THE RESSEN FORMATION OF "SCHLEIFSTEINBRUCH" ON MT. RESSEN AND ASTERBACH (GOSAU, UPPER AUSTRIA)

DIE RESSEN-FORMATION DES SCHLEIFSTEINBRUCHS AM RESSEN UND DER LOKALITÄT ASTERBACH-BRÜCKE (GOSAU, OBERÖSTERREICH)

Lilian Švábenická[(1)], Marcela Svobodová [(2)], Franz Ottner [(3)] und Harald Lobitzer[(4)]

ABSTRACT

Two samples of the marly top-layers above the economically exploited sandstones from Gosau grinding stone quarry of the classical area of the Ressen Formation (Upper Gosau Subgroup) have been studied by means of calcareous nannoplankton, palynomorphs and from the mineralogical point of view. The presence of the nannofossil taxon *Broinsonia parca parca* evidences zone UC14a sensu Burnett 1998, lower part of Lower Campanian. In addition four samples from the transition zone from the Ressen- to the Nierental Formation at the locality of Asterbach-Brücke have been biostratigraphically evaluated by calcareous nannoplankton that proves the Lower Campanian age (zone UC14c-d^{TP}).

ZUSAMMENFASSUNG

Zwei Proben der mergeligen Überlagerung des ökonomisch genutzten Sandsteins im Gosauer Schleifsteinbruch (klassisches Gebiet der Ressen-Formation, Obere Gosau-Gruppe) wurden im Hinblick auf kalkiges Nannoplankton, Palynomorphen und Mineralogie studiert. Das Vorkommen des Nannoplankton-Taxons *Broinsonia parca parca* spricht für ein unteres Untercampan-Alter (Nanno-Zone UC14a sensu Burnett 1998). Weiters wurden vier Proben aus dem Übergangsbereich der Ressen- zur Nierental-Formation von der Lokalität Asterbach-Brücke mit Hilfe von Nannoplankton untersucht. Auch dieser andersartig ausgebildeten Lithofazies konnte ein Alter von unterem Untercampan (Nanno-Zone UC14c-d^{TP} sensu Burnett 1998) zugewiesen werden.

I. PREVIOUS RESEARCH

When the Bohemian naturalist Johann Baptist Bohadsch explored in 1763 (published in 1782) also the natural resources of the Gosau region, he refers already to a long tradition of grinding stone mining in the „Schleifsteinbrüche" on Mt. Ressen. He also mentions the export of these high-quality products. Practically all later larger papers dealing with the geology of the Gosau region also refer to the peculiar grinding stone mining on Mt. Ressen, e.g. Lill von Lilienbach (1830), Reuss (1853, 1854), Felix (1908), Brinkmann (1934), Weigel (1937), Ganss (in Ganss et al. 1954) and Wagreich (2002).
Reuss (1854) gives a very detailed description of the [at that time] abundant grinding stone quarries. Also Kittl (1903) describes briefly the "Schleifsteinbrüche am Löckermoos": "On top of the fossil-rich marls of the Hofergraben follow marls poor in fossils ... and the slightly SSE dipping sandstones without fossils [of the Schleifsteinbrüche] represent the top of the sequence...". Brinkmann (1934) considers the sandstones of the Ressen Formation to be a lateral equivalent of the Nierental Formation. A paper by Ganss (in Ganss et al. 1954) deals with the peculiar petrological properties responsible for the excellent quality of the grinding stone: "hard quartz grains embedded in a tough clayey-marly matrix". He considered the Ressen Formation. as being partly coeval with the lower part of the Nierental Formation, i.e. of the Upper Santonian to Lower Campanian age.

List of samples

Sample No. GO3: Marls overlying the sandstone in the grinding stone quarry (Schleifsteinbruch), which is quarried at present by Mr. Manfred Wallner.
Sample No. GO3A: brittle grey marls from the western part of the quarry;
Sample No. GO3B: soft, ochre weathered marls from the eastern part of the quarry.

[1)] Czech Geological Survey, Klárov 131/3, P.O.Box 85, CZ-118 21 Prague (svab@cgu.cz); [2)] Academy of Sciences of the Czech Republic, Institute of Geology, Rozvojová 135, CZ-165 00 Prague (msvobodova@gli.cas.cz); [3)] Universität für Bodenkultur, Institut für Angewandte Geologie, Peter Jordan Str. 70, A-1190 Wien (ottner@mail.boku.ac.at); [4)] Geologische Bundesanstalt, Rasumofskygasse 23, A-1031 Wien (hlobitzer@cc.geolba.ac.at)

II. RESSEN FORMATION OF SCHLEIFSTEINBRUCH TOP-CLAYS

The Ressen Formation comprises a sequence of well bedded sandstones with soft and brittle fine-bedded (sandy) marl intercalations and conglomerates. The sandstone is often rich in plant debris, scarce trace fossils and also small coal particles can be observed, otherwise it seems to be unfossiliferous. The sandstone of the grinding stone quarry is under- and overlain by marls. The hanging marls of the grinding stone quarry are presently well exposed. At present the basis of the grinding stone is not cropping out, however, Reuss (1854) mentions "grey, thin-bedded sandy marls, which underlay the grinding stone".

II.1. Mineralogy

The bulk mineralogical composition of the two marl samples (Nos. GO3A/GO3B) from the top-set of Schleifsteinbruch is rather homogenous. Calcite (12/24 mass-%) is present in moderate amounts, dolomite (7/4 mass-%) and feldspar (mostly plagioclase 5/8 mass-%) in rather low amounts. The predominant mineral group are the layer silicates (63/53 mass-%), which are represented mainly by muscovite and chlorite. Also traces of paragonite (Na-mica) are present.
Also the clay mineralogical composition of samples Nos. GO3A/GO3B is quite homogenous. Illite (61/64 mass-%) predominates, chlorite (25/24 mass-%) can be found in moderate amounts, while smectite (11/10 mass-%) occurs in rather low quantities and kaolinite (3/2 mass-%) only in very low contents.
From the mineralogical composition it can be concluded, that the provenance-region of the marls consisted of slightly metamorphic rocks rich in mica and chlorite.

II.2. Palaeontology and biostratigraphy

Foraminifers

Above mentioned deposits were washed for microfossils, however, despite of one poorly preserved specimen of the foraminifer *Ataxophragmium* in sample No. GO3A, no microfossils were found. This taxon is without any stratigraphic value (determinations courtesy by Mrs. Lenka Hradecká, Czech Geological Survey, Prague).

Calcareous nannofossils

Sediments of samples Nos. GO3A,B provided very poor (1-3 specimens per 1 field of view of the microscope) and poorly preserved nannofossils. Placoliths are etched and mostly in fragments. Nannofossil assemblages contain rare specimens of *Lucianorhabdus cayeuxii* (both species A and B sensu Wagreich 1992) and rare specimens of *Broinsonia parca parca.* On rare occasion, *Rucinolithus hayi* and *Arkhangelskiella cymbiformis* are present. *Broinsonia parca parca* evidences zone UC14a (Burnett 1998), the lower part of Lower Campanian.
Concerning the Lower Campanian marker species (subspecies respectively) *Broinsonia parca parca*, it is not easy to distinguish sometimes this subspecies from the other one of *Broinsonia parca expansa* its first occurrence is mentioned from the Coniacian. Probably transitional froms of *B. p. expansa-parca* were observed in sample No. GO3A. Unfortunately, their identification was problematical thanks to the poor preservation of specimens. *Broinsonia parca parca* was found in sample GO3B. These specimens show the following phenomena: 1. relatively large placolith, 2. broadly elliptical in outline, 3. broad outer rim, 4. approximately the same size of outer rim and central area in short axis of ellipsoid are evident.
Wagreich (1992) mentioned the first occurrence of *Lucianorhabdus cayeuxii* species B ("curved forms") within the upper part of Santonian in the Lower Gosau Group of Austria.

Palynomorphs

Both marine microplankton and spore-pollen assemblages were studied. The preservation of most palynomorphs was rather poor and the quantity was low. Sample No. GO3B provided palynomorphs for biostratigraphical and palaeoecological evaluation. Dinoflagellate cysts were more important for both purposes mentioned than triporate angiosperm pollen.
A relatively rich assemblage of dinoflagellate cysts of at least three species of *Dinogymnium*, namely *Dinogymnium acuminatum* Evitt et al., *Dinogymnium denticulatum* (Alberti) Evitt et al., *Dinogymnium curvatum* (Vozzhennikova) Lentin & Williams occurs. *Dinogymnium denticulatum* was recorded so far from the Santonian and Campanian-Maastrichtian sections.

Dinogymnium acuminatum was recorded from the Coniacian-Maastrichtian. The important species *Odontochitina operculata* (O. Wetzel) Deflandre & Cookson occurs in sample No. GO3B (Williams & Bujak 1985).
The triporate pollen are represented by *Oculopollis* cf. *principalis*, *Oculopollis* spp., *Interporopollenites* sp. and *Hungaropollis* sp.

Palaeoecological remarks

From the palaeoecological point of view, the presence of the dinoflagellate cyst of the genera *Odontochitina* and *Dinogymnium* reflects an environment with reduced salinity or salinity fluctuations, which may evidence a nearshore, probably estuarine depositional environment (May Palynology 1). In contrast to this conclusion, the occurrence of calcareous nannofossils documents shallow marine conditions of normal salinity.

III. TRANSITION OF RESSEN- TO NIERENTAL FORMATION AT THE LOCALITY OF ASTER-BACH-BRÜCKE

In their guidebook Kollmann & Summesberger (1982) described as "stop 12.: Bridge over Aster Graben" an outcrop of "sandstone with greenish shales of the Ressen formation" (Fig. 1: altitude about 1030 m). They assume the Lower to Upper Campanian age of the Ressen Formation.

Fig. 1: The outcrop at the Asterbach bridge

The flyschoid sequence on a road-cut south of Asterbach-Brücke shows an outcropping thickness of about 3,5 m and comprises grey, greenish and more scarcely reddish-brown, more or less brittle, sandy marlstones intercalated with cm-dm thick sandstone layers. The marly intercalations are in the cm-range. A more than 0.5 m thick sandstone bed marks the top of the exposure. According to the opinion of present authors, this outcrop represents a transitional development from the Ressen- into the Nierental Formation. The dominating sandstone layers are surely characteristic for the Ressen Formation, however, according to some authors the onset of the reddish marl intercalations marks the basis of the Nierental Formation.
Four samples from the sandy marl intercalations were studied:
Sample No. AB1: grey, brittle marls from the bottom of the section. Upwards follow 30 cm intercalated sandstones and marls.
Sample No. AB2: the lowermost red marl intercalation; followed by a 1,5 m thick sequence of grey and red marls and sandstones.
Sample No. AB3: red marls, approximately 1 m below the sandstone top-set.
Sample No. AB4: variegated red/grey marls directly underlying the sandstone top-set.

Calcareous nannofossils

The four samples (Nos. AB1 to AB4) provided poorly preserved calcareous nannofossils; large- or medium-sized placoliths are mostly present in fragments. Assemblages are characterized by presence of *Broinsonia parca constricta* that indicates Campanian age, by abundance of *Watznaueria barnesae* and by higher numbers of *Cribrosphaerella ehrenbergii*. On rare occasions, *Lucianorhabdus cayeuxii* (including form B sensu Wagreich 1992), *Zeugrhabdotus praesigmoides*, *Calculites obscurus*, *Arkhangelskiella specillata* and specimens of genus *Rucinolithus* occur. Scarce presence of poorly preserved specimen of *Bukryaster hayi* was observed in sample No. AB2. The occurrence of *B. hayi* is known in short stratigraphic range. It is correlated within zone UC14c-d^{TP}, lower part of Lower Campanian sensu Burnett (1998). Moreover, this zone interval is compared with the upper part of the macrofossil (echinoid) Offaster pilula zone.

Asterbach Brücke	Early Campanian			
Nannofossil zone (Burnett 1998)	UC14b-c^{TP}			
sample Nos.	AB1	AB2	AB3	AB4
abundace of nannofossils	M	L	L	M
Arkhangelskiella specillata		R		R
Axopodorhabdus brooksii		R		
Biscutum ellipticum		R	R	
Broinsonia enormis	R			R
Broinsonia parca constricta	C	F	R	F
Broinsonia parca parca	F	R		R
Bukryaster hayi		R		
Calculites obscurus	F	F	R	F
Calculites ovalis	F	R	R	F
Chiastozygus litterarius	R	F	R	F
Corollithion signum		R		
Cribrosphaerella ehrenbergii	C	F	F	C
Cylindralithus cf. *sculptus*	R			
Cylindralithus sp.		R		R
Discorhabdus sp.	R			R
Eiffellithus eximius	F	F	R	F
Eiffellithus turriseiffelii	F	F	F	F
Gartnerago obliquum		R	R	R
Lucianorhabdus cayeuxii sp. A				R
Lucianorhabdus cayeuxii sp. B	R			
Lucianorhabdus inflatus	R			
Lucianorhabdus maleformis	F			R
Manivitella pemmatoidea	R	R	R	R
Microrhabdulus attenuatus	R	R	R	
Microrhabdulus belgicus	F			
Microrhabdulus decoratus				R
Micula staurophora	F	R	F	R
Placozygus cf. *fibuliformis*		R	R	F
Prediscosphaera cretacea	C	F	C	F
Prediscosphaera grandis		R		R
Prediscosphaera ponticula			R	
Reinhardtites anthophorus	F	F	R	F
Retacapsa angustiforata		R		
Retacapsa crenulata	F	F	F	F
Rucinolithus cf. *hayi*		R		
Rucionlithus sp.			R	
Watznaueria barnesae	C	C	C	C
Zeugrhabdotus bicrescenticus	F	F	R	F
Zeugrhabdotus diplogrammus	F			R
Zeugrhabdotus embergerii	R			
Zeugrhabdotus praesigmoides	R			

Tab. 1 Distribution of calcareous nannofossils at the locality of Asterbach-Brücke.
Abundance of nannofossils in sample: M = medium (>10 specimens per 1 view of microscope), L = low (<10 specimens per 1 view of the microscope). Abundance of nannofossil taxa: C = common (>5 specimens per 1 field/1 field of view), F = few (5-1 specimens/1 field of view), R = rare (<1 specimen/1 field of view).

Acknowledgments

Fieldwork was financed by the bilateral cooperation programme between the Austrian and Czech Geological Surveys and by the Czech-Austrian project Kontakt 2002-5.
Thanks to Mrs. Elisabeth Zecha (Geol. Survey, Vienna, Austria) for typeing the manuskript.

APPENDIX I: REFERENCES

Bohadsch J. B. 1782. Bericht über seine auf allerhöchsten Befehl im Jahre 1763 unternommene Reise nach dem oberösterr. Salzkammerbezirk. In: Born I. von (Ed.), Abh. Privatges. Böhmen **5**, 91-227, Prague.

Brinkmann R. 1934. Zur Schichtfolge und Lagerung der Gosau in den nördlichen Ostalpen. Sitzber. Preuß. Akad. Wiss., phys.-math. Kl. **144**, 145-149, Berlin.

Burnett J.A. 1998. Upper Cretaceous. In Bown P.R. (Ed.): Calcareous Nannofossil Biostratigraphy. British Micropalaeontological Society Publication Series. 132-199, London.

Evitt W.R., Clarke R.F.A., Verdier J-P. 1967. Dinoflagellate studies III. *Dinogymnium acuminatum* n. gen., n. sp. (Maastrichtian) and other fossils formerly referable to *Gymnodinium* Stein: Stanford Univ. Publ. Geol. Sci. **10**, 1-27.

Felix J. 1908. Studien über die Schichten der oberen Kreideformation in den Alpen und den Mediterrangebieten. II. Teil: Die Kreideschichten bei Gosau. Palaeontographica **54**, 251-344, 2 tabs., pls. 25-26, Stuttgart.

Ganss O. 1954. Das Becken von Gosau. In: Ganss O., Kümel F. & Spengler E. Erläuterungen zur geologischen Karte der Dachsteingruppe. Wiss. Alpenvereinshefte **15**, 77-82, Innsbruck.

Kittl E. 1903. Geologische Exkursionen im Salzkammergut. (Umgebung von Ischl, Hallstatt und Aussee). In: IX. Internat. Geol.-Kongr., Führer Nr. **IV**., 118p., 8 text-figs., photos, 1 geol. map 1:200.000, Wien.

Kollmann H. A. & Summesberger H. 1982. Excursions to Coniacian-Maastrichtian in the Austrian Alps. Working Group on the Coniacian-Maastrichtian stages. Fourth meeting. 105p., Wien (Naturhistor. Museum).

Lill von Lilienbach 1830. Ein Durchschnitt aus den Alpen, mit Hindeutungen auf die Karpathen. Jb. Miner. Geognosie etc., 153-220, Heidelberg.

May F. E.: Functional morphology, palaeoecology, and systematics of *Dinogymnium* test. Palynology **1**, 103-121, Houston.

Reuss A. E. 1853. Geologische Untersuchungen im Gosau-Thale im Sommer 1851. N. Jb. Miner., Geol., Geognosie u. Petrefakten-Kunde, Jg. 1853, 712-719, Stuttgart.

Reuss A.E. 1854. Beiträge zur Charakteristik der Kreideschichten in den Ostalpen, besonders im Gosauthale und am Wolfgangsee. Denkschriften kais. Akad. Wiss., mathem.-naturwiss. Cl. **7**, 1-156, 31 pls., Wien.

Wagreich M. 1988. Sedimentologie und Beckenentwicklung des tieferen Abschnittes (Santon-Untercampan) der Gosauschichtgruppe von Gosau und Rußbach (Oberösterreich-Salzburg). Jb. Geol. B.-A. **131**, 663-685, 12 text-figs., 2 tabs., Wien.

Wagreich M. 1992. Correlation of Late Cretaceous calcareous nannofossil zones with ammonite zones and planktonic Foraminifera. The Austrian Gosau sections. Cretaceous Research **13**, 505-516, London.

Wagreich M. 2002. Basin dynamics at the type locality of the Gosau Group (Late Cretaceous – Paleogene). Pangeo Austria Field Guide Excursion 1, 13 p., 5 figs., Wien.

Weigel O. 1937. Stratigraphie und Tektonik des Beckens von Gosau. Jb. Geol. B.-A. **87**, 11-40, 6 figs., geol. map 1:25.000, Wien.

Williams G.L., Bujak J.P. 1985. Mesozoic and Cenozoic dinoflagellates. In: Bolli H.M., Saunders J.B., Perch-Nielsen K. (Eds.), Plankton Stratigraphy, 847-964, Cambridge.