

A unique ammonoid fauna from the Upper Jurassic Loser section (Northern Calcareous Alps, Salzkammergut)

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Abstract: An ammonoid fauna from the Upper Jurassic Loser section (Oberalm Formation and Tressenstein Formation) is presented. The fauna is unique with respect to biofacial composition, biostratigraphic implications, and sedimentary facies. The ammonoids were found in a loose block derived from the basal part of the Tressenstein Fm. and allow the first dating of this unit based on megafossils. The ammonoids are derived from a single bed and are mostly fragmented due to submarine redeposition. The phylloceratid-dominated, Ammonitico Rosso type assemblage is characteristic for the Alpine Agatha Fm. from where it may have been derived by mudflow transport. It contains *Sowerbyceras silenum* (FONTANNES), *Phylloceras* cf. *isomorphum* GEMMELLARO, *Taramelliceras* (*Metahaploceras*) cf. *strombecki* (OPPEL), *Presimoceras* cf. *herbichi* (NEUMAYR), *Lithacosphinctes?* sp. ind., and *Aspidoceras* sp. ind. The fauna reveals an Early Kimmeridgian age (*Strombecki* to *Herbichi* Zone) for this interval of the Loser section. Additionally, the correlation problems of lithostratigraphic units with similar lithology but different ages across tectonic boundaries are briefly discussed.

Kurzfassung: Eine Ammonoideenfauna aus dem Ober-Jura des Losers (Oberalm-Fm. und Tressenstein-Fm.) wird beschrieben. Die Einzigartigkeit dieser Fauna liegt in ihrer biofaziellen Zusammensetzung, ihrer biostratigraphischen Bedeutung und der sedimentären Fazies. Die Ammonoideen stammen aus einem losen Block von der Basis der Tressenstein-Fm. und erlauben die erste Datierung dieser Einheit anhand von Megafossilien. Sie stammen aus einer einzigen Bank und sind aufgrund submariner Umlagerung fragmentiert. Die Phylloceratiden-dominierte Assoziation weist Ähnlichkeiten mit dem Ammonitico Rosso auf. Sie ist charakteristisch für die alpine Agatha-Fm., aus welcher sie durch mudflow synsedimentär umgelagert worden sein könnte. Sie enthält *Sowerbyceras silenum* (FONTANNES), *Phylloceras* cf. *isomorphum* GEMMELLARO, *Taramelliceras* (*Metahaploceras*) cf. *strombecki* (OPPEL), *Presimoceras* cf. *herbichi* (NEUMAYR), *Lithacosphinctes?* sp. ind. und *Aspidoceras* sp. ind. Anhand der Ammonoideen kann dieser Bereich des Loser-Profiles mit Unterkimmeridgium (*Strombecki* bis *Herbichi* Zone) datiert werden. Zusätzlich wird die Problematik

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lithostratigraphischer Korrelationen über tektonische Grenzen hinweg, die sich aufgrund des biostratigraphischen Befundes ergibt, diskutiert.

Keywords: Upper Jurassic, Ammonoids, Biostratigraphy, Loser section, Austria

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1. INTRODUCTION

The Upper Jurassic of the Loser represents a succession from micritic basinal sediments (Oberalm Fm.) to detrital rudstones (Tressenstein Fm.) transported downslope from an unpreserved carbonate platform (Plassen Fm.). The Tressenstein Fm. forms a crucial link between the Upper Jurassic carbonate platforms and basins, but the exact dating of this unit is difficult due to the long stratigraphic range of the microfossils. We present the first biostratigraphic study of the Alpine Tressenstein Fm. based on megafossils. After an overview of the Loser section, we describe the ammonoid fauna, including discussions on taxonomy and biostratigraphic implications. Finally, we discuss the lithostratigraphic problems for the units involved.

2. GEOLOGICAL BACKGROUND AND STUDY AREA

The Early Jurassic to Oxfordian time in the Northern Calcareous Alps was characterized by deep-marine conditions with extensive radiolarian cherts along the Middle/Upper Jurassic boundary (DIERSCHKE, 1980; LACKSCHEWITZ et al., 1991; GAWLICK & SUZUKI, 1999; GAWLICK et al., 1999; MISSONI et al., 2001). Due to tectonic events, gravitational sliding masses were then transported towards the north (TOLLMANN, 1987; GAWLICK et al., 1999; MANDL, 2000), causing a high structural relief that enabled the first carbonate platform development since the beginning of the Jurassic. Shallow-water development lasted until the earliest Cretaceous (TOLLMANN, 1987; DARGA & SCHLAGINTWEIT, 1991; GAWLICK et al., 1999). Alpine Upper Jurassic to Lower Cretaceous shallow water environments are usually interpreted as steeply bordered isolated 'Bahamas-type' platforms, which inter-finger with bathypelagic basin sediments (FENNINGER & HOLZER, 1972). The basin sediments are represented by the Oberalm Formation, characterized by micritic limestones, which can be interbedded with allodapic Barmstein Limestones. The Tressenstein Fm. is explained as the platform slope breccia and the carbonate platform sediments are represented by the Plassen Fm. and Lerchkogel Limestone.

The Loser section is located in the Styrian Salzkammergut (Austria) and is situated north of the village Altaussee (Fig. 1). The Loser is part of the Totengebirgs Nappe and

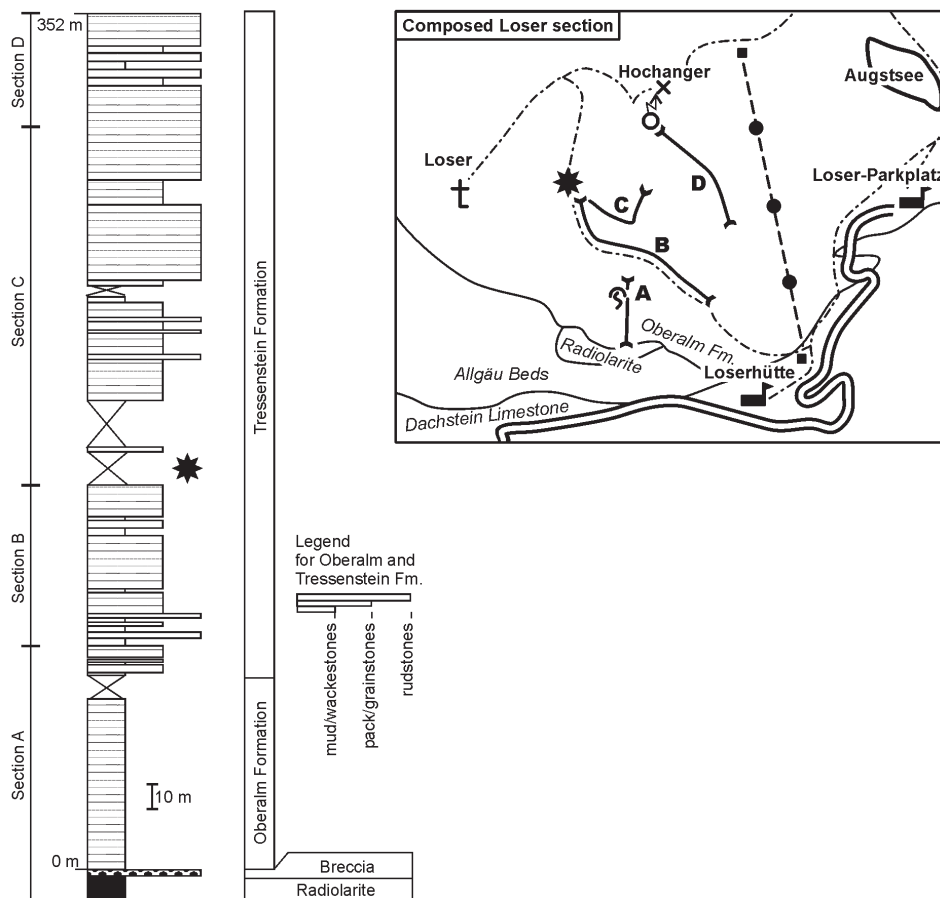
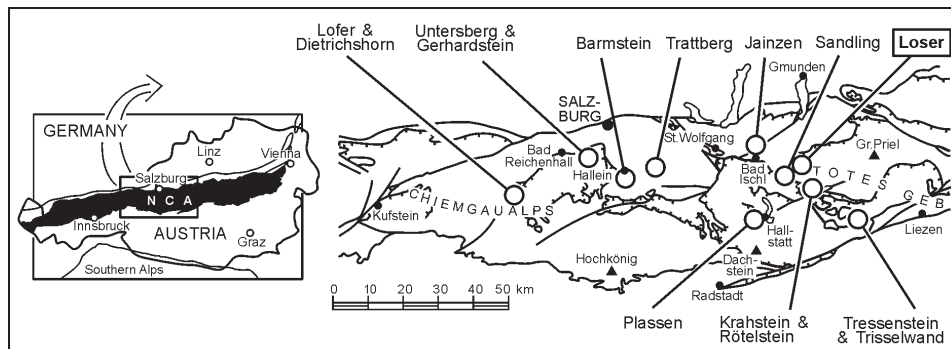


Fig. 1: Tectonic map of the Northern Calcareous Alps (after MANDL, 2000) with location of the Loser section (above); schematic map of the Loser plateau (after SCHÄFFER, 1982) with position of the measured section (asterisk marks the location of the ammonite-bearing block) (right); schematic lithological section (left).

as such part of the Tirolic Unit (MANDL, 2000). The Loser consists mainly of Dachstein Limestone, partly showing Lofer Cycles. On top of these lagoonal Triassic sediments the Loser shows a steep cliff built by Jurassic rocks: lenticular bodies of "Adnet Limestones", cherty Allgäu Beds, radiolarites, Oberalm Fm., and Tressenstein Fm. (BAUSCH & POLL, 1984; FENNINGER & HOLZER, 1972; SCHÄFFER, 1982).

3. THE LOSER SECTION

The Upper Jurassic of the Loser represents a 350 m thick succession of micritic and detrital calcareous sediments. At the southern mountainside, Triassic Dachstein limestone is overlain by Oxfordian (?) cherty Allgäu Beds and radiolarite (SCHÄFFER, 1982). The radiolarite is overlain by a thin breccia, followed by thin-bedded micritic sediments of the Oberalm Fm. A schematic section is given in Fig. 1.

The basal micritic sediments are approx. 80 m thick and contain radiolarians, sponge spicula, and fragments of the fragile crinoid *Saccocoma*; calpionellids are absent. Patchy chertification within the micrites and chert layers along the bedding planes increase upsection. Above these 80 m of micrites, the succession is dominated by detrital sediments, but micritic intercalations were found up to 330 m. These micritic intercalations within the detritus-dominated higher succession can contain micritic lithoclasts, which are supposed to be intraclasts. The latter are unknown from the basal 80 meters.

The following 160 m are dominated by bedded and mostly laminated peloid-echinoderm-bearing grain- and packstones. Echinoderms are dominated by crinoid fragments. Lamination is caused by alternations of peloid and echinoderm layers. Upsection, the grain/packstones are dominated by shallow-water bioclasts (especially foraminifera, dasycladalean algae, microproblematica, and 'stromatoporoids'), while the abundance of echinoderms decreases. The stratigraphically highest peloid grainstone was found at 338 m. Vertical or lateral trends within the particular beds could not be found.

Rudstone beds are intercalated within the middle part of the section, starting at 95 m; they dominate the uppermost 110 meters. A thickening upward trend cannot be recognized. Rudstones are composed of bio- and lithoclasts, usually with a micritic matrix. Lithoclasts are composed of shallow-water limestones and micritic limestones, bioclasts are dominated by framework builders and oncoids. There seems to be a general trend showing an increasing abundance of micritic clasts upsection, but this needs further evidence from detailed microfacies analysis. Vertical or lateral trends within the particular rudstone beds were not found. Chert layers and chertified macrofossils (mostly 'stromatoporoids') can be abundant in certain horizons.

The cephalopods presented in this paper were found at the footwall of section C within a loose block with a diameter of approx. 80 cm, at the hiking trail between Loser and Hochanger, about 1670 m above sea-level (corresponding to 160 m in the section). The origin of this loose block is unknown, but the large thickness excludes its presence in the well exposed thin-bedded parts and suggests an origin from the poorly outcropping intervals in the middle part of the section between 160 and 190 m.

4. AMMONOID FAUNA

The above mentioned block consists of a packstone rich in bioclasts. Radiolarians and sponge spicula are absent. The main difference to all other facies types found in the Loser section is the abundance of cm-sized fragments of unspecified cephalopods representing most probably phylloceratids. Among the well preserved and less fragmented specimens, nearly 30 determinable ammonoids have been extracted from the block and document a fossil record, which is unique for the Tressenstein Fm. Many ammonoids are preserved as incomplete internal moulds or body chamber fragments without any traces of the original shell. Suture lines and details of the fine sculpture are mostly missing. Complete specimens are restricted to involute phylloceratid forms of the genus *Sowerbyceras*. The more evolute oppeliids and perisphinctids are stronger fragmented and often reduced to fragments of less than one whorl length (e.g., Pl. 1, Figs. 7–8). All this makes precise determinations difficult and explains the majority of the adapted species approximations. The following list of identified taxa gives the number of specimens, the respective stratigraphic range, and the figures.

Sowerbyceras silenum (FONTANNES 1876), 17 – Kimmeridgian, Pl. 1, Figs. 1 – 5.

Phylloceras cf. *isomorphum* GEMMELLARO 1872, 1 – not figured.

Taramelliceras (*Metahaploceras*) cf. *strombecki* (OPPEL 1857), 3 – Lower Kimmeridgian (*Strombecki* Zone), Pl. 1, Figs. 7 – 8.

Presimoceras cf. *herbichi* (HAUER 1866), 4 – Lower Kimmeridgian (*Herbichi* Zone), Pl. 2, Figs. 1 – 3.

Lithacosphinctes? sp. ind., 3 – Lower Kimmeridgian, Pl. 2, Figs. 4 – 6.

Aspidoceras sp. ind., 1 – Lower Kimmeridgian, Pl. 1, Fig. 6.

5. TAXONOMIC REMARKS

Two different phylloceratids and four genera of Ammonitina were found in the studied material.

A single fragmented specimen of an involute form with a high-oval cross-section is identified as *Phylloceras* cf. *isomorphum* GEMMELLARO. Very common is another phylloceratid with an open umbilicus, flat flanks and a ventrolaterally shortly rounded, externally flattened venter (Pl. 1, Figs. 1–5). Common to all specimens are a high rectangular cross-section ($wh > wb$; $wh =$ whorl height, $wb =$ whorl width) and 4–5 slightly sigmoid, externally forward bending constrictions. According to SARTI (1993) these two characteristics are typical for *Sowerbyceras silenum*, a species considered by this author as diagnostic for the lowermost Kimmeridgian. Stratigraphically younger species of *Sowerbyceras* are thicker ($wh < wb$) and show stronger arched, externally elevated constrictions. JOLY (2000), however, does not agree with SARTI's differentiation and treats the two species (*S. silenum* and *S. loryi*) in synonymy.

The two specimens of *T. (Metahaploceras) cf. strombecki* (OPPEL) are suture-less and therefore interpreted as body chambers (Pl. 1, Figs. 7–8). They show distant slightly sigmoid primary ribs with ventrolateral nodes and faint secondary ribs. This sculpture as well as the high-oval cross-section and the open umbilicus are typical for *T. (M.) strombecki*, but the poor preservation prevents a precise specific determination.

A rather evolute, disc-shaped perisphinctid is represented by three, relatively complete internal moulds (Pl. 2, Figs. 1–2) and a single adult body chamber fragment (Pl. 2, Fig. 3). The species is characterized by very evolute and only slowly in size growing whorls with narrow spaced single, externally forward bending ribs which become strong and distant on the presumed adult body chamber (Pl. 2, Fig. 3). The latter fragment is very similar to the body chamber of an adult specimen of *Presimoceras herbichi* (HAUER) figured by CARACUEL et al. (1998; Pl. 1, Fig. 1) and the specimens are thus determined as *Presimoceras cf. herbichi* (HAUER).

Three other phragmocone fragments (Pl. 2, Figs. 4–6) show identical biplicate fine ribs and evolute whorls with a subcircular cross-section. They are different from nearly all known Kimmeridgian perisphinctid genera and morphologically more similar to Oxfordian representatives of the family Ataxioceratinae. Without knowledge of the body chamber sculpture any closer identification is difficult and as *Lithacosphinctes* ? sp. ind. rather tentative.

Aspidoceras sp. ind. is represented by a single fragmented specimen (Pl. 1, Fig. 6).

6. BIOSTRATIGRAPHY

Before establishing the age of the fauna the possibility of stratigraphic faunal mixing has to be evaluated. The local shell concentrations in a single bed within a more than 150 m thick sequence of otherwise unfossiliferous hemipelagic basinal rocks underlines the unique sedimentary nature of the bed. Together with the occurrence of ammonoids of presumably two different ammonoid zones (e.g., *Strombecki* and *Herbichi* Zone) stratigraphic condensation cannot be excluded a priori. Another peculiar feature of the ammonoid assemblage is the dominance of broken shells and phragmocone fragments pointing to a current-induced submarine transport and/or redeposition of the fossils. Local reworking may be excluded by the absence of intraclasts, graded bedding and the relatively fine-grained nature of the surrounding sediment. A more appropriate explanation may be seen in a mudflow transport of the assemblage from an adjacent topographic high. Such time-equivalent rocks are known in neighboring regions as Agatha Fm., formerly named *Acanthicus* Limestones and well known for their rich Kimmeridgian ammonoid fauna (NEUMAYR, 1873; TOLLMANN, 1976). An analysis of the Loser faunal spectrum shows a dominance of phylloceratids with more than 60% accompanied by an under-representation of ribbed ammonoids. This association is well comparable with typical epiocenic or so-called Ammonitico Rosso faunal spectra, where leiostracean genera usually dominate with more than 50% (SARTI, 1993; CECCA et al., 1994).

Cephalopod limestones of Ammonitico Rosso type are well known for their potential of stratigraphic condensation, which is usually indicated by dark red-colored, strongly corroded and encrusted ammonoids with Fe/Mn oxide coatings. The Loser ammonoids are light grey, not encrusted and miss the characteristic oxidic crusts known from Alpine condensed deposits. They are just broken, and a presumable faunal mixing could therefore better be explained by a transport related amalgamation of previously differentiated fossil beds in the primary deposition area. Though this possibility cannot be ruled out, its plausibility is questioned by the missing of any brecciation and microfacies differentiation within the bed, or block, respectively. However, if syn-depositional faunal

mixing has occurred, the youngest possible age of the bed is still Early Kimmeridgian (*Herbichi* Zone) according to the presence of the index form of the zone. In any case, the indication of an older ammonoid zone suggested by *T. (Metahaploceras) cf. strombecki* does not change much the age from a geological point of view.

7. LITHOSTRATIGRAPHIC REMARKS

Traditionally, the lithostratigraphic subdivision of Upper Jurassic to Lower Cretaceous carbonate sediments in the middle part of the Northern Calcareous Alps follows TOLL-MANN (1976). (1) Oberalm Fm.: micritic bedded limestones representing pelagic basinal sediments. (2) Barnstein Limestones as a part of the Oberalm Fm.: turbiditic intercalations of lithoclastic and bioclastic limestones. (3) Tressenstein Fm.: lithoclastic rudstones overlying the Oberalm Fm., interpreted as platform slope breccias. (4) Plassen Fm.: autochthonous shallow water carbonates (Fig. 2).

In the current study, the Kimmeridgian micritic sediments at the base of the Loser section are attributed to the Oberalm Fm., which follows the geological map of the study

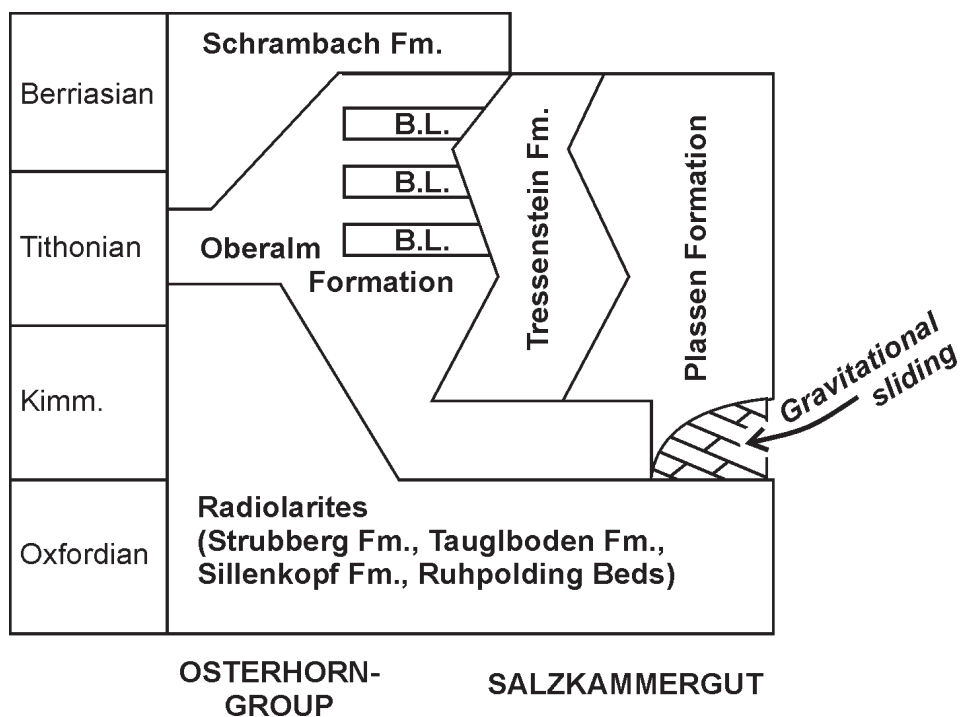


Fig. 2: Schematic stratigraphic overview of the Upper Jurassic in the middle part of the Northern Calcareous Alps (after RASSER, in press). The left part shows the pure pelagic development typical for the Osterhorn area; the right part shows the development from basinal to shallow water sediments in the Salzkammergut area.

area (SCHÄFFER, 1982). This attribution is, however, problematic, since the typical sediments of the Oberalm Fm. in the type area (Osterhorn area) are Tithonian to Berriasian in age, contain intercalations of Barmstein Limestone, and grade vertically into Lower Cretaceous pelagic sediments (Schrambach Fm.; see also RASSER et al., this vol.). The micritic sediments of the Loser section are, however, Kimmeridgian in age, lack intercalations of Barmstein Limestone beds, and are part of a different tectonic unit.

Furthermore, the lithostratigraphic position of the grain/packstone-dominated part of the Loser section (between 80 and 240 m) is problematic. Due to their grain size they do not fit with the traditional definition of the Tressenstein Fm. and therefore the question arises, whether they can be attributed to the Barmstein Limestone or Oberalm Fm., respectively. However, the Barmstein Limestone beds are usually defined as intercalations in the Oberalm Fm., which is not the case in the studied section. Moreover, as mentioned above, they occur in different tectonic units and are of different ages.

All of this points to a main problem in lithostratigraphy: the correlation of units of different ages across different tectonic units. The solution of these problems requires, however, further lithostratigraphic research, which is beyond the scope of this paper. In the current study, the terms Oberalm Fm. and Tressenstein Fm. (Fig. 1) are therefore used tentatively.

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Plate 1

Figs. 1–5: *Sowerbyceras silenum* (FONTANNES 1876), (x 1); 2002z0154/0001 and 2002z0161/0001 – 0005.

Fig. 6: *Aspidoceras* sp. ind., (x 1); 2002z0162/0001.

Figs. 7–8: *Taramelliceras* (*Metahaploceras*) cf. *strombecki* (OPPEL 1857), body chamber fragments (x 1); 2002z0162/0002.

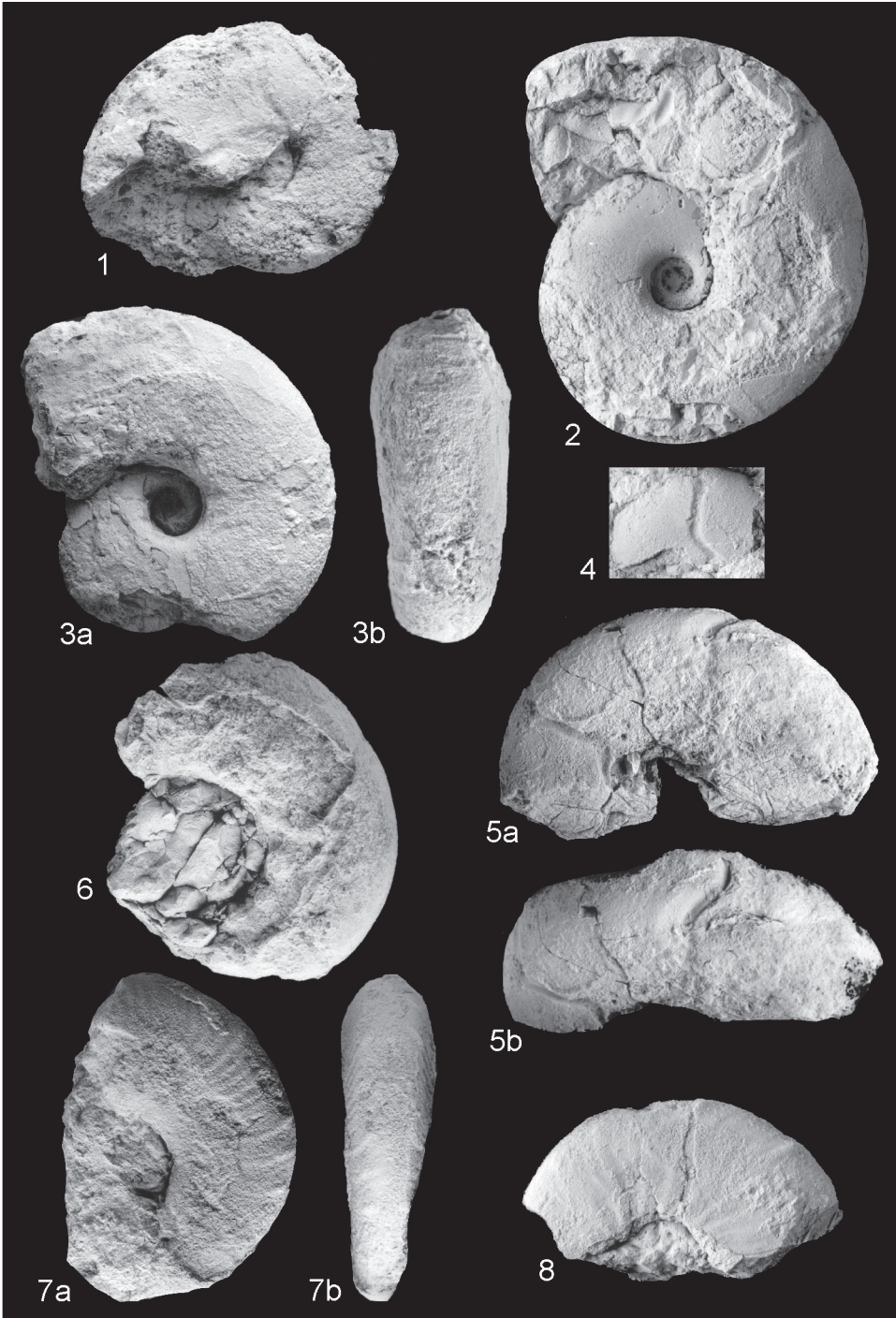


Plate 2

Figs. 1–3: *Presimoceras* cf. *herbichi* (HAUER 1866), 1-2 = inner whorls, 3 = body chamber fragment (x 1); 2002z0163/0001 – 0003.

Figs. 4–6: *Lithacosphinctes* ? sp. indet., inner whorl fragments, Fig. 4 (x 1); Fig. 5 (x 1), Fig. 6a, b (x 2), Fig. 6c (x 1); 2002z0164/0001 – 0002.

