©Geol. Bundesanstalt, Wien; download unter www.geologie.ac.at

STOP 1. SPARBACH (SCHRAMBACH FORMATION; VALANIGINIAN TO BARREMIAN)

An Early Cretaceous radiolarian assemblage and its palaeoecological implications of the Northern Calcareous Alps (Barremian, Lunz Nappe, Lower Austria)

Compendium from Alexander LUKENEDER, Miroslava SMREČKOVA (2006)

Abstract: Detailed palaeontological and lithological studies of Lower Cretaceous sediments from Lower Austria uncovered spectra of Lower Barremian microfaunal elements (e.g. radiolarians). Lower Barremian radiolarians are figured for the first time from the Northern Calcareous Alps. The radiolarian assemblage from Sparbach was obtained out of marly limestone beds of the *Karsteniceras* Level. The Early Barremian level is dominated by the ammonoid *Karsteniceras ternbergense* (*Coronites darsi* Zone). The geochemical results (e.g. TOC, S, and $CaCO_3$) combined with preservational features (e.g. different pyrititization stages) of the radiolarian fauna indicate that the *Karsteniceras* Level was deposited under oxygen-depleted conditions, showing partly eutrophic peaks and producing mass occurrences of pyritized radiolarians in laminated, dark sediments.

Introduction

The Early Cretaceous of the Flössel Syncline is considered to range from the Late Valanginian to the Early Barremian (Lukeneder in press). The discovery of a Lower Cretaceous ammonoid mass-occurrence in the Flössel Syncline (Lunz Nappe, Northern Calcareous Alps, Lower Austria), of Early Barremian age, was recently published by Lukeneder (in press). The latter occurrence (*Karsteniceras* Level) is dominated by the heteromorph ancyloceratid *Karsteniceras*. An invasion of an opportunistic (r-strategist) *Karsteniceras* biocoenosis during unfavourable conditions over the sea-bed during the Early Barremian was proposed for the Sparbach section section. As noted by Lukeneder (2003b), the deposition of the limestones in this interval occurred in an unstable environment and was controlled by short- and long-term fluctuations in oxygen levels.

The main focus of this paper is to give a detailed description and stratigraphy combined of the known ammonoid zonation (Lukeneder in press) correlated with new microfossil data. As preservation and radiolarian abundance reflects primary environmental conditions the described radiolarian fauna is also investigated on these patterns. It has to be noted that the radiolarian abundance and their preservation depends on many factors, e.g. fertility of sea-water surface and amount of dissolution by sinking on the sea floor and in sediment.

In systematics and stratigraphy of Lower Cretaceous radiolarian faunas (mostly Europe) we refer to the extensively and accurate papers of Bak (1999), Baumgartner (1984), Baumgartner et al. (1995), Jud (1994), O' Dogherty (1994), Schaaf (1984), Goričan (1994) and De Wever et al. (2000). Most of these papers also deal with topics of biology, ecology and taphonomy. The most detailed compendium of the Jurassic and Lower

©Geol. Bundesanstalt, Wien; download unter www.geologie.ac.at

Cretaceous radiolarian systematic framework was done by Baumgartner et al. (1995). This book is till present days state of the art.

Specific investigations on microfacies and changing environmental conditions during Upper Jurassic and Lower Cretaceous times within the Northern Calcareous Alps and adjacent areas in the Carpathians were undertaken by Boorová et al. (1999), Ondrejíčková et al. (1993), Ožvoldová (1990), Ožvoldová and Peterčáková (1992), Peterčáková (1990), Reháková (2000), Sýkora – Ožv. Reháková et al. (1996), and Vašíček et al. (1994).

Study area and tectonic position

The outcrop is situated in the Frankenfels-Lunz Nappe System (Höllenstein Unit) in Lower Austria, about 1.5 km north of Sparbach (350 m, ÖK 1:50 000, sheet 58 Baden; Fig. 1; Schnabel 1997). This outcrop is located in the south-easternmost part of the northeast-southwest striking Flössel Syncline, running between the Höppelberg (700 m) to the west and near the Heuberg (680 m) to the east. It lies at the southern side of the Sparbach stream, 300 m west of the Johannstein ruin within the nature park of Sparbach. The exact position of the radiolarian-occurrence was determined by GPS (global positioning system): N 48°05'15'' and E 16°11'00'' (Fig. 1).

The fossiliferous beds (metre 160, 0.3 m thickness, dipping 320/40°) are part of the Schrambach Formation within the Flössel Syncline (see Toula 1886; Richarz 1905, 1908; Spitz 1910; Schwinghammer 1975). The Flössel Syncline is formed of Upper Triassic dolomite, followed by a reduced Jurassic sequence (see also Rosenberg 1965; Plöchinger & Prey 1993). The core of the Flössel Syncline consists of the Lower Cretaceous Schrambach Formation, which occurs throughout the Northern Calcareous Alps. Within the Lunz Nappe the Schrambach Formation comprises Upper Valanginian to Lower Barremian sediments.

Lithology

The Lower Cretaceous Schrambach Formation is a sequence of limestones and marls marked by rhythmically intercalated turbiditic sandstones, sedimented under relatively deep-water conditions (2003a). A short-term sedimentation is proposed for the sandstone layers, whereas the limestone- and marl-beds reflect 'normal' sedimentation rates. Dark marls and grey, spotted limestones are highly bioturbated biogenic mudstones to wackestones (Lukeneder in press).

The distinct-laminated appearance of the rock is a result of wispy, discontinuous, flaser-like laminae of dark (organic) material and some sorting of radiolarian tests into the layers. Many of these tests have been partly to completely replaced by pyrite (secondarily limonitic) in a micritic carbonate matrix. Pyritized radiolarians seem to be predominantly preserved around ammonoid tests. This could be due to the altered 'micro-environment', specifically the higher organic content (soft-body). The laminae range in thickness from 0.07-0.1 mm to 0.7-2.4 mm. Contacts between them are gradational to sharp. Phosphatic debris is abundant and consists mainly of fish scales, bones and teeth. Laminated brown-black mudstone is rich in organic carbon. Dark material is wispy amorphous organic matter. Pale areas are laminae of flattened radiolaria now replaced by microcrystalline chalcedony.

©Geol. Bundesanstalt, Wien; download unter www.geologie.ac.at

Thin sections: 0 not laminated mudstone; 1a distinct laminated mudstone; 1b laminated mudstone; 2a - 2c distinct laminated mudstone; 3a slightly bioturbated mudstone.

Constituent parts of marly limestones are: predominantly calcified radiolarians impregnated by Fe minerals, calcified sponge spicules, ostracods, rare bivalve fragments, seldom roveacrinids, crinoid ossicles, fragments of fish fish-scales, -teeth and -bones, ichthyoliths, planktonic foraminifers (*Favusella* sp.), benthic foraminifers (*Patellina* sp.). There are also small disintegrated floral fragments distributed in matrix, framboidal pyrit, organic matter accumulated in the nests and very rare glauconite grains. Carefully selected and washed samples of distinct laminated limestones contain primarily fine silt-sized, angular quartz grains, some pyrite and phosphatic material.

The calcium carbonate contents within the radiolarian beds (K1 and K2) ($CaCO_3$ equivalents calculated from total inorganic carbon) vary between 73 and 83%. The weight % TOC (Total Organic Carbon) values vary between 0.03 and 0.52%. Sulphur ranges from 0.27 to 0.57 mg/g (Fig. 4).

Material and radiolarian fauna

Bed-by-bed collecting and a systematic-taxonomic study provide the basic data for statistical analysis of the investigated radiolarian faunas. Palaeontological and palaeoecological investigations, combined with studies of lithofacies in thin sections, peels from polished rock surfaces and geochemical investigations, yielded information about the environmental conditions in the area of deposition.

Radiolarian assamblages were extracted from the marly limestone by means of dissolution in the 12% acetic acid (5 days). After sieving through 40μm screen and drying residue was prepared for picking up of specimens under the binocular microscope. Species determination was made by SEM.

The most abundant assemblage, obtained from sample 1a comprise 10 species of radiolarians, belonging to the order Nassellaria and 7 species to Spumellaria (Fig. 2). The assemblage analyzed is dominated by the species *Holocryptocanium barbui* DUMITRICA, representative of spherical cryptothoracic and cryptocephalic Nassellaria from the family *Williriedellidae*. The assemblage also includes nassellarians *Crolanium puga* (SCHAAF), *Cryptamphorella clivosa* (ALIEV), *Dibolachras tytthopora* FOREMAN, *Dictyomitra pseudoscalaris* (Tan), *Hiscocapsa asseni* (TAN), *Pseudodictyomitra lilyae* (TAN), *Sethocapsa dorysphaeroides* (NEVIANI), *Sethocapsa orca* FOREMAN, *Thanarla brouweri* (TAN) and *Xitus clava* (PARONA). Spumellarians, which are less common are represented by the species *Acaeniotyle diaphorogona* FOREMAN, *Acaeniotyle umbilicata* (RŰST), *Archaeospongoprunum patricki* JUD, *Pantanellium squinaboli* TAN, *Paronaella cf. trifoliacea* OŽVOLDOVÁ, *Suna hybum* (FOREMAN) and by the genus *Praeconosphaera* sp., which prevails among them. The radiolarians are pyritized, what is common in Lower Cretaceous literature (Ožvoldová 1990, Bak, 1995, 1996; Pessagno 1977; Thurow 1988) but not well understood till the recent paper of Bak and Sawlowicz (2000).

©Geol. Bundesanstalt, Wien; download unter www.geologie.ac.at

The macrofauna from bed K1 (beds 1-2; samples 1a-2c) and K2 (bed A; sample Aa) is predominated by sculpture-moulds of cephalopods which are described by Lukeneder (in press). The *Karsteniceras* Level at Sparbach yields important ammonoid taxa such as *Eulytoceras* sp., *Barremites (Barremites)* cf. *difficilis*, *Pulchellia* sp., *Holcodiscus* sp., *Anahamulina* cf. *subcincta* and *Karsteniceras ternbergense*. The cephalopod fauna is accompanied by aptychi (*Lamellaptychus*) and bivalves (*Propeamusium*).

The analysis of the fauna supports the interpretation of a soft to level bottom palaeoenvironment with a cephalopod-dominated community living near the epicontinental (epeiric) sea floor (Lukeneder, in press).

Biostratigraphy

The ammonoid association indicates that the cephalopod-bearing beds in the Schrambach Formation belong to the latest Early Barremian (probably to the *Moutoniceras moutonianum* ammonoid Zone; according to the results of the Vienna meeting of the Lower Cretaceous Ammonite Working Group of the IUGS; Hoedemaeker & Rawson 2000). The *M. moutonianum* Zone was recently replaced (according to the results of the Lyon meeting of the Lower Cretaceous Ammonite Working Group of the IUGS) by the *Coronites darsi* Zone (Hoedemaeker et al. 2003) (Fig. 3). Although *Moutoniceras moutonianum* and *Coronites darsi* are missing, the typical association hints to the latest Early Barremian. The radiolarian fauna of the Schrambach Formation belong to the *Coronites darsi* Zone ammonite Zone of the latest Lower Barremian (Hoedemaeker et al. 2003; Lukeneder 2001). The biostratigraphical evaluation of radiolarian assemblages was based on the biozonation of Baumgartner et al. (1995). The composition of association represents the longer stratigraphical range early Hauterivian - earliest late Aptian (sensu Baumgartner et al. 1995).

Discussion and conclusions

The microfauna of the Lower Cretaceous beds in the Sparbach succession (Flössel Syncline) is represented especially by radiolarians. The abundance of pyritized radiolarians tests is restricted to the distinctly laminated beds. The radiolarian assemblage enfolds a stratigraphical range from Early Hauterivian - earliest Late Aptian. The stratigraphic investigation of the accompanying ammonoid fauna constricts the age data and reveals that the investigated part of the Sparbach section comprises Lower Barremian sediments.

The geochemical results indicate that the assemblage was deposited under conditions of intermittent oxygen-depletion associated with stable water masses. The process was controlled by short- and long-term fluctuations in oxygen content, coupled with a poor circulation of bottom-water currents within an isolated, basin-like region. The brighter colour of the sediment and the lower content of TOC and sulphur at the Sparbach section indicate a less dysoxic environment as in comparable darker beds elsewhere in the Northern Calcareous Alps (e.g. KB1-B, Upper Austria). No evidences for condensationan can be found.

©Geol. Bundesanstalt, Wien; download unter www.geologie.ac.at

In the radiolarian assemblage nassellarians are dominant. Within the latter, genera *Holocryptocanium, Sethocapsa, Thanarla, Dictyomitra* and *Xitus* are the most important taxa. The assemblage is characterized by little diversification but specimen richness. *Holocryptocanium barbui* DUMITRICA dominates above all other species.

Holocryptocanium barbui DUMITRICA is a cryptocephalic and cryptothoracic species of the family *Williriedellidae* and in addition with the thick-walled forms of the genus *Praeconosphaera* hint to a deep-water fauna. The latter forms predominate over the spumellarians showing spiny test (e.g. *Acaeniotyle umbilicata, Pantanellium squinaboli*) which indicate shallower levels in the water column.

Bartolini et al. (1999) showed that the reproduction-speed of deep-water populations is much higher, where mixed water layers prevail containing high nutrient supply. Such conditions are proposed for the investigated radiolarian mass occurrence at the Sparbach. We therefore assume that the radiolarian association at Sparbach indicates eutrophic conditions and high flux of organic matter towards the sea-bottom. This presumption is supported by the geochemical and faunal facts given by Lukeneder (in press) for the same beds.

The spumellarians/nassellarians ratio of the Sparbach assemblage shows, that nassellarians dominate in specimen numbers and species occurrence markedly above spumellarians.

From Heackel´s time (1873-1887) to up to date the opinion outlasts, that spumellarians are more abundant in shallow waters and nassellarians prefer deeper water and/or oceanic conditions. However, Bartolini et al. (1999) pointed out, that spumellarians/nassellarians ratio is a more complex problem, where important role play many factors such as quantity nutrient, temperature and salinity gradient.

Based on the described features from the Sparbach section radiolarians are showing abundance peaks during times of oxygen depletion at the sea floor. This leads to the conclusions that “plankton blooms” (e.g. radiolarian blooms) at the sea-water surface induced a reduction of oxygen content at lower water layers at the sea floor. The increasing content of biogene particles at the sea floor leds to an oxygen depletion in such phases. Note that the abundance peaks of radiolarians and their increasing pyritization are associated with strong lamination and peaks in TOC (Fig. 4)

As dark laminated deposits are preferentially enriched in radiolarians, phases of high nutrient availability and primary productivity are suggested to be a motor of the formation of such radiolarian rich, dark, laminated sediments. A distal deeper environmental position of the place of accumulation is assumed and the facies hints to eutrophication of parts of the water mass above. Concerning the conclusions of Bak and Sawlowicz (2000) on the significance and the preservation of pyritized radiolarians, pyritization of radiolarians herein is to weak to presume a formation while floating within the anoxic water column. The pyritization of the radiolarian tests described took most probably place on the sea floor and /or in the sediment. This strengthens the results of Lukeneder (in press) who proposed in his recent investigations on these

©Geol. Bundesanstalt, Wien; download unter www.geologie.ac.at

laminated sediments of the same locality a low oxygen environment combined with decreasing bottom-current activity.

References

Bak, M. (1995): Mid Cretaceous radiolarians from the Pieniny Klippen Belt, Carpathians. *Poland. Cretaceous Research*, **16**, 1-23.

Bak, M. (1996): Abdomen wall structure of *Holocryptocanium barbui* (Radiolaria). Journal of *Micropalaeontology*, **15**, 131-134.

Bak, M. and Sawlowicz, Z. (2000): Pyritized radiolarians from the Mid-Cretaceous deposits of the Pieniny Klippen Belt – a model of pyritization in an anoxic environment. *Geologica Carpathica*, **51**, 2, 91-99.

Bartolini, A., Baumgartner, P.O. & Guex, J. (1999): Middle and Late Jurassic radiolarian palaeoecology versus carbon-isotope stratigraphy. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **145**, 43-60,

Baumgartner, P.O. (1984): A Middle Jurassic-Early Cretaceous low latitude radiolarian zonation based on Unitary Associations and age of tethyan radiolarites*. Eclogae Geologicae Helvetiae*, **77**, 3, 729-837, Basel.

Baumgartner, P.O., O' Dogherty, L., Gorican, S., Urquhart, E., Pillevuit, A. and De Wever, P. (Eds.) (1995): Middle Jurassic to Lower Cretaceous Radiolaria of Tethys: Occurrences, Systematics, Biochronology. *Mémoires de Géologie* (Lausanne), **23**, 900 pp.

Boorová, D, Lobitzer, H., Skupien, P. and Vašíček, Z. (1999): Biostratigraphy and Facies of Upper Jurassic-Lower Cretaceous pelagic carbonate sediments (Oberalm-, Schrambach- and Rossfeld-Formation) in the Northern Calcareous Alps, South of Salzburg. *Abhandlungen der Geologischen Bundesanstalt*, **56**/2, 273-318, Wien.

De Wever, P. de, Dumitrica, P., Caulet, J.P., Nigrini, C., and Caridroit, M. (2002) : Radiolarians in the Sedimentary Record. Taylor & Francis, pp. 533, New York.

Faupl, P., Vašíček, Z., Michalik, J. & Reháková, D. 1994: Stratigraphische Daten zur Unterkreide der Lunzer und Reichraminger Decke (Östliche Kalkalpen, Ober- und Niederösterreich). *Jb. Geol. B.-A ,.* **137**, 407-412.

Gorican, S. (1994): Jurassic and Cretaceous radiolarian biostratigraphy and sedimentary evolution of the Budva Zone (Dinarides, Montenegro). *Mémoires de Géologie* (Lausanne), **18**, 120 pp.

Hoedemaeker, P.J. & Rawson, P.F., 2000: Report on the 5th International Workshop of the Lower Cretaceous Cephalopod Team (Vienna, 5 September 2000; Lukeneder, A. (org.). *Cretac. Research,* **21**, 857-860, London.

Hoedemaeker, P.J., Reboulet, St., Aguirre-Urreta, M., Alsen, P., Aoutem, M., Atrops, F., Barrangua R., Company, M., Gonzales, C., Klein, J., Lukeneder, A., Ploch, I., Raisossadat, N., Rawson, P.F., Ropolo, P., Vašíček, Z., Vermeulen, J. and Wippich, M., 2003. Report on the 1st International Workshop of the IUGS Lower Cretaceous Ammonite Working Group, the 'Kilian Group' (Lyon 2002). *Cretac. Research,* **24**, 89-94.

Immel, H., 1987: Die Kreideammoniten der Nördlichen Kalkalpen. *Zitteliana,* **15**, 3-163.

Jud. R. (1994): Biochronology and Systematics of Early Cretaceous Radiolaria of the Western Tethys. *Mémoires de Geology* (Lausanne), **19**, 147 pp.

Lukeneder, A., 1998. Zur Biostratigraphie der Schrambach Formation in der Ternberger Decke (O.-Valanginium bis Aptium des Tiefbajuvarikums-Oberösterreich). *Geol. Paläont. Mitteil. Innsbruck,* **23**, 127-128.

©Geol. Bundesanstalt, Wien; download unter www.geologie.ac.at

Lukeneder, A., 1999: Excursion-guide to the Lower Cretaceous sequence of the Flösselberg Syncline (Lower Austria). 5th International Symposium “Cephalopods - Present and Past“, 17 p., Wien.

Lukeneder, A., 2001: Palaeoecological and palaeooceanographical significance of two ammonite mass-occurrences in the Alpine Early Cretaceous. *PhD-Thesis*, Univ. Vienna, 1-316.

Lukeneder, A. 2003a. Ammonoid stratigraphy of Lower Cretaceous successions within the Vienna Woods (Kaltenleutgeben section, Lunz Nappe, Northern Calcareous Alps, Lower Austria). In: Piller W.E. (Ed.): *Stratigraphia Austriaca. Austrian Acad. of Sci. Series*, *"Schriftenreihe der Erdwissenschaftlichen Kommissionen"* 16, Vienna, 165-191.

Lukeneder, A. 2003b: The *Karsteniceras* Level: Dysoxic ammonoid beds within the Early Cretaceous (Barremian, Northern Calcareous Alps, Austria). *Facies,* 49, 87-100.

Lukeneder, A., 2004a. Late Valanginian ammonoids: Mediterranean and Boreal elements - implications on sea-level controlled migration (Ebenforst Syncline; Northern Calcareous Alps; Upper Austria). Austrian Journal of Earth Sciences, 95/96, 46-59.

Lukeneder, A., 2004b. The *Olcostephanus* Level: An Upper Valanginian ammonoid mass-occurrence (Lower Cretaceous, Northern Calcareous Alps, Austria). Acta Geologica Polonica, 54(1), 23-33.

Lukeneder, A., 2004c. Ein Ammoniten-Massenvorkommen aus der Unterkreide - Der *Olcostephanus* Leithorizont (Nördliche Kalkalpen, Oberösterreich). Oberösterreichische Geonachrichten, 19, 25-41.

Lukeneder, A., 2004d. A Barremian ammonoid association from the Schneeberg Syncline (Early Cretaceus, Northern Calcareous Alps, Upper Austria). Annalen des Naturhistorischen Museums Wien, 106A, 213-225, Wien.

Lukeneder, A. 2005. First nearly complete skeleton of the Cretaceous duvaliid belemnite *Conobelus*. Acta Geologica Polonica, 55 (2), 147-162.

Lukeneder, A. 2005, in press. The Early Cretaceous Karsteniceras Level in the Vienna Woods (Northern Calcareous Alps, Lower Austria). Geologica Carpathica, 56 (4).

Lukeneder, A. and Harzhauser, M., 2003. *Olcostephanus guebhardi* as cryptic habitat for an Early Cretaceous coelobite community (Valanginian, Northern Calcareous Alps, Austria). Cretaceous Research, 24, 477-485.

O’ Dogherty, L. (1994): Biochronology and Paleontology of Mid-Cretaceous radiolarians from Northern Apennines (Italy) and Betic Cordillera (Spain). *Mémoires des Géologie* (Lausanne), **21**, 415 pp.

Ondrejíčková, A, Borza, V., Korábová, K. and Michalík, J. (1993): Calpionellid, radiolarian and calcareous nannoplankton association near the Jurassic – Cretaceous boundary (Hrušové section, Čachtické Karpaty Mts., Western Carparthians). *Geologica Carpathica*, **44**, 3, 177-188, Bratislava.

Ožvoldová, L. 1990: Occurrence of Albian radiolaria in the underlier of the Vienna Basin. *Geologický zborník - Geologica Carpathica,* **41,** 2, 137-154, Bratislava.

Ožvoldová, L. and Peterčáková , M. 1992:Hauterivian Radiolarian association from the Lúčkovská Formation, Manín Unit (MT: Butkov, Western Carpathians). *Geologica Carpathica*, **43**, 5, 313-324, Bratislava.

Pessagno, E.A. (1977): Lower Cretaceous radiolarian biostratigraphy of the Great Valley Sequence and Franciscan Complex, California Coast Ranges. Cushman Foundation for

©Geol. Bundesanstalt, Wien; download unter www.geologie.ac.at

Foraminiferal Research, Special Publication, **15**, 1-87, Washington.

Peterčáková , M. 1990: Radiolaria from cherts of the Kališčo limestone Formation of the Manín Unit (Butkov, West Carpathians). *Geologický zborník - Geologica Carpathica,* **41,** 2, 155-169, Bratislava.

Plöchinger, B. & Prey, S. 1993: Der Wienerwald. *Sammlung geol. Führer,* **59**, Berlin-Stuttgart, 1- 168.

Reháková, D. and Michalík, J. (1994): Abundance and distribution of Late Jurassic – Early Cretaceous microplankton in Western Carpathians. *Geobios*, **27**, 2, 135-156, Villeurbanne.

Reháková, D., Michalík, J. and Ožvoldová, L. (1996): New Microbiostratigraphical data from several Lower Cretaceous pelagic sequences of the Northern Calcareous Alps, Austria (preliminary results). – *Geologisch-Paläontologische Mitteilungen,* Innsbruck, Sonderband **4**, 57-81, Innsbruck.

Reháková, D. 2000: Calcareous dinoflagellate and calpionellid bioevents versus sea-level fluctuations recorded in the West Carpathian (Late-Jurassic/Early Cretaceous) pelagic environments. *Geologica Carpathica*, **51** (4), 229-243, Bratislava.

Richarz, P.S. 1905: Die Neokombildungen bei Kaltenleutgeben. *Jb. Geol. R. -A.* 54, 343-358.

Richarz, P.S. 1908: Ein neuer Beitrag zu den Neokombildungen bei Kaltenleutgeben. *Verh. Geol. R. -A.* 1908, 312-320.

Rosenberg, G. 1965: Der kalkalpine Wienerwald von Kaltenleutgeben (NÖ und Wien). *Jb. Geol. B. -A.,* **108,** 115-153.

Schwinghammer, R. 1975: Stratigraphie und Fauna des Neokoms von Kaltenleutgeben, NÖ. - *Sitzber. Österr. Akad. Wiss., math.-naturw. Kl., Abt.,* **1/183**, 149-158.

Schnabel, W. (1997): Geologische Karte des Republik Österreich 1: 50 000, **58** Baden. Geologische Bundesanstalt, Wien.

Spitz, A. 1910: Der Höllensteinzug bei Wien. *Mitt. Geol. Ges., Wien* 3, 315-434.

Thurow, J. (1988): Cretaceous radiolarians of the North Atlantic Ocean. ODP Leg. 103. Proceedings of the Ocean Drilling Program, Scientific Results, **103**, 379-416, College Staton.

Toula, F., 1886: Mittelneokom am Nordabhange des Großen Flösselberges bei Kaltenleutgeben. *Verh. Geol. R. -A.* 1886, 189-190.

Vašíček, Z. & Faupl, P. 1998: Late Valanginian cephalopods in relation to the palaeogeographic position of the Rossfeld and Schrambach Formation of the Reichraming Nappe (Northern Calcareous Alps, Upper Austria). *Zbl. Geol. Paläont.,* (Teil 1) **11/12**, 1421-1432.

Vašíček, Z, Michalík, J., Reháková, D. & Faupl, P. 1994: Stratigraphische Daten zur Unterkreide der Lunzer und Reichraminger Decke (Östliche Kalkalpen, Ober- und Niederösterreich). *Jb. Geol. B.-A.,* **137,** 407-412.

©Geol. Bundesanstalt, Wien; download unter www.geologie.ac.at

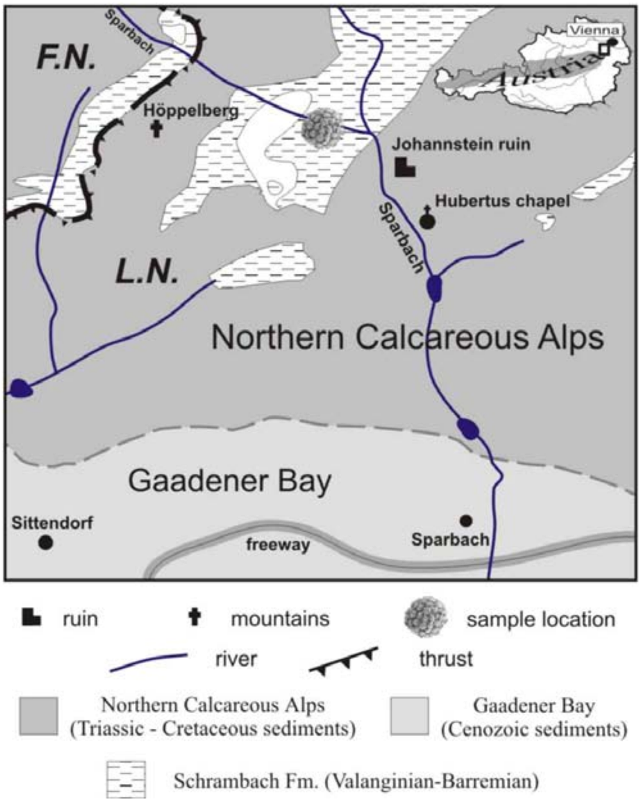

Fig. 1. Sketch map of the excavation site N of Sparbach and the geological situation and sediments of the Flössel Syncline. The Upper Austroalpine Northern Calcareous Alps extend from the Austrian western border to the city area of Vienna. Map after ÖK 1:50 000, sheet 58 Baden, Geological Survey Vienna, Schnabel 1997).

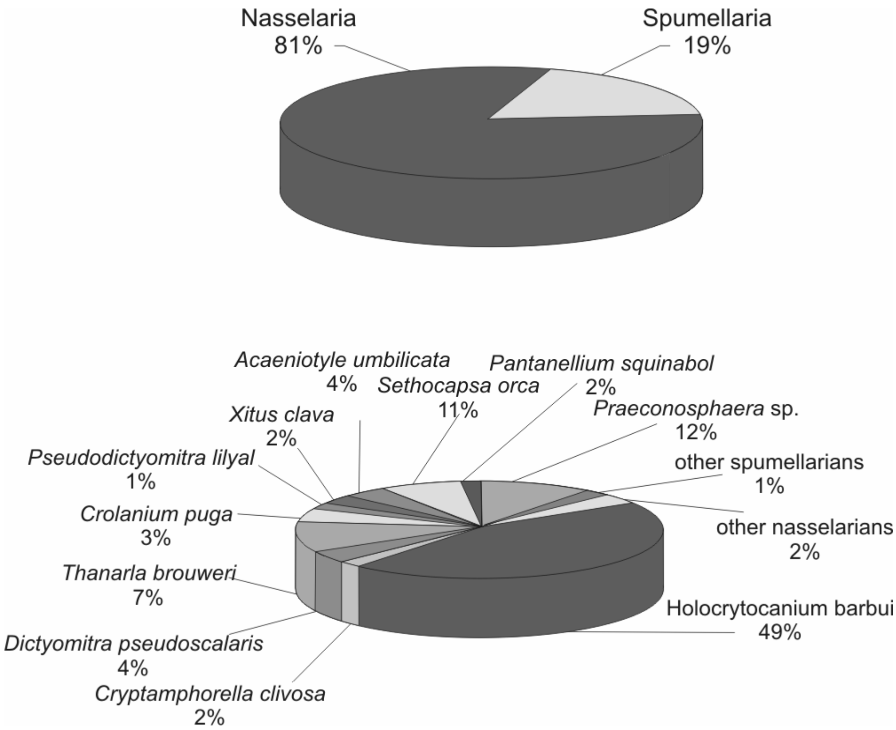

Fig. 2. Radiolarian spectrum from the Sparbach locality.
Note the dominance of the genus *Holocryptocanium* (Nassellaria).

©Geol. Bundesanstalt, Wien; download unter www.geologie.ac.at

BARREMIAN	Upper	*P. waagenoides*	
		C. sarasini	
		I. giraudi	
		H. feraudianus	
		G. sartousiana	*G. provincialis*
			G. sartousiana
		A. vandenheckii	
	Lower	*C. darsi*	
		K. compressissima	
		N. pulchella	
		K. nicklesi	
		T. hugii auct.	

Fig. 3. Stratigraphic position within the Early Barremian (*C. darsi* Zone) of the Sparbach fauna (in grey). Table modified after Hoedemaeker et al. (2003).

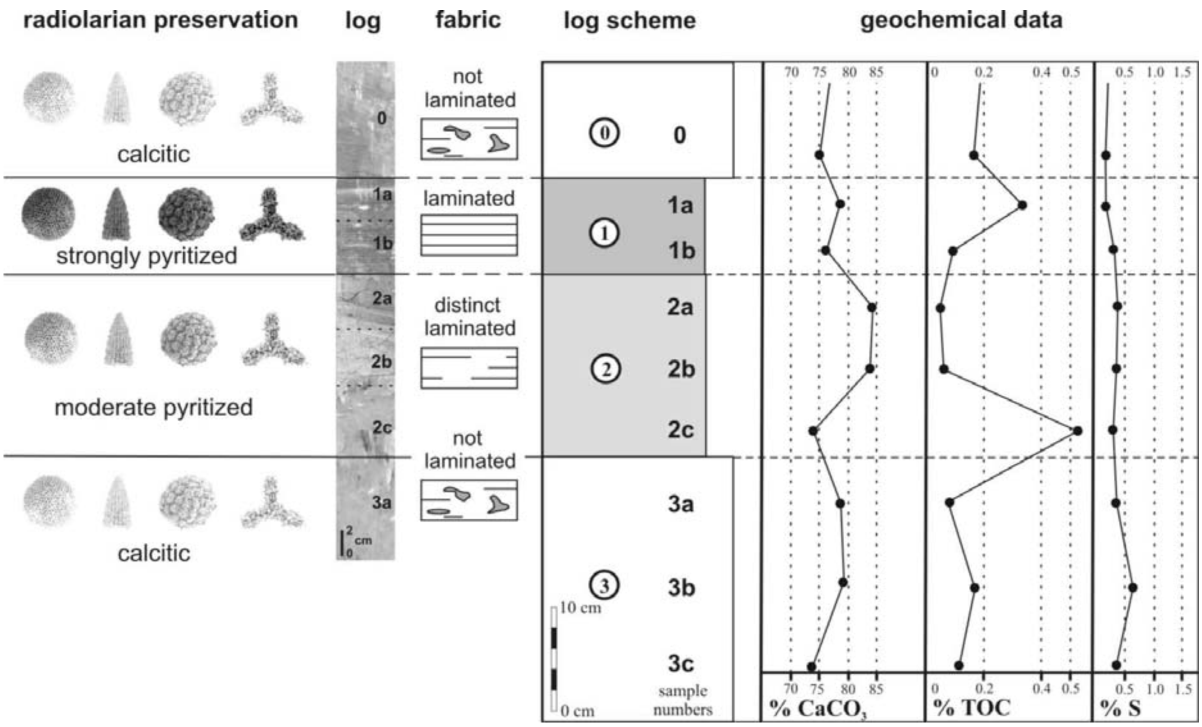

Fig. 4. The different preservational features of the radiolarian fauna. Correlated with the original log (longitudinal scan of the polished surface), the sediment fabric (laminated. distinct laminated and not laminated), and the geochemical parameters from the Sparbach section within and around the *Karsteniceras* Level.

©Geol. Bundesanstalt, Wien; download unter www.geologie.ac.at

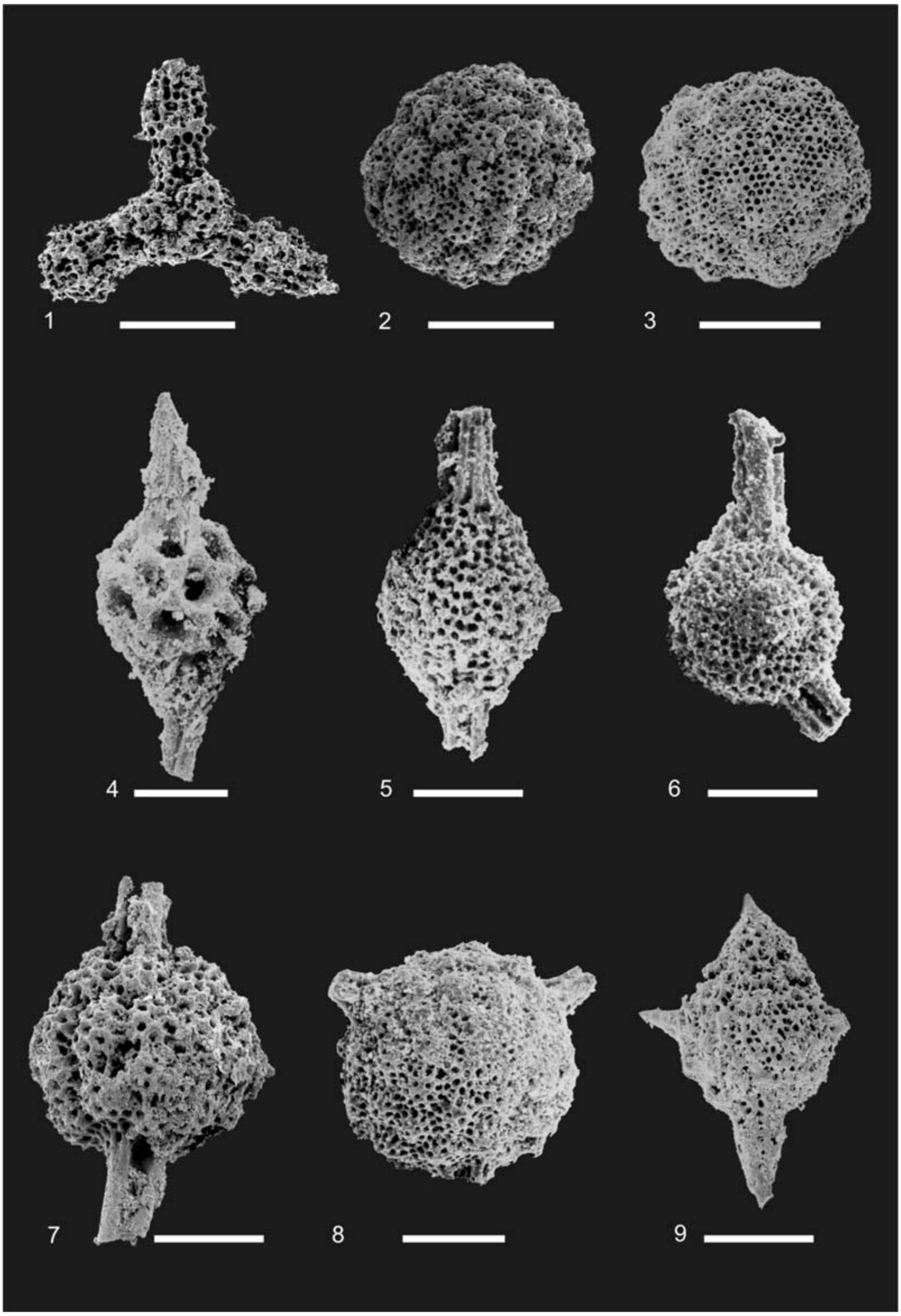

Plate 1.

All specimens figured on plate 1 are Spumellaria from bed 1a,

except Fig. 9 which belongs to Nasselaria.

Fig. 1. *Paronaella* cf. *trifoliacea* OŽVOLDOVÁ - x 120. Fig. 2-3. *Praeconosphaera* sp. - x 180. Fig. 4. *Pantanellium squinaboli* TAN - x 100. Fig. 5. *Archaeospongoprunum patricki* JUD - x 120. Fig. 6. *Suna hybum* (FOREMAN) - x 120. Fig. 7. *Acaeniotyle umbilicata* (RŰST) - x 125.Fig. 8. *Acaeniotyle diaphorogona* FOREMAN - x 130. Fig. 9. *Dibolachras tytthopora* FOREMAN - x 120.

©Geol. Bundesanstalt, Wien; download unter www.geologie.ac.at

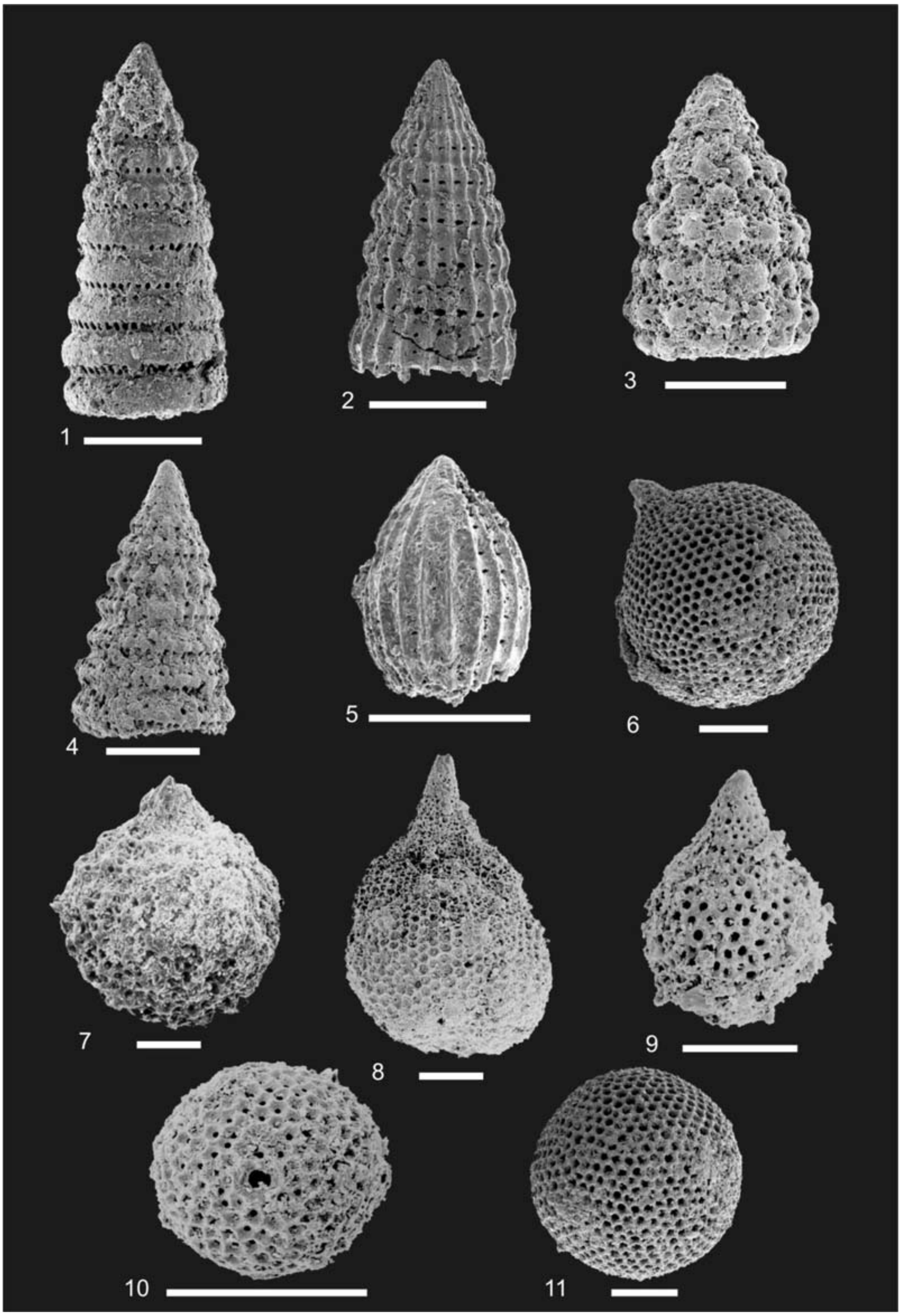

Plate 2.

All specimens figured on plate 2 are Nasselaria from bed 1a.

Fig. 1. *Pseudodictyomitra lilyae* (TAN) - x 130. Fig. 2. *Dictyomitra pseudoscalaris* (Tan) - x 120. Fig. 3. *Xitus clava* (PARONA) - x 110. Fig. 4. *Crolanium puga* (SCHAAF) - x 110. Fig. 5. *Thanarla brouweri* (TAN) - x 130. Fig. 6. *Sethocapsa orca* FOREMAN - x 110. Fig. 7. *Cryptamphorella clivosa* (ALIEV) - x 125. Fig. 8. *Sethocapsa dorysphaeroides* (NEVIANI) - x 125. Fig. 9. *Hiscocapsa asseni* (TAN) - x 160. Fig. 10-11. *Holocryptocanium barbui* DUMITRICA - x 160.

② ZOBODAT - www.zobodat.at

Zoologisch-Botanische Datenbank/Zoological-Botanical Database

Digitale Literatur/Digital Literature

Zeitschrift/Journal: Berichte der Geologischen Bundesanstalt

Jahr/Year: 2008

Band/Volume: 74

Autor(en)/Author(s): Lukeneder Alexander, Smrecková Miroslava

Artikel/Article: Excursion to Lower Cretaceous Sites. Stop 1: Sparbach (Schrambach Formation, Valaniginian to Barremian): An Early Cretaceous radiolarian assemblage and its palaeoecological implications of the Northern Calcareous Alps (Barremian, Lunz Nappe, Lower Austria) 126-137