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First Findings of Orbitolinids (Larger Benthic Foraminifera) from the Early Cretaceous Rossfeld Formation (Northern Calcareous Alps, Austria)

Felix Schlagintweit[1], Oliver Krische[2] & Hans-Jürgen Gawlick[2]

5 Text-Figures, 2 Plates

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Northern Calcareous Alps
Orbitolinid foraminifera
Barremian-Aptian
Rossfeld Formation
Urgonian limestones

Contents

Erste Funde von orbitoliniden Foraminiferen aus der unterkretazischen Rossfeld-Formation (Nördlichen Kalkalpen, Österreich)

Zusammenfassung

Aus den höheren, klastischen Anteilen der unterkretazischen Rossfeld-Formation der Weitenau südlich von Salzburg werden erstmalig Funde von Orbitolinen bekannt gemacht. Diese sind vertreten durch *Montseciella arabica* (Henson) und einer – aufgrund fehlender Schnitte durch den Embryonalapparat – nicht näher bestimmbaren Form, bei der es sich aber höchstwahrscheinlich um *Palorbitolina lenticularis* (Blumenbach) handeln dürfte. *M. arabica* ist auf das Obere Barremium bis in das Unterste Aptium und *P. lenticularis* auf den Zeitbereich Oberes Barremium bis Unteres Aptium beschränkt. Beide Taxa sind bereits aus kalkalpinen allochthonen Urgon-Kalken (Gerölle, allodapische Kalke, Olistolithe) beschrieben worden. Neben Resten von Rotalgen und Korallen in der klastischen Rossfeld-Formation belegen diese Orbitolinenfunde den Einfluss einer heute nicht mehr existenten Flachwasserkarbonatentwicklung, für die bereits früher ein Liefergebiet in der Nähe des Kalkalpensüdrandes postuliert wurde.

Abstract

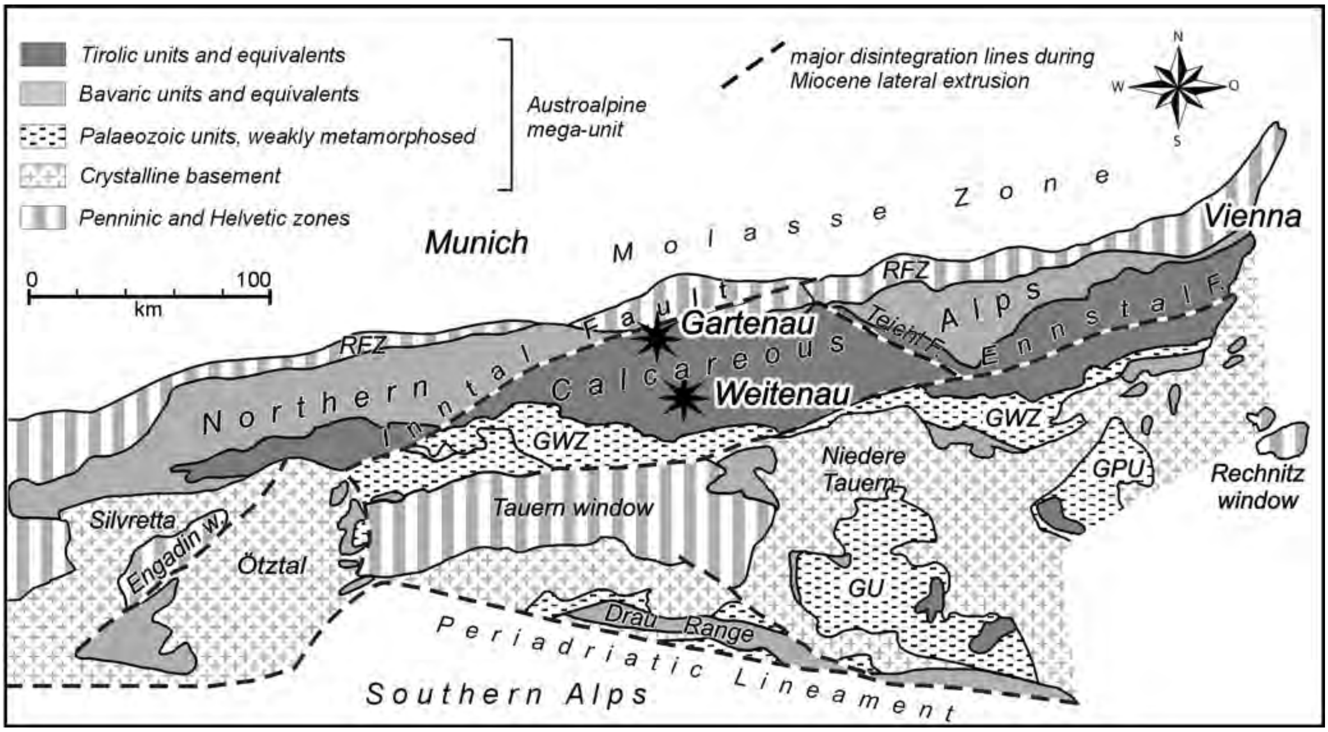
For the first time, orbitolinids are described from the upper parts of the Early Cretaceous clastic Rossfeld Formation of the Weitenau area south of Salzburg. These are *Montseciella arabica* (Henson) and one – due to missing of sections of the embryonic apparatus – not further determinable form that most likely, however, represents *Palorbitolina lenticularis* (Blumenbach). *M. arabica* is restricted to the Upper Barremian to lowermost Aptian, *P. lenticularis* to the time-span Upper Barremian to Lower Aptian. Both taxa were already described from allochthonous Urgonian-type limestones (pebbles, allodapic limestones, olistolites) of the Northern Calcareous Alps. Beside remains of red algae and corals, these orbitolinid findings give further evidence of this today no more existing former shallow-water evolution for which already a source area near the southern rim of the Northern Calcareous Alps was postulated.

1 Felix Schlagintweit: Lerchenauerstraße 167, 80935 München, Germany. Felix.Schlagintweit@gmx.de
2 Oliver Krische, Hans-Jürgen Gawlick: Department for Applied Geosciences and Geophysics, Chair of Petroleum Geology, Peter-Tunner-Straße 5, 8700 Leoben, Austria.

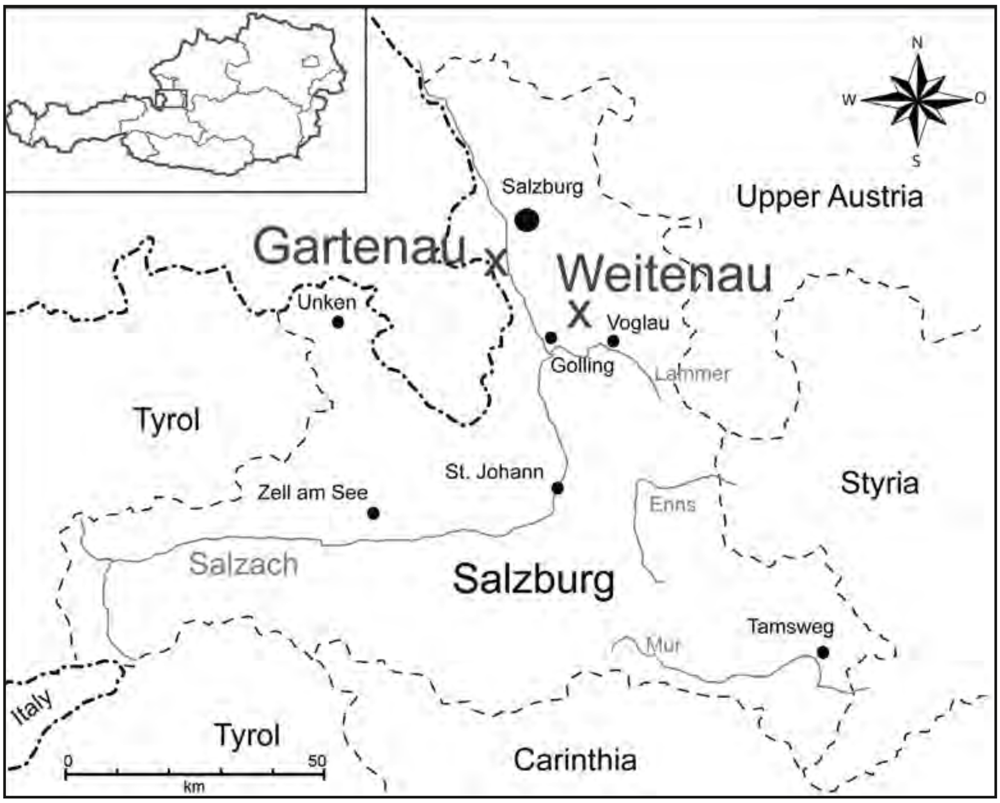
Introduction

Early Cretaceous deep-water sediments (Schrambach, Lackbach and Rossfeld Formations and equivalents) form lithostratigraphic units of significant thickness in the different tectonic units of the Northern Calcareous Alps, i.e., the Bavaric and (Lower) Tirolic nappes (e.g., TOLLMANN, 1976, compare TOLLMANN, 1985) (Text-Fig. 1). As shown for Middle/Late Jurassic sediments, component analysis of turbidites and mass flows are the key for reconstructions of facies characteristics of provenance areas, the overall palaeogeographic configuration and tectonic regime (e.g., GAWLICK et al., 1999, 2009; MISSONI & GAWLICK, 2011). For the Early Cretaceous formations a detailed component analysis, especially of the carbonate clasts of the different turbidites or mass flows, is missing or is only fragmentary. E.g., in the eastern Northern Calcareous Alps components in allodapic limestone layers yield evidence for a Late Hauterivian (based on the proof of the *Euptychoceras* abundance Zone) siliciclastic-influenced shallow-water carbonate area in the southern part of the Northern Calcareous Alps (LUKENEDER & SCHLAGINTWEIT, 2005). From the time-interval between the growth of the Late Jurassic to Earliest Cretaceous Plassen Carbonate Platform (up to Late Berriasian: GAWLICK & SCHLAGINTWEIT, 2006) and the late Early Cretaceous shallow-water limestones (from Late Barremian onwards) as yet no records of shallow-water deposits in the Northern Calcareous Alps are known. A relationship between biodetritus observed in the Rossfeld Formation and an "Urgonian-type" platform, assumed to be contemporaneous, was briefly discussed by SCHLAGINTWEIT (1991), but has not been investigated in detail.

In a lateral distribution of about 50 km, between the rivers Saalach and Traun, the marly Schrambach Formation (= "Neocomian Aptychi beds") grades into the thick siliciclastic coarsening-upward sequence of the Rossfeld Formation for which a synorogenic deposition was assumed by FAUPL & TOLLMANN (1979). Generally, it is interpreted as "a clastic wedge in front of incoming thrust sheets" (e.g., FAUPL & TOLLMANN, 1979; SCHWEIGL & NEUBAUER, 1997a, b), "final flysch" (LEISS, 1992) or, in contrast, as "molasse" respectively foreland basin fill (GAWLICK et al., 2008; MISSONI & GAWLICK, 2011: Rossfeld Molasse). The section at the type-locality ascribed to the Upper Valanginian to Upper Hauterivian time interval, was subdivided into the Lower (= marl group, thin- and thick bedded sandstone group) and the coarse-grained clastic conglomeratic Upper Rossfeld Formation (FAUPL & TOLLMANN, 1979; DECKER et al., 1987). Sediments of the Rossfeld Formation can be dated by means of benthic and planctonic foraminifera (FAUPL & TOLLMANN, 1979; FUCHS 1968; WEIDICH, 1990), ammonites (IMMEL, 1987; LUKENEDER, 2005), dinoflagellate cysts (BOOROVÁ et al., 1999) and in the basal parts also by calpionellids (e.g., LUKENEDER & REHÁKOVÁ, 2007). The youngest age obtained was Early Aptian by means of planktonic foraminifera (FUCHS, 1968: locality Grabenwald in the Weitenau area) (Text-Figs. 2, 4), later revised as Middle Aptian (*Leupoldina cabri* Zone) by WEIDICH (1990: locality Grabenwald). The first occurrence of *Leupoldina cabri* is ~ 124 MA just below the *selli* level to ~ 122 MA (e.g., VERGA & PREMOLI SILVA, 2002). In the stratigraphic table of Austria (PILLER et al., 2004), the Upper Rossfeld Formation is segregated as Grabenwald Subformation (= Grabenwald Beds of PLÖCHINGER, 1968: p. 83) (Text-Fig. 3) with an approximate range from ~120 to 124 MA, referring to the lowermost Bedoulian to lowermost Gargasian. Within the Aptian, the shallowing and filling of the remaining basinal area is documented by local remnants of coal and amber (PLÖCHINGER, 1968; WINKLER, 2004).



Text-Fig. 1.
Main geotectonic elements in the Eastern Alps (modified after FRISCH & GAWLICK, 2003, based on TOLLMANN, 1985).
Abbreviations: GU Gurktal Unit, GPU Graz Paleozoic Unit, GWZ Greywacke Zone, RFZ Rhenodanubian Flysch Zone.

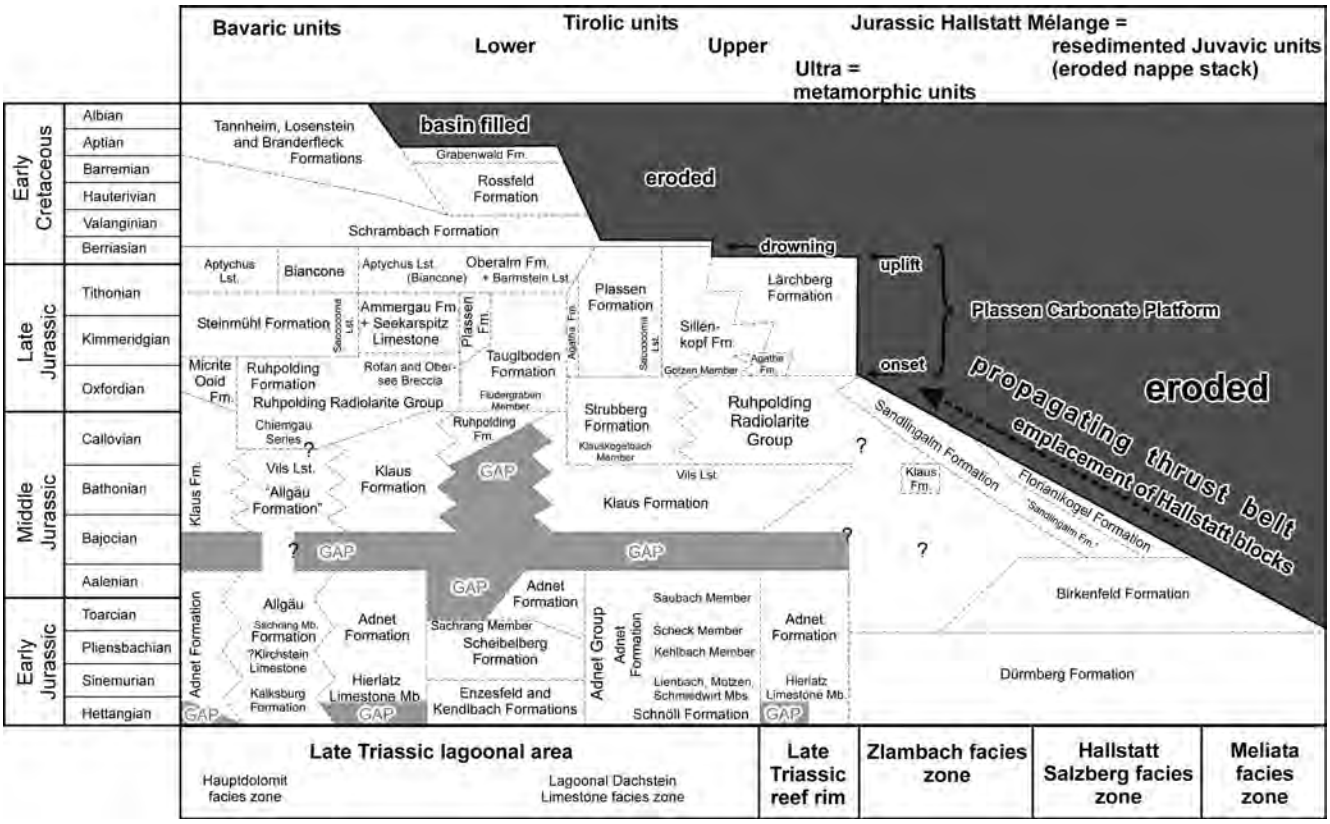


Text-Fig. 2.
Geographic overview and indication of the investigated area. For details and location of the samples see Text-Figs. 4–5.

In the present paper resedimented orbitolinid foraminifera are described for the first time from the upper part of the Rossfeld Formation from the Weitenau area south of Salzburg.

Geological Setting

The Weitenau area is located between the township of Golling in the west and the village of Voglau in the east



Text-Fig. 3.
Formation names, stratigraphy and main tectonic events of the Jurassic to Early Cretaceous period of the Northern Calcareous Alps (modified after GAWLICK et al., 2009; MISSONI & GAWLICK, 2011; compare PILLER et al., 2004).

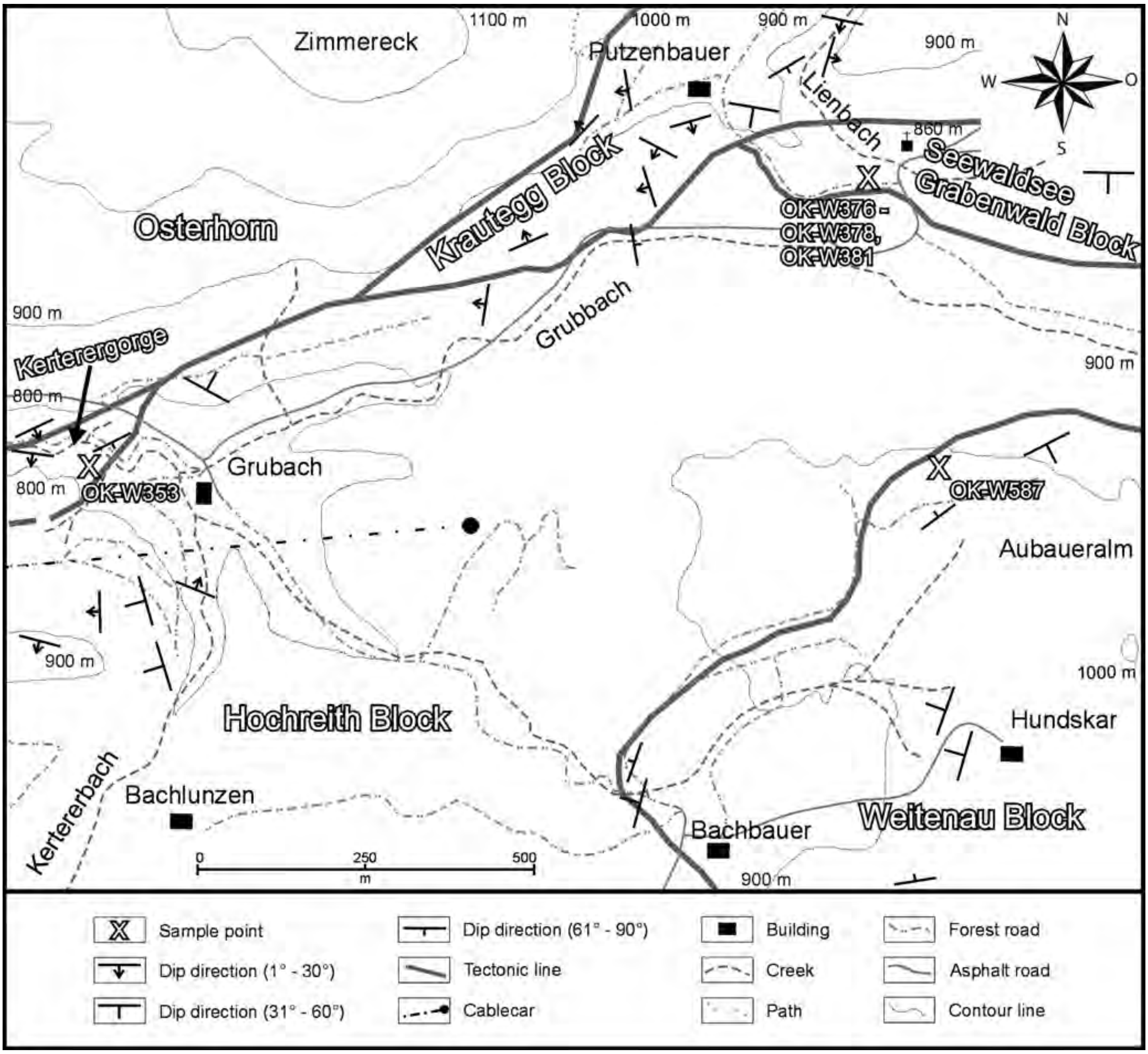
(Text-Fig. 2, Text-Fig. 4): see geological map of Austria, sheet no. 94 Hallein (PLÖCHINGER, 1987). The low mountain range is commonly known as a typical Late Jurassic to Early Cretaceous Tirolic basin fill, i.e., Weitenau syncline (e.g., PLÖCHINGER, 1968, 1990; SCHWEIGL & NEUBAUER, 1997b; SCHORN & NEUBAUER, 2011). On the other hand it is known since BITTNER (1883, 1884) and revised by KRISCHE et al. (2011) that the Weitenau area is built up of independent blocks of different paleogeographic origin, which are separated by faults with different character. The orbitolinid-bearing samples from the Rossfeld Formation were taken from four different localities (Text-Fig. 4).

Grabenwald

The outcrop is located in the central part of the Weitenau area (Text-Fig. 4: samples OK-W376 to OK-W378, OK-W381; Seewaldsee Grabenwald Block), near the little Grabenwald chapel (860 m). In the Lienbach valley, turbiditic brownish marls with intercalated up to 40 cm thick siliciclastic packstone beds are outcropping. Where the forest road to the cottage called Putzenbauer turns off from the Weitenau main road, the overlying orbitolinid-bearing lithoclastic arenites and rudites can be studied. They belong to the Grabenwald Subformation of the Rossfeld Formation. The siliciclastic fraction of the rudites and arenites consists of subangular quartz grains, quartzites, volcanites, reddish radiolarites, metasedimentary colourless cherty rocks and yellowish chertified clays.

Hundskar

Crinoidal-rich silty marls of the Rossfeld Formation are outcropping north of the Hundskar (Text-Fig. 4: sample OK-W587; Weitenau Block) at 940 m. Intercalated in the marl beds dense, grain-supported lithoclastic rudites with orbitolinids, together with subangular quartz grains, quartzites, metasedimentary colourless cherty rocks and yellowish chertified clays occur.



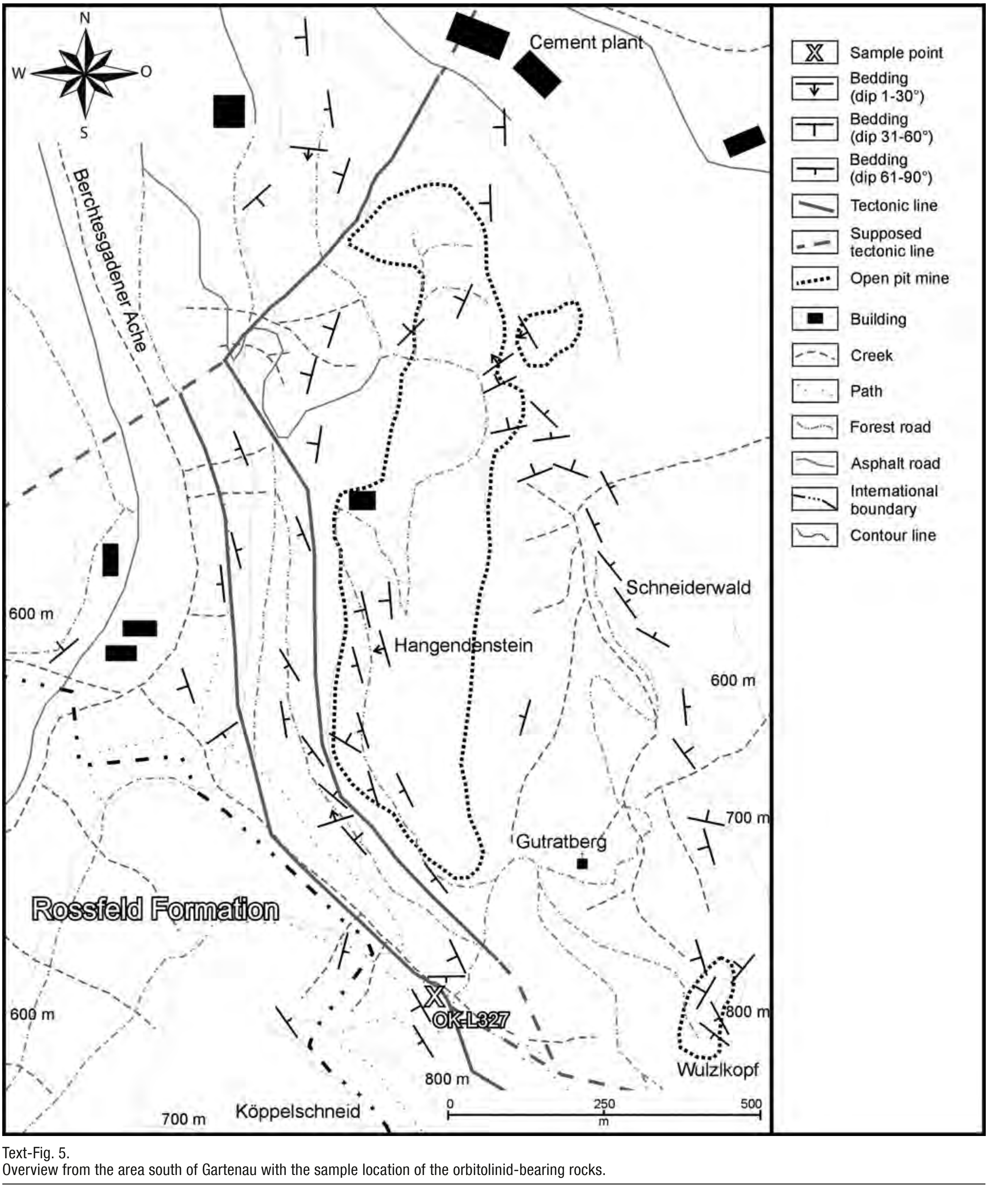
Text-Fig. 4.
Detailed map of the study area in the "Weitenau syncline" with the location of the orbitolinid-bearing samples in the Rossfeld Formation.

Kerterer gorge

Greenish silty, turbiditic marls build up the area of the eastern Kerterer gorge. Along the ridge southwest of the former mill at 940 m altitude (Text-Fig. 4: sample OK-W353; Kerterer gorge), quartz-rich, lithoclastic arenites with orbitolinids overlie the greenish marls. The siliciclastic fraction of the arenites is built up by subangular quartz grains, quartzites, volcanites and rounded, yellowish to orange chertified clays. These marls can be described as packstones with radiolarians, sparitic and micritic lithoclasts, sponge spicula, heavy minerals, quartz and plant remnants.

Gartenau

The study area is located south of the village Gartenau (Text-Fig. 2) close to the border of Germany (compare temporary geological map of Austria, sheet no. 93 Bad Reichenhall (PAVLIK, 1998). From the Berchtesgadener



Text-Fig. 5.
Overview from the area south of Gartenau with the sample location of the orbitolinid-bearing rocks.

Achen valley (Text-Fig. 5) up to the ridge of the Köppelschneid, the Rossfeld Formation is outcropping. At the base with coarse-grained conglomerates the sedimentary succession changes to cherty arenites and cherty marls. This part of the profile is dated by IMMEL (1987) with the ammonites *Oosterella kittli* (RICHARZ), *Crioceratites* (*Crioceratites*) *nolani* (KILIAN) and *Moutoniceras annulare* (D´ORBIGNY) as Late Hauterivian. Above follow quartz-rich arenites with heavy minerals, sparite and micrite clasts with intercalated cherty marls and limestones. The steep northeast dipping succession is cutted by a steep, southeast to northwest striking fault. Nearby the fault, southeast dipping, lithoclastic orbitolinid-bearing rudites, intercalated in the dark, cherty marls and cherty limestones mark the upper part of the Rossfeld Formation. The siliciclastic components of the rudite beds consist of subangular quartz grains, quartzites, volcanites and rounded, yellowish to orange chertified clays. The outcrop situation can be studied at 720 m altitude nearby the hiking path.

Micropaleontological Part

Following taxa of orbitolinids were observed: the conical *Montseciella arabica* (HENSON) and an unknown flattened form, that due to its co-occurrence with the former, most likely represents *Palorbitolina lenticularis* (BLUMENBACH).

Genus *Montseciella* CHERCHI & SCHROEDER, 1999

Montseciella arabica (HENSON, 1948)

(Pl. 1, Figs. d–f pars, Pl. 2, Figs. a–f, h–i)

*1948 *Dictyoconus arabicus* n. sp. – HENSON, p. 35, Pl. 1, Figs. 5–8, Pl. 14, Figs. 1–12.

1977 *Dictyoconus balkanicus* n. sp. – PEYBERNÈS & CUGNY, p. 73, Pl. 1, Figs. 1–7, Pl. 2, Figs. 1–7.

1979 *Paleodictyoconus arabicus* HENSON – SCHROEDER & CHERCHI, p. 575, Pl. 1, Figs. 3–7, Pl. 2, Figs. 1–2, 4–5.

1986 *Dictyoconus arabicus* HENSON – MANTEA & TOMESCU, Pl. 8, Figs. 1–4.

1987 *Dictyoconus arabicus* HENSON – LUPERTO SINNI & MASSE, p. 362, Pl. 38, Figs. 2, 5–6.

1990 *Dictyoconus arabicus* HENSON – SCHÖLLHORN & SCHLAGINTWEIT, Pl. 3, Figs. 1–2.

1991 *Dictyoconus arabicus* HENSON – SCHLAGINTWEIT, p. 37, Pl. 12, Figs. 10, 12–14.

1999 *Dictyoconus arabicus* HENSON – CHERCHI & SCHROEDER, p. 6, Pl. 2, Figs. 1–8, Text-Fig. 2.

2002 *Montseciella arabica* (HENSON) – SCHROEDER et al., p. 856, 858.

2010 *Montseciella arabica* (HENSON) – SCHROEDER et al., p. 53, Figs. 4a–3, Fig. 4b–1?, 2–7.

Remarks

Within the studied samples, either *Montseciella arabica* or gen. et sp. indet. (=? *Palorbitolina lenticularis*) are present. *M. arabica* occurs in samples with reduced siliciclastic input whereas the other species is typically for the samples bearing abundant siliciclastic detritus that became incorporated in its chamber layers. In contrast hereto, the tests of *M. arabica* are visibly devoid of incorporated siliciclastic particles. *M. arabica* occurs in the allodapic Urgonian-like limestones of the Thiersee syncline (HAGN, 1982; HARLOFF, 1989; own observation) and the Langbath Zone (SCHÖLLHORN & SCHLAGINTWEIT, 1990).

Orbitolinid gen. et sp. indet.

(Pl. 1, Figs. b–c pars, Pl. 2, Figs. g, j–m)

Remarks

These forms show a low-conical to almost flat disc-shaped tests and often broken and marginally eroded (rounded periphery!). In none of the specimens the apical embryonic apparatus, important for generic and species identification is preserved, so that these must be treated in open nomenclature. Due to the co-occurrence with *Montseciella arabica* (HENSON) and the inferred stratigraphy (e.g., SCHROEDER et al., 2010), however, it is most likely that the tests belong to *Palorbitolina lenticularis* (BLUMENBACH) a species widespread in the allochthonous Urgonian limestones of the Northern Calcareous Alps (SCHLAGINTWEIT, 1991). Within the allodapic Urgonian limestones of the Thiersee Syncline, *M. arabica* and *P. lenticularis* are co-occurring (HAGN, 1982; own observation).

Discussion

Orbitolinids are typical inhabitants of Early Cretaceous shallow-water platform carbonates (e.g., ARNAUD-VANNEAU, 1980: Urgonian) or marly-siliciclastic deposits, e.g., "*Orbitolina* beds" of the Schratten Limestone of Switzerland (LIENERT, 1965). In the Northern Calcareous Alps the Early Cretaceous strata comprise marly to sandy deeper-water successions, e.g., Schrambach Formation, Rossfeld Formation, whereas autochthonous shallow-water sediments are lacking (e.g., TOLLMANN, 1976). Since the 1980ies, resediments of Urgonian-type shallow-water facies with orbitolinids, rudists, corals and calcareous algae have been reported within time-equivalent basin sediments (as allodapic limestones, olistolites) or as components in several formations of Late Cretaceous age, i.e., Branderfleck Formation and Lower Gosau Subgroup, and Cenozoic conglomerates (HAGN, 1982; WEIDICH, 1984; HARLOFF, 1989; SCHÖLLHORN & SCHLAGINTWEIT, 1990; SCHLAGINTWEIT, 1991). This former and today eroded Urgonian-type sedimentation lasted from the Upper Barremian to the Albian. The most western record of this former platform carbonates are breccias with crystalline detritus, orbitolinids, corals, algae and other shallow-water bioclasts in the Lechtaler Kreideschiefer in the Lechtal Alps (HUCKRIEDE, 1958). Interestingly, these breccias were interpreted by LEISS (1992: p. 623) as synorogenic sediments stating that the "Rossfeld Beds and the Lechtal Shale exhibit a perfect harmony". The shallow-water bioclasts of the Lechtal Shale, however, still lack a modern micropaleontological investigation. The most eastern occurrences of remnants of Urgonian-type sediments are clasts within the basal conglomerates of the Lower Gosau Subgroup of Lilienfeld, Lower Austria (WAGREICH & SCHLAGINTWEIT, 1990). This accounts for a lateral east-west extension of about 400 km where resediments of this Early Cretaceous shallow-water evolution can be traced in the northern units of the Northern Calcareous Alps.

Early Cretaceous shallow-water detritus was already reported from the Rossfeld Formation, i.e. from the more southern units of the Northern Calcareous Alps. Within the Upper Rossfeld Formation, coral bioclasts were observed by PLÖCHINGER (1968: p. 82). SCHLAGINTWEIT (1991) reported the corallinacean alga *Archaeolithothamnium rude* LEMOINE and fragments of "*Bacinella-Lithocodium*" from the Rossfeld Formation (named Lackbach Formation in that area) of the Unken Syncline near the Salzburg-Tyrolian boundary west of the township Unken. As *A. rude* is common in the clasts of Urgonian limestones, its occurrence in the Rossfeld Formation documents influence from the former platform that was assumed in a position south of the depositional realm of the Rossfeld Formation, i.e. near the todays southern rim of the Northern Calcareous Alps. This connection is further substantiated by the findings of the orbitolinid foraminifera that were reported from allodapic Urgonian limestones of the Thiersee Syncline (HAGN, 1982; own observation) belonging to the Lower Tirolic unit resp. the Lowermost Tirolic unit (GAWLICK et al., 2009, 2011), or the Langbath Zone (SCHÖLLHORN & SCHLAGINTWEIT, 1990). Also the detrital chromium spinels occurring in the sediments of the Rossfeld Formation and those incorporated into the test of orbitolinids from allochthonous Urgonian limestone clasts show identical geochemical signatures (WAGREICH et al., 1995) and give further evidence for the southern source area (for details: POBER & FAUPL, 1988). We observed that in the orbitolinids of the Grabenwald succession no detrital chromium spinel occur as test-building material. Chromium spinel is together with garnet, zircon, feldspar and mica part of the detrital grain fraction of the underlying marly rocks (PLÖCHINGER, 1983: p. 32; PLÖCHINGER, 1990: p. 28; own data). This feature, however, is not rather common in orbitolinids from the allochthonous Urgonian limestones and seems to be restricted to the influencing areas of distributary systems that crossed the former platform areas and brought this detritus from an emerged hinterland, i.e. the Neotethyan ophiolite nappe stack as known in the Dinarides and Albanides.

Conclusions

The finding of orbitolinids together with other shallow-water carbonate clasts and ophiolite detritus in the Late Barremian to Early Aptian Rossfeld Formation (Grabenwald Subformation: Text-Fig. 3) of the Northern Calcareous Alps proves the existence of a carbonate platform deposited on top of ophiolites. Such a scenario of the onset and evolution of an Early Aptian carbonate platform, rich in orbitolinids is known from the Mirdita Ophiolite Zone in Albania (e.g., GAWLICK et al., 2008; SCHLAGINTWEIT et al., 2012).

Montseciella arabica (HENSON) is stratigraphically restricted to the Upper Barremian to Lowermost Bedoulian, *Palorbitolina lenticularis* (BLUMENBACH) to the Upper Barremian-Bedoulian (SCHROEDER et al., 2010). Thus, the resedimented orbitolinids can be taken as biostratigraphic marker fossils in the younger parts of the Rossfeld Formation assuming pene-contemporaneous resedimentation of the isolated tests.

Therefore these findings fit perfectly in the reconstructed Middle Jurassic to Early Cretaceous geodynamic history of the southern Northern Calcareous Alps; i.e. the partial closure of the Neotethys Ocean with accompanied ophiolithe obduction and the onset of different carbonate platforms on top of them, as known e.g. in Dinarides, Albanides and Hellenides.

Plate 1

Microfacies of the orbitolinid-bearing resediments from the Early Cretaceous Rossfeld Formation:

Fig. a: Poorly sorted mixed carbonatic-siliciclastic resediment with dispersed bioclasts (here: a coral). Locality Grabenwald, sample OK W 381-1, width of photo: 1,4 cm.

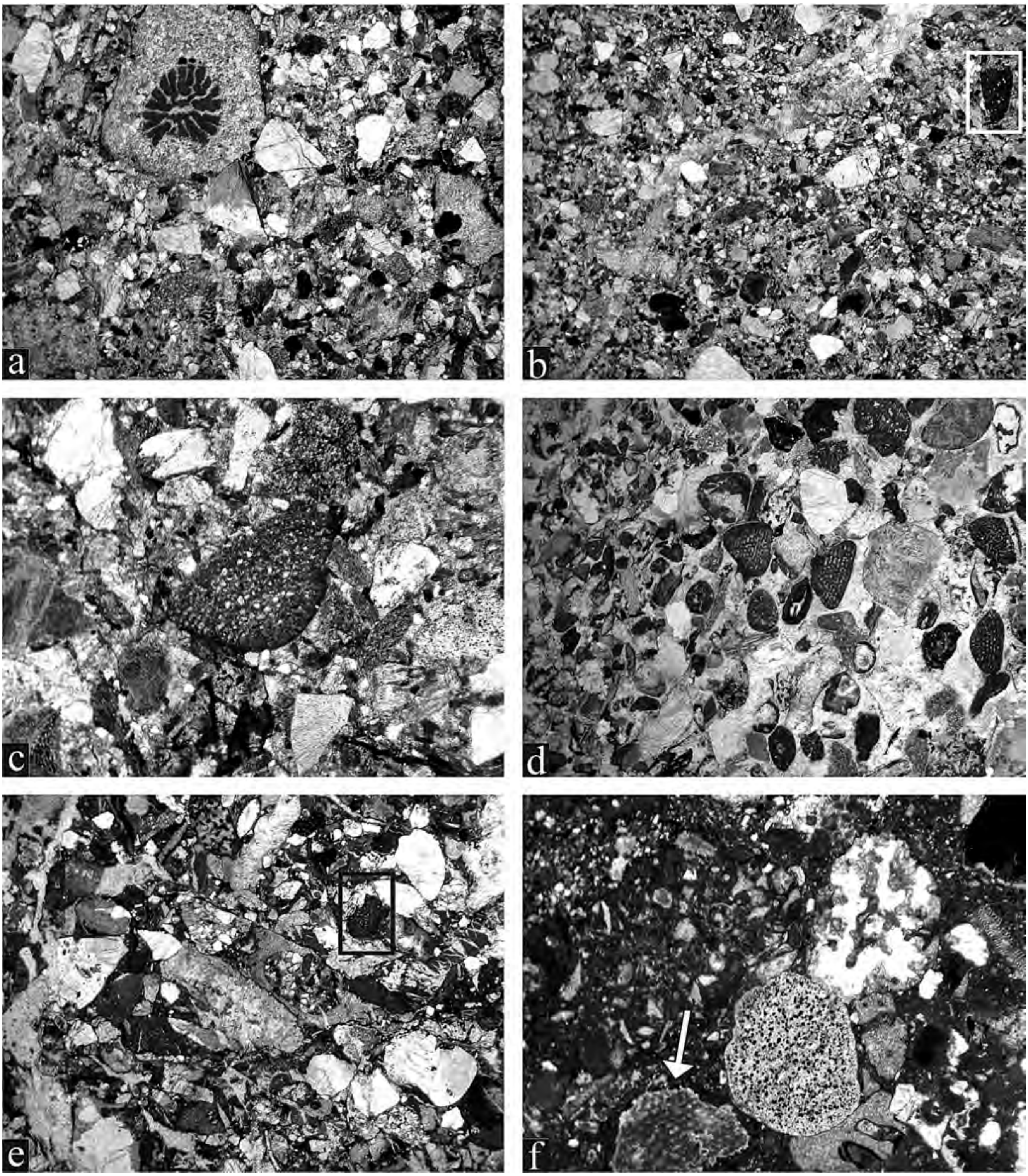
Fig. b: Mixed carbonatic-siliciclastic resediment with broken orbitolinid test (white rectangle on the right).
Locality Grabenwald, sample OK W 377-2, width of photo: 1,4 cm.

Fig. c: Mixed carbonatic-siliciclastic resediment with orbitolinid test.
Locality Kerterer gorge, sample OK W 353-1, width of photo: 0,5 cm.

Fig. d: Moderate sorted resediment with numerous tests of *Montseciella arabica* (HENSON) and sparitic matrix.
Locality Gartenau, sample OK L 327-2, width of photo: 1,4 cm.

Fig. e: Coarse-grained poorly sorted resediment with subangular to rounded quartz grains and bioclasts among *Montseciella arabica* (HENSON) (black rectangle).
Locality Gartenau, sample OK 327-1, width of photo: 1,4 cm.

Fig. f: Close-packed bio- and lithoclasts in a fine-siliciclastic micritic matrix. The arrow points to a corroded and partly silicified test of *Montseciella arabica* (HENSON).
Locality Hundskar, sample OK W 587-1, width of photo: 0,5 cm.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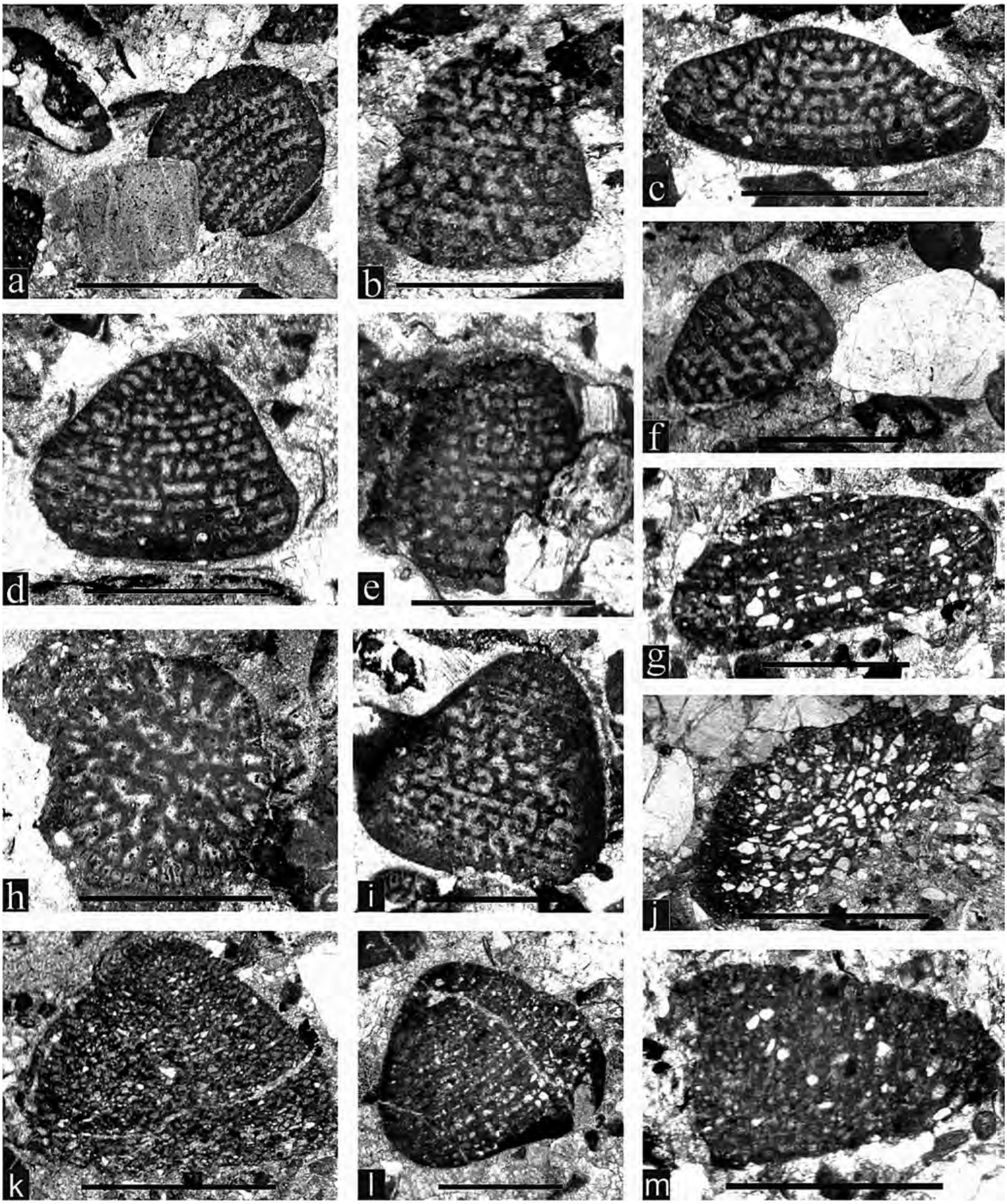
d
e
f

Plate 2

Orbitolinids from the Early Cretaceous Rossfeld Formation:
Figs. a–f and h–l show *Montseciella arabica* (Henson); Figs. g and j–m show orbitolinid gen. et sp. indet. Scale bars: 1 mm.

Fig. a: Locality Gartenau, sample OK L 327-1.
Fig. b: Locality Gartenau, sample OK L 327-1.
Fig. c: Locality Gartenau, sample OK L 327-1.
Fig. d: Locality Gartenau, sample OK L 327-1.
Fig. e: Locality Hundskar, sample OK W 587-2.
Fig. f: Locality Gartenau, sample OK L 327-1.
Fig. g: Locality Grabenwald, sample OK W 378-3.
Fig. h: Locality Hundskar, sample OK W 587-1.
Fig. i: Locality Gartenau, sample OK L 327-2.
Fig. j: Locality Grabenwald, sample OK W 376-2.
Fig. k: Locality Grabenwald, sample OK L 376-1.
Fig. l: Locality Grabenwald, sample OK L 376-1.
Fig. m: Locality Grabenwald, sample OK L 377-2.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