The Neogene in Austria

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Introduction

In the East Alpine area sedimentation during theNeogene is confined to the Molasse zone and to several intramountain–basins (fig.1). Concerning calcareous algae, the small intramountain–basins are unimportant, whereas the molasse zone and the marginal basins in the east (Vienna Basin, Eisenstadt Basin, Styrian Basin) contain remarkably well developed algal sediments, however, restricted to a few stratigraphic horizons.

1. Molasse Zone

Despite a characean flora in the "Untere Süßwasser Molasse" (lowermost Miocene: Egerian) of Vorarlberg(TOLLMANN 1985), algal-dominated sediments occur only during the Eggenburgian (fig.2) in the northeastern part of the Molasse zone. They are located at the eastern margin of the Bohemian massif in close neighbourhood to the type locality of the Eggenburgian. In this area a pronounced facies differentiation is developed during the Eggenburgian.Algal sediments, however, are restricted to the Zogelsdorf Formation. This formation is built mainly by shallow – water limestones influenced by a variable amount of siliciclastics. The microfacies of this formation was recently studied by NEBELSICK(1989) in the vicinity of Eggenburg. He distinguished 8 facies zones (Coralline Algal F., Bryozoan F., Coralline Algal–Bryozoan F., Echinoderm–Foraminiferal F., Bivalve–Barnacle F., Oyster F., Conglomerate F., Calcareous Sandstone F.). The facies distribution (fig.3) is controlled by a complex palaeotopography, the general hydrodynamic conditions and the terrigenous input. For the deposition of coralline algal facies (frequently with rodoliths) as well as the bryozoan facies, low energy conditions in protected areas were postulated. A first,provisional identification of coralline algae of this area was presented in NEBELSICK et al. (1991).

Most of the material is poorly preserved due to the sandy, siliciclastic composition of the rocks. Briefly reinvestigating the material, the following non–geniculate coralline red algae could be identified:

Sporolithon sp.,
Lithothamnion div. sp.,
Lithothamnion operculatum CONTI,
?*Palaeothamnium* sp.,
Mesophyllum div.sp.,
Lithophyllum div. sp.,
Spongites albanense (LEMOINE),
Spongites duplex (MASLOV),
?*Spongites microsporum* (MASLOV),
Titanoderma cf. *nataliae* (MASLOV),
Lithoporella sp.

The coralline algae mainly occur in rhodoliths where they are frequently intergrown with bryozoans and balanids. The general trend in the studied section shows rhodoliths most frequently in the lower part of the sections, upsection becoming replaced by bryozoans. This trend is interpreted by a deepening of the environment.

2. Basins along the eastern margin of the Alps

The basins included in this description are the Vienna Basin, the Eisenstadt Basin and the Styrian Basin. All three are part of the Paratethys and belong, structurally, to the Pannonian basin system (ROYDEN & HORVATH 1988). The Vienna basin is a typical pull–apart basin along a northeast–striking, left–slip fault zone (ROYDEN 1988; WESSELY 1988; SAUER et al. 1992). Basin extension and sedimentation started during the Karpatian (STEININGER et al. 1986) and tectonic movements created a complex structural pattern. Tension and subsidence reached their maximum in Middle (Badenian) to Late Miocene (Pannonian) times. The synsedimentary filling of the basin created deposits up to more than 5000 m in thickness.

The facial development starts in the Karpatian and Lower Badenian with clastic sediments of fluvial origin, sometimes with the formation of lignites (STEININGER et al. 1989) in marginal positions. A full marine environment was established during the Lower Badenian (Lagenid Zone), however, in the uppermost Badenian and during the Sarmatian a reduction in salinity occured. This evolution led to a brackish environment in the Pannonian and deposition of terrestrial sediments in the Pontian. Due to this development, carbonate sediments and calcareous algae are restricted to the Badenian and Sarmatian.

The development of the Eisenstadt basin is very similar to that of the Vienna basin. Therefore, this small area is usually considered as a subbasin of the Vienna basin (e.g. SAUER et al. 1992: 49).

For the origin of the Styrian basin also a pull–apart mechanism is suggested (FLÜGEL 1988), however, its evolution is also closely related to block–rotation and –tilting in connection with a "continental–escape" in the Eastern Alps (NEUBAUER & GENSER 1990; FRIEBE 1991). Due to these processes it is internally separated into several subbasins by morphological highs. Sedimentation started in the (?)Ottnangian (Early Miocene) and continued to the Pannonian (Late Miocene). Similar to the Vienna basin, carbonate sediments and the occurrence of calcareous algae are restricted to the Badenian and Sarmatian (KOLLMANN 1965).

Algal dominated or influenced sediments are very similar in all three basins and are therefore be discussed together.

2.1. Badenian

In the Badenian, besides the typical, fine–clastic, basinal sediments of the Baden Tegel, the most characteristic and widespread shallow-water carbonate equivalent is the Leitha Limestone ("Leithakalk"). This unit is well known since the beginning of the 19th century (KEFERSTEIN 1928) and the term is used also outside the Vienna basin (e.g. STUDENCKI 1988). Due to the abundance of coralline algae this unit is frequently (also recently) called Nullipora–, Lithothamnium or Lithothamnion Limestone (e.g. WESSELY 1983; BRIX & PÖLCHINGER 1988, SAUER et al. 1992). The term was very unprecisely used from the beginning, until PAPP & STEININGER in: PAPP et al. (1978: 194ff.) newly defined its content and took also its high variable facial development into consideration (compare Stop 14, chapter B7). The greatest thickness of the Leitha Limestone is about 50m (TOLLMANN 1985). Mainly basing on a study of Leitha Limestone of the Eisenstadt Basin, a classification of microfacies was introduced by DULLO (1983) resulting in 10 microfacies types (bioclastic algal debris facies, bio-

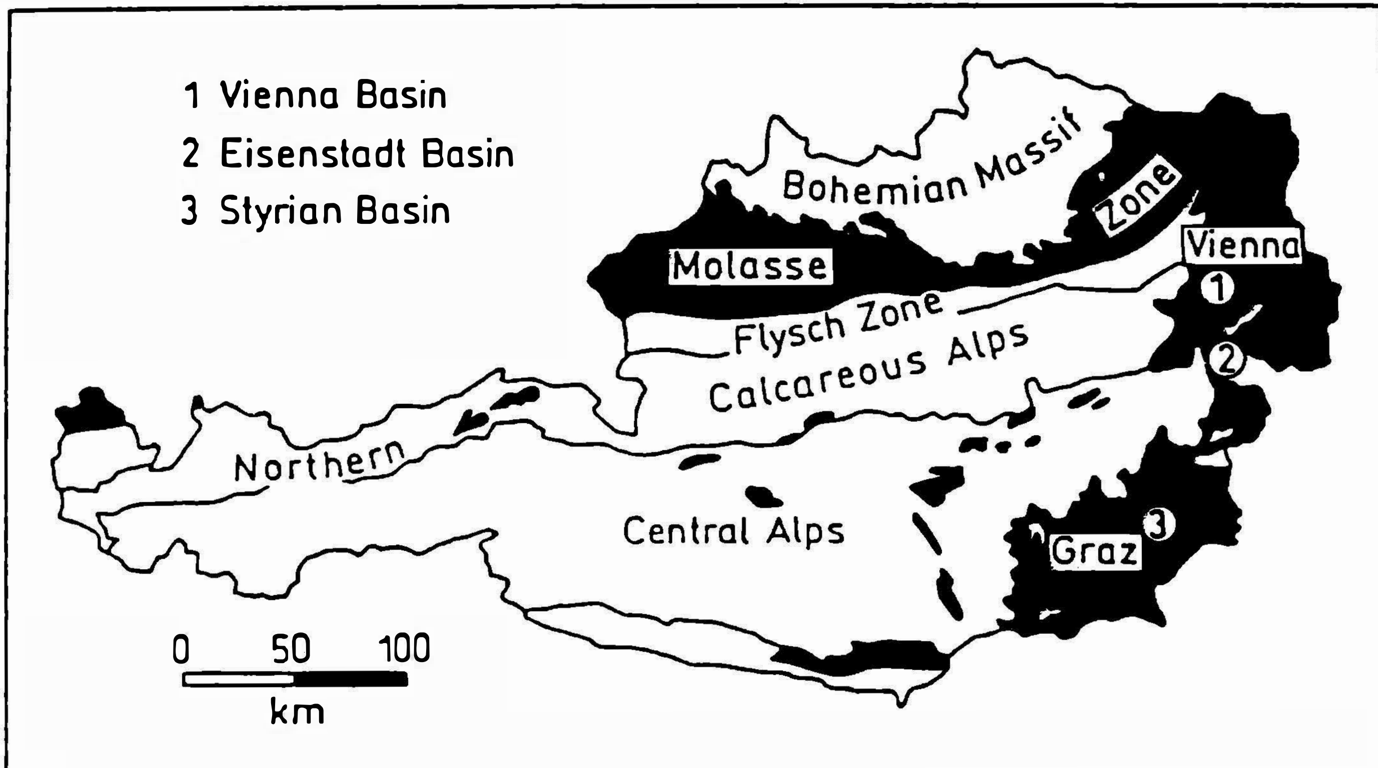

Fig. 1: Occurrence of Neogene sediments (shown in black) in the Austrian Eastern Alps (after TOLLMANN 1985).

clastic rhodolite debris f., bioclastic algal mollusc f., bioclastic f., bafflestone f., foraminiferal algal mollusc f., pavement f., foraminiferal rhodolite f., foraminiferal algal debris f., foraminiferal f.). These microfacies types were also applied to the Leitha Limestone of the Styrian Basin by FRIEBE (1988, 1990, 1991a, b). He also summarized the Leitha Limestones of the Styrian Basin together with other shallow-water sediments in the "Weißenegg Formation".

From the above microfacies types it is obvious that coralline algae are the dominant and/or characteristic sediment constituents of the Leitha Limestone. Considering an historic aspect, the Leitha Limestone is of great importance since the first fossil coralline red alga ever described originates from this unit – *Nullipora ramosissima* described by REUSS 1847 (however, asigned to corals). After only a few papers dealing with coralline algae of the Leitha Limestone (UNGER 1858; GÜMBEL 1871; LEMOINE 1939), the first more detailed description of the coralline algal flora was performed by CONTI (1946a, b). The material for this study was provided by J. PIA and CONTI described 16 species, comprising 1 new genus (*Palaeothamnium)* and 10 new species, as well as providing a revision and emendation of *Lithothamnium ramosissimum* REUSS (CONTI 1946a). Subsequently, coralline algae of 2 Leitha Limestone localities of the northeastern margin of the Vienna Basin (belonging to Slovakia) were described by SCHALEKOVA (1969, 1973).

The flora described by the authors comprises the following 25 species:

Archaeolithothamnium leithakalki CONTI,
Archaeolithothamnium cf. cyrenaicum RAINERI,
Lithothamnium ramosissimum (GUEMBEL) CONTI,
Lithothamnium florea brassica (MILLET) LEMOINE,
Lithothamnium operculatum CONTI,
Lithothamnium elongatum CONTI,
Palaeothamnium archaeotypum CONTI,
Mesophyllum roveretoi CONTI,
Mesophyllum ingestum CONTI,
Mesophyllum laffittei LEMOINE,
Lithophyllum ramosissimum (REUSS),
Lithophyllum pseudo–ramosissimum (UNGER),
Lithophyllum Piai CONTI,
Lithophyllum atrum CONTI,
Lithophyllum nobile CONTI,
Lithophyllum aequinnixum CONTI,
Lithophyllum exiguum CONTI,
Lithophyllum anguineum CONTI,
Lithophyllum expansum PHILIPPI,
Lithophyllum prelichenoides LEMOINE,
Lithophyllum capederi LEMOINE,
Lithophyllum (Dermatolithon) sp.,
Melobesia sp.,
Jania guamensis JOHNSON,
Corallina sp.

The discovery of original material of REUSS by the author (PILLER 1991) renders – once more – reclassification and emendation of "*Nullipora ramosissima*". The Leitha Limestone flora is currently under study, its diversity, however, is much higher than listed above.
Characeans are also reported from the Badenian (e.g. DANIELOPOL et al. 1991), however, a detailed descritption is missing.

2.2. Sarmatian

Due to a general reduction in salinity, calcareous sedimentation is less important during the Sarmatian. It is characterized by so-called "detrital Leitha

Limestones", ooliths and the occurrence of typical serpulid–bryozoan–foraminiferan–bioherms (e.g. PAPP et al. 1974; FRIEBE 1993). The "detrital Leitha Limestone" represents mainly reworked Badenian Leitha Limestone since synsedimentary carbonate production is low. However, 2 Sarmatian species of coralline algae were described by KAMPTNER (1941, 1942) (*Lithophyllum sarmaticum*, *Melobesia (Litholepis) carnuntina)*. Recently, *L. sarmaticum* KAMTNER and *Titanoderma ucrainica* (MASLOV) were reported by FRIEBE (1993) from the Styrian Basin, together with *Cymopolia* sp. and the occurrence of microbial limestones. The latter are composed of stromatolite layers and micritic crusts; sometimes also *Wetheredella*–like structures occur.

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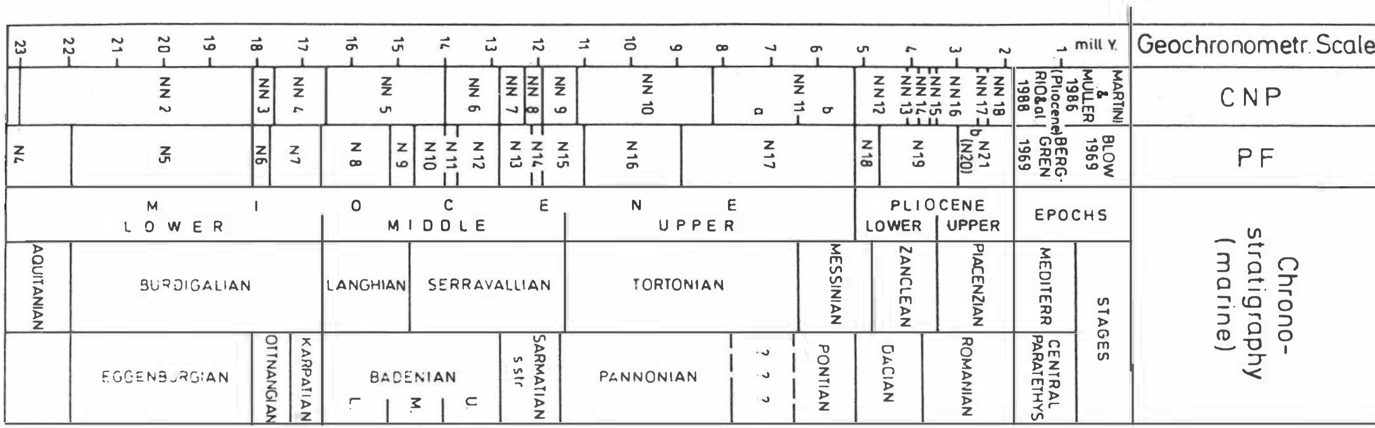
Fig. 2: Lithostratigraphy, facies and chronostratigraphy of the Upper Oligocene and Lower Miocene in the Eggenburg area.



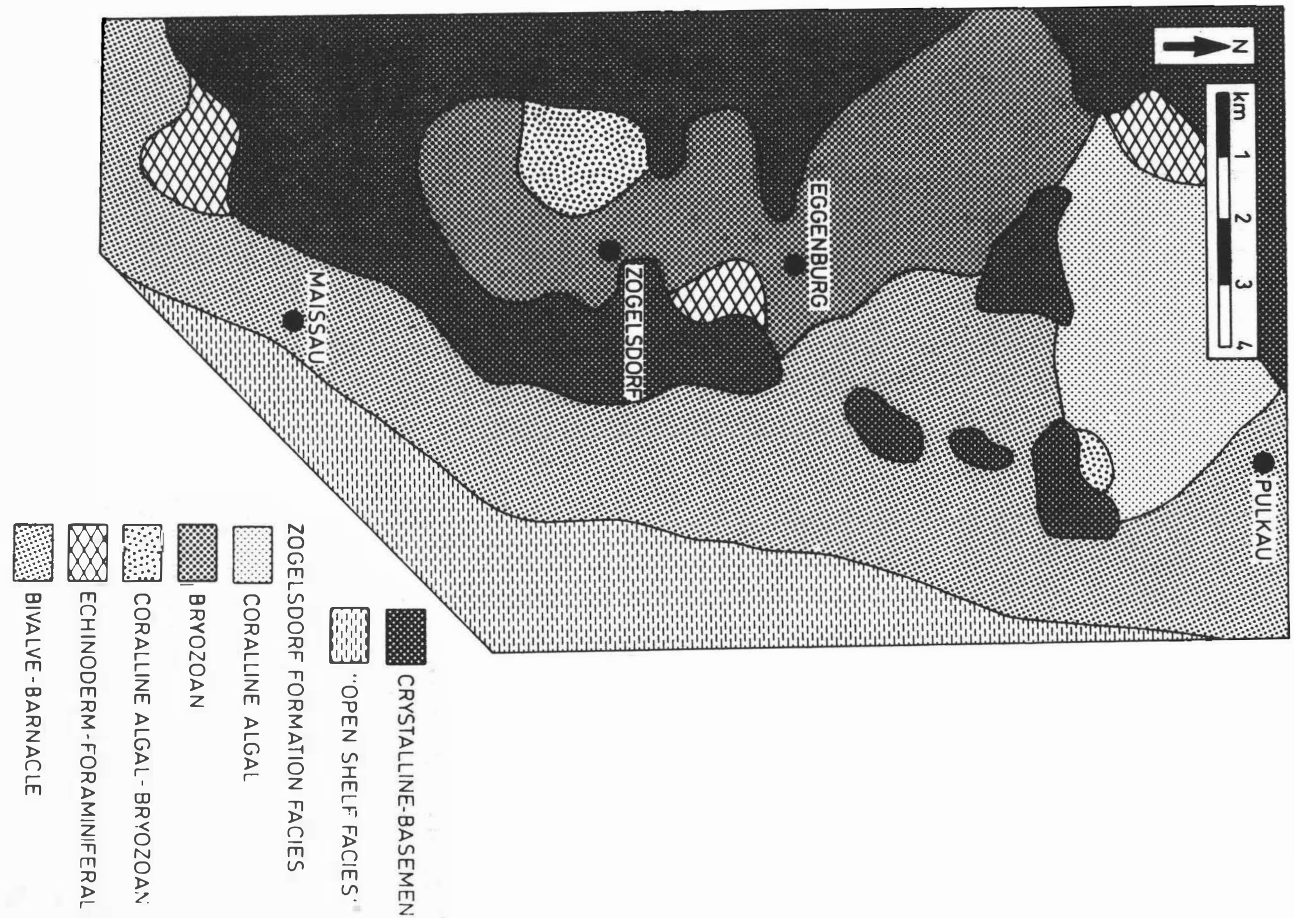


Fig.3 Facies distribution of the Zogelsdorf Formation (Eggenburgian) in the Eggenburg area (after NEBELSICK 1989: fig.9).

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