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Muranella sphaerica BORZA (Microproblematicum) from the Carnian Hallstatt Limestone of the Feuerkogel (Austria/Northern Calcareous Alps): a nonskeletal precipitate

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With 1 figure and 2 plates

Kurzfassung

Muranella sphaerica BORZA 1975, ein problematisches Sphäroid, tritt in einem kondensierten Hartgrund im karnischen Hallstätter Kalk des Feuerkogels (Steirisches Salzkammergut) in großen Mengen auf. Eine detaillierte Beschreibung (Lichtmikroskop und SEM) wird gegeben und sein Ursprung diskutiert. Es wird gezeigt, daß es sich um Kalzitpräzipitate, die wahrscheinlich biogen induziert sind, handelt.

Abstract

Muranella sphaerica BORZA 1975, a problematic spheroid, occurs in great abundance in a condensed hardground of the Feuerkogel (Styrian Salzkammergut). A detailed description (light microscope and SEM) is given and its origin discussed. It is demonstrated that *M. sphaerica* represents calcite precipitates that are probably biogenic induced.

1. Introduction

The Feuerkogel near Bad Aussee (Styrian Salzkammergut), partly built up of Hallstatt Limestone, represents a classical location for cephalopods that has been known for a long time (MOJSISOVICS 1893: 733 ff.).

Tectonically the Feuerkogel belongs to the Sandling Nappe of the Hallstatt Zone (TOLLMANN 1976). The overall geological situation of this locality is summarized in WENDT (1969), KRYSTYN et al. (1971) and KRYSTYN (1973).

In the Carnian parts of the Hallstatt Limestone a limonitisized hardground with boarings and "microreefs", built up of sessil foraminifera occurs (WENDT 1969). These "microreefs" normally reach a height of some millimeters, consisting mainly of overgrown crusts of *Tolypammina gregaria* WENDT (Pl. 1, Fig. 1). In thin sections some remains of echinoids, pelecypods, as well as *Ophthalmidium leischneri* (KRISTAN-TOLLMANN) and *Planiinvoluta* sp. can be observed additionally. The most remarkable are small, spherical, calcitic "bodies" that occur in great abunduance (up to 140 individuals per mm^2) in the micritic matrix.

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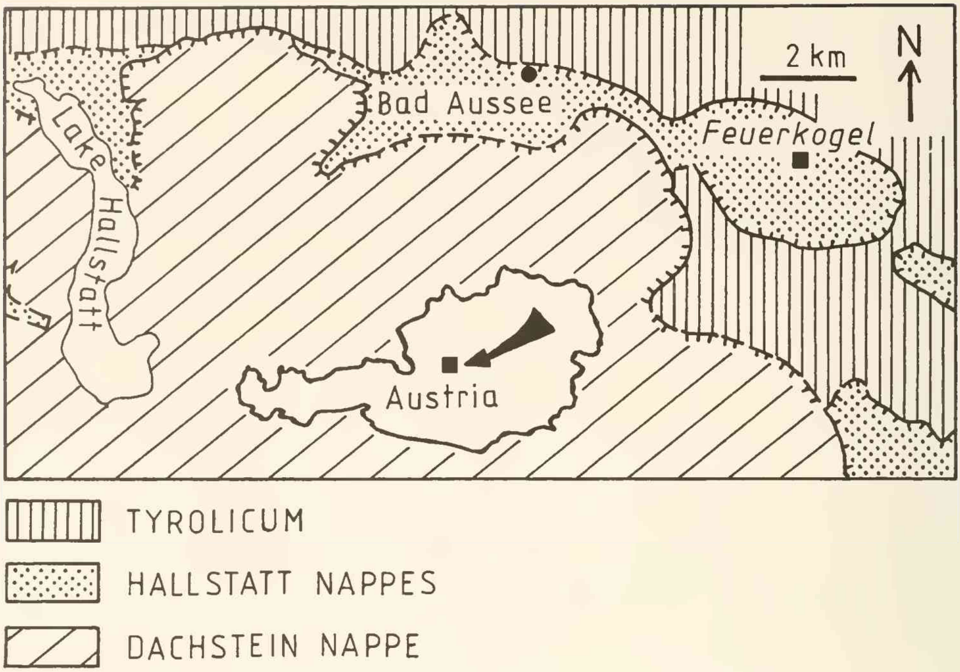

Fig. 1: Locality map and tectonical situation (After TOLLMANN 1976).

In order to classify their structure and systematic position they have been studied under the SEM, both with polished and slightly etched rock surfaces as well as fresh broken sample surfaces.

The samples, belonging to the so-called Metternichi Lager, have been collected during a student field trip together with Dr. T. STEIGER (Munich) and Dr. D. WURM (Erlangen).

2. Description

The spheroids in question occur always isolated, whereas aggregated colonies are lacking. Under the light microscope one can merely detect that they are composed of an outer envelope, built up of radial fibrous calcite (spherulitic microstructure, e. g. ELIÁŠOVÁ 1985) and an inner micritic nucleus (Pl. 1, Fig. 3).

The total diameter ranges from 0,014 to 0,032 mm with a frequency maxima between 0,016 and 0,02 mm, the range of silt. The nuclei reach a size of 0,008 to 0,02 mm. Only seldom (8 of 100) the thickness of the wall exceeds the diameter of the nucleus. In addition it is worth mentioning that, with reflected light the outer fringe appears dark. The scanning electron micrographs, providing significant more information, show that each spheroid consists of 20 to 34 anhedral to subhedral calcite crystals with their axes perpendicular to the spherical surface. The length of the crystals reaches a maxima of 14 μm with a width of 5 μm; the ratio length/width ranges from 1,9 to 4,5 (bladed crystal shape sensu FOLK 1965).

The width of the crystals typically increases in the direction of growth; the boundaries between adjacent crystals are plane (Pl. 2, Figs. 2–4). The distal termination of each crystal is sharp and often plane. The origin of the outer fringe is not contemporaneous for all spheroids indicated by a concave termination of single bladed crystals that meet adjacent, not overgrown, nuclei (Pl. 2, Fig. 4, arrows). Thus further crystal growth comes to an end.

The volume of the calcitic crust normally exceeds that of the nucleus by the factor 8. Only seldom in specimens with a very small nucleus in relationship to the crust by the factor 90 (e. g. Pl. 2, Fig. 3).

In polished, as well as in slightly etched rock surfaces the contact between the outer fringe and the nucleus is indicated by a distinct dark ring (Pl. 2, Figs. 1–2), being a „shadow" effect. The nuclei itselfes represent a mosaic, consisting of aphano crystalline micrite (0,3–2,4 μm).

3. Discussion

Although being much smaller, our spherulites fit well with the original diagnosis of *Muranella sphaerica* Borza 1975, a microproblematicum from the Carnian of the Western Carpathians. But the total diameter seems to be not a significant feature and is more dependent on the size of the available nuclei. Subsequently it has been reported also from the Upper Triassic (Norian-Rhetian) of the Northern Calcareous Alps and Sicilia (Wurm 1982, Senowbary-Daryan 1984). The latter author gives the stratigraphic range as Carnian to Rhaetian. Except *Muranella parvissima* (Dragastan 1966) that differs from *M. sphaerica* in being larger and in having calcite crystals somewhat coarser (Eliášová 1985), no scanning electron micrographs have been figured of *Muranella sphaerica* up to now.

Taking into consideration an organic origin of *M. sphaerica*, one has to look closer at the globular, calcitic bodies occurring in Upper Triassic strata. Besides a particular confined size these forms should occur in great abundance, too. Both requirements are fulfilled in the class Dinophyceae Fritsch, 1929.

Jafar (1983) described several new species of calcareous nannofossils from the alpine Upper Triassic. For our purposes above all the genus *Prinsiosphaera* with the two species *P. triassica* and *P. geometrica* shall be treated closer. The generic definition of *Prinsiosphaera* (Jafar 1983: 232) is as follows: Spherical to hemispherical solid nannofossils often containing a depression at one end and consisting of parallely stacked groups of calcite plates oriented in a random fashion.

The forms originally described as *P. geometrica*, do not belong to the genus *Prinsiosphaera*, because of representing hollow spheroids consisting of calcite crystals. Their generic position is treated controverse in recent literature. Thus *P. geometrica* is placed within the genus *Orthopithonella* by Janofske (1987), whereas Bown (1987) refers it to the genus *Thoracosphaera*.

Like all calcareous nannofossils these are strongly affected by diagenetic alteration (secondary crystal growth, solution phenomena), too, which are described in detail by Janofske (1987: 51 ff.). As being the final stages of diagenesis she reports spherical aggregates of calcite crystals without posessing a definite structure.

The only form known that exhibits a similar calcitic, outer fringe as *M. sphaerica* is the Dinophyceae *Schizosphaerella punctulata* Deflandre & Dangeard from Jurassic strata. Its ultrastructure is based "on a rectangular (tetragonal) mutual disposition of the oblique parallelogram-shaped elementary crystallites" (Kälin & Bernoulli 1984: 412), being very resistent against solution (Pl. 2, Fig. 6).

In our opinion *M. sphaerica* cannot be interpreted as being a calcareous nannofossils. Thus, observing several hundred of individuals, neither an archaeopyle nor an characteristic ultrastructure, or even a wall, respectively, that would point to a biogenic origin have been observed.

Moreover no hemispherical sections or collapsed individuals as reported by JANOFSKE (1987: 52) are detectable.

According to the above-mentioned aspects an abiogenic origin of *M. sphaerica* is much more likely.

Already WURM (1982: 228) assumed that it might be a cyanophycean induced precipitation product on pellets and arenitic detritus.

FLÜGEL et al. (1984) report rims of bladed calcite crystals that surround small peloids (total diameter 50–75 μm, thickness of the cement rim about 10–15 μm) from Permian sponge reefs of Slovenia/Jugoslavia and compare them with *Muranella* BORZA. The authors doubt the organic nature of *Muranella*, concluding "a combination of cyanobacterial activity and coeval cementation" (op. cit. 188).

Recently REID (1987) reported peloids which are surrounded by a rim of radially oriented calcite crystals in confined cavities from Upper Triassic reefs of the Yukon Territory/Canada. She suggests either a biochemically or physicochemically precipitation with respect also to *M. sphaerica* (op. cit. 899).

However, conclusive indications concerning the diagenesis of pelleted textures were turned up by investigating Pleistocene and Holocene reefs.

"The peloids (20–60 μm) consist of a well developed euhedral rim of sparry dentate microcrystalline (4–30 μm) magnesium calcite around a tightly interlocking submicrocrystalline (4 μm) nucleus" (MACINTYRE 1985: 109).

After a comprehensive synopsis and discussion of the feasible peloidal genesis (e. g. biogenic, detritic, replacement of aragonitic clots) the author concludes (op. cit. 112ff.) that they originated in repeated nucleation, a mechanism effective especially in isolated or confined cavities. The first step is a precipitation of submicrocrystalline, dense mosaic of interlocking anhedral crystals. In a second step the precipitation delays giving rise to a coarser, organized Mg-calcite crystals.

By the means of etched SEM-preparations the mechanism of the rapid carbonate precipitation could be proved as being induced by bacteria activity (CHAFETZ 1986). These bacteria cause a microenvironment favourable for carbonate precipitation. When the bacteria die because of the precipitated calcite, the physicochemical conditions in the surrounding area are changing, too. The following, pure abiogenic developing crystals reaching a size of 5–10 μm are characteristically light translucent and must be classified as a cement.

It is worth mentioning that *M. sphaerica* is restricted to reef complexes, where it prevails in the free spaces between the reef framebuilders. For comparisons a peloid occurring in an ammonite phragmocon (confined cavity) from a Middle Jurassic pelagic limestone of the Unken syncline/Northern Calcareous Alps is shown on Plate 2, Fig. 5.

The description of *M. sphaerica* of the Feuerkogel is nearly identical to the peloidal definition given by MACINTYRE (1985), concerning both the dimensions as well as the bimodal grain size distribution of the crystals involved.

The only difference remaining is the crystal form, being anhedral calcite in *M. sphaerica*, whereas in recent peloids euhedral Mg-calcite is prevailing.

The bacteria in the nuclei of the peloids detected by CHAFETZ (1986) don't seem to be preservable in the fossil record and couldn't be observed in our etched samples.

4. Conclusions

Muranella sphaerica BORZA represents a very frequent "microfossil" incertae sedis in the Carnian Hallstatt Limestone of the Feuerkogel. Observing several hundreds of individuals in both light microcope as well as with the SEM there's no evidence for a primary biogenic nature of *M. sphaerica*, because of the lacking of an ultrastructure typical for calcareous nannofossils. On the other hand *M. sphaerica* corresponds very well with the definition of recent peloids, whose mechanism of formation is due to repeated nucleation (MACINTYRE 1985). This mechanism is in causal connection to the activity of carbonate seggregating bacteria (CHAFETZ 1986).

Although we couldn't observe this bacteria in the samples studied this possibility is the most plausible one.

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Plate 1

Fig. 1 Condensed horizon within the Hallstatt Limestone of the Feuerkogel showing remains of pelecypods and dark, Fe-Mn-impregnated foraminifera buildups. Scale = 1 cm.

Fig. 2 Confined cavity between overgrown foraminifera "microreefs" with *Muranella sphaerica* BORZA. Scale = 0,1 mm. Thin section No. G 4757 a/89.

Fig. 3 Detail of Fig. 2 with abundant *Muranella sphaerica* BORZA showing the micritic nuclei and the calcitic fringes. Scale = 0,5 mm. Thin section No. G 4757 a/89.

Plate 2

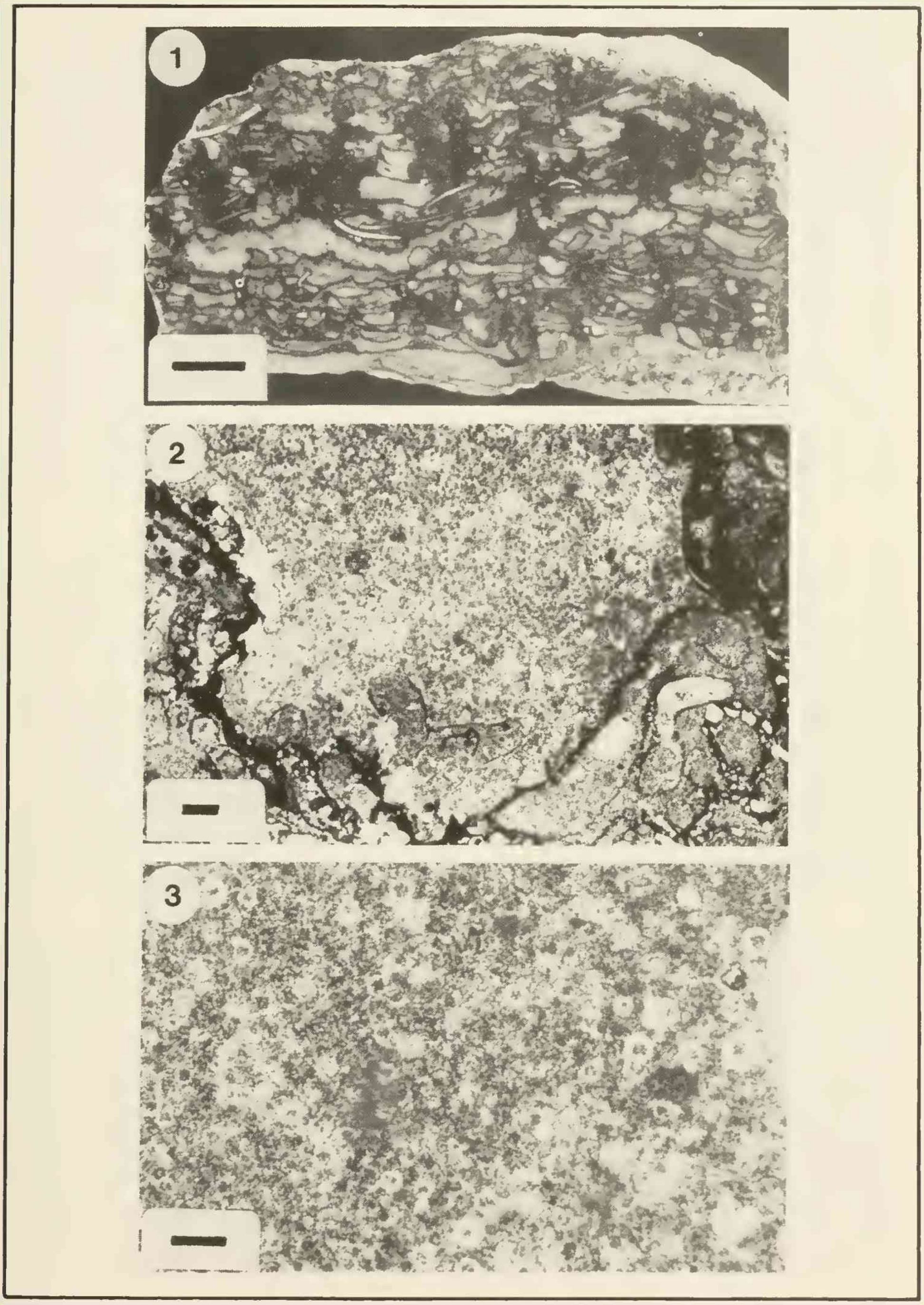
Fig. 1, 2 *Muranella sphaerica* BORZA in rock building quantities with a dark ring between the nucleus and the outer fringe. Fig. 2 Detailed view showing that the dark ring in question is only an optical effect because of lacking of the outer fringe in some individuals due to preparation method. In such cases the nucleus is somehow elevated above the surrounding area.

Fig. 3, 4 Single individuals of *Muranella sphaerica* BORZA with the typical bimodal grain size distribution. The nucleus consists of an aphano crystalline, anhedral mosaic; the outer fringe is built up of bladed, very finely crystalline calcite, thickening characteristically towards the distal termination. The enveloping of the nuclei (arrows) gives witness of the non contemporaneous genesis of the outer layer. Note that in Fig. 4 the nucleus is missing.

Fig. 5 For comparisons shown a peloid also from a restricted microenvironment (ammonite phragmocon; Middle Jurassic Klaus Limestone).

Fig. 6 *Schizosphaerella punctulata* DEFLANDRE & DANGEARD with secondary calcite cement (b). In comparison to Muranella sphaerica BORZA the typical wall ultrastructure (heringbone structure, a) is preserved even after strong diagenetic alteration. Specimen from Lower Jurassic Scheibelberg Limestone.

Scale: Fig. 1: 10 μ.
Scale: Fig. 1: 105 μ.
Fig. 2–6: 10 μ.



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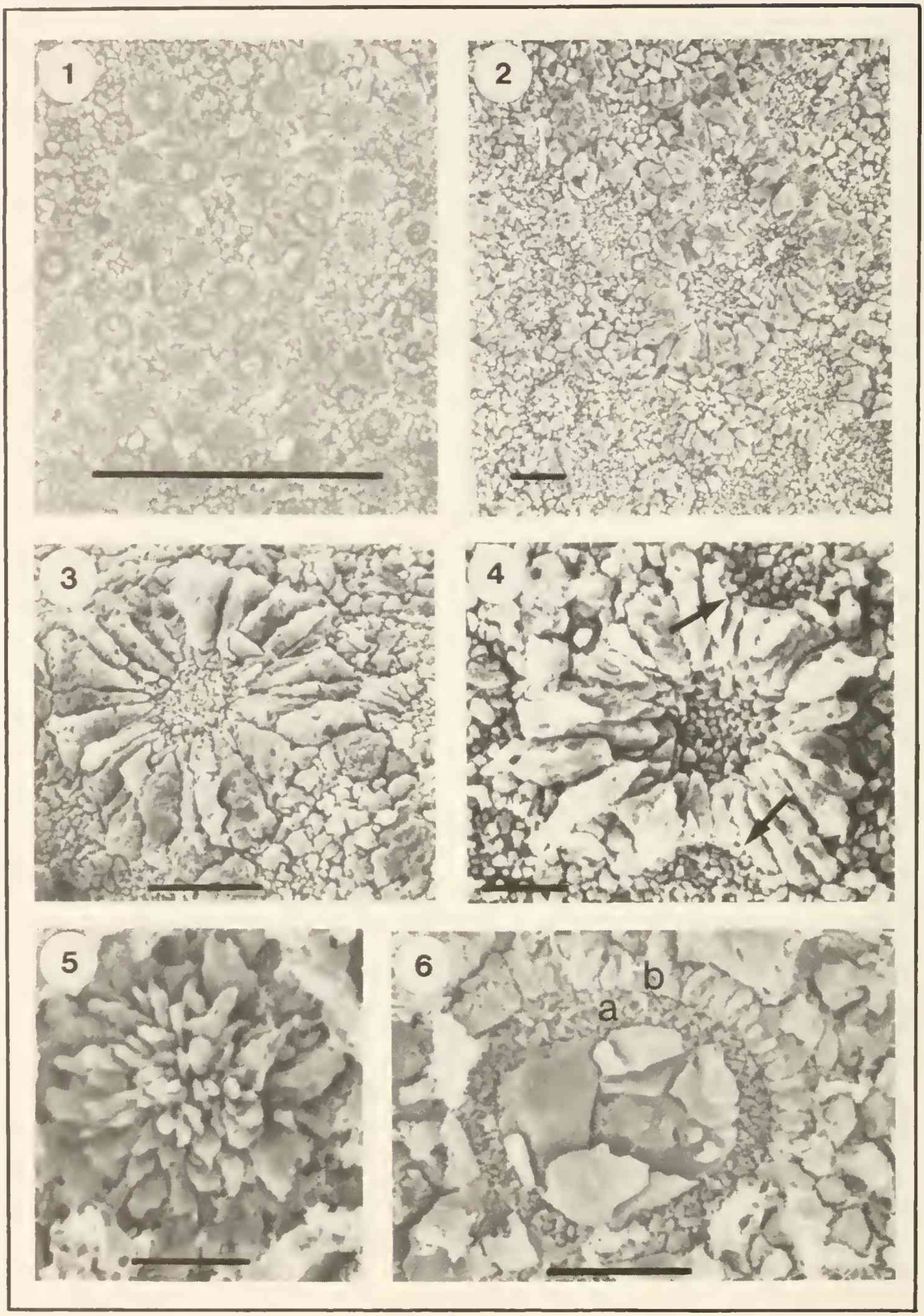

Ebli, O. & Schlagintweit, F.: *Muranella sphaerica* **Plate 2**

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