoslovakia comprise a complex mosaic of peritidal, lagoonal, reef and reef-derived breccia (Wettersteinkalk), and distal slope to basinal facies. Interior platform deposits consist of loferitic dolomites (peritidal facies) and biopackstones to grainstones with local patch-reefs (lagoonal facies), all of which were extensively lithified in the marine environment. Proximal portions of some of these platt-forms were periodically subaerially exposed and altered in the meteoric diagenetic environment. Platform-edges were constructed by marine-cemented calcispongal reefs that were deposited in shallow shelf-margin environments. The reefs of the Middle Triassic thus define rimmed platforms and locally, subdued rimmed platforms. The biotic composition, setting, and abundance of syndepositional marine cements are strikingly similar in Permian and Middle Triassic reefs, although there was a change in the mineralogy of the marine cements from aragonite to calcite. A major biotic change in Late Triassic time heralded the dominance of framebuilding coral reefs in shelf-margin environments.

This biotic change followed the development of rimmed platforms as a prominent depositional motive that persists into the Recent. Reef-derived breccias were deposited in shelf-margin and slope settings seaward of many of the Wetterstein reefs, and originated during destructional phases of platform-edge evolution probably related to Middle Triassic tectonism and inherent slope instability. These deposits were rapidly cemented, perhaps in the syndepositional marine and shallow burial environments, by coarse crystalline, radiaxial-fibrous cements.

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Fig. 1: Near-reef lagoonal Wetterstein Limestone in birdseye-facies with solenoporaceans. Between Friedrich Haller Haus and Feichterberg.

Fig. 2: Lagoonal Wetterstein Limestone with abundant solenoporaceans. South of Haslitz-Adriganbauer.

Fig. 3: Wetterstein Limestone in reef-facies with sphinctozoan sponges, "tubes in the reef-debris" sensu OTT.
Strong biogenic encrustation. Schacherberg.

Fig. 4: Wetterstein Limestone in reef-facies with abundant *Tubiphytes obscurus*. Asandberg, top-plateau.

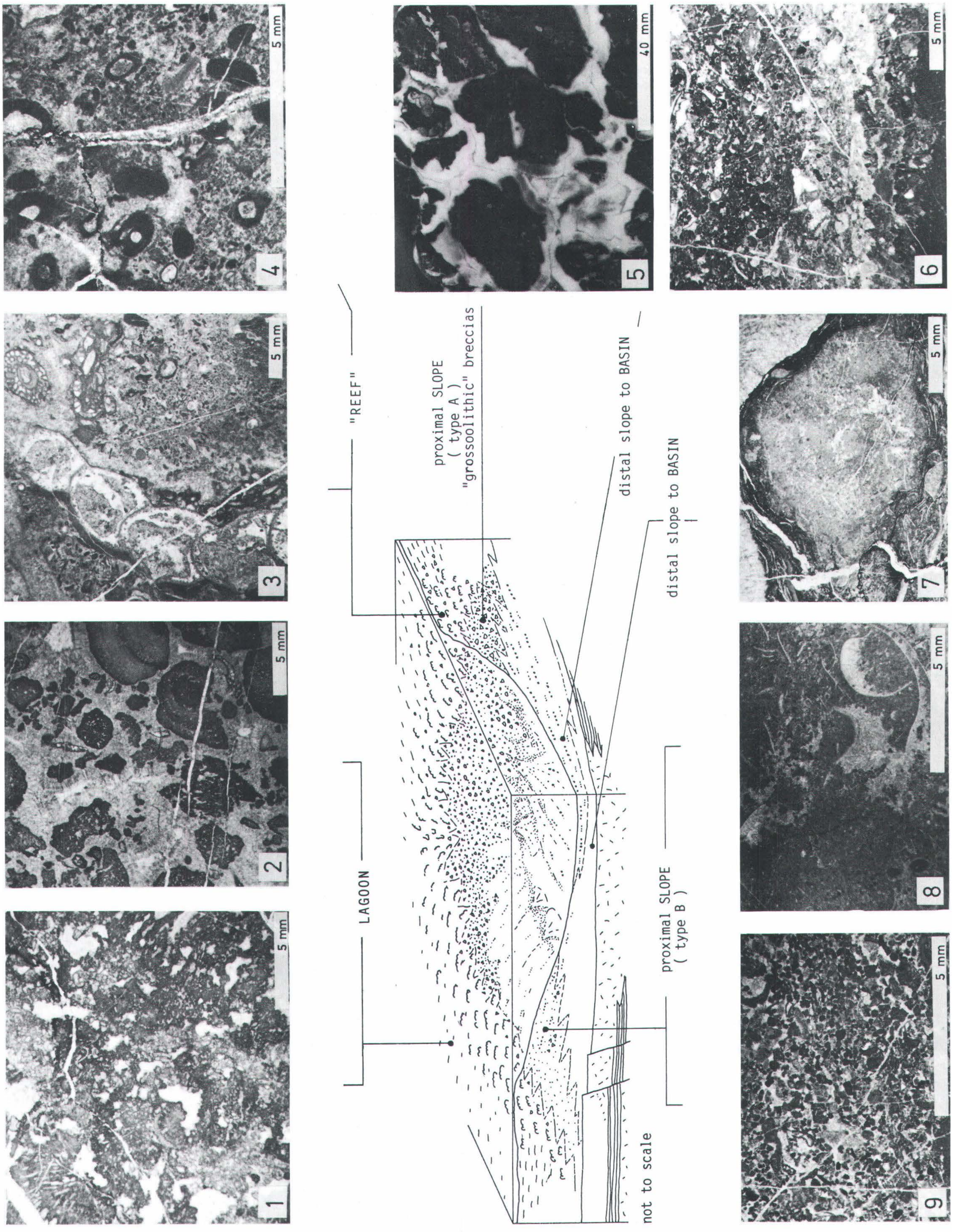
Fig. 5: Grossoolite-facies of Wetterstein Limestone. Clasts (dark) composed of marine-cemented calcispongal reef lithology. Schneeberg plateau.

Fig. 6: Grafensteig Limestone: graded allodapic intercalations of platform-derived debris within black micritic basinal limestone. Himberg.

Fig. 7: Reifling Limestone. Light grey nodular limestone of pelmicritic composition, abundant "filaments" between but also within the nodules. Sierningtal.

Fig. 8: Variegated limestone, mainly fine-grained pelmicritic limestone with filaments and sparse platform debris (*Tubiphytes*). Himberg.

Fig. 9: Variegated limestone, arenitic layer of platform debris. Himberg.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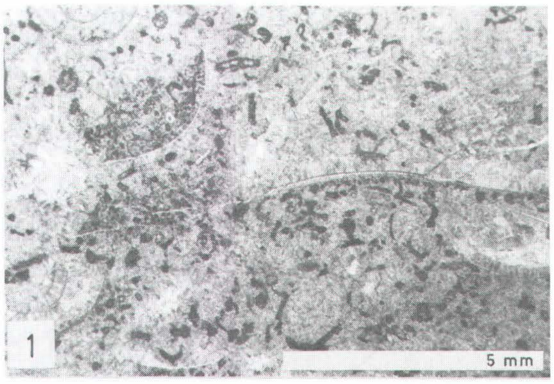
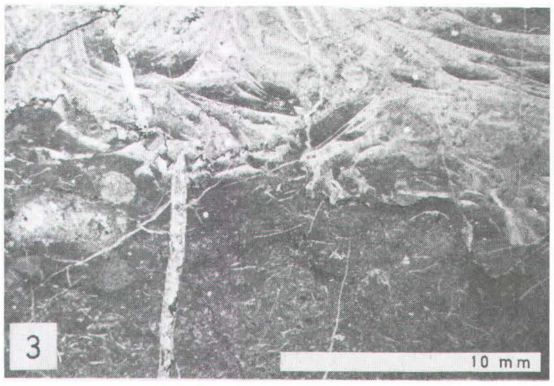
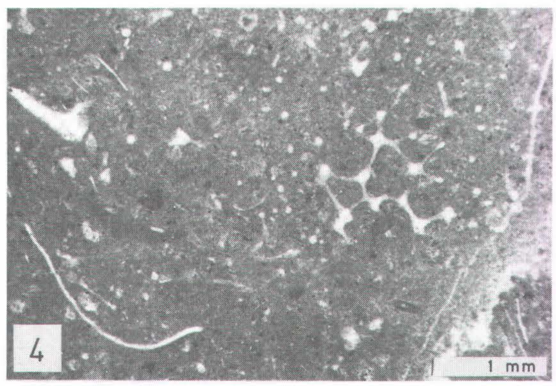
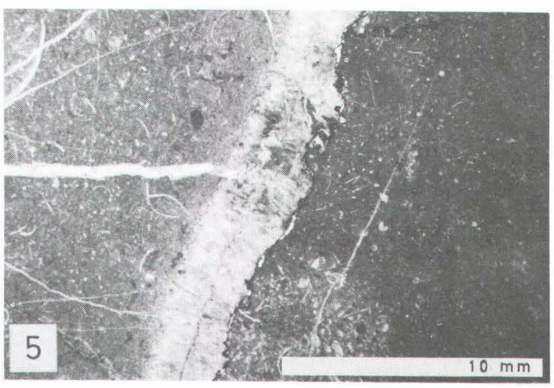
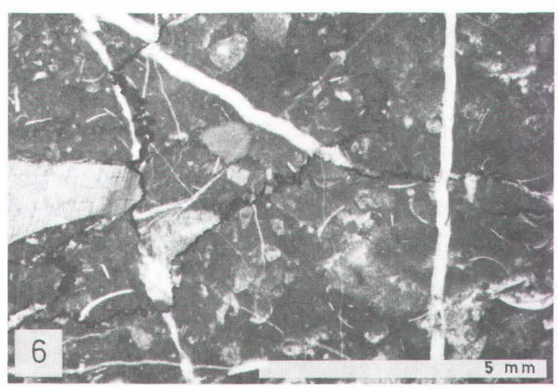










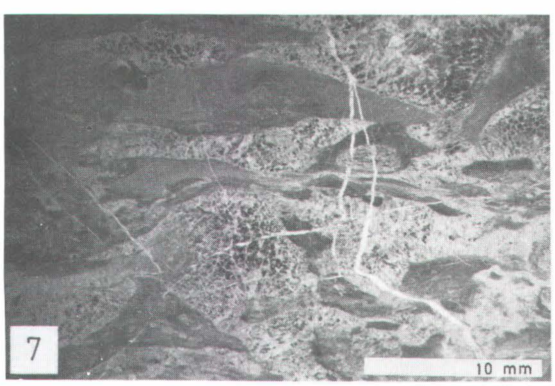


Fig. 1: Variegated limestone of slope facies in part with reef-derived debris ("tubes in reef debris" sensu OTT) and "filaments" (probably delicate pelecypod shells). Sierningtal.

Fig. 2: Grafensteigkalk of distal slope environment; allodapic layer of reef-derived debris and brachiopods within black micritic limestone. Himberg, northern terrain.

Fig. 3: Grey micritic limestone of Hallstatt-type with abundant "filaments" and pelecypod-coquina. Rax Plateau, Heukuppe.

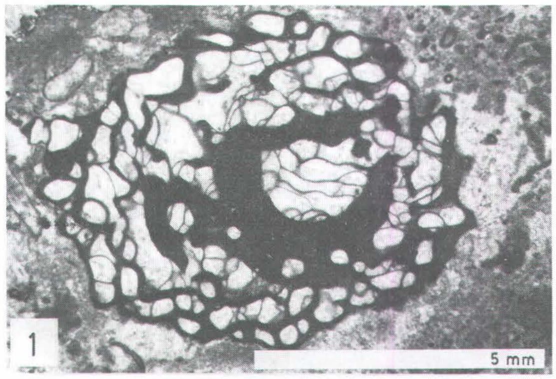
Fig. 4: Pinkish micritic limestone of Hallstatt-type (intercalation within reef facies) with "filaments", skeletal elements of siliceous sponges and pelecypod shells. Rax Plateau, Heukuppe.

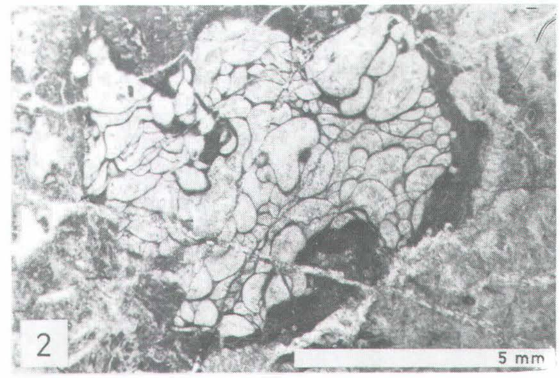
Fig. 5: Pinkish micritic limestone of Hallstatt-type intercalation within reef facies with "filaments" and larger pelecypod shells; conspicuous zebra-fissure. Rax Plateau, Heukuppe.

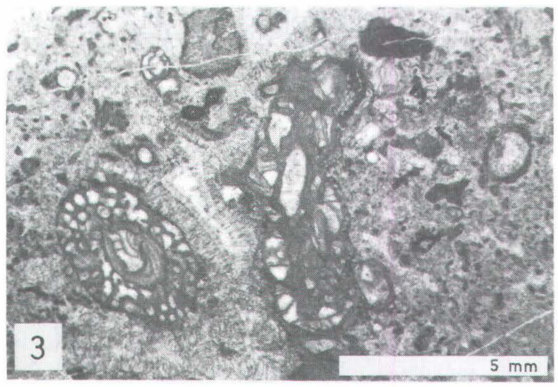
Fig. 6: Pinkish micritic limestone of Hallstatt-type as intercalation in basal Wetterstein Limestone reef. "Filaments" and debris of echinoderms; stylolites. Upper trail from Karl Ludwig Haus in direction to Preiner Gscheid.

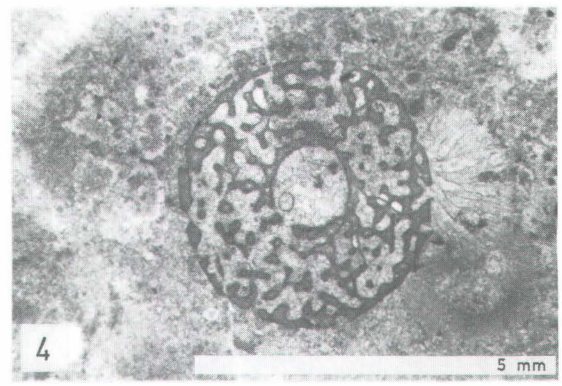
Fig. 7: "Schlierenkalk", flasered, recrystallized; the biota is preserved as "ghost-structures" only. Probably former, strongly altered Wetterstein Limestone of reef facies. As informal working name we use "Gösing Limestone" for this type of sediment. Mt. Gösing.

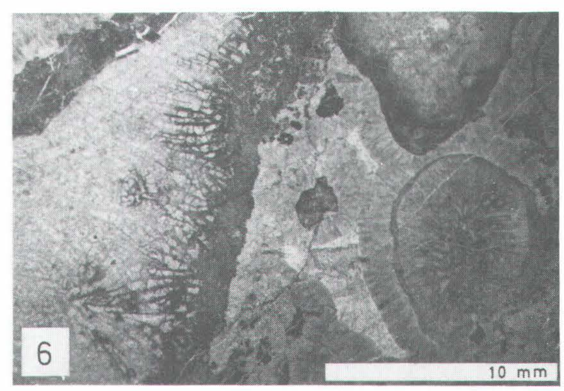
Fig. 8: Wetterstein Limestone in reef facies. Pervasively cemented boundstone with sphinctozoan sponges encrusting shell debris. Trail from Haller Haus to Promiskagraben.

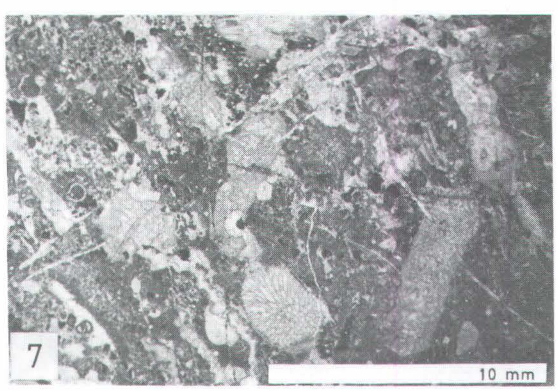












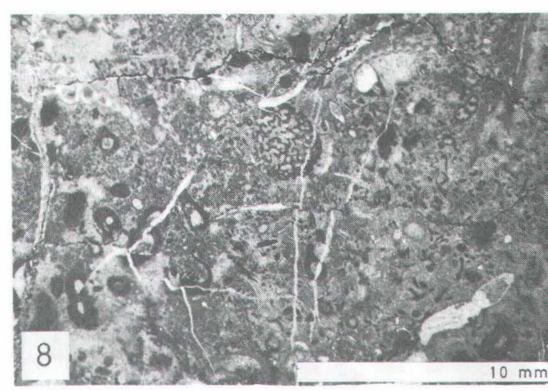


Fig. 1: Wetterstein Limestone in reef-facies with sphinctozoan sponge. Schacherberg summit.

Fig. 2: Wetterstein Limestone in reef-facies with sphinctozoan sponge. Southern Gahns area.

Fig. 3: Wetterstein Limestone in reef-facies with sphinctozoan sponges, "tubes in the reef debris" sensu OTT, and *Tubiphytes obscurus*. Schacherberg.

Fig. 4: Wetterstein Limestone in reef-facies with cross section of calareous sponge and *Baccanella floriformis*. Second generation biogenic growth on sponge. Wiege.

Fig. 5: Coral patch-reef in lagoonal Wetterstein Limestone. Besides branches of corals and sphinctozoan sponges, clams of brachiopods which seem to be the most important dwellers in lagoonal patch-reefs. Trail from Preiner Wand to Neue See-Hütte/Rax-Plateau.

Fig. 6: Coral buildup in lagoonal Wetterstein Limestone. West Preinerwand, Rax-Plateau.

Fig. 7: Wetterstein Limestone with abundant reef debris, comprising also bryzoans. Wassersteig, Krummbachstein.

Fig. 8: Wetterstein Limestone in reef-facies with *Tubiphytes obscurus*, debris of calcisponges, brachiopods and "tubes in the reef-debris" sensu OTT. Asandberg.

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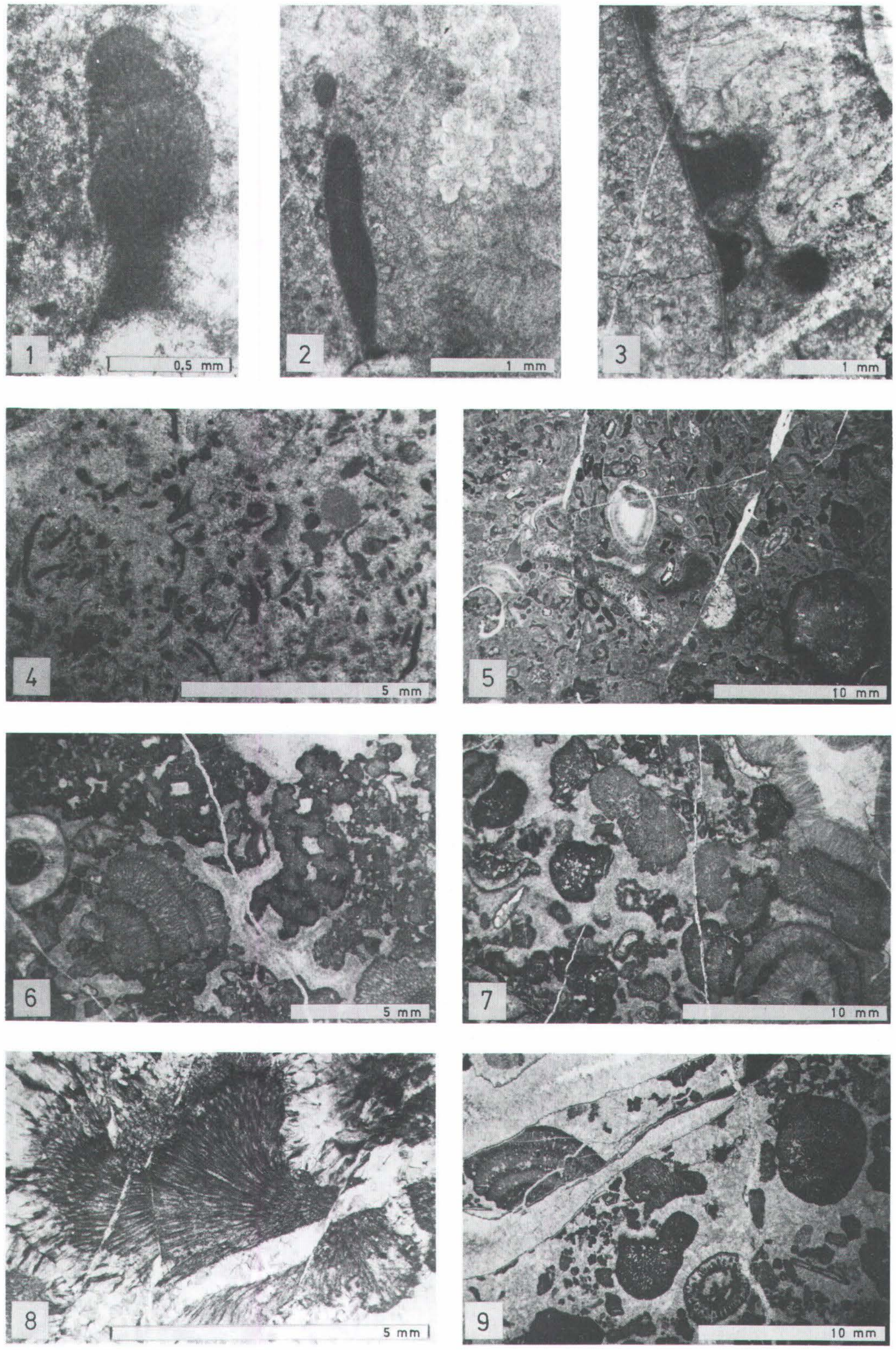

Fig. 1: Wetterstein Limestone in reef-facies with superb Ladinella porata. Wiege.

Fig. 2: Wetterstein Limestone in reef-facies with elongate growth-form of *Ladinella porata* and *Baccanella floriformis*. Wiege.

Fig. 3: Wetterstein Limestone in reef-facies with *Ladinella porata*. Trail from Hallerhaus to Promiskagraben.

Fig. 4: Wetterstein Limestone in reef-facies with abundant "tubes in the reef-debris" sensu OTT and peloids. Waxriegel/Hochschneeberg.

Fig. 5: Wetterstein Limestone in reef-facies with debris of calcareous sponges, corals and brachiopods, "tubes in the reef-debris" and gastropod hash. Predigtstuhl/Rax-Plateau.

Fig. 6: Lagoonal Wetterstein Limestone in birdseye-facies with solenoporaceans. Saubersdorfer Wald, north "Kehr".

Fig. 7: Lagoonal Wetterstein Limestone. Grainstone with *Teutloporella herculea*, solenoporacean and codiacean algae. North of Scheibwaldhöhe/Rax.

Fig. 8: Lagoonal Wetterstein Limestone. Solenoporacean alga surrounded by pervasive generations of fibrous cement. Creek west Johannesbachklamm.

Fig. 9: Lagoonal Wetterstein Limestone. Grainstone with solenoporaceans and dasycladaceans. Trail from Otto Haus to Wachthüttelkamm, Rax-Plateau.

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Abstrakt

Pri faciálnom porovnávaní východoalpských a západokarpatských wettersteinských karbonátových platforiem a priľahlých pánvových oblastí sa podľa očakávania ukazuje množstvo spoločných znakov.

Wettersteinské karbonátové platformy majú prevažne progradačný (regresívny) charakter. Ich vývoj začal od vrchného anisu postupným narastaním do pánvových oblastí (reiflinské a schreyeralmské vápence). Vývoj viedol cez svahové (grafensteigské, raminské a iné vápence) a predrífové brekcie k „rífovej" fáze wettersteinských vápencov. Tieto sú prekryté lagunárnou fáciou wettersteinských vápencov, často dolomitizovaných.

Rífový vývoj wettersteinských vápencov má z biologického hľadiska ešte mnoho spoločných znakov s vrchnopermskými rífmi (napr. s guadalupskou formáciou) s prevládaním bindstones a bafflestones. Na rozdiel od prevažne vo vrchnej časti svahu situovaných vrchnopermských rífov sú však hubovo-tubifytové nárasty wettersteinských vápencov situované prevažne na okraj karbonátovej platformy (tým vykazujú značnú analógiu s pozdejším vývojom dachteinského vápenca v noriku a v „réte"). Poukazuje na to často pozorované prstovité prelínanie rífov s peritidálnymi lagunárnymi sedimentami, napr. so stromatolitmi. Na druhej strane tiež často pozorovaná synsedimentárna cementácia morským radiaxiálnym fibróznym kalcitom (včítane cementácie s veľkými oolitmi) poukazuje ešte na úzku afinitu k permskému charakteru rífov.

Wettersteinským rífom teda prislúcha dôležitá „sprostredkovateľská" úloha medzi paleozoickými typmi rífov a modernejšími rífmi na okrajoch šelfov s dominujúcou stavbou typu framestone.

Zusammenfassung

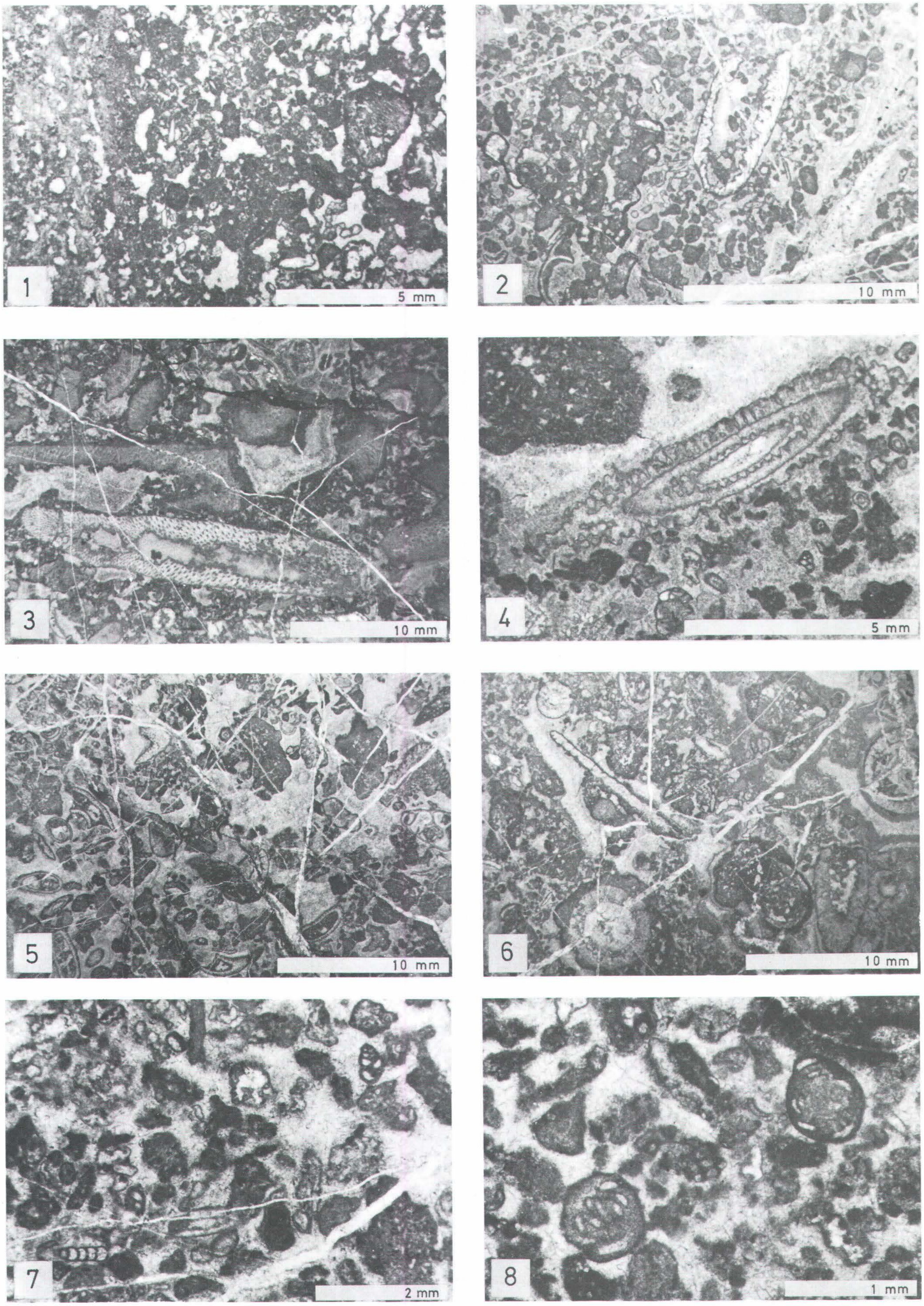
Ein Faziesvergleich zwischen den ostalpinen und westkarpatischen Wettersteinkalk-Karbonatplattformen zeigt erwartungsgemäß größte Übereinstimmung. Die progradierende regressive Wetterstein-Karbonatplattformentwicklung setzte im Oberanis über eine Beckenentwicklung ein und führte über Slope-Sedimente (Grafensteigkalk, Raminger Kalk u.a.) zu einer „Riff"-Phase, die wiederum von einer lagunären Entwicklung abgelöst wird mit häufig auftretender Dolomitisierung.

Die „Riff"-Entwicklung des Wettersteinkalks ist in biologischer Hinsicht noch stark an das Oberperm (z.B. Guadalupe-Formation) angelehnt, mit einer Dominanz von Bindstones und Bafflestones. In Gegensatz zu den überwiegend am oberen Slope situierten Oberperm-Riffen sind die Spongien/Tubiphyten-Bauten des Wettersteinkalks als deutlicher Anklang an die folgende Dachsteinkalk-Entwicklung im Nor/„Rhät" zu verstehen und überwiegend am Plattformrand gelegen. Dafür spricht die oftmals beobachtete Verzahnung der Riffe mit peritidalen lagunären Sedimenten, etwa mit Birdseye-Kalken. Sehr häufig zu beobachtende synsedimentäre marine radiaxial fibröse Kalzit-Zementation (inkl. der Großoolith-Zementation) weist noch auf enge Bindung an den permischen Riffcharakter hin.

Den Wettersteinkalk-Riffen kommt also eine wichtige „Vermittlerrolle" zwischen dem paläozoischen Rifftyp und den modernen Framestone-dominierten Schelfrandriffen zu.

►

Fig. 1: Lagoonal Wetterstein Limestone; biointrapelsparite, birdseye-facies. Trail from Otto Haus to Wachthüttelkamm/Rax-Plateau.
Fig. 2: Lagoonal Wetterstein Limestone. Grainstone (peloidal, grapestone-lumps) with fragments of dasycladaceans (*Teutloporella herculea*), solenoporaceans, molluscs and abundant biogenic incrustations. Northwestern slope of Dürrenberg.
Fig. 3: Lagoonal Wetterstein Limestone with *Teutloporella herculea* and partly micritized grains. Dürrenberg.
Fig. 4: Lagoonal Wetterstein Limestone with dasycladaceans (*Poikiloporella duplicata*), solenoporaceans and codiaceans, foraminifera. North of Feichterberg.
Fig. 5: Lagoonal Wetterstein Limestone. Grainstone with *Aciculella*, fragments of dasycladaceans and gastropods. Most grains are micritized. Entrance of Kesselgraben, northern slope of Rax.
Fig. 6: Lagoonal Wetterstein Limestone. Grainstone with dasycladaceans (*Teutloporella herculea* and *Poikiloporella duplicata*). 400 meters west of Raxgmoa Hütte.
Fig. 7: Lagoonal Wetterstein Limestone. Grainstone with foraminifera (nodosariids and textulariids) and debris of solenoporaceans and gastropods. Peloids and intraclasts in part micritized. Trail from Haller Haus to Kaiserbrunn, approximately 1 120 meters above sea level.
Fig. 8: Lagoonal Wetterstein Limestone. Biointrapelsparitic grainstone with involutinid foraminifera (Permodiscids) and often micritized clasts of solenoporaceans. Location as Fig. 7: 1 160 meters above sea level. Diagenetic fabrics in Middle Triassic limestones.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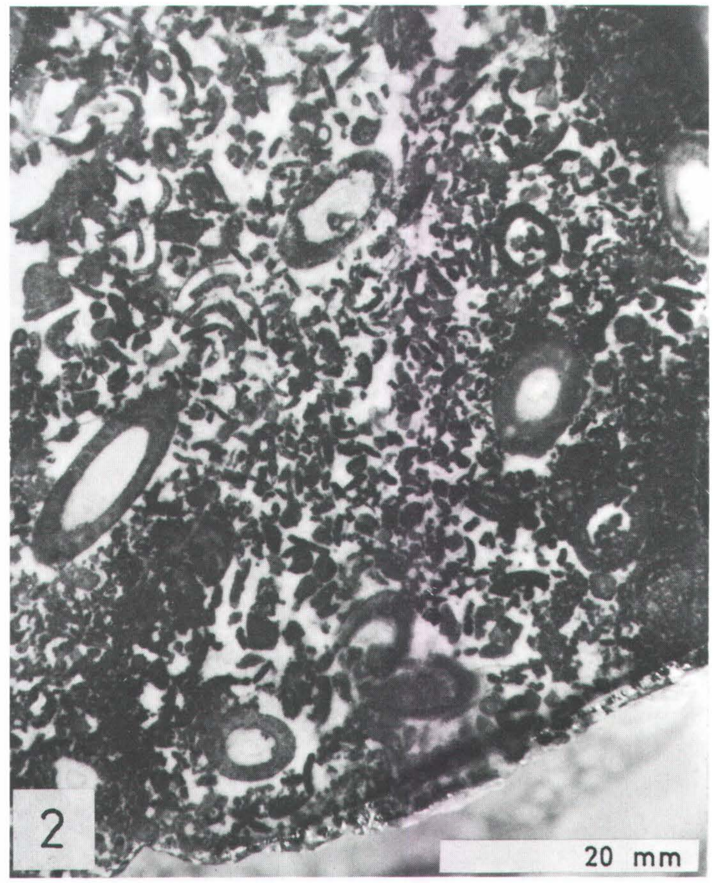

Fig. 1: Photomicrograph (cross-polars) of radiaxial-fibrous calcite fabric of grossoolite cement; length of scale 5.0 mm. Schneeberg Plateau.

Fig. 2: Slab of lagoonal facies with *Teutloporella*, pervasively marine-cemented (white interparticle matrix); length of scale 20 mm. Rax Plateau.

Fig. 3: Photomicrograph (cross-polars) of syndepositional marine cements in reef facies; note recrystallized sponge (arrow); length of scale 1.0 mm. Rax Plateau.

Fig. 4: Slab of grossoolite-breccia facies, showing truncated earlier generation of laminated radiaxialfibrous cement (arrows) overlain by later generation of cement (white); length of scale 25 mm. Schneeberg Plateau.