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CONODONT BIOSTRATIGRAPHY OF THE LERCHECK / KÖNIGSLEITEN SECTION NEAR BERCHTESGADEN (LATE LADINIAN – HALLSTATT LIMESTONES)

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With 3 figures and 1 plate

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Abstract

Grey to faintly red-coloured, well-bedded limestones in the south-western part of the Lercheck-Hallstatt Limestone succession near Berchtesgaden, Southern Germany, were age-dated by conodonts into the Longobardian 1-2. This disagrees with earlier studies, which assigned the succession to the "Carnian and Norian" limestones. These investigations, however, did not provide detailed biostratigraphical data. A monospecific presence of *Gladigondolella tethydis* (Huckriede) found within reddish-coloured limestones of the lower (Königsleiten) part of the section defines the *Budurovignathus truempyi* to *B. hungaricus* conodont assemblage zone (A.Z.) representing Fassanian 2 to Longobardian 1. The assemblage of five species (*Budurovignathus mungoensis*, *Gladigondolella malayensis*, *Gl. tethydis*, *Paragondolella inclinata* and *P. trammeri*), occurring in bedded grey limestones in the upper (Lercheck) part of the section, indicates the *B. mungoensis* A.Z. (Longobardian 2).

The Limestones can be compared to the thick-bedded grey limestones of the uppermost Longobardian to lower Julian. As exposed at the adjacent Freygutweg section and in the Jakobberg gallery, the Lercheck and Königsleiten section can be interpreted as their downward continuation (Hornung and Brandner 2005, Hornung 2006, this volume).

Zusammenfassung

Im Rahmen des FWF-Projektes P16878-N10 ("Das Reingraben-Event im westlichen Tethysraum") wurde die Südwestecke des Lercheck-Blocks (Berchtesgadener Hallstätter Kalke) einer eingehenden Beprobung unterzogen, insbesondere, um Daten aus dem Liegenden der tuvalischen Roten Knollenflaserkalke zu erhalten, welche im nahen Draxllehen-Steinbruch aufgeschlossen sind. Die gefundenen Conodonten-Assoziationen erlauben eine genaue Zuordnung der gut gebankten, unten rötlichgrau, nach oben hellgrau gefärbten Hallstätter Kalke in den Bereich des obersten Fassans bis Longobard 2. Das widerspricht Literaturdaten, die diesen Bereich des Lerchecks zu „Karnisch-Norischen Hallstätterkalken" stellen, jedoch ohne einen genaueren biostratigraphischen Nachweis durch entsprechende Leitfossilien zu liefern.

Nahezu monospezifisches Auftreten der Gattung *Gladigondolella tethydis* mit sehr seltenen *Gl. malayensis* im unteren Abschnitt lässt auf die *Budurovignathus truempyi*- bzw. *B. hungaricus* Condonten Zone (Oberstes Fassan bzw. Longobard 1) schließen. Die Vergesellschaftung von fünf Conodonten-Arten (*Budurovignathus mungoensis*, *Gladigondolella malayensis*, *Gl. tethydis*, *Paragondolella inclinata* und *P. trammeri*) im oberen Abschnitt deutet auf die *B. mungoensis* Conodonten-Zone (Langobard 2) hin.

Die untersuchte Abfolge gleicht lithologisch den dickbankigen Graukalken des nahen Freygutweges und Jakobbergstollens. Die neu gewonnenen biostratigraphischen Daten deuten darauf hin, dass sich das südwestliche Lercheck, vermutlich mit Schichtlücken, sehr wahrscheinlich als die untere Fortsetzung der Dürrnberger Profile (Hornung und Brandner 2005, Hornung 2006, dieser Band) ansehen lässt.

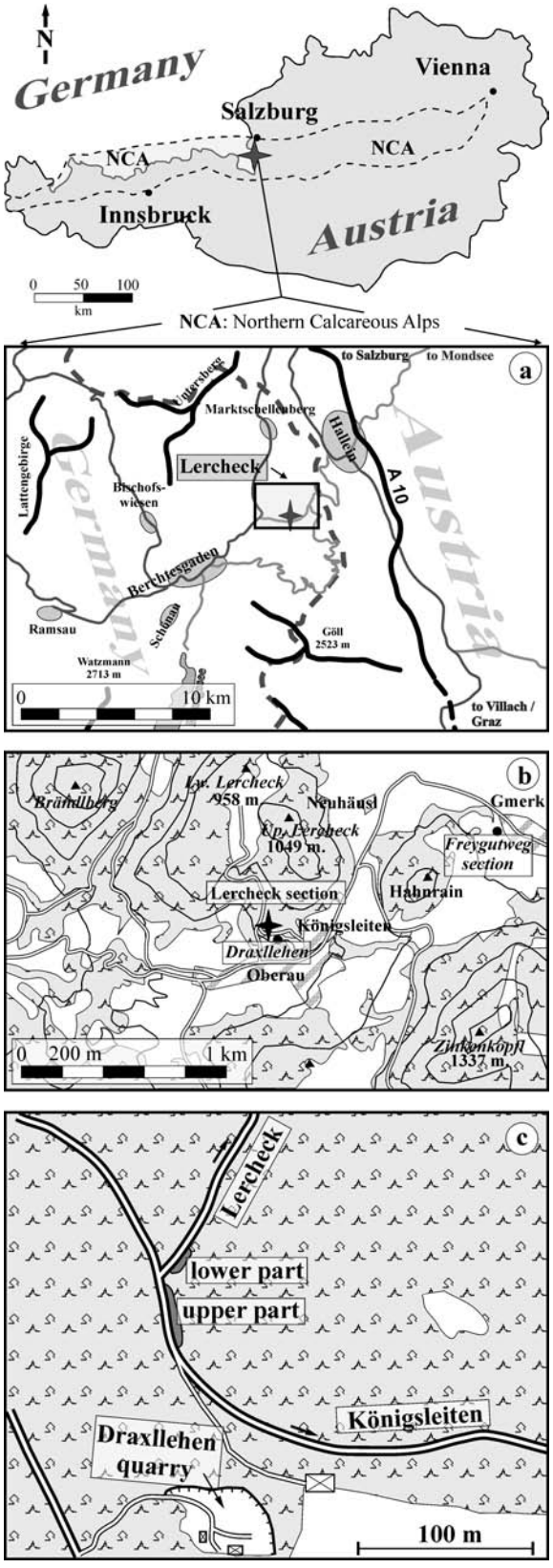

Fig. 1: a) Geographic overview and detailed geographic maps from the outcrops (b and c); Lercheck section UTM: WGS84, Zone 33; E 354767; N 5279689).

Introduction – Previous studies

The lithologic successions of the Lercheck mountain range have been known since the nineteenth century. Descriptions can be found in Gümbel (1861) and Schlosser (1898). Detailed mapping was carried out by Plöchinger (1955) and Pichler (1963). The exposed limestones were classified to Middle and Upper Triassic (Anisian to Norian), but age-dating was based on rare macrofossils (Plöchinger 1955). As high-resolution conodont-microbiostratigraphy remained underdeveloped during that time, reliable chronostratigraphic data did not exist in this region. Both Plöchinger (1955) and Pichler (1963) mapped the south-western part of the Upper Lercheck as "Carnian and Norian Hallstatt limestones". Rieche (1971) described a composed cross-section from Königsleiten to the Upper Lercheck as questionably Late Anisian to Norian. His short outcrop description, however, does neither provide geographic position, nor tectonic and stratigraphic information and macro- and microfossil descriptions. At this time, first proposals about conodont zonation in the Hallstatt succession were established by Krystyn (1970).

Due to the adjacent Draxllehen Quarry (Fig. 1b) exposing a Tuvalian sequence of nodular red flaser limestones, and its obvious lithological similarities to Early Carnian thick-bedded grey limestone successions exposed in the Dürrnberg sections (Hornung and Brandner 2005 and Hornung 2006, this volume), the studied section was sampled in order to obtain conodont data in high-resolution. The question, whether the Lercheck section might be the temporal equivalent or a possible downward continuation of the Early Carnian thick-bedded grey limestones exposed at the Dürrnberg sections (Hornung and Brandner, 2005; Hornung, 2006, this volume), may be solved only by this biostratigraphic statement.

Geological setting

The studied section is located near Oberau circa 5.4km ENE of Berchtesgaden on a private driveway from Lercheck (lower part) to Königsleiten (upper part), close to the Draxllehen Quarry (Figs. 1b, c). The succession is part of the Lercheck Block which consists of Anisian to lowermost Norian limestone successions.

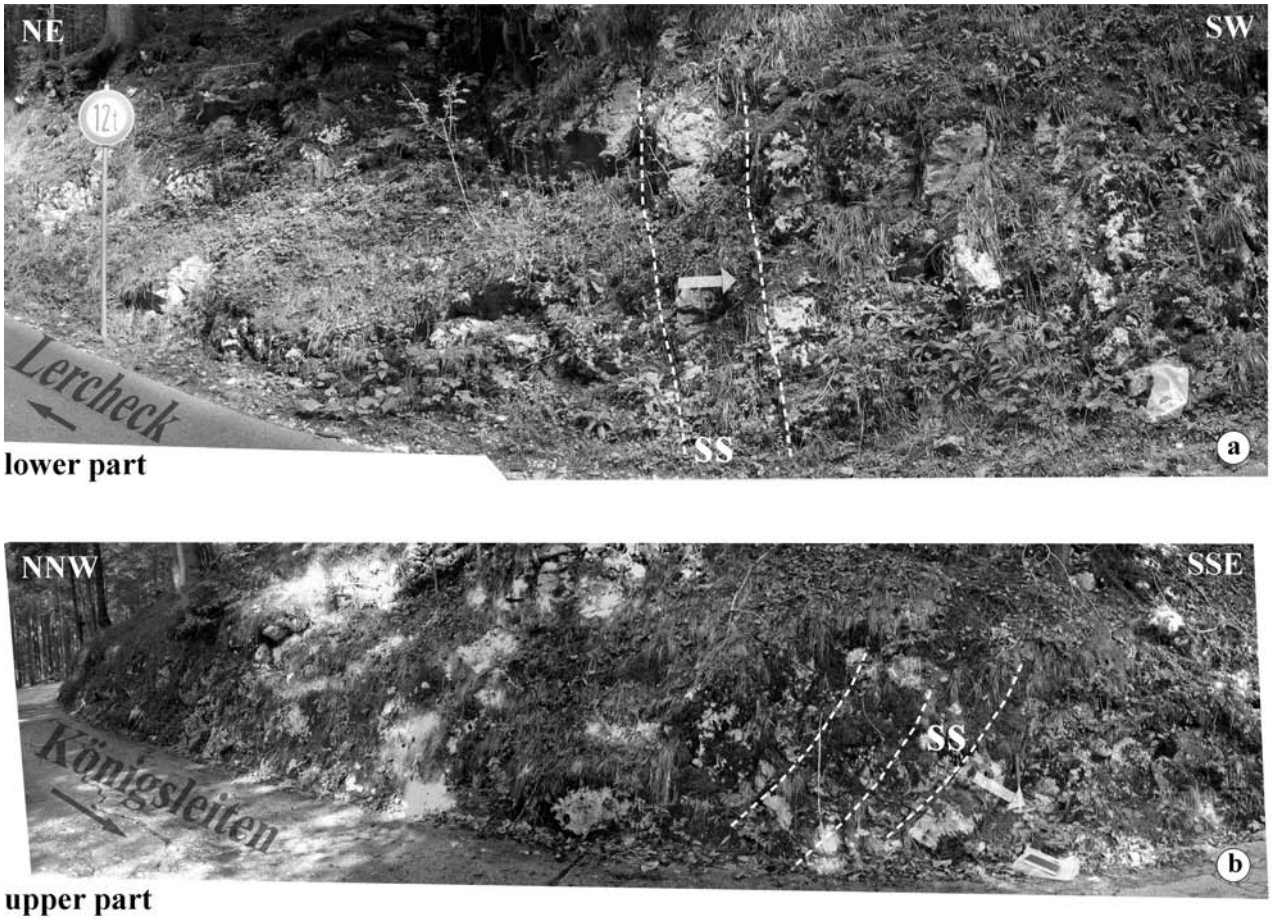

Fig. 2: Lower (a) and upper part (b) of the Lercheck section. The dashed lines show the bedding planes, the white arrow the direction of sedimentation.

The lower part of the Lercheck section consists of medium to thick-bedded light grey coloured limestones (per bed max. 1.25 m), whereas its upper part is made up of a medium-bedded limestone succession (per bed max. 0.5 m) of faintly red tints (Figs. 2, 3). The red colouring is primarily due to the presence of finely dispersed hematite and dark red pressure solution seams of argillaceous lime mudstones. All layers dip uniformly and steeply NNW at 70°. The section is overturned. Due to the obvious difference in stratification relative to the upright and steeply southern dipping succession of red Draxllehen limestone, a normal fault and a block-rotation between the units can be assumed. The complete Lercheck Block exhibits complicated and narrow-spaced imbrication faults, which subsequently became steepened. All layers show – along intensive pressure solution caused by compaction – common vertical tension joints cemented by radial-fibrous calcites and, subsequently, by coarse blocky calcite spar.

Results

All samples (max. 1 kg per layer) were digested in acetic acid, the insoluble residue was washed and fractioned by sieving (coarse: 250 µm; fine: 100 µm). All selected material is archived at the Institute of Geology and Paleontology in Innsbruck (archive Hornung, "Lercheck").

Conodont-Parataxonomy

As ammonite findings lacked completely, the biostratigraphy had to be based on conodonts. All conodonts found within the Lercheck succession show a CAI (Conodont Alteration Index) of 1.0 representing an average thermal overprint of 65°C. The following description is restricted to platform conodonts. The different species being found are shortly described, in order of their first stratigraphical appearance.

A) *Gladigondolella tethydis* Huckriede, 1958

* 1958 *Gladigondolella tethydis* n. sp.; in Huckriede (1958); pl. 12, figs. 38a-b; pl. 13, figs. 2-5
* 1980 *Gladigondolella tethydis*, Huckriede (1958): in Kovács and Kozur (1980); pl. 3, figs. 5-6
* 1983 *Gladigondolella tethydis*, Huckriede (1958); in Kolar-Jurkovsek (1983); pl. 3, figs. 1a-b, 2a-c
* 1995 *Gladigondolella tethydis*, Huckriede (1958); in Neri et al. (1995); pl. 2, fig. 1
* 1995 *Gladigondolella tethydis*, Huckriede (1958); in Mastandrea (1995); pl. 2, figs. 1-2
Pl. 1, figs. 3, 4, 5, 6

Material:
Common appearance in the section. Two nearly complete specimens in the lower part, ten broken specimens in the upper part.

Description:
Large and asymmetrical units showing thick-bulged reticular brims. Flat scupltureless troughs laterally of the reduced carina are characterised by discrete, roundish to oval-shaped denticles. The big and robust keel includes a small oval basal pit, situated between the midlength and the posterior third, often producing a laterally or downwards directed torsion of the platform as described by Vrielynck (1987) and Mastandrea (1995). This was observed only on some specimen.

Remarks:
The most important difference between *Gl. tethydis* and *Gl. malayensis* is the different position of the basal pit: *Gl. malayensis* has a posterior position of an eye-shaped basal pit.

B) *Gladigondolella malayensis* Nogami, 1968

* 1968 *Gladigondolella malayensis* n. sp.; in Nogami (1968); pl. 9, figs. 11-18; pl. 11, fig. 7
* 1995 *Gladigondolella malayensis malayensis* Nogami (1968); in Mastandrea (1995); pl. 1, figs. 1-3.
Pl. 1, fig. 2, 8

Material:
Rare occurrence in the complete section. Three fragmented specimens.

Description:
Large-sized robust and broken units showing a low posterior carina, which consists of four low and stepped denticles descending into a very low ridge of fused, oval-shapes nodules at midlength. All specimens show very flat, indistinct and scupltureless troughs along the nodules. The central keel contains a terminal, eye-shaped basal pit.

Remarks:
Gl. malayensis differs from *Gl. tethydis* in that it has a larger and more thickened platform and stepped distinct roundish nodules and a posterior basal pit. *Gl. tethydis* is more oblong, the nodules are oval-shaped and fused to a low carinal ridge. The example pictured in plate 1, no. 1 is classified as *Gl.* cf. *malayensis* representing most probably a "super - adult" growth-stage of this species (pers. comm. L. Krystyn, Vienna, and H. Kozur, Budapest).

C) *Paragondolella trammeri* (Kovács 1983)

* 1980 *Gondolella trammeri* (Kozur 1971); in Kovács and Kozur (1980); pl. 6, figs. 6-8
Pl. 1, fig. 14

Material:
Rare occurrence. Two specimens in Le 10.

Description:
Almost flat, very slightly arched, robust, but slender units. The platform comprises thickened margins embraces the whole unit without a free blade; the marginal rims have the same height as the low posterior carina with deep scupltureless furrows in-between. The terminal oval-shaped and node-like tooth is stepped, robust and inclined posteriorly. Only the anterior carina shows three to four distinct and high teeth, developed as a saw-blade. The carinal ridge tends to be straight, subsequently descending to the very anterior part. Unfortunately, the anterior part is broken on both specimens. A broad posterior keel with a narrow basal pit is also noted.

D) *Budurovignathus* cf. *mungoensis* (Diebel)

* 1972 *Metapolygnathus mungoensis* (Diebel); in Kozur (1972): pl. 2, figs. 1-4

* 1980 *Metapolygnathus mungoensis* (Diebel); in Kovács and Kozur (1980); pl. 7, fig. 3
* 1995 *Budurovignathus mungoensis* (Diebel); in Neri et al. (1995); pl. 2, figs. 7-9

Pl. 1, fig. 11

Material:
Rare occurrence. One broken specimen.

Description:
Small-sized unit with abrupt incipient platform and characteristic marginal teeth. Short free blade with a high carina of six denticles, whose height decreases slowly towards the posterior part. Unfortunately, the posterior platform third and some of the carinal teeth are broken. This is why this specimen can be assigned to *B. mungoensis* only under reserve.

Remarks:
According to Kovács (1983), *B. mungoensis* coexists with the similar shaped species *B. longobardicus*: due to the fragmentary preservation, a firm assignment to *B. mungoensis* thus cannot be assured.

E) *Paragondolella inclinata* (Kovács 1983)

* 1983 *Gondolella foliata inclinata*, n. subsp.; in Kovács (1983); pl. 11, figs. 1-4
* 1983 *Gondolella inclinata* (Kovács 1983); in Krystyn (1983); pl. 3, fig. 5; pl. 4, figs. 1-2; pl. 5, figs. 1-2
* 1995 *Neogondolella foliata inclinata* (Kovács 1983); in Neri et al. (1995); pl. 2, figs. 10, 14, 20

Pl. 1, figs. 7, 9, 10, 12, 13

Material:
Frequent within the complete section. Circa 20 complete specimens.

Description:
Longish and slender, drop-shaped and slightly arched specimens in lateral view. The platform extends the whole length of the unit embracing a denticled carina of moderate height. In its anterior half to two-thirds, the carina tends to be straight but descending slightly at the very anterior part. Towards the posterior half the carina descends gradually, forming a low ridge of fused older teeth (especially in adult growth stages). All carinal denticles are inclined posteriorly defining an angle of less than 90° with respect to the basal edge. The most terminal tooth is stepped and stronger inclined than the others. From the lower view, the keel is slightly elevated widening posteriorly and comprising an oval-shaped to rounded terminal basal pit. The honeycomb structure covers about one to two thirds of the posterior thickened platform margins. The anterior third and the adcarinal troughs are *unsculptured.*

Remarks:
According to Kovács (1983), *P. inclinata* developed from the similar *P. excelsa*: the main differences are the slight arching and the absent downward bending of the posterior end.

Discussion - Biostratigraphy

According to Kozur (1980), the monospecific but rare presence of *Gl. tethydis* within the grey- to reddish-coloured limestones (lower part) is typical for the time interval of the *Budurovignathus truempyi* to the *B. hungaricus* conodont assemblage zone. In general, uppermost Fassanian to lowermost Longobardian successions of the Austroalpine Facies yield only rare conodonts and often provide solely gladigondolellids without the type species *B. truempyi* and *B. hungaricus*. Thus, only a general assignment to these two conodont assemblage zones seems to be reasonable, even because parts of the section are overgrown.

The co-existence of at least five conodont species within the bedded grey limestones (upper part section) points to a range within the *Budurovignathus mungoensis* A. Z. representing the *Protrachyceras archelaus* ammonite zone or the Longobardian 2 (Kozur, 1980 and 2003). In the revision of the Austroalpine conodont zonation of Kozur (1980), this assemblage zone is characterised by the co-occurrence of rare *B. mungoensis* and *Paragondolella trammeri*, common *Gladigondolella tethydis* and *Gl. malayensis* as well as *P. inclinata*, but without *M. diebeli*, *M. polygnathiformis* and *M. tadpole*. The rare appearance of *M. noah* (see Kozur 1980 – synonymous for *M. polygnathiformis noah*) in the uppermost part of this assemblage zone could not be evidenced.

Because of the presence of a typical Longobardian conodont assemblage in the SW' Lercheck suc-

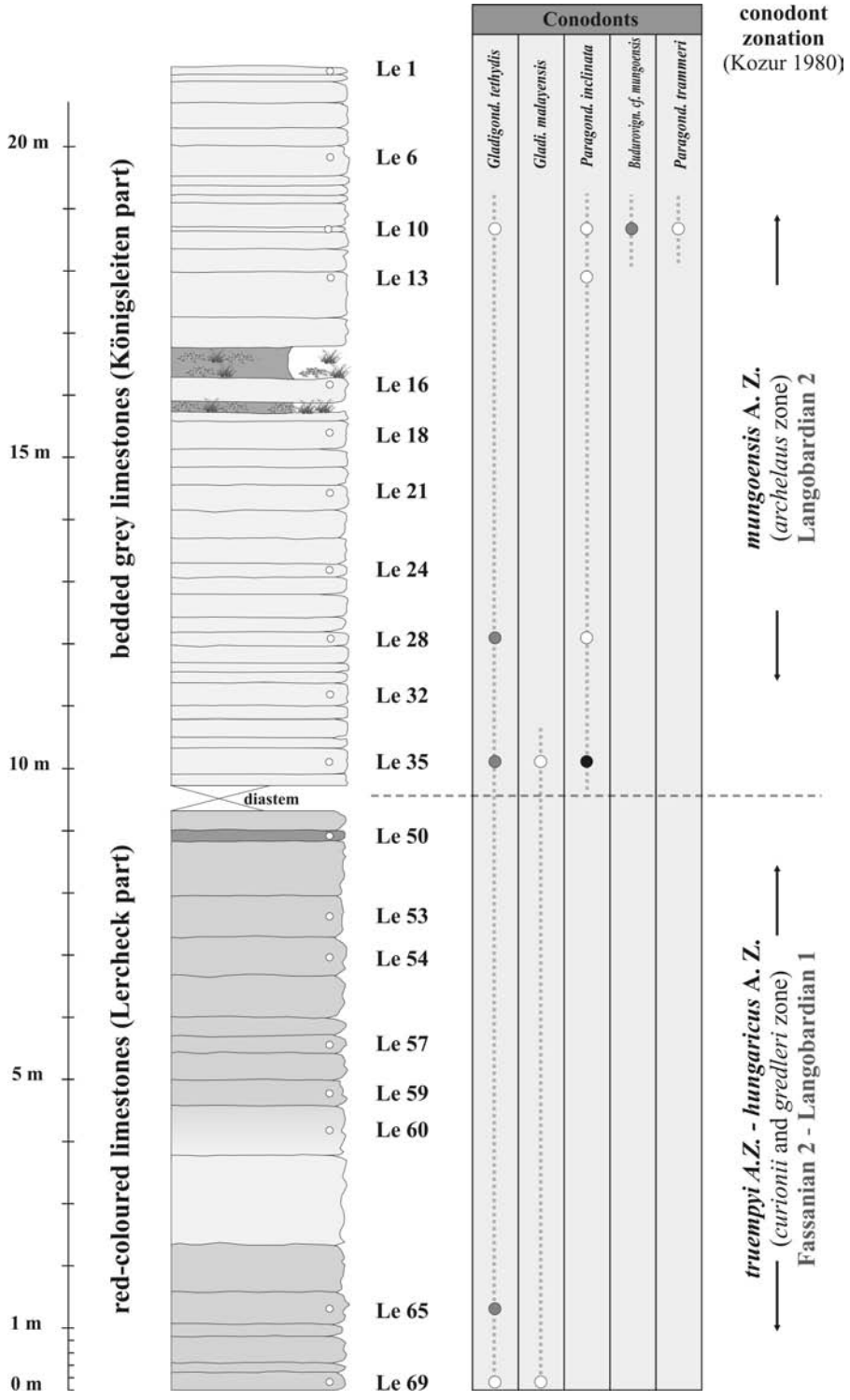

Fig. 3: Lithology, conodont biostratigraphy and reconstructed conodont zones (after Kozur 1980) of the Lercheck section including possible stratigraphical gaps and non-outcropping parts of the sequence. Due to the lack of ammonite findings, the ammonite zones are constructed after the conodont zones. The exact boundaries, thus, are questionable.

cession, Rieche (1971) must be disagreed as he mapped "Carnian and Norian Limestones" in this location. The bedded grey to light-reddish coloured limestones studied herein can be compared to a sequence which he described similarly as the "Late Anisian": in its base white-coloured, the limestones are getting subsequently grey, light-reddish and finally dark reddish-coloured. With regards to Rieche's work in 1971, there is no exact proof about the age-dating, e.g. evidenced or confirmed by biomarkers of stratigraphical importance. The overturning of the section, thus, remained unperceived to him.

Conclusions

Despite of lithological similarities to the Early Carnian part of the adjacent Dürrnberg sections, the biostratigraphical data gained from the Lercheck / Königsleiten section show evidently uppermost Fassanian to Longobardian age. Thus it is most likely that the presented succession can be seen as their downward continuation.

The obvious stratigraphical hiatus between the Longobardian Lercheck limestones and Tuvalian red limestones outcropped in the adjacent Draxllehen quarry (ca. 100 metres in SE direction) can be explained by the occurrence of a steeply dipping normal fault between the two sections. The complete lacking of the Reingraben Shales (found at Freygutweg) as a corresponding stratigraphical unit between the Lercheck and the adjacent Draxllehen section, maybe due to the following two reasons: a) the formation was not deposited primarily, b) during orogenetic faulting, the Reingraben Shales, as the ductile and mobile member, were sheared off from their underlying part.

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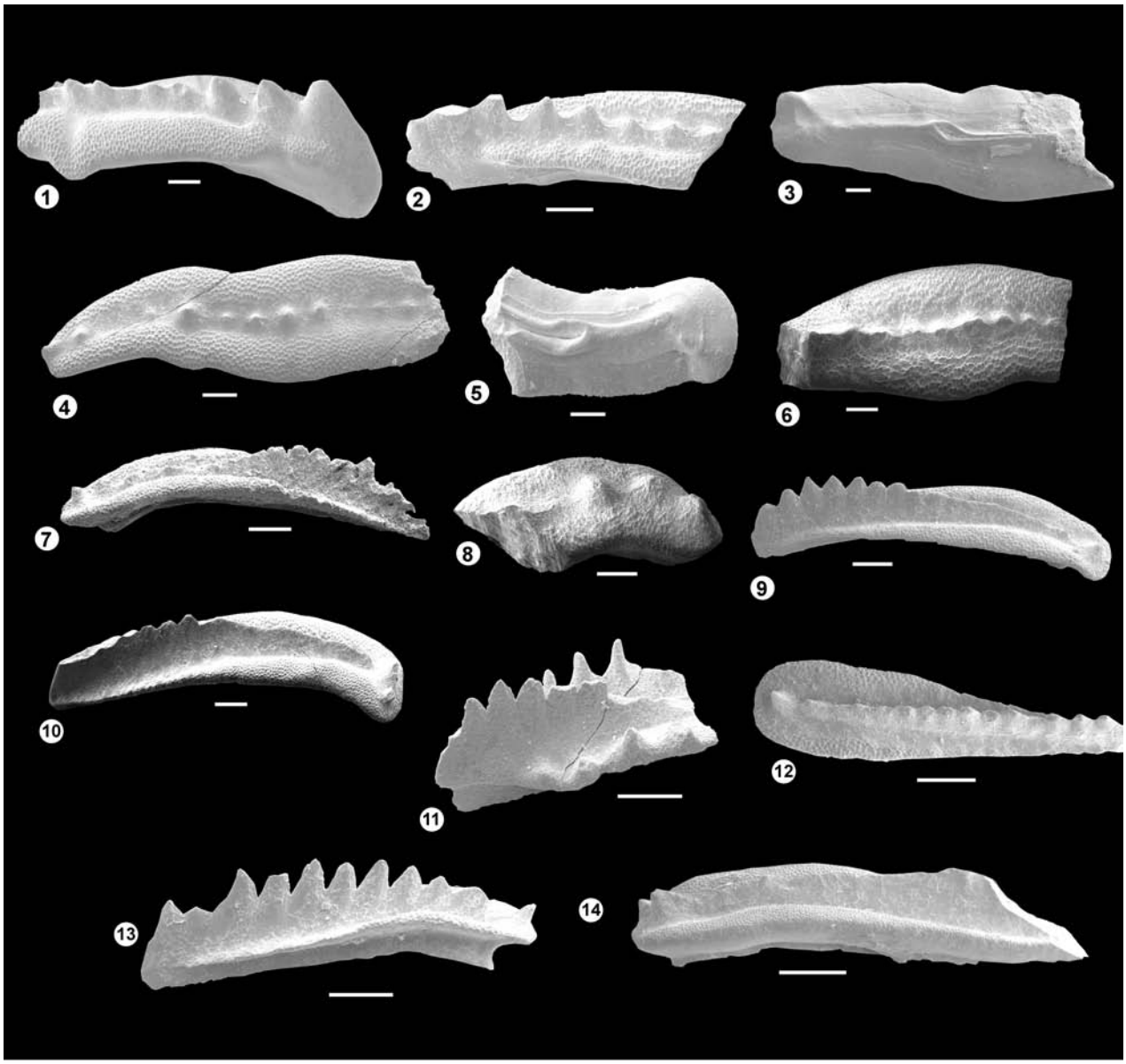
Plate 1: Conodonts of the Lercheck section: for all specimens CAI = 1.0; scale bar = 100 µm:

1: *Gladigondolella* cf. *malayensis* Nogami, 1968; very robust, superadult and pathological specimen, anteriorly broken; very big terminal, keel-like tooth; Lercheck section (Le 69).
2: *Gladigondolella malayensis* Nogami, 1968; angular view; anteriorly broken; Lercheck section (Le 65)
3: *Gladigondolella tethydis* Huckriede, 1958; lower view; anterior part broken; Lercheck section (Le 65)
4: *Gladigondolella tethydis* Huckriede, 1958; upper view; nearly complete specimen; Lercheck section (Le 65)
5: *Gladigondolella tethydis* Huckriede, 1958; lower view, posterior half with the basal pit, characteristically situated in midlength of the unit; Lercheck section (Le 35)
6: *Gladigondolella tethydis* Huckriede, 1958; upper view, adult growth stage, anterior part as well as the posterior third are broken off; Lercheck section (Le 35)
7: *Paragondolella inclinata* (Kovács 1983); angular view, adult growth stage, anteriorly fragmented carina; Lercheck section (Le 35)
8: *Gladigondolella malayensis* Nogami 1968; angular view, broken anterior half with robust isolated nodules; Lercheck section (Le 28)
9: *Paragondolella inclinata* (Kovács 1983); angular view, adult growth stage; note the melted low posterior carinal ridge (also Plate 1, fig. 2); Lercheck section (Le 10)
10: *Paragondolella inclinata* (Kovács 1983); angular view, adult growth stage; Lercheck section (Le 10)
11: *Budurovignathus cf. mungoensis* (Diebel); angular view, posterior platform third is broken off; Lercheck section (Le 10).
12: *Paragondolella inclinata* (Kovács 1983); upper view, adult growth stage; note the posterior restriction of the honeycomb structure of platform rims (also fig. 5); Lercheck section (Le 10)
13: *Paragondolella inclinata* (Kovács 1983); angular view, mid-age growth stage (denticled posterior carina), broken anterior carinal denticle; Lercheck section (Le 10)
13: *Gondolella trammeri* Kozur, 1971; angular view, adult growth stage, broken anterior carina and platform rims; Lercheck section (Le 10)
14: *Paragondolella trammeri* Kozur, 1971; angular view, adult growth stage, broken anterior carina and platform rims; Lercheck section (Le 10)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