 Gedenkband zum 100. Todestag von Dionys Stur				Redaktion: Harald Lobitzer & Albert Daurer	
Jb. Geol. BA.	ISSN 0016-7800	Band 136	Heft 4	S.919-932	Wien, Dezember 1993

Early Liassic Ammonites from the Steinplatte-Kammerköhralm Area (Northern Calcareous Alps/Salzburg)

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With 18 Text-Figures and 2 Plates

Österreichische Karte 1 : 50.000 Blätter 91, 92 Salzburg Nördliche Kalkalpen Steinplatte Lias Ammoniten

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Ammoniten aus dem Unterlias des Gebietes Steinplatte – Kammerköhralm (Nördliche Kalkalpen/Salzburg)

Zusammenfassung

Aufgrund der Palaeogeomorphologie zeigt die Lias-Auflagerung des Kammerköhralm-Steinplatte-Gebietes eine keilförmige Konfiguration, wobei ein Ausdünnen vom Kössener Becken über den Slope zur Karbonatplattform zu beobachten ist. Dementsprechend wird auch die Schichtlücke vom Becken über den oberen Slope bis zur Karbonatplattform zunehmend ausgeprägter, wobei an den von uns studierten drei Aufschlüssen eine kondensierte Ammoniten-Assoziation des Ober Hettang–Unter Sinemur (Marmorea-Zone) dem Oberrhät-Riffkalk auflagert.

Interessant ist ferner der erste und stratigraphisch älteste Fund des Genus Bouhamidoceras DUBAR, 1961 in den Alpen, während Badouxia GUEX & TAYLOR, 1976 erstmals im Bereich der Tethys angetroffen wurde.

Abstract

The palaeogeomorphological situation of the Kammerköhralm/Steinplatte area implies a wedge-shaped configuration of Liassic limestones. The Upper Triassic intraplatform Kössen basin is overlain by grey cherty biomicrites (Scheibelberg Limestone). Towards the slope and the carbonate platform due to pinching out the stratigraphic gap is getting wider and the Liassic is represented by variegated micritic limestones of Adnet type. The three studied Liassic sections overlying the Upper Rhaetian reef limestone show condensed ammonite assemblages of Late Hettangian–Early Sinemurian age (Marmorea-Zone). The finding of *Bouhamidoceras* DUBAR, 1961 represents the first record in the Alps and shows the stratigraphically earliest appearance of this genus. The occurrence of *Badouxia* GUEX & TAYLOR, 1976 is new for the Tethyan region.

1. Introduction

Since the early studies by MOJSISOVICS (1869) the Steinplatte-Kammerköhralm region represents one of the most attractive playgrounds for Mesozoic carbonate (and siliciclastic) specialists and paleontologists. Most papers are focused on the facies relationships between the Norian/Rhaetian carbonate platform of Steinplatte (lagoonal Dachstein Limestone and Upper Rhaetian "Reef" Limestone) and the transition towards the intraplatform

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basin of the Kössen Formation; e.g. HAHN, 1910; VORTISCH, 1926; OHLEN, 1959; ZANKL, 1971; PILLER & LOBITZER, 1979; PILLER, 1981; STANTON & FLÜGEL, 1991; KRISTAN-TOLLMANN et al., 1991; WEIN-BRUKNER et al. in press.

However since the monographic papers by WÄHNER (1882–1898) the Steinplatte-Kammerköhralm region is also a classical terrain for Liassic ammonite studies. Particularly the spectacular outcrops in the Middle to Late Liassic Adnet Formation east of Kammerköhr restaurant attracted as well sedimentological investigations (WILSON, 1969; GARRISON & FISCHER, 1969), as also studies of ammonite stratigraphy (e.g. FISCHER, 1966).

This paper presents the results of a stratigraphic study of the Rhaetian/Liassic boundary at three localities in the Steinplatte area (Text-Fig. 1). At all three localities studied, there exists an unconformity between the Upper Rhaetian Limestone ("Oberrhät-Riffkalk") and the varieated Liassic limestone of Adnet type. However, it cannot be ruled out, that there exists an undisturbed and complete section in the intraplatform basin environment from the Norian/Rhaetian (Kössen Formation) to the Early Liassic Scheibelberg Limestone Formation (e.g. Scheibelberg loc. class.). Both these basinal micritic limestones show dark grey colour and bituminous smell, the latter is cherty (KLEBELSBERG, 1935; KRISTAN-TOLLMANN et al., 1991; WEIN-BRUKNER et al. in press). The hanging part of the Kössen Formation of Kammerköhralm holds the Rhaetian index ammonite Choristoceras marshi HAUER. Unfortunately the ammonite sections observed so far in the Scheibelberg Limestone did not allow a more distinct determination. It is our impression, that due to different palaeogeomorphology at the Rhaetian/Liassic boundary, the Hettangian sediments formed a sedimentary wedge, pinching out towards the south, i.e. from the Kössen basin in direction to the carbonate platform. Due to the Upper Rhaetian palaeorelief, the transgression of the Liassic sea reached the reef proper respectively the carbonate platform later than the (former) basinal and slope environments. This fact seems to be responsible, that the record of basal Liassic transgression is getting stratigraphically younger from North to South. In addition, of course, the

weathering also reduced the geological record in many places almost to nil. Some of the most complete Liassic profiles are preserved in shattered palaeokarst depressions. Similar as in the classical Adnet quarries (BÖHM, 1992), the Hettangian limestones of Steinplatte show a condensation which is underlined also by sedimentary features, such as ferrolitic crusts, deep water stromatolites and subsolution. Also most biota are Fe-encrusted and therefore the ammonites could be easily separated from the parent rock.

The brachiopod assemblage of the three Steinplatte localities was studied simultaneously by SIBLIK (1993; same volume).

2. Profile Description

The three profiles studied (Text-Fig. 1) are located on the northern palaeoslope of Steinplatte (1869 m).

Profile Steinplatte I (ST 90/1)

On the eastern flank of the Plattenkogel, close to a seasonal spring (Text-Figs. 2, 3).

Profile Steinplatte II (ST 90/2)

On the northern slope of the Plattenkogel, above a tourist trail, respectively a skiing route. The outcrops were artificially created by blasting the rugged palaeokarst surface for a skiing slope (Text-Fig. 4–7).

 Profile Steinplatte III (ST 90/3) Adjacent to ST 90/2, on the tourist trail directly under the eastern ski-lift to the Plattenkogel.

Text-Fig. 4 shows a schematic sketch of the profiles Steinplatte II and III. The following text describes this section from bottom to top:

- 1) Light-grey to white thick-bedded organogenic limestones, representing the uppermost part of Late Rhaetian coral limestones.
- 2) Light-grey organogenic limestones in beds of dmthickness.
- 3) Light-grey to beige organogenic limestones with scarce bivalves (? Cardinia sp.).



Situation map of sample localities Steinplatte ST 90/1 (I), ST 90/2 (II), ST 90/3 (III).



Text-Fig. 2.

View of the contact between Upper Rhaetian reef limestone and red hematitic limestones of the Late Hettangian/Early Sinemurian. Locality: Steinplatte I.



8) Red ferrolitic biomicritic limestones with abundant Fe-stromatolite concretions, ammonites, brachiopods and bivalves. Towards the north (in the cut of the ski trail - Steinplatte III) the layer is split into three beds. Abundant ammonites were collected from this layer: Geyeroceras cylindricum (Sow.), Paradasyceras stella (Sow.), ? Nevadaphyllites sp., Analytoceras articulatum (Sow.), Ectocentrites petersi (HAU.), Bouhamidoceras sp., Angulaticeras marmoreum (GUEMB.), Sulciferites ventricosus (Sow.), Schlotheimia gr. montana (WÄHNER), Kammerkaroceras guidonii (SOW.), Paracaloceras gr. coregonense (Sow.), Badouxia sp., Cenoceras sp. The assemblage is characteristic for the Late Hettangian-Early Sinemurian, or for the Marmorea zone.

9) Red crinoidal biosparites.

Text-Fig. 4. Idealized profile of localities Steinplatte II and III. h.g. = hardground.



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SEM-photomicrograph showing micritic variegated Early Liassic lime-stone of locality ST 90/1.

- 5) Light-grey (base) and pinkish coquina filled with separate or joint shells of ? Cardinia sp. (= Cardinia coguina). The lumachelle pinches out laterally (Text-Fig. 5).
- 6) Pink to reddish biomicritic limestones with scarce bivalves brachiopods and frequent disintegrated crinoid fragments. Dissolution cavities filled with RFC (= radiaxial fibrous calcite, MAZZULLO et al., 1990) (Text-Figs.
- 7) Red, reddish-brown biomicritic limestones with transitions to crinoid-bearing limestones. This laver consists of three, more-orless distinctly separated beds. The uppermost bed is brecciated and its uneven top surface represents a hardground which is covered by irregular hematite incrustations and flattened concretions of the same composition. This bed contains Geyeroceras cylindricum (Sow.) and Paracaloceras sp.



Text-Fig. 5. Detailed view of the *Cardinia* coquina (bed number 5). Locality: Steinplatte II.



Text-Fig. 6. Bedding plane with ammonite casts. Locality: Steinplatte II, bed-no. 7. A: Angulaticeras marmoreum (OPP.). B: Ectocentriles petersi (HAU.).



Text-Fig. 7. Surface of the same bed as Text-Fig. 6 with Angulaticeras marmoreum (OPP.).

3. Systematic Part

In the following paragraphs a brief description of ammonite taxa encountered in the localities Steinplatte I-III is given.

Phylloceratidae ZITTEL, 1884 Geyeroceras HYATT, 1900

Geyeroceras cylindricum (SOWERBY, 1831)

(Text-Fig. 8; Pl. 1, Figs. 1, 2; Pl. 2, Fig. 1)

- 1831 Ammonites cylindricus Sowerby. De LA BECHE, p. 318, Fig. 54.
- 1910 Phylloceras cylindricum Sow. HAHN, p. 357.
- 1969 Geyeroceras cylindricum (SOWERBY, 1831). N. FANTINI-SESTINI, p. 99, Text-Fig. 2; Pl. 1, Figs. 1a,b et Fig. 4a,b (cum syn.).
 1971 Phylloceras cylindricum (SOWERBY). – WENDT, p. 110.
- Material: Eleven more or less complete steinkerns (internal moulds) and some whorl fragments.

Dimensions:

D	Wh	Ww	u
16,2	8,4	6,4	1,0
17,3	9,0	6,6	1,8
17,8	9,6	7,0	1,8
20,5	11,3	7,2	2,0
22,3	11,8	8,4	2,0
24,5	12,0	-	-
29,5	16,4	-	3,4
34,7	19,8	16,0	5,8
45,8	24,3	17, 8	9,0

- Remarks: Our specimens represent subadult stages, with typically flat flanks and a subrectangular whorl section. They are in good accordance with the description and depiction of the neotype of this species by FAN-TINI-SESTINI (1969).
- Stratigraphic range and distribution: Hettangian-Lotharingian. The species appeared for the first



Late Hettangian – Éarly Sinemurian.

Steinplatte.

time in the Early Hettangian (LANGE, 1952). It is, however, most frequent in the Late Hettangian–Early Sinemurian (= Marmorea zone). The latest occurrences known are from the Early Sinemurian (FUCINI, 1901) to Lotharingian (GEYER, 1896). It occurs in all three Steinplatte profiles.

Juraphyllitidae ARKELL, 1950 Paradasyceras SPATH, 1923

?Paradasyceras stella (SOWERBY, 1833)

(Text-Fig. 9; Pl. 1, Fig. 3; Pl. 2, Fig. 8)

- 1833 Ammonites stella SOWERBY. DE LA BECHE, p. 333, Fig. 63.
- 1888 Rhacophyllites stella Sow. sp. CANAVARI, p. 92, Pl. 2, Figs. 1-5.
- 1901 *Rhacophyllites stella* Sow.. FUCINI, p. 68; Pl. 7, Figs. 8, 9; Pl. 8, Fig. 8; Pl. 9, Fig. 1; Pl. 12, Fig. 4.
- 1936 Rhacophyllites stella (Sow.). GUGENBERGER, p. 157, Pl. 13, Fig. 29.
- 1942 Rhacophyllites stella SOWERBY. KOVACS, p. 97; Pl. 2, Fig. 8 (cum syn.).
- Material: Five sub-adult specimens with partly preserved calcified shells.

Dimensions:

D	Wh	Ww	u
D	Wh	Ww	u
15,5	7,0	5,5	2,9
15,7	7,2	5,8	4,2
21,0	10,2	6,8	4,5

Description: A small convolute shell, laterally compressed. The whorl section on the juvenile stage is broad-elliptic, with arched, ventrum-converging flanks and with a strongly rounded non-differentiated umbilical edge. The subadult stage is characterized by an elliptical whorl section with parallel compressed flanks (Text-Fig. 9). The umbilical edge is prominent and the umbilical wall is flat, oblique-oriented. The steinkern



shows strongly prorsiradiate constriction, invisible on the shell. The shell surface is smooth.



- Remarks: The definition of the species Paradasyceras stella (Sow.) has been unclear for a long time. CANAVARI (1882) used the term Rhacophyllites stella Sow. to denote two morphotypes differing in the presence or absence of constrictions and of the umbilical edge. WÄHNER (1898, p. 175) revised CANAVARI's original material and decided to range to the species stella only the forms with constrictions and diphyllous S1. The forms without constrictions and with triphyllous S1 are regarded by WÄHNER (I.c.) as typical of the species P. uermoesense (HERBICH). So, with respect to this generic definition, it is hardly possible to range the species stella to the genus Paradasyceras, because the genotype is just characterized by the absence of constrictions! It should, however, be noted that the presence and absence of constrictions and umbilical edge depends upon whether the shell is preserved or not. This fact was perhaps neglected by former authors. Our specimens are in good accordance with the species description and depiction by CANAVARI (1888), GEYER (1886) and FUCINI (1901). The species Paradasyceras stella (Sow.) belongs to the easily identifiable and characteristic species of the Late Hettangian assemblage of ammonites at the locality Steinplatte.
- Stratigraphic range and distribution: The species is quite frequent from the Late Hettangian–Early Sinemurian (Marmorea zone) to the Lotharingian (Oxynotum zone). It is a typical Tethyan form; Steinplatte III.

Nevadaphyllites sp.

(Text-Fig. 10; Pl. 2, Fig. 9)

Four incomplete specimens of juraphyllitid taxa have been found at the locality Steinplatte II in bed 8a. In their



inplatte II in bed 8a. In their whorl sections and general appearance they are in good accordance with the definition of the genus *Nevadaphyllites*. An exact determination is difficult due to poor preservation.

Text-Fig. 10. Nevadaphyllites sp. Cross-section of a subadult specimen. Late Hettangian – Early Sinemurian. Steinplatte II.

Pleuroacanthitidae HYATT, 1900 Analytoceratinae SPATH, 1927 Analytoceras HYATT, 1900

Analytoceras articulatum (Sowerby, 1831) (Text-Fig. 11)

- 1831 Ammonites articulatus Sowerby. De LA BECHE, p. 333, Fig. 70.
- 1888 Lytoceras articulatum Sow. sp. CANAVARI, p. 113; Pl. 3, Figs. 4–7; Pl. 9, Fig. 8.

1890 Lytoceras articulatum Sow. (ORB.). – WÄHNER; p. 44; Pl. 3, Fig. 3; Pl. 7, Figs. 1–5; Pl. 8, Figs. 1–15; Pl. 9, Figs. 1, 2.

1910 Lytoceras articulatum Sow. – HAHN, p. 357.





Text-Fig. 11. Analyloceras articulatum (Sow.). Cross-sections of juvenile specimens. Late Hettangian – Early Sinemurian. Steinplatte II.

- Remarks: Four incomplete specimens with a diameter smaller than 40 mm. According to their whorl sections, shape, and number of constrictions they evidently belong to *A. articulatum* (Sow.).
- Stratigraphic range and distribution: Late Hettangian–Early Sinemurian (Marmorea zone) of the locality Steinplatte II. It is a typical Tethyan form.

Ectocentrites CANAVARI, 1888

Ectocentrites petersi (HAUER, 1856) (PI. 2, Fig. 6)

(FI. 2, FIG. 0)

- 1856 Ammonites petersi HAU. HAUER, p. 65, PI. 21, Figs. 1–3.
 1898 Ectocentrites petersi HAU. WÄHNER, p. 53 et 155, PI. 9, Figs. 6, 7; PI. 10, Figs. 1–5; PI. 20, Figs. 1–5 (cum syn.).
- 1910 Ectocentrites petersi v. HAU. HAHN, p. 357.
- 1953 Ectocentriles petersi HAUER. PREDA et RAILEANU, p. 58, Pl. 6.
- 1970 Ectocentriles petersi (HAUER). WIEDMANN, p. 1002, Fig. 28.

Material: Two incomplete specimens, one of them with a partly preserved body chamber.

Dimensions:

D	Wh	Ww	u
146,9	57,0	33,5	65,8

- Remarks: In their whorl section and ornamentation our specimens correspond to the species depiction by WÄHNER (1898).
- Stratigraphic range and distribution: Late Hettangian-Early Sinemurian (Marmorea zone) of the locality Steinplatte II. It is a typical Tethyan form, most frequent in the Alpine-Carpathian region.

Ectocentrites sp. juv.

(PI. 2, Fig. 7)

Remarks: The juvenile specimen originates from the locality Steinplatte II. In its laterally compressed whorl section and constrictional juvenile stage it resembles the subspecies *E. petersi italicus* (CAN.). A more exact determination is difficult due to poor preservation. The species occurred together with *Geyeroceras cylindricum* (SOW.). It is stratigraphically ranged to the Latest Hettangian-Early Sinemurian.

Psiloceratidae HYATT, 1867 Discamphiceratinae GUEX & RAKUS, 1991 Bouhamidoceras DUBAR, 1961

Bouhamidoceras sp.

(Text-Fig. 12; Pl. 1, Fig. 10)

Material: Two incomplete steinkerns with partly preserved calcified shell.

Dimensions:

D	Wh	Ww	u
133,5	73,0	29,6	12,5

Remarks: According to their lanceolate whorl sections (Text-Fig. 12), distinctly separated ventrum ("rounded keel"), longitudinal depressions, the shape of the umbilicus (sous-cavé), our specimens belong evidently to the genus *Bouhamidoceras*. According to their stratigraphic

position (Marmorea zone) they are the earliest known representatives of this genus. In their slim whorl sections, distinctly separated ventrum and a narrow umbilicus, our specimens differ from all so far known species of the genus Bouhamidoceras. In the size and shape of the umbilicus and partly in the whorl section our specimens are most similar to the form described by MOUTERDE et al. (1986) from Rif in Morocco. This form differs from our species in a somewhat wider whorl section and a wider ventrum.

Text-Fig. 12. Bouhamidoceras sp. Cross-section of a subadult specimen. Late Hettangian – Early Sinemurian. Steinplatte II.

Stratigraphic range and distribution: Late Hettangian–Early Sinemurian (Marmorea zone) of locality Steinplatte II. It is a rare, typical Tethyan form.

Psiloceratidae HYATT, 1867 Kammerkaroceras LANGE, 1941

Kammerkaroceras guidonii (Sowerby, 1833) (Text-Figs. 13, 14; Pl. 1, Figs. 6, 7, 8, 9)

- 1833 Ammonites guidonii Sowerby. De La Beche, p. 33, Fig. 69.
- 1882 Aegoceras guidonii Sow. sp. CANAVARI, p. 167; Pl. 18, Figs. 14–16, (non Fig. 16d).

- 1886 Aegoceras emmrichi GUEMB. WÄHNER; р. 154; Pl. 26, Figs. 4–6, 8-10.
- 1886 Aegoceras guidonii SOW. WÄHNER, p. 161; Pl. 26, Figs. 3, 7.
- 1888 *Psiloceras guidonii* Sow. sp. CANAVARI, p. 154; Pl. 4, Figs. 14–16a, Pl. 8, Fig. 8.
- 1910 Psiloceras emmrichi Güмв.. Нанм., р. 357.
- 1910 ?Psiloceras aff. guidonii Sow. (Сам.). Нанм, р. 357.
- 1941 Kammerkaroceras guidonii (SOW.) (CANAV.). LANGE, p. 44.
- 1958 Kammerkaroceras emmrichi (GÜMBEL.). DONOVAN, p. 209.
- Material: Six more or less complete specimens and ten whorl fragments.

Dimensions:

D	Wh	Ww	u
12,4	5,6	4,0	2,4
14,8	7,0	4,5	3,0
16,6	8,0	5,2	3,4
17,0	8,4	-	3,6
18,0	8,0	-	5,4
24,0	12,0	7,3	5,2

Description: The shell is small, discoid, laterally compressed. The section of juvenile stages is circular or broad-elliptical. The section of sub-adult stages is elliptical with indications of a rounded "keel" (Text-Fig. 13). The flanks are evenly arched, almost subparallel in the periumbilical area. The umbilicus is relatively narrow; the umbilical edge is rounded, prominent.



Text-Fig. 13.

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Kammerkaroceras guidonii (Sow.). Cross-sections of subadult specimens. Late Hettangian–Early Sinemurian. Steinplatte III.

Ornamentation: The juvenile stages (up to 5–6 mm in diameter) are distinctly tuberculate (Text-Fig. 14). During the ontogeny the tubercles are radially elongating to pass into prominent prorsiradiate ribs.

Sub-adult stages are characterized by even sigmoid ribs – either bifurcated or with an intercalated rib (Text-Fig. 14; Pl. 1, Figs. 7, 9). The ribs are weaker on the ventral side but they extend continuously to the other side. The adult stages are characterized by the fasciculation of the ribs into bundles by 3. Single bundles are separated by a deep intercalated "groove" (Pl. 1, Fig. 8).

Remarks: CANAVARI (1888, p. 155, 156) considers WÄH-NER's (1886) description of "Aegoceras" emmrichi GUEMB. as a younger synonym of the species *guidonii* (Sow.). The specimens from locality Steinplatte III are in good accordance with the description and depiction by the above authors. The species *K. guidonii* from the Steinplatte area was already described in the past.



Text-Fig. 14. *Kammerkaroceras guidonii* (Sow.). Distinct tuberculate stage, followed by sigmoidal ribs. Late Hettangian–Early Sinemurian. Steinplatte III.

Stratigraphic range and distribution: K. guidonii (Sow.) occurs at the locality Steinplatte in the Latest Hettangian–Early Sinemurian (Marmorea zone). WÄHNER (1886) had already found it in the middle Hettangian (Megastoma zone). It is a typical Tethyan form occurring in the Northern Limestone Alps and in Italy (Spezia).

Badouxia GUEX & TAYLOR, 1976

Badouxia cf. columbiae (FREBOLD, 1967)

(Text-Fig. 15; Pl. 1, Fig. 4)

Material: One incomplete steinkern with a partly preserved body chamber.

Description: A medium-sized (about 150 mm in dia-



meter), convolute, discoidal shape. The whorl section of sub-adult stages is elliptical, with gently arched flanks and rounded umbilical wall. The adult stages and body chamber show a high elliptical section of whorls with a ventreconverging tendency.

Text-Fig. 15. Badouxia columbiae (FREBOLD). Cross-section of an adult specimen. Late Hettangian – Early Sinemurian. Steinolatte II

- Ornamentation: slightly prorsiradiate, distinct ribs are located on the subadult stage. From the diameter 45–50 mm they are getting blunt and flat to disappear. The body chamber may be characterized as smooth, with very weak plications on flanks. The sutural line is not preserved.
- Remarks: Our specimen is most similar in dimensions and type of costation to *Badouxia columbiae* (FREBOLD, 1967). A more detailed determination is difficult due to poor preservation. We regard it as the first record of this genus in the Alpine Tethys.
- Stratigraphic range and distribution: Marmorea zone of Steinplatte II. Western coast of North America, Nevada (GUEX & TAYLOR, 1976; TAYLOR, 1990), Canada (FREBOLD, 1967).

Schlotheimiidae SPATH, 1923 Angulaticeras QUENSTEDT, 1883

Angulaticeras marmoreum (OPPEL, 1862) (Text-Fig. 16; Pl. 2, Fig. 2)

- 1856 Ammonites charmassei D'ORBIGNY. HAUER, p. 49; Pl. 14, Figs. 1-3.
- 1862 Ammonites marmoreus OPPEL. OPPEL, p. 130.
- 1886 Aegoceras marmoreum OPP. WÄHNER, p. 180, Pl. 22, Figs. 1–5.
- 1910 Schlotheimia marmorea OPP. HAHN, p. 359.
- 1953 Schlotheimia marmorea OPP PREDA & RAILEANU, p. 61.
- 1988 Aegoceras marmoreum (OPPEL). BLOOS, p. 6; Pls. 1-3, Pl. 4, Figs. 1-8; Pls. 5-8; Pl. 9, Fig. 1; Text-Fig. 3-11 (cum syn.).
- Material: Several incomplete specimens, mainly parts of whorls of phragmocon.
- Remarks: The whorl section, the shape and course of ribs on our specimens are in good accordance with the description and depiction of the species by BLOOS (1988). It is particularly similar to Alpine specimens depicted by WÄHNER (1886, Pl. 22, Fig. 1) and by BLOOS (1988). These specimens show indications of a "rounded keel". From the ventral view it looks like a keel stripe.
- Stratigraphic range and distribution: The stratigraphic range of this index ammonite is rather controversial (GUEX & TAYLOR, 1976; BLOOS, 1988). On the localities Steinplatte II and III this ammonite is quite frequent and occurs together with an ammonite assemblage of Late Hettangian-Early Sinemurian age. The species is known from the Northern Limestone Alps, southern Germany, eastern France and Italy.



Text-Fig. 16. Angulaticeras marmoreum (OPPEL). Cross-section of a subadult specimen. Late Hettangian – Early Sinemurian. Steinolatte.

Sulciferites SPATH, 1922

Sulciferites ventricosus (SOWERBY, 1833) (Text-Fig. 17; Pl. 2, Fig. 5)

- 1833 Ammonites ventricosus SowERBY; in DE LA BECHE, p. 334; Fig. 72.
- 1886 Ammonites ventricosus Sow. (CANAV.). WÄHNER, p. 186; Pl. 23, Figs. 5-11.
 1888 Schlotheimia ventricosa Sow. sp. - CANAVARI, p. 136; Pl. 4,
- Figs. 10, 11.
- 1936 Sulcilerites ventricosus (Sow., 1833). SCHLEGELMILCH, p. 37; Pl. 7, Fig. 6; Pl. 8, Fig. 3.

Material: Three incomplete specimens.

Remarks: From lateral view the adult specimens of this species may be erroneously regarded as *Angulaticeras marmoreum* (OPP). They differ from it in their lanceolate adult whorl sections (Text-Fig. 17).

The ventrum consists of a rounded undetached keel. From the ventral view the keel looks blunt – the place of termination of unweakened ribs. The flanks are evenly arched, converging to the umbilicus, so the whorl is broadest in the umbilical part.

The whorl sections on sub-adult stages are trapezoidal, with a "groove" representing the break in ribs.



Text-Fig. 17. Sulciferites ventricosus (Sow.). Cross-section of an adult specimen. Late Hettangian – Early Sinemurian. Steinplatte II.

Stratigraphic range and distribution: This significant Tethyan form is best known from the Early Sinemurian – the Rotiforme zone. On the locality Steinplatte II it occurs in a Late Hettangian–Early Sinemurian assemblage.

Schlotheimia BAYLE, 1878

Schlotheimia sp.

(Pl. 2, Fig. 4)

Material: Two sub-adult, partly preserved specimens.

Remarks: In the type of their costation the specimens from the locality Steinplatte III resemble the species *S. montana* (WÄHNER, 1884). It was impossible to determine the poorly preserved and immature specimens more exactly. They were found together in an assemblage with *A. marmoreum* (OPP.).

Arietitidae Hyatt, 1875 Paracaloceras Spath, 1923

Paracaloceras gr. coregonense (SOWERBY, 1833) (Text-Fig. 18; Pl. 1, Figs. 5, 11)

Material: Four incomplete specimens.

Dimensions:

D	Wh	Ww	u
51,4	12,6	_	31,0
114,4	20,0,	22,0	76,0

- Remarks: In their whorl section (Text-Fig. 18) and type of costation the specimens from the locality Steinplatte are most similar to *P.coregonense* (Sow.). The exact determination was not possible due to poor preservation of the specimens.
- Stratigraphic range and distribution: This Alpine form was already mentioned by HAHN (1919). It oc-

curs in the assemblage with *A. marmoreum* (OPP.) at the localities Steinplatte II and III.



Text-Fig. 18. Paracaloceras gr. coregonense (Sow.). Cross-section of an adult specimen. Late Hettangian – Early Sinemurian. Steinplatte II.

4. Conclusions

The study of the Rhaetian/Liassic boundary at the locality Steinplatte yields the following results:

- There exists a stratigraphic hiatus between the Late Rhaetian reef limestone and Hettangian biomicritic limestones. As a result of palaeogeomorphology the hiatus increases from the north to the south, i.e. towards the top part of the reef. No arguments point to an existence of Rhaeto-Liassic reef limestone (Rhätolias-Riffkalk) sensu FABRICIUS (1962).
- The Hettangian sediments show all the characteristics of condensed sedimentation. It is also evidenced by subsolution, ferrolitic crusts and cyanobacterial concretions (deep water stromatolites and *Frutexites* sensu BÖHM & BRACHERT, 1993).

- Detailed stratigraphical studies have proved that the Late Hettangian-Early Sinemurian is the only confirmed stratigraphical interval at the localities Steinplatte I - III. The interval may also be denoted as the "Marmorea" zone in the sense of WÄHNER (1886) or as the "Canadense" zone in the sense of TAYLOR (1990).
- So far we cannot prove the earlier Hettangian zones, although their existence is indicated by fauna, quoted by HAHN (1910).
- The fauna comprises two rare genera, so far unknown from the Alps: Bouhamidoceras DUBAR, 1961 and Badouxia GUEX & TAYLOR, 1976.

The genus *Bouhamidoceras* DUBAR, 1961 is mainly known from the North-African Lotharingian (Tunisia, Morocco).

Plate 1

The presence of this genus on Steinplatte represents the first and stratigraphically earliest finding.

The occurrence of the genus *Badouxia* GUEX & TAYLOR, 1976 represents the first finding in the Tethyan region at all. It might be a significant correlation element between the North-American faunal province and the Alpine region.

Acknowledgements

This study was carried out in the framework of the bilateral cooperation agreement on geology between Austria and Slovakia.

The authors thank the authorities at Geologische Bundesanstalt in Vienna and at the Dionyz Stur Institute of Geology in Bratislava for logistic and financial support. Dr. R. SURENIAN provided the SEM-photomicrographs.

Figs.	1,2:	Geyeroceras cylindricum (Sow.). Magnified 0,8×. GBA 1992/1/1.
Fig.	3:	<i>Paradasyceras stella</i> (Sow.). Natural size. GBA 1992/1/2.
Fig.	4:	Badouxia cf. columbiae (FREBOLD). Natural size. GBA 1992/1/3.
Fig.	5:	<i>Paracaloceras</i> gr. <i>coregonense</i> (Sow.). Natural size. GBA 1992/1/4.
Figs.	6,7,8,9:	<i>Kammerkaroceras guidonii</i> (Sow.). Natural size. GBA 1992/1/5.
Fig.	10:	<i>Bouhamidoceras</i> sp. Slightly diminished. GBA 1992/1/6.
Fig.	11:	<i>Paracaloceras</i> gr. <i>coregonense</i> (Sow.). Natural size. GBA 1992/1/4.

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Plate 2

- Fig. 1: *Geyeroceras cylindricum* (Sow.). Natural size. GBA 1992/1/1.
- Fig. 2: *Angulaticeras marmoreum* (OPPEL). Natural size. GBA 1992/1/7.
- Fig. 3: *Angulaticeras marmoreum* (OPP.). 0,5×. GBA 1992/1/7.
- Fig. 4: Schlotheimia sp. juv. Natural size. GBA 1992/1/8.
- Fig. 5: **Sulciferites ventricosus (Sow.).** 0,3×. GBA 1992/1/9.
- Fig. 6: *Ectocentrites petersi* (HAUER). Diminished 0,3 ×. GBA 1992/1/10.
- Fig. 7: *Ectocentrites* sp. juv. 1,5×. GBA 1992/1/10.
- Fig. 8: **?** Paradasyceras stella (Sow.). 0,3×. GBA 1992/1/2.
- Fig. 9: *Nevadaphyllites* sp. 0,3×. GBA 1992/1/12.



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Digitale Literatur/Digital Literature

Zeitschrift/Journal: Jahrbuch der Geologischen Bundesanstalt

Jahr/Year: 1993

Band/Volume: 136

Autor(en)/Author(s): Rakus Milos, Lobitzer Harald

Artikel/Article: <u>Early Liassic Ammonites from the Steinplatte-Kammerköhralm Area</u> (Northern Calcareous Alps/Salzburg) 919-932