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Fwd: [NOS] Editor Decision

1 messaggio

Carlo Corradini <carlcorr66@gmail.com> 19 gennaio 2017 18:58
Rispondi a: corradin@unica.it
A: Schoenlaub Hans-Peter <hp.schoenlaub@aon.at>, Annalisa Ferretti <ferretti@unimore.it>, Corriga Maria <corrigamaria@hotmail.it>

Dear all,

as you can see below the manuscript on Rauchkofel Boden section has been accepted!!
Another step of our cooperation is done. Thank-you very much
All the best,
Carlo

-------- Messaggio Inoltrato --------
Oggetto:[NOS] Editor Decision
Data: Thu, 19 Jan 2017 15:43:21 +0000
Mittente: Borntraeger Science Publishers <mail@schweizerbart.de>
Rispondi-a: Jochen Erbacher <jochen.erbacher@bgr.de>
A:Prof. Carlo Corradini <corradin@unica.it>

Dear Prof. Carlo Corradini:

I have reached a decision regarding your submission to Newsletters on Stratigraphy, "Chrono-, Litho- and conodont Bio-stratigraphy of the Rauchkofel Boden Section (Upper Ordovician-Lower Devonian), Carnic Alps, Austria".

My decision is: ACCEPT MANUSCRIPT.

If you have not already uploaded the final files to the system, please store all submission related files in one compressed archive and make sure that the maximum file size does not exceed 25 mB per upload.
Please upload the final files as new authors version under the Editors Decision tab of your submission entry.
Please wait until the revised uploaded file is visible on the submission page. This will make identification of submission files easier and speed up the processing time.

Please be aware that extensive modifications to the text will have to be approved by the Chief Editor and that this file will be used for typesetting. In the galleys only typographical errors will be corrected, any content related correction will have to be charged.

Thank you very much for choosing "Newsletters on Stratigrahy" for publishing your work.

Best regards,
Jochen Erbacher
jochen.erbacher@bgr.de

DIPARTIMENTO SCIENZE CHIMICHE E GEOLOGICHE
UNIVERSITA' DEGLI STUDI DI CAGLIARI
Via Trentino 51, 09127 – CAGLIARI ITALIA

Cagliari, January 13th, 2017

Dear Prof. Erbacher,

we submit the revised version of the manuscript:

Chrono-, Litho- and conodont Bio-stratigraphy of the Rauchkofel Boden Section (Upper Ordovician-Lower Devonian), Carnic Alps, Austria

by Hans Peter Schönlaub, Carlo Corradini, Maria G. Corriga and Annalisa Ferretti

We followed most of the reviewer suggestions, and all the variations in the text than the previous version are in red in the file "*Schoenlaub et al text post referees*".

In the file named "*Replay to reviews*" we summarized the variations in the text according to reviewers comments, and in a few cases why we do not agree with their notes.

The paper includes 6 figures and 3 plates.

With best regards,

Carlo Corradini

Reviewer A:

68 significant gap is present at the Ordovician/Silurian boundary, where possibly part of the
typing error corrected (line 71)

98 clearly to the Katian Stage. Based on the heavy minerals zircon, tourmaline and rutile for these
typing error corrected (line 101)

127 adult, partly oriented nautiloids associated with articulate brachiopods, bivalves and gastropods (deleted d from articulated)
typing error corrected (line 130)

146 147 148 The Silurian/Devonian boundary is drawn in the uppermost part of the unit, about 40 cm below its top, where the basal Devonian conodont Icriodus woschmidti was recovered.
Carls, Slavik, and Valenzuela-Rios, 2007. Revisions of conodont biostratigraphy across the Silurian-Devonian Boundary, Bulletin of Geosciences 82 (2), 145-164
They consider Icriodus woschmidti s.s. to not be a good index for the base of the Devonian. In fact, the level of the FAD of the holotype is considered to be slightly younger than the level of the FAD of Icriodus postwoschmidti at another location.
Carls et al 2007 based their notes on material from Bohemia and Germany. Later Icr. woschmidti was documented to enter together with the conodont index of the boundary (Icr. hesperius), or slightly above in Sardinia and in the Carnic Alps (Corriga & Corradini 2009, Corriga 2011, Corradini & Corriga 2012, Corradini et al. 2015, Corriga et al 2016). We added some sentencences to explain this in the Chronostratigraphy chapter (section 6, lines 533-539)

182 the Přídolí was preliminarly attempted. Faunas from the uppermost part of the Alticola Fm.
typing error corrected (line 186)

213 the Wolayer Fm. (Fig. 4). Conodonts are abundant in the upper part of the unit (samples 309 (deleted and from abundant and in the)
typing error corrected (line 186) and slightly rephrased the last part of the sentence (line 188)

218 219 The Pt. am. amorphognathoides Zone as defined by Walliser (1964) corresponds to the total range interval of the index Pt. am. amorphognathoides Walliser. This interval was later considered a "Zonal group" by Jeppsson (1997), who subdivided it into four zones.
The total range interval of Walliser was based on the range of that species in the section at Cellon, which does not likely represent the entire range.
Jeppsson (1997) recognized a Pt. am. amorphognathoides Zone and a Pt. am. amorphognathoides Zonal group. The latter includes two additional zones, the Lower and Upper Pseudooneotodus bicornis Zones, for a total of THREE, not four, zones.
right!. we corrected (Line 225)

222 (Fig. 4) in millimetric carbonatitic infillings of small pocket on the irregular (infillings are of carbonate, so to make that an adjective, probably need to drop the e and add itic)

“carbonatic” is already adjective!
223 224 225The conodont association includes Pt. p. procerus (Walliser) and Distomodus staurognathoides (Walliser) and coniform taxa, and does not allow to recognize any of the zones proposed by Jeppsson. Therefore we refer to the Pt. am. amorphognathoides Zone by Walliser. Jeppsson (1997) showed that the ranges of those two taxa and Pt. am. amorphognathoides overlap in his Pt. am. amorphognathoides Zone and also in the Lower and Upper Ps. bicornis Zones. The co-occurrence of those three taxa in the infillings of small pockets on the Wolayer surface do permit recognition of the Pt. am. Zonal group. Additionally, since Jeppsson (1997) shows that the end of discontinuously represented and beginning of continuously represented Pt. procerus is in the upper part of the Upper Ps. bicornis Zone, it would seem most likely, as is concluded in lines 226-228, but stated differently, that the Upper Ps. bicornis can be recognized, the only zone of the Pt. amorphognathoides Zonal group that is likely just above the Llandovery/Wenlock boundary.
226 227 228 However, since all these taxa range up to the top of the Zone, and due to the continuity in the sedimentation with the overlying beds, the interval can be likely attributed to the uppermost part of the Zone, just above the Llandovery/Wenlock boundary.
The reviewer comment is interesting, but does not add anything sure: the dotted line traced in Jeppsson (1997) for the lower range of Pt. procerus indicates that the taxon may occur in the lower part of his Pt. amorphognathoides zonal. Therefore we cannot use the beginning of the solid line to state the age of this level, since the species may occur below. We maintain our previous text

232 233 234 Jeppsson (1997) subdivided this interval into two biozones at Gotland, and this scheme is accepted in various papers in Baltica and Laurentia (i.e.: Cramer et al., 2010; Männik et al., 2014), but this subdivision is not applicable in the condensed sequence of the Carnic Alps.
(deleted very detailed from but this very detailed subdivision is not applicable because a two-part subdivision is not really very detailed, and it is a two-part, not a four-part, subdivision, at least in Jeppsson (1997))
OK. rearranged lines 238-240

242 243 244 Jeppsson (1997) subdivided this interval into seven zones, that are impossible to discriminate in the Rauchkofel Boden Section. However, two of them (K. patula Zone and K. o. ortus Zone) were recognized in the Cellon Section by Corradini et al. (2015a).
Jeppsson (1997) recognized seven zones if the post K. walliseri interregnum is considered as a zone, and Jeppsson did consider it a zone in all of his figures.
right!. we corrected (Line 248)

256 Oz. s. rhenana is present in the lowermost part of the Zone (sample 313), as documented in other areas of the Carnic Alps (Corradini et al. 2016).
I do not have a copy of Corradini et al. 2016, however, I do think it would be likely that Oz. s. rhenana would co-occur with Oz. s. sagitta within the lower part of its range. It is difficult to determine what the difference is between the P1 element identified as that of Oz. s. rhenana (Plate 2, fig. 1) and the P1 element identified as that of Oz. s. sagitta (Plate 2, fig. 4). The former is larger, but appears to have just as many denticles above the basal cavity, perhaps even more, than the latter. The denticles anterior to the basal cavity on the specimen identified as the P1 element of Oz. s. sagitta do appear to be really small and numerous, but it is difficult to determine that they are more numerous than the denticles anterior to the basal cavity in the specimen identified as the P1 element of Oz. s. rhenana. Lateral views of those two specimens, in addition to the upper views, would be helpful. It would also be helpful if a specimen of Oz. s. rhenana from the Oz. s. rhenana Zone were also included on Plate 2, to show the similar and different characteristics of earlier and later populations of Oz. s. rhenana.

Unfortunately it is not possible take a new photo of the figured specimen of Oz. s. rhenana: we took a new photo of the specimen figured by Schönlaub (1980), but the specimen is still sticked on the original stub. Moving from there after almost 40 years may be very dangerous, since the conodont could be damaged or even destroied.
Also, we do not have now accessibility to the samples stored at Geological Survey in Vienna: so it is not possible take now photos from that material in a reasonable time (beside difficult arrangements)

269 270 not present in the lowermost part of the Zone (Calner & Jeppsson 2003), it looks more appropriate to name this interval as the classical Oz. bohemica Zone, even if the definition of the upper boundary is different than the original definition by Aldridge & Schönlaub (1989).
Since no subspecies of Oz. bohemica occur in this 20-cm thick interval tentatively identified as the classical Oz. bohemica Zone, and the lower boundary of Calner & Jeppsson's (2003) upper subdivision of the Oz. bohemica Zone is recognized, the K. o. absidata Zone, then it would seem to be just as appropriate to tentatively identify this 20-cm interval as the Oz. bohemica longa Zone.
For this point we accepted the suggestion by reviewer B, naming the Zone as Oz. bohemica Interval Zone" (lines 268-276)

292 In the Rauchkofel Boden section is recognized in the central-upper part of the Kok Fm. (Fig. 4).
We have not understood this comment… since it is reported the same sentence than the text.

342 Panderodus recurvatus has its last occurrence in the section
typing error corrected (line 351)

346 347 348 5.14 "Ozarkodina" eosteinhornensis s.l. Interval Zone, Corriga & Corradini (2009)
The "Oz." eosteinhornensis s.l. Interval Zone is defined as the interval between the last occurrence of Oz. crispa and the first occurrence of Oulodus elegans detortus (Walliser) (Corradini & Corriga 2012)
Which publication is the one that truly defines this Interval Zone, Corriga & Corradini (2009) or Corradini & Corriga (2012)
Corriga & Corradini (2009) introduced the name of the zone, renaming the former "remscheidensis interval Zone", whereas Corradini & Corriga (2012) described it in detail. We report both the quotation in line 357-358

352 in a similar position as in other sections in the region, like the Cellon Section (Corradini et al. 2015a).
Ok. text corrected (line 362)

363 in a similar position as at other sections in the Carnic Alps, like Cellon
Ok. text corrected (line 372)

373 At Rauchkofel Boden this zone has
Ok. text corrected (line 383)

391 392 393 In the Rauchkofel Boden Section these two species are not present, therefore the lower and upper boundaries were detected by the entries of Icr.woschmidti (Walliser) and Pandorinellina optima (Moskalenko), respectively: in many sections Icr. woschmidti enters at the same level of Icr. hesperius (Corradini & Corriga 2012).

Specimens recognized as Icr. woschmidti have been recognized in uppermost Pridoli samples at some localities, as well as from different levels in the lower part of the Lochkovian. Carls et al. (2007) do indeed conclude that Icr. hesperius (formerly Icr. woschmidti hesperius) is best for recognizing the base of the Devonian. Carls et al. (2007) also discussed the problem with the use of other subspecies of Icr. woschmidti for recognition of the base of the Devonian, including Icr. woschmidti woschmidti, which they indicated may even have an FAD higher than that of Icr. postwoschmidti. Since Icr. hesperius does not occur in the Rauchkofel Boden Section, and since the P1 element identified as that of Icr. woschmidti is incomplete and not identified as Icr. woschmidti woschmidti, the base of the Icr. hesperius Zone could be either slightly higher or lower than recognized. This is particularly so because the means for recognizing the Icr. postwoschmidti Zone, P. optima, as is stated in the manuscript, has not been shown to have an FAD that correlates with that of Icr. postwoschmidti.
Carls et al 2007 based their notes on material from Bohemia and Germany. Later Icr. woschmidti was documented to enter together with the conodont index of the boundary (Icr. hesperius), or slightly above in Sardinia and in the Carnic Alps (Corriga & Corradini 2009, Corriga 2011, Corradini & Corriga 2012, Corradini et al. 2015, Corriga et al 2016). We added some sentences to explain this in the Chronostratigraphy chapter (section 6, lines 533-539)
Also, there are no subspecies of Icr. woschmidti described, since the only former one is now considered a true species (Icr. hesperius)

433 beside the Carnic Alps (i.e.: Corriga et al. 2011) it is detected in Bohemia
Ok. text corrected (line 449)

434 and Sardinia (Corriga 2011
Ok. text corrected (line 450)

489 part or the whole Hirnantian and
typing error corrected (line 511)

510 511 the Silurian/Devonian boundary occurs in the uppermost part of the Alticola Fm., at level of sample 201, where the conodont Icr. woschmidti first appears.
It is likely close to that level, but the FAD of Icr. woschmidti, while certain populations/subspecies can have an FAD at about the same level as Icr. hesperius, others can have an FAD in the late Pridoli or later in the early Lochkovian.
We added some sentences reporting recent data from the Carnic Alps, on which the boundary is recognized (lines 533-539)

Reviewer B:

In general, I think that zones listed here without presence of indexes or other relevant markers and thus without clear limits and factual proof of the presence are only guessed and should be indicated as „tentatively proposed" in all cases (in some cases it is mentioned, in others it is written „zone is dicriminated" - not fully correct.

line 171 MGC, not MCG
typing error corrected (line 172)

Chapter 5.6. It would be good to mention shortly also the similar situation in the Prague synform (a sister area) whre the problems with the lower limits of the bohemica zone and subzones is commented (Slavík 2014).

I suggest to use "Oz. bohemica Interval Zone" as this is the typical case for that.
We agree on this (lines 268-278)

Just a surprise for me: No bohemica in the section! - very strange that it did not liked this place:-)...
We remarked the fact that Oz. bohemica has not been found in teh Carnic Alps up to now (line 273)

Chapter 5.7. The same issue related to that above, K. ortus absidata is treated as Subzone in the PS (and the reasons are hopefully clearly explained).There is doubtful lower and upper limit and most probably the taxon range is completely overlapped by the range of various morphotypes of bohemica. Moreover, the zonation in Cramer et al. (2011) is full of errors caused by oversimplifications. Therefore, to copy it should be better avoided.
the base of the K.o.absidata Zone is defined by the FAD of the index species, and therefore is easily applicable everywhere the taxon is present.
Slavik (2014) treated the K.O. absidata Zone as subzone in Bohemia, due to the overlap of the stratigraphical distribution of Oz. b. longa and K. o. absidata and the long ranging of the latter (Slavik 2014, p. 309). Maybe that in his mind he intended total range zones, only, but the definition of the K.o.absidata Zone is evident and easy to apply.
Therefore we stay with our zonation

Chapter 5.10.
Formal - the text should be a bit clarified: genreal definition of the given zone should be distinguished from the local definition of the zone, e.g., "Herein, the base of the zone..." Otherwise is seems confusing.
OK: rephrased (line 307)

Chapter 5.12.
This is very interesting and the composition of faunas exactly confirms the typical crisis of the Lau interval and the Post-Lau recovery of faunas (starting with re-appearing of spathognathodontids, which are at the very beginning very small and slender, then comes Ped. latialatus and then the larger snajdri-like morphologies in the Prague Synform).
Would be good to say something about this striking coincidence with the PS (Slavík & Carls 2012) because it is fantastic correlation!

Ref: Slavík, L., Carls, P. 2012: Post-Lau Event (late Ludfordian, Silurian) recovery of conodont faunas of Bohemia. – Bulletin of Geosciences 87(4), 815-832. DOI: 10.3140/bull.geosci.1368
Added a sentence to remark this important similitude (lines 339-341)

5.13. Ped. latialata becomes extinct within this zone...– Yes, a nice confirmation of the succession from the PS (Slavík & Carls 2012), see above.

5.14. Pitty that Z. zellmeri – a promissing basal Přídolían marker is not present here, but strangely it occurs in the upper part... Is it really zellmeri? (no figure was provided). This makes me a bit inquiet as this taxon is so typical for the early Přídolí and in the Požáry section enters together with the parultimus! (cf. Carls et al. 2007).
The taxon was reported from the lower Pridoli in Bohemia (Carls et al 2007), whereas is documented in the whole Pridoli in the Carnic Alps (Corradini and Corriga 2010, 2012, Corradini et al. 2015a, Corriga et al. 2016). We added a sentence to remark this (lines 391-394)

5.15.-5.16.

Although I understand the reasons for such a subdivision, it is clear from here that to use the coniform element for the zonal limit is extremely problematic. Especially for the bias of occurrence of coniform elements largely caused by depositional conditions – e.g., material sorting in calciturbidites...
We do not agree with this comment. Coniform elements are almost always an important part of the fauna, but many workers do not consider them because are more difficult to study than ozarkodinids and prioniodinids. The zonation proposed by Corradini and Corriga (2012) for the Carnic Alps and Sardinia, here followed, works well is several other areas (Morocco, Estonia, Montagne Noire, ...)

We will have to search jointly for better markers in near future.
We agree on this (and we already have some ideas...

5.16. Here is a problem with the zonal boundary - in the figure D. obliquicostatus is marked by blind dot = "problematic identification" in samples 7X-200! Therefore there cannot be discriminated any boundary limit based on that!
We checked again the incomplete specimen of Daps. obliquicostatus in sample 7, and the identification is sure. So we corrected Fig. 5: in the previous version we reported a blind dot because the specimen is incomplete. Now a full dot is reported

In the second paragraph, Z. zellmeri is mentioned in the uppermost Silurian, but this is in contradiction to Corradini & Corriga (2012) where zellmeri is typically lower Přídolían taxon (as it is also in the PS – cf. Carls et al. 2007).
see comment above (at paragraph 5.14). We added a sentence on the occurrence of Z. zellmeri in the Carnic Alps, and another possibly explaining the late entries of many taxa in the Rauchkofel Boden section, where are missing in the lower and middle Pridoli (lines 389-396)

5.17. formal – Is it 30cm or 40cm interval? – two different numbers in the chapter.
40 cm is correct. We erased the sentence in the final part of the paragraph, where the wrong thickness was reported

5.18. I would be very careful with usage of I. postwoschmidti and its superposition above woschmidti and hesperius (cf. extensive comments in Carls et al. 2007). It would be good to mention at least "some doubts" due to date from other regions.
We state at the beginning (Chapter 5 – lines 193-202) which zonations we follow in this paper. However we agree that a different scheme for the upper part of the lower Lochkovian should be proposed soon, possibly combining data from various areas. We added a sentence in this respect (lines 420-421)

"The I. poswoschmidti Zone is discriminated" – in this case (also following the general remark above) it should be mentioned as "tentatively suggested" or something alike.
OK. we corrected the text (line 422)

5.19. Yes, carlsi was suggested for the base of the middle Lochkovian in Slavík (2011) and then by Corradini & Corriga (2012) and also again in zonation for the PS in Slavík et al. (2012).
added the citation of Slavik et al (2012) (Line 428)

5.21. Anc. kutscheri – I disagree that the taxon is "very rare and therefore it looks hardly usable for long distance correlation". In fact, it has almost the same dispersal as trigonicus!
We disagree with this note: up to now the taxon is not documented in the Carnic Alps, whereas in Sardinia only one specimen has been collected. Also, in the Pyrenees (one of the areas on which the Valenzuela Rios et al 2015 zonation is base) it is missing in some sections... Also in North America *A. kutscheri* is a rare component of the faunas (M. Murphy personal communication to CC, dec 2016). The fact that a taxon is sometimes present in many areas does not mean that it is abundant, nor that it can be a good stratigraphical index taxon!
We added a sentence to make thic more clear (lines 453-454)

If we compare the potentials of kutscheri and D. obliquicostatus for boundary subdivision... Is D. obliguicostatus in this comparison better?
Definitely better! (see comments above)

Fortunatelly the Lochkovian is much easier for detailed subdivision:-).

5.22.
"trigonicus LAD just below the entry of pandora" – I think, it is not completely right as in other areas there is trigonicus, then kutscheri + other crazy morphologies (e.g., sequeirosi, and in the PS many others not yet described branching morphs), often with Kimognathus limbacarinatus and then a small gap (frew meters) and then the entry of pandora morphs. So not just above in more complete succession.
Pitty is that the uppermost Lochkovian is often hardly condensed in peri-gondwana (PS, Pyrenees), probably it is also the case of the Carnic Alps?
We refer to distribution in the Carnic Alps (added in line 469)

5.24. Icr. steinachensis beta – actually, the original proposal for the base in Slavík (2004) was Icr. steinach. eta. But later in Slavík et al. (2007) the base has been modified to beta morph, because it has been found together with early eognathodontids. So, for the meantime, it seems the beta and earliest eognothodus have the same entry.
ref. Slavík, L., Valenzuela-Ríos, J.I., Hladil, J. & Carls, P. (2007): Early Pragian conodont-based correlations between the Barrandian area and the Spanish Central Pyrenees. – Geological Journal, 42, p. 499-512. ISSN 0072-1050

We added a few lines with the “story” of the zone (lines 487-491). We also added the quotation of Slavik et al 2007 in references

line 489- parts instead of pars
typing error corrected (line 511)

lines 513-514. I do not want only to push my citation, but in general it should be cited the original paper (Slavík & Hladil 2004) and not the compilation by Becker et al. (2012).
ref. Slavík, L. & Hladil, J. (2004): Lochkovian/Pragian GSSP revisited: evidence about conodont taxa and their stratigraphic distribution. – Newsletters on Stratigraphy, 40/3: 137-153. ISSN 0078-0421. Berlin, Stuttgart.
We agree with this comment: we changed the reference and added this paper in the reference list (Line 542)

Chrono-, Litho- and conodont Bio-stratigraphy of the Rauchkofel Boden Section (Upper Ordovician-Lower Devonian), Carnic Alps, Austria

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Abstract

An updated stratigraphy of the Rauchkofel Boden Section, a classical reference section for the Carnic Alps that exposes rocks from the Katian (Upper Ordovician) to the Pragian (Lower Devonian) is here presented, following latest developments in conodont taxonomy and biostratigraphy, as well as in chronostratigraphy, and the recent introduction of a new lithostratigraphic outline of the Carnic Alps. The original conodont collection of the'70s and '80s was restudied and complemented by a detailed resampling in order to achieve a more precise conodont biostratigraphic assignment. Twenty-five conodont Zones are now documented. The lithostratigraphy is precisely fixed to the new lithostratigraphic scheme of the Pre-Variscan sequence by definition of seven distinct formations. Finally, the position of chronostratigraphic boundaries is discussed.

Key words

Carnic Alps, Ordovician, Silurian, Devonian, conodont biostratigraphy.

1. Introduction

The Rauchkofel Boden Section is one of the classical and most spectacular sections of the Carnic Alps. An almost continuous calcareous sequence ranging from the upper Katian (Upper Ordovician) to the Pragian (Lower Devonian) is there exposed, representing a reference section for this long time interval in the Southern Alps and in the peri-Gondwana area. Several papers dealt on various aspects of geology and fossil content of the section. The stratigraphic assignment was mainly based on the detailed conodont studies by H.P. Schönlaub in the '70s. However, later conodont studies have introduced new taxa and proposed more refined zonal schemes. The lithostratigraphic scheme of the Pre-Variscan sequence of the Carnic Alps was recently updated (Corradini and Suttner 2015), and all the formations are now established according to the International Stratigraphic Guide.

In this paper we present an updated conodont stratigraphy of the Rauchkofel Boden Section, based on a restudy of the original collections and a consistent new sampling throughout the section. Lithostratigraphy is further implemented by the recognition of seven formations, and the position of the chronostratigraphic boundaries is discussed.

2. Geological Settings

The Carnic Alps are located on either side of the Italian-Austrian border. Here, one of the best exposed and most complete Palaeozoic successions in the world, ranging from the Middle Ordovician to the Upper Permian, is exposed.

During the early Palaeozoic the Carnic Alps belong to those group of terrains (Galatian terranes; von Raumer and Stampfli 2008), that detached from the northern Gondwana margin within the Lower Ordovician, and moved northward faster than the main supercontinent. The drift from about 50°S in the Late Ordovician, to 35°S in the Silurian and to tropical belt in the Devonian (Schönlaub 1992) is reflected by distinct litho- and biofacies patterns.

Rocks from the Middle Ordovician to the lower Pennsylvanian, that were affected by the Variscan orogeny during the late Bashkirian and Moscovian (Venturini 1990, Schönlaub and Forke 2007) constitute the so-called Pre-Variscan sequence. The lithostratigraphy of this sequence was recently revised and 36 formations were finally discriminated in the Pre-Variscan sequence of the Carnic Alps (Corradini and Suttner 2015). For a recent description of the geology of the Carnic Alps, refer to Corradini et al. (2015e, 2016).

3. The Rauchkofel Boden Section

The Rauchkofel Boden Section is located on the southwestern slope of Mt. Rauchkofel, at coordinates N 46°36’54", E 12°52’30", and an altitude of 2175 m (Fig. 1). It is easily accessible along the trail running from the Lake Wolayer to the top of Mount Rauchkofel. About 65 m of calcareous rocks documenting the Upper Ordovician-Lower Devonian are exposed (Figs 2-3). A significant gap is present at the Ordovician/Silurian boundary, where possibly part of the Hirnantian and almost the whole Llandovery is missing.

3.1 Previous papers on the Rauchkofel Boden Section

The Rauchkofel-Boden section is one of the best known and most fossiliferous sections of the whole Carnic Alps corresponding to the "Wolayer facies" of Spitz (1909). A detailed description was published, among others, by von Gaertner (1931), Heritsch (1929) and later by Schönlaub (1970, 1971, 1977, 1980, 1985, 1997a, b), Ferretti and Histon (1997), Ferretti et al. (1999, 2004), Ferretti (2005), Brett et al. (2009) and Corradini et al. (2015e).

Many studies were specifically devoted to describing the rich fossil association. The orthoconic nautiloid fauna was studied by Ristedt (1968, 1969), Bogolepova (in Schönlaub and Bogolepova, 1994), Ferretti et al. (1999, 2004) and Histon (1999, 2000). Trilobites were described by Haas (1969) and Santel (2001); bivalves by Kříž (1974, 1979); corals by Pickett (2007); dacryoconarids by Alberti (1985); Problematica by Ferretti and Serpagli (2008) and Ferretti et al. (2013); and peculiar echinodermal holdfasts by Ferretti et al. (2016). Conodonts were illustrated by Schönlaub (1980) and, limited to the Ordovician, by Ferretti and Schönlaub (2001). The firm biostratigraphy from these papers was the basis for other more global studies that have enabled correlation of the Rauchkofel Boden Section outside the Carnic Alps and the peri-Gondwana area: sedimentology and microbiofacies analysis was run by Dullo (1992), Ferretti and Histon (1997), Ferretti et al. (1999, 2004, 2012a,b) and Ferretti (2005); sequence stratigraphy was investigated by Brett et al. (2009); stable isotopes and geochemistry by Wenzel (1997), Ferretti (2005), Schönlaub et al. (2011), Ferretti et al. (2012b) and Hammarlund et al. (2012). Finally, the heavy minerals of the underlying clastic strata were studied by Schnabel (1976).

3.2 Lithostratigraphy

The base of the Rauchkofel Boden section is represented by a more than 100 m thick unfossiliferous clastic sequence named the Himmelberg Formation (Schönlaub 2015). It comprises massive to well bedded greyish to greenish sandstones and interbedded arenaceous shales showing locally cross-bedding, ripples and conglomeratic intercalations indicating a shallow marine environment. This formation is tentatively assigned to the Middle Ordovician and more clearly to the Katian Stage. Based on the heavy minerals zircon, tourmaline and rutile for these clastics, a source area of acid plutonic rocks (granites, pegmatites) has been inferred (Schnabel 1976).

The Himmelberg Formation is sharply overlain by the 10 to 15 m thick Wolayer Formation, the varying thickness of which depends on the amount of erosion upon its deposition (Schönlaub and Ferretti 2015). The Rauchkofel-Boden Section represents the type section for this formation. The massive limestone of the unit is indistinctly bedded and rich in cystoid debris or complete cystoid thecae, bryozoans, rare corals, brachiopods, ostracods, trilobites and conodonts (Ferretti and Histon 1997, Ferretti et al. 1999, 2004, 2012b, Ferretti 2005, Brett et al. 2009). The grain-sized and rudstone fabric indicate a dominant allochthonous accumulation of echinoderm debris and other bioclasts possibly deriving from shallow water high-energy crinozoan mounds (Dullo 1992). On the basis of conodonts, the Wolayer Fm. is dated to the late Katian-?basal Hirnantian (*Am. ordovicicus* Zone; Ferretti and Schönlaub 2001).

The contact to the overlying Kok Formation (Ferretti et al. 2015a) is represented by an up to 5 mm thick irregular clayish stylolitic seam indicating a distinct disconformity (Fig. 3C). Locally, a limestone-limestone-contact is developed. Stromatolite-like structures along discontinuity surfaces have been associated to a peculiar microbial activity (Ferretti 2005; Ferretti et al. 2012b). The conodont biostratigraphy and sedimentology of the Kok Formation was studied in detail by Schönlaub (1970, 1971, 1977), Ferretti and Histon (1997), Ferretti et al. (1999, 2004), Histon (1999), Ferretti (2005) and Brett et al. (2009). According to Ferretti (2005), hematitic to manganese-rich crusts and thin oolitic grainstones infill small pockets on the upper irregular surface of the underlying Wolayer Formation. The infillings have yielded conodonts of the *Pt. a. amorphognatoides* Zone, corresponding to the end-Llandovery or close to the Llandovery/Wenlock boundary. Apparently, most (if not all) of the Hirnantian Stage and most of the Llandovery Series are missing (Ferretti 2005, Brett et al. 2009, Ferretti et al. 2012b).

The Kok Formation is 3.50 m thick and is represented by pinkish to greyish nautiloid-rich packstones and wackestones of Wenlock age in the lower part, followed by indistinctly bedded encrinitic, bioclastic and oolitic grainstones with iron-rich shaly partings of lower Gorstian. The uppermost part comprises grayish and pinkish wacke-/packstones with abundant juvenile and adult, partly oriented nautiloids associated with articulate brachiopods, bivalves and gastropods (Ferretti and Histon 1997, Ferretti et al. 1999, 2004, 2012b, Ferretti 2005, Brett et al. 2009).

The overlying 40-50 cm thick Cardiola Formation (Ferretti at al. 2015b) was excavated during World War I as a trench and later covered by soil and loose rocks that were easily dug for current sampling. Black bituminous shales interfinger with lenses of dark micritic limestones yielding nautiloids, bivalve representatives of the genus *Cardiola* (Kříž 1979, 1999) and conodonts of the *P. siluricus* Zone. The fauna is dominated by nautiloids embedded in a matrix of bioclasts which are frequently coated by micritic envelopes (Ferretti and Histon 1997, Ferretti et al. 1999, 2004, Ferretti 2005, Brett et al. 2009).

With a sharp boundary, the Cardiola Fm. is overlain by 18 m thick limestones assigned to the Alticola Formation (Ferretti et al. 2015c) of upper Ludfordian to basal Lochkovian age. Its upper part forms a steep southward facing mostly grass-covered slope which ends up at the Silurian/Devonian boundary. The limestone sequence is composed of massive pink to gray wackestones/packstones with locally rich occurrences of large nautiloids, trilobites and solitary rugose corals in the middle part (Ferretti and Histon 1997, Ferretti et al. 1999, 2004, Ferretti 2005, Brett et al. 2009). The Ludlow/Přídolí boundary is drawn in the uppermost part of the steep slope, just below the upper boundary of the *Oz. crispa* Zone. Towards the top, the Přídolían part of the limestone sequence is represented by dark grey, massive to coarse-bedded wackestones and packstones rich in echinoderms including *Scyphocrinites* debris and even loboliths (Ferretti and Histon 1997, Ferretti et al. 1999, 2004, Ferretti 2005, Brett et al. 2009). The Silurian/Devonian boundary is drawn in the uppermost part of the unit, about 40 cm below its top, where the basal Devonian conodont *Icriodus woschmidti* Walliser was recovered.

The following Rauchkofel Formation (Corradini et al. 2015d) is extremely condensed and consists of 1.80 m thick thin-bedded limestone beds interbedded with black shales of Lochkovian age.

The flat area south of the steep meadow is represented by 18 m thick limestones of the La Valute Formation (Corradini et al., 2015c) which was previously named "Bodenkalk" by Schönlaub (1985). It is composed of grey, coarse-bedded, very compact cephalopod limestones (mudstones to wackestones). The Rauchkofel Boden Section is the type section of the La Valute Fm. As in other areas (i.e., Mt. Zermula: Pondrelli et al. 2015, Corradini et al. 2016) the upper part the La Valute Fm. becomes more marly and nodular and gradually passes into the overlying Findenig Fm. (Corriga et al. 2011, Spalletta et al. 2015). This unit is represented by 20 m of reddish nodular mudstones and wackestones. Orthoceratid nautiloids and hardly visible dacryconoarids (Alberti, 1985) are the only fossils observable in the field. The Lochkovian/Pragian boundary is drawn just above the formation boundary by the occurrence of the dacryoconarid *Nowakia acuaria* (Richter) at the base of the Findenig Fm. (Schönlaub 1980, Alberti 1985).

4. Conodont fauna

The Schönlaub conodont Collection from Rauchkofel Boden is stored at the Austrian Geological Survey in Vienna. It includes 108 samples, mainly collected between 1969 and 1979, with a few integration on selected intervals in the early '80s. This material was restudied and updated by MGC and CC in 2015, according to the recent taxonomic and biostratigraphic novelties. We complemented the original Schönlaub Collection with 36 new samples collected by AF in the Ordovician and Silurian part of the section, mainly in the Wolayer, Kok and Cardiola formations, and 41 picked by CC and MGC in the Ludlow to Lochkovian part. The additional Ordovician samples are stored at the Palaeontological Museum of the University of Modena and Reggio Emilia (IPUM code), and the Silurian and Devonian ones in the Palaeontological and Geological Museum "Domenico Lovisato" of Cagliari University (MDLCA code).

Conodonts are in general quite abundant and relatively well preserved throughout the section, but with great differences from level to level. Best preserved and richest associations are derived from the lower part of the section, in the sector morphologically above the steep slope: the associations from the Wolayer to the lower part of the Alticola formations (Katian to Ludfordian) are particularly good. Samples from the steep slope (central and upper part of Alticola Fm.) yielded very scarce and/or poorly preserved conodont elements and a precise biostratigraphy within the Přídolí was preliminarly attempted. Faunas from the uppermost part of the Alticola Fm. (uppermost Přídolí) to most of the La Valute Fm. (middle Lochkovian) are well preserved and relatively abundant, and they suddenly became very scarce in the upper part of the section, where many samples are barren of conodonts.

5. Conodont Biostratigraphy

The biostratigraphic assessment is based on the conodont zonation schemes in use for the Upper Ordovician to the Lower Devonian. Bergström and Ferretti (2016) have recently re-tuned the conodont biostratigraphic schemes in use for the Ordovician. The scheme by Cramer et al. (2011) was followed for the Silurian, with the emendations by Corradini and Corriga (2012) and Corradini et al. (2015a). However, the scheme by Corradini and Serpagli (1999) was utilized for the Wenlock, as the detailed subdivision of the Wenlock by Cramer et al. (2011) revealed to be unfitting for the Carnic Alps, as already pointed out by Corradini et al. (2016). The zonation schemes provided by Corradini and Corriga (2012) and Valenzuela-Ríos et al. (2015) are applied for the Lochkovian, with the variations suggested by Corriga et al. (2016) in the lower Lochkovian. Finally, the scheme by Slavík (2004) is adopted for the lower Pragian.

The studied conodont fauna allows the discrimination in the Rauchkofel Boden Section of twenty-five biozones documenting an interval ranging from the Katian (Upper Ordovician) to the lower Pragian (Lower Devonian) (Figs 4-6). However, as reported above, possibly the Hirnantian and the Llandovery are missing (Fig. 2). The conodont zones are briefly discussed below. For each zone, its original definition, relative interval in the Rauchkofel Boden Section, occurrence of the most characteristic taxa, and a few comments, if necessary, are provided. The complete conodont distribution data are provided in Figures 4-6. Main taxa are illustrated in Pls. 1-3.

5.1 *Amorphognathus ordovicicus* Zone, Bergström (1971)

The *Am. ordovicicus* Zone was defined by Bergström (1971) as corresponding to the total range of the marker index *Am. ordovicicus* (Branson and Mehl). For a review of the *Amorphognathus* evolutionary lineage, on which the Late Ordovician conodont biozonation is based, refer to Ferretti et al. (2014) and Bergström and Ferretti (2015). The population of *Amorphognathus* present in the

Rauchkofel Boden Section includes both *Am. ordovicicus* and *Am. duftonus*. The Zone is documented in the Wolayer Fm. (Fig. 4). Conodonts are abundant in the upper part of the unit (samples 309 and 309 top), where the fauna is dominated by coniform elements of *Walliserodus*, associated with numerous elements of *Amorphognathus* and rare *Hamarodus* and *Plectodina*.

5.2 *Pterospathodus amorphognathoides amorphognathoides* Zone, Walliser (1964)

The *Pt. am. amorphognathoides* Zone as defined by Walliser (1964) corresponds to the total range interval of the index *Pt. am. amorphognathoides* Walliser. This interval was later considered a "Zonal group" by Jeppsson (1997), who subdivided it into three zones.

In the Rauchkofel Boden Section the *Pt. am. amorphognathoides* Zone is discriminated at the very base of the Kok Fm. (Fig. 4) in millimetric carbonatic infillings of small pocket on the irregular erosive surface of the underlying Wolayer Fm. The conodont association includes *Pt. p. procerus* (Walliser) and *Distomodus staurognathoides* (Walliser) and coniform taxa, and does not allow to recognize any of the zones proposed by Jeppsson. Therefore we refer to the *Pt. am. amorphognathoides* Zone by Walliser. However, since all these taxa range up to the top of the Zone, and due to the continuity in the sedimentation with the overlying beds, the interval can be likely attributed to the uppermost part of the Zone, just above the Llandovery/Wenlock boundary.

5.3 *Kockelella ranuliformis* interval Zone, Corradini and Serpagli (1999)

The *K. ranuliformis* interval Zone is defined as the interval between the LAD of *Pt. am. amorphognathoides* and the FAD of *Oz. s. rhenana* Walliser (Corradini and Serpagli 1999). Jeppsson (1997) subdivided this interval into two biozones at Gotland, and this scheme is accepted in various papers in Baltica and Laurentia (i.e., Cramer et al.,2010, Männik et al. 2014), but this subdivision is not applicable in the condensed sequence of the Carnic Alps.

The named Zone is discriminated at the Rauchkofel Boden Section in the lower part of the Kok Fm. (Fig. 4), in the 40 cm thick interval between samples 310 and 312, where the fauna is dominated by coniform elements of genera *Dapsilodus*, *Panderodus* and *Pseudooneotodus*.

5.4 *Ozarkodina sagitta rhenana* Zone, Aldridge and Schönlaub (1989)

The *Oz. s. rhenana* Zone is defined as the interval between the FAD of the index taxon *Oz. s. rhenana* and the FAD of *Oz. s. sagitta* Walliser (Aldridge and Schönlaub, 1989). Jeppsson (1997) subdivided this interval into seven zones, that are impossible to discriminate in the Rauchkofel Boden Section. However, two of them (*K. patula* Zone and *K. o. ortus* Zone) were recognized in the Cellon Section by Corradini et al. (2015a).

At Rauchkofel Boden, the *Oz. s. rhenana* Zone is discriminated in the lower part of the Kok Fm. by the entry of *Oz. s. rhenana* in sample 312, and is 30 cm thick only (Fig. 4). In the Carnic Alps the Zone has been documented a few km to the East in the La Valute area in a different facies represented by an alternation of shales and limestone, and is about 3 m thick (Corradini et al., 2016).

5.5 *Ozarkodina sagitta sagitta* Zone, Aldridge and Schönlaub (1989)

The Zone corresponds to the interval of total range of *Oz. s. sagitta* (Jeppsson 1997, Jeppsson and Calner 2002). In the Rauchkofel Boden Section the Zone is discriminated from sample 313 to 322/2 by the occurrence of *Oz. s. sagitta* (Walliser), and is 45 cm thick (Fig. 4). Within the Zone, the index taxon largely dominates the association. *Oz. s. rhenana* is present in the lowermost part of the Zone (sample 313), as similarly reported in other areas of the Carnic Alps (Corradini et al. 2016). *Ps. linguicornis* Jeppsson has its only occurrence within this Zone (sample 321/1), as documented also in other areas (Männik and Małkowski 1998, Jeppsson (in Calner and Jeppson)

2003, Corradini 2008, Corradini et al. 2016). *Kockelella o. ortus* (Walliser), that normally has a longer range is here documented only from the upper part of the Zone.

5.6 *Ozarkodina bohemica* Interval Zone

The interval between the LAD of *Oz. s. sagitta* (Walliser) and the FAD of *K. ortus absidata* Barrick and Klapper is assigned to the *Oz. bohemica* Interval Zone. This interval was named *Oz. b. longa* Zone by Calner and Jeppsson (2003), who subdivided the former *Oz. bohemica* Zone by Aldridge and Schönlaub (1989) into two parts, the *Oz. bohemica longa* and *K. o. absidata* zones respectively. However, since *Oz. bohemica bohemica* (Walliser) and *Oz. b. longa* Jeppsson have not been found in the Carnic Alps so far, and because the latter taxon is not present in the lowermost part of the Zone (Calner and Jeppsson 2003), it looks more appropriate to name this interval as *Oz. bohemica* Interval Zone.

In the Rauchkofel Boden Section the *Oz. bohemica* interval Zone is tentatively detected in the short (20 cm thick) not sampled interval between samples 322/2 and 323/1 (Fig. 4).

5.7 *Kockelella ortus absidata* Zone, Calner and Jeppsson (2003)

The *K. o. absidata* Zone represents the interval between the FAD of *K. o. absidata* and the FAD of *K. crassa* (Walliser), and includes the top Homerian strata (Cramer et al. 2011).

At Rauchkofel Boden the Zone is detected in the narrow interval of sample 323/1 by the entry of the index taxon (Fig. 4).

5.8 *Kockelella crassa* Zone, Walliser (1964)

The *K. crassa* Zone corresponds to the interval of the total range of the marker *K. crassa* (Corradini and Serpagli 1999). The base of this Zone coincides with the base of the Ludlow series (Cramer *et al*. 2011).

In the Rauchkofel Boden Section the Zone is discriminated in a 40 cm interval in the central part of the Kok Fm., from sample 313/3 to 314 (Fig. 4). *Kockelella v. variabilis* Walliser enters within the Zone, and *Coryssognathus dubius* (Rhodes) in its upper part.

5.9 *Kockelella variabilis variabilis* Interval Zone, Cramer et al. (2011)

The *K. v. variabilis* Interval Zone corresponds to the interval between the LAD of *K. crassa* and the FAD of *Ancoradella ploeckensis* Walliser (Cramer et al. 2011).

In the Ranchkofel Boden Section it is recognized in the central-upper part of the Kok Fm. (Fig. 4). The lower boundary is marked by the last occurrence of *K. crassa* in sample 314, and the upper boundary is here detected by the entry of *Kockelella o. sardoa* Serpagli and Corradini in sample Y, because the index taxon *A. ploeckensis* is not present. *Wurmiella excavata* (Branson and Mehl) and *Belodella resima* (Philip) have their first occurrence in the lower part of the Zone.

5.10 *Ancoradella ploeckensis* Zone, Walliser (1964)

The *A. ploeckensis* Zone is defined as the interval between the FAD of *A. ploeckensis* and the FAD of *Polygnathoids siluricus* Branson and Mehl. However, as pointed out by other authors (i.e.: Corradini and Serpagli 1999; Slavík 2014), *A. ploeckensis* is a rare species, which has not been found also in the Rauchkofel Boden Section. The base of the Zone is here recognized by the entry of *Kockelella o. sardoa*, which has its FAD coincident with the FAD of *A. ploeckensis* (Serpagli and Corradini 1999).

The *A. ploeckensis* Zone is discriminated in the uppermost 90 cm of the Kok Fm. (Fig. 4). *Wurmiella inflata* Walliser occurs only in this Zone, whereas elsewhere it appears in older strata (Corradini and Serpagli 1999, Corriga *et al*. 2009). *Wurmiella? posthamata* Walliser has its only occurrence in samples 325 and X, both collected in the uppermost bed of the Kok Fm. *Kockelella v. ichnusae* Serpagli and Corradini and *Wurmiella* sp. A, characterized by an asymmetrical P1 element, enter in the upper part of the Zone, in the same level where *C. dubius* has its last occurrence.

5.11 *Polygnathoides siluricus* Zone, Walliser (1964)

This Zone corresponds to the interval of total range of *P. siluricus* and is one of the zones with widest distribution in the Silurian: it has been indicated in all published zonal schemes and everywhere its boundaries are defined on the same criteria.

In the Rauchkofel Boden Section this Zone is discriminated in the Cardiola Fm. and in the lower 50 cm of the Alticola Fm. (Fig. 5). The lower boundary is recognized by the entry of the marker *Polygnathoides siluricus*, and the upper boundary by the last occurrence of elements of the genus *Kockelella*. In fact, all the last representatives of this genus became extinct in the uppermost part of the zone (Serpagli and Corradini 1999, Slavík et al. 2010). Among them *Kockelella maenniki* Serpagli and Corradini occurs only within this Zone. *Ozarkodina confluens* (Branson and Mehl) enters in the central part of the Zone.

Within this Zone a few anomalous elements, represented mainly by ramiforms with branched processes, are present. Such specimens are documented in various intervals of the Silurian and Lower Devonian, but are particularly abundant in the *P. siluricus* Zone (e.g., Corradini et al. 1996, 2015a, 2016, Slavík et al. 2010, Corriga et al. 2014).

5.12 *Pedavis latialata–Ozarkodina snajdri* Interval Zone, Corradini et al. (2015a)

This Zone corresponds to the interval between the *Po. siluricus* and the *Oz. crispa* zones (Corradini et al. 2015a). For the reasons of defining the Zone by the two more representative taxa refer to Corradini et al. (2015a, p. 60).

At Rauchkofel Boden the Zone is discriminated in the lower part of the Alticola Fm. and is about 4 m thick. This interval documents the "Lau event" and the "post-Lau recovery", with an evolution of faunas similar to that documented in other nearby areas (i.e., Prague Synform, Slavík and Carls 2012): in the lower part of the Zone the conodont diversity is scarce, and the association is dominated by coniform elements (*Panderodus*, *Belodella* and *Dapsilodus*). *Pedavis latialata* (Walliser) enters in the upper part of the Zone, and *Oz*. cf. *snajdri* (Walliser) and *Wurmiella* sp. B occur in the upper part, only. The latter species is characterized by a distinct enlargement of the blade in the P1 element, just below the insertion of denticles.

5.13 *Ozarkodina crispa* Zone, Walliser (1964)

The *Oz. crispa* Zone corresponds to the interval of total range of *Oz. crispa* Walliser (Corradini and Serpagli 1999). At Rauchkofel Boden it is detected in a 1.5 m interval in the lower part of the Alticola Fm., around the upper edge of the steep slope (samples 81/27-2I; Fig. 5). *Pedavis latialata* became extinct within the Zone; *Panderodus recurvatus* has its last occurrence in the section at the top of the Zone, whereas it normally ranges longer in the upper Přídolí (Corradini and Corriga 2012).

5.14 *"Ozarkodina" eosteinhornensis* s.l. Interval Zone, Corriga and Corradini (2009)

The "*Oz.*" *eosteinhornensis* s.l. Interval Zone is defined as the interval between the last occurrence of *Oz. crispa* and the first occurrence of *Oulodus elegans detortus* (Walliser) (Corriga and Corradini 2009, Corradini and Corriga 2012). Conodonts are very rare in samples collected in the steep slope, and *O. e. detortus* enters only at a younger level. It appears therefore impossible to locate precisely the upper boundary of the "*Oz.*" *eosteinhornensis* s.l. Interval Zone, which is tentatively drawn a couple of meters below the "*Oz.* " *eosteinhornensis* s.s. horizon, in a position similar to other sections in the region, like the Cellon Section (Corradini et al. 2015a).

5.15 Lower *Oulodus elegans detortus* Zone, Corradini and Corriga (2012)

The lower boundary of the Lower *O. e. detortus* Zone is defined by the first occurrence of *O. e. detortus* and the upper boundary by the last occurrence of *Dapsilodus obliquicostatus* (Branson and Mehl) (Corradini and Corriga 2012).

In the Rauchkofel Boden Section the Zone has been discriminated along the lower part of the steep slope, but it not possible to precisely place its lower boundary. The index taxon *O. e. detortus* enters higher in the section, and other diagnostic taxa are missing. Therefore the base of the Zone is tentatively located about 2 m below the occurrence of *"Oz." eosteinhornensis* s.s. (Walliser), in a similar position than other sections in the Carnic Alps, like Cellon (Corradini et al. 2015). The upper boundary is placed just above sample 7 (Fig. 5), from where an incomplete specimen of *D. obliquicostatus* was collected.

Conodonts are very rare in this interval, and mainly represented by *W. excavata* and coniform elements. In the central part of the Zone *W. alternata* Corradini and Corriga and *"Oz." eosteinhornensis* s.s. are present: the latter taxon always marks a well defined horizon, that can be used for correlations (see discussion in Corradini and Corriga 2012, p. 647).

5.16 Upper *Oulodus elegans detortus* Zone, Corradini and Corriga (2012)

The Upper *O. e. detortus* Zone is the interval between the LAD of *Daps. obliquicostatus* and the FAD of *Icriodus hesperius* Klapper and Murphy (Corradini and Corriga 2012). At Rauchkofel Boden this Zone has been discriminated in the upper part of the Alticola Fm. (beds of samples 7X-200): its lower boundary is placed just above the last occurrence of the index taxon, and the upper boundary by the first occurrence of *Icriodus woschmidti* (Walliser), that has its FAD together with the marker (Corradini and Corriga 2012).

Anomalously *Oulodus el. elegans* (Walliser) and *Oul. el. detortus* occur only in the lower part of this Zone, and *Zieglerodina planilingua* (Murphy and Valenzuela-Ríos) enters within this Zone, whereas elsewhere in the Carnic Alps these taxa have their first occurrences in the middle Přídolí (*Oul.el. detortus* and *Z.planilingua*) or in the uppermost Ludlow (*Oul. el. elegans*) (Corradini and Corriga 2012, Corradini et al. 2015a). Also, *Zieglerodina zellmeri* Carls et al. that is documented in most of the Přídolí in the Carnic Alps (Corradini and Corriga 2010, 2012, Corradini et al. 2015a, Corriga et al. 2016) and in the lower part of the Series in Bohemia (Carls et al.2007) at Rauchkofel Boden occurs only in this Zone. These late first occurrences may be related to the scarcity of conodonts within the "steep slope" of the section, where the Alticola Fm. appears to have a more marly facies than the classical one of the unit.

In the upper part of the Zone the typical succession of events documented in other parts of the Carnic Alps (Corradini and Corriga 2010, 2012; Corradini et al. 2015; Corriga et al. 2016) occurs: last occurrence of *Oz. confluens* (Branson and Mehl) in sample 7Z, just followed by the entries of *Z. remscheidensis* (Ziegler) and *Z. eladioi* (Valenzuela-Rios) in sample 199, and by the last occurrence of *Z. zellmeri* (sample 7W).

5.17 *Icriodus hesperius* Zone, Corriga et al. (2016)

The *Icr. hesperius* Zone is discriminated in a very short interval, 40 cm thick, across the boundary between the Alticola and the Rauchkofel Fm. (Fig. 5). The lower boundary is defined by the FAD of *Icr. hesperius* Klapper and Murphy, and the upper boundary by the FAD of *Icr. postwoschmidti* Mashkova (Corriga et al. 2016). In the Rauchkofel Boden Section these two species are not present, therefore the lower and upper boundaries were detected by the entries of *Icr. woschmidti* (Walliser) and *Pandorinellina optima* (Moskalenko), respectively: in many sections *Icr. woschmidti* enters at the same level of *Icr. hesperius* (Corradini and Corriga 2012).

Ziegerodina sp. A Corriga et al. 2016, characterized by an alternate denticulation (Pl. 3, Fig. 3), occurs in this Zone.

5.18 *Icriodus postwoschmidti* Zone, Corriga et al. (2016)

The *I. postwoschmidti* Zone is defined as the interval between the FAD of *Icr. postwoschmidti* and the FAD of *Ancyrodelloides carlsi* (Boersma). As *Icr. postwoschmidti* was not recovered in the Rauchkofel Boden Section, the lower boundary is tentatively aligned with the entry of *Pandorinellina optima*, that has been already used as zonal index in the lower Lochkovian of Bohemia (Slavík et al. 2012). However, the alignment of the FAD of *Pand. optima* with the FAD of *Icr. postwoschmidti* is still to be demonstrated. A new, more precise zonation for the upper part of the lower Lochkovian should be developed in the near future.

The *I. postwoschmidti* Zone is tentatively suggested in a 80 cm thick interval in the lower part of the Rauchkofel Fm. (Fig. 5). *Lanea omoalpha* Murphy and Valenzuela-Ríos enters within the Zone.

5.19 *Ancyrodelloides carlsi* Zone, Corradini and Corriga (2012)

The *Ad. carlsi* Zone is defined as the interval between the FAD of *Ad. carlsi* and the FAD of *Ad. transitans* (Bischoff and Sannemann) (Corradini and Corriga 2012). Slavík (2011), Corradini and

Corriga (2012) and Slavík et al. (2012) proposed the entry of the index taxon to be used to define the base of the middle Lochkovian.

At the Rauchkofel Boden Section the Zone is discriminated in the upper part of the Rauchkofel Fm. and in the lowermost part of the La Valute Fm. (Figs 5-6). *"Ozarkodina" malladai* Valenzuela-Ríos enters in the upper part of the Zone, just above the last occurrence of *Z. planilingua.*

5.20 *Ancyrodelloides transitans* Zone, Valenzuela-Ríos (1994)

The *Ad. transitans* Zone is defined as the interval between the FAD of *Ad. transitans* and the FAD of *Ad. trigonicus* Bischoff and Sannemann, and includes the *Ad. transitans* and *L. eleanorae* zones by Corradini and Corriga (2012). The latter taxon in fact was reported before the entry of *Ad. transitans* in the Pyrenees (Valenzuela-Ríos et al. 2015) and cannot be used for correlations.

In the Rauchkofel Boden Section the Zone occurs in the lower part of the La Valute Fm., in a 2 m interval between samples 208 and 211 (Fig. 6). The lower boundary is discriminated in sample 208 by the entry of *Flajsella schulzei* (Bardashev), that has its FAD in the lower part of the Zone (Valenzuela-Ríos et al. 2015), whereas *Ad. trigonicus* enters 30 cm higher in sample 209. *Flajsella stygia* Flajs, *Lanea telleri* (Schulze) and *Wurmiella wurmi* (Bischoff and Sannemann) enter within the Zone.

5.21 *Ancyrodelloides trigonicus* Zone, Valenzuela-Ríos and Murphy (1997)

The *Ad. trigonicus* Zone includes strata between the FAD of *Ad. trigonicus* and the FAD of *Masaraella pandora* β (Murphy, Matti and Walliser) (Corradini and Corriga 2012). The Zone is widely used worldwide: beside the Carnic Alps (i.e., Corriga et al. 2011) it is detected in Bohemia (Slavík et al. 2012), Nevada and Pyrenees (Valenzuela-Ríos and Murphy 1997), and Sardinia (Corriga 2011). Recently Valenzuela-Ríos et al. (2015) subdivided the Zone, discriminating in the upper part an interval characterized by *Ancyrodelloides kutscheri* Bischoff and Sannemann. However, this taxon is always a minor component of the conodont association and up to now has not been documented in the Carnic Alps. Therefore it looks hardly significant for long distance correlations.

In the Rauchkofel Boden Section the Zone is discriminated in a 6 m interval from samples 212 to 222, and corresponds to the range interval of the marker *Ad. trigonicus* (Fig. 6). Several species occur only within this interval: *Fl. sigmostygia* Valenzuela-Ríos and Murphy, *Fl. streptostygia* Valenzuela-Ríos and Murphy, *Kimognathus delta* (Murphy and Matti) and *K. limbacarinatus* (Murphy and Matti). All the late taxa of the genera *Ancyrodelloides*, *Lanea* and *Flajsella* became extinct within this Zone, as well as *Z. remschiedensis* and *Z. eladioi*.

5.22 *Masaraella pandora* β Zone, Valenzuela-Ríos (1994)

The upper and lower boundaries of the Zone are defined by the FADs of *Masaraella pandora* β and *Pedavis gilberti* Valenzuela-Ríos, respectively (Valenzuela-Ríos 1994). The base of the Zone indicated the base of the upper Lochkovian (Valenzuela-Ríos et al. 2015).

The Zone is detected in the upper part of the La Valute Fm., and is 3.2 m thick (Fig. 6). Because the index taxon is missing, the lower boundary is recognized by the last occurrence of *Ad. trigonicus*, which in the Carnic Alps has its LAD just below the entry of *M. pandora* β (Corradini and Corriga 2012). In this Zone the conodont abundance is lower than in the strata below. A single specimen of *Pedavis robertoi* Valenzuela-Ríos was collected from sample 224a, and the younger representatives of the genus *Zieglerodina* occur in the upper part of the Zone.

5.23 *Pedavis gilberti* Zone, Slavík et al. (2012)

The *P. gilberti* Zone, defined as the interval between the FAD of the index taxon, *P. gilberti*, and the FAD of *Icr. steinachensis* β Al Rawi, represents the uppermost part of the Lochkovian (Slavík et al. 2012).

The Zone is documented in the Rauchkofel Boden Section in the uppermost part of the La Valute Fm. by the occurrence of a single specimen of *P. gilberti* recovered in sample 224d. The conodont association is very scarce in this interval, and mainly represented by long-ranging taxa, therefore the upper boundary is approximatively placed just below the first evidence of the Pragian tentaculite *Nowakia acuaria*, documented by Schönlaub (1980) in the bed of sample 227, within the lithostratigraphic gradual transition between the La Valute and Findenig formations.

5.24 *Icriodus steinachensis* β Zone, Slavík (2004)

The lower and upper boundary of the Zone are defined by the FADs of *Icr. steinachensis* β and *Pel. serratus* Jentzsch, respectively. Slavík (2004) introduced a "*steinachensis* Zone" on the basis of the first occurrence of *Icr. steinachensis* η-morph to discriminate the earliest Pragian beds in Bohemia. Later Slavík et al. (2007) modified the definition of the base of the Zone with the entry of *Icr. steinachensis* β-morph, because it has been documented at the same level as the entry of *Eognathodus sulcatus* (Philip), the index taxon for the base of the Pragian.

In the Rauchkofel Boden Section the Zone is discriminated in the lower part of the Findenig Fm. (Fig. 6). Conodonts are very scarce in this interval, and many samples are barren. The lower boundary is indirectly placed by the entry of *Nowakia acuaria*, and the upper boundary by the first occurrence of *Pel. serratus*. A few poorly preserved specimens possibly attributed to *Icr. steinachensis* have been collected in the upper part of the Zone from sample 234-236.

5.25 *Pelekysgnathus serratus* Zone, Slavík (2004)

The *Pel. serratus* Zone is "determined by the first and last occurrence of taxa belonging of the *Pelekysgnathus serratus* group" (Slavík 2004, p. 62).

At Rauchkofel Boden it is discriminated in the uppermost part of the section, by the entry of *Pel. s. serratus* in sample 237. *Belodella devonica* is the only other conodont taxon occurring in this Zone.

6. Chronostratigraphy

As reported above, the Rauchkofel Boden Section exposes an almost continuous sequence from the Katian (Upper Ordovician) to the Pragian (Lower Devonian), and therefore contains several chronostratigraphic boundaries. The conodont fauna allows to locate, or approximate, these boundaries, even if many of them are defined by the FAD of a graptolite species:

- the Ordovician/Silurian boundary is drawn between the Wolayer Fm. and the Kok Fm. It should be noted that a large hiatus is present, corresponding to part or the whole Hirnantian and Llandovery.
- the Sheinwoodian/Homerian boundary can be traced in the lowermost part of the *Oz. s. sagitta* Zone, about 80 cm above the base of the Kok Fm. The index taxon for the base of the Homerian is the graptolite *Cyrtograptus lundgreni* Tullberg, and its FAD is correlated with the lowermost part of the *Oz. s. sagitta* Zone (Corradini and Serpagli 1999, Cramer et al. 2011, Melchin et al. 2012).
- the Wenlock/Ludlow boundary (= Homerian/Gorstian boundary) is placed 1.55 m above the base of the Kok Fm., where *K. crassa* is found in sample 313/3. The base of the *K. crassa* Zone is aligned with the FAD of *Neodiversograptus nilssoni* (Lapworth), the index taxon for the base of the Gorstian stage (Melchin et al. 2012).
- the Gorstian/Ludfordian boundary can be tentatively traced at the base of the *A. ploeckensis* Zone, about 85 cm below the top of the Kok Fm. The boundary is defined by the FAD of the

graptolite *Saetograptus lentwardinensis* (Hopkinson). According to Cramer et al. (2011, p.194) "the position of the base of the *A. ploeckensis* conodont Zone with respect to the base of the *Sa. leintwardinensis/Sa. linearis* graptolite Zone, and the position of the base of either of these biozones with respect to the base Ludfordian GSSP remains uncertain and these three positions are tentatively correlated at the same level here".

- the Ludlow/Přídolí boundary can be tentatively located in the lower part of the Alticola Fm., in the uppermost part of the steep slope, in the upper part of the range of *Oz. crispa*. In the Cellon Section, the index graptolite species *Neocolonograptus parultimus* Jaeger, occurs slightly below the upper boundary of the *Oz. crispa* conodont Zone (Corradini et al. 2015a).

- the Silurian/Devonian boundary occurs in the uppermost part of the Alticola Fm., at level of sample 201, where the conodont *Icr. woschmidti* first appears. The base of the Devonian is defined by the FAD of the graptolite *Monograptus uniformis* Pribyl, and the conodont taxon "with wide distribution that appears closest to the Lower Devonian boundary" is *Icr. hesperius* (Carls et al. 2007, p. 157-158). In the Carnic Alps at places *Icr. woschmidti* enters together with *Icr. hesperius* (i.e., Monte Cocco II section, Corriga and Corradini 2009), whereas elsewhere it enters a few centimetres above (i.e., 10 cm in the Cellon Section, Corradini et al. 2015, Corriga et al. 2016), and therefore its entry is a good tool to precisely approximate the boundary.

- the Lochkovian/Pragian boundary is defined by the FAD of the conodont *Eognathodus sulcatus* in the Velka Chuchle Section (Czech Republic), but recent taxonomic revisions demonstrate that the FAD of the taxon is no more aligned with the GSSP (Slavík and Hladil 2004). Slavík (2004) indicates that the boundary can be detected by the entry of *Icriodus steinachensis* and this level was used to locate the base of the Pragian in the nearby Seekopf Section (Suttner 2007). In the Rauchkofel Boden Section conodonts are very scarce in the boundary interval and no diagnostic taxa have been recovered. Therefore the base of the Pragian is approximately traced around the transition from the La Valute Fm. to the Findenig Fm., where the dacryioconarid *Nowakia acuaria* is reported at level of sample 227 (Schönlaub 1980; Alberti 1985). However, this datum differs from other areas in the Carnic Alps (i.e., Mt. Zermula area), where the transition between the two formations is dated to the uppermost Lochkovian by conodonts (Corriga et al. 2011, Pondrelli et al. 2015, Corradini et al. 2016).

7. Conclusions

The main results of this paper can be summarized as follows:

- the conodont association from the Rauchkofel Boden Section has been revised. Ninety-seven taxa (species and subspecies) were recognized.
- the conodont fauna allows the discrimination of 25 biozones, from the Katian (Upper Ordovician) to the Pragian (Lower Devonian).
- in terms of chronostratigraphy, all the Silurian and two Lower Devonian stage boundaries have been located in the section. However, the Llandovery series is completely missing, and possibly the upper Hirnantian strata, too.
- the lithostratigraphy of the section has been updated according to the new lithostratigraphic scheme of the Carnic Alps.

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Figures and Plates

Fig. 1 - Location map of the Rauchkofel Boden Section.

Fig. 2 - Chronostratigraphy and lithostratigraphy of the Rauchkofel Boden section. Stratigraphic log modified after Schönlaub (1980). Lines on the right side of the log indicate the parts of the section illustrated in Figs 3-6.

Fig.3 - Selected views of the Rauchkofel Boden Section. A) Lower part of the section from the upper part of the Wolayer Fm. to the lower part of the Alticola Fm. B) Orthoceras limestone in the uppermost bed of the Kok Fm. C) The transition between the Wolayer and the Kok formations. D) Encrinitic limestone in the Wolayer Fm. E) Panoramic view of the upper part of the section from above the steep cliff. F) The steep cliff with the Přídolí part of the Alticola Fm., and the Rauchkofel (covered) and the lower part of the La Valute formations. G) Well bedded light gray limestone in the lower part of the La Valute Fm. H) View of the upper part of the section, with the transition between the La Valute and Findenig formations.

Fig. 4 - Distribution of conodonts in the lower part (Wolayer and Kok formations) of the Rauchkofel Boden Section. From left to right: system, series, stage, formation, lithological log, samples, sample number, distribution of taxa (white dots indicate taxa identified with question), zones. Arrows at the end of distribution lines indicate that the taxon also occurs above/below the illustrated interval. Horizontal lines mark boundaries of chrono-/litho-/biostratigraphical units. For graphical reason not all the sample numbers are reported. Abbreviations: Card.=Cardiola;

Hirn.=Hirnantian; Ordov.=Ordovician; *abs*.=*absidata*; *bohem*.=*bohemica*; *ranulif*.=*ranuliformis*; *amorph*.=*amorphognathoides*.

Fig. 5 - Distribution of conodonts in the central part (Cardiola, Alticola and Rauchkofel formations) of the Rauchkofel Boden Section. From left to right: system, series, stage, formation, lithological log (modified after Schönlaub 1980), samples, sample number, distribution of taxa (white dots indicate taxa identified with question), zones. Arrows at the end of distribution lines indicate that the taxon also occurs above/below the illustrated interval. Horizontal lines mark boundaries of chrono-/litho-/biostratigraphical units. For graphical reason not all the sample numbers are reported. Abbreviations: Card.=Cardiola; L.V.=La Valute; *postwosch*.=*postwoschmidti*; *eosteinhorn*.=*eosteinhornensis*; *ploeck*.=*ploeckensis*.

Fig. 6 - Distribution of conodonts in the upper part (La Valute and Findenig formations) of the Rauchkofel Boden Section. From left to right: system, series, stage, formation, lithological log (modified after Schönlaub 1980), samples, sample number, distribution of taxa (white dots indicate taxa identified with question), zones. Arrows at the end of distribution lines indicate that the taxon also occurs above/below the illustrated interval. Horizontal lines mark boundaries of chrono-/litho-/biostratigraphical units. For graphical reason not all the sample numbers are reported. Abbreviations: RK.=Rauchkofel; *steinachens*.=*steinachensis*.

Plate 1

Selected Ordovician conodonts from the Rauchkofel Boden Section. All from the *Am. ordovicicus* Zone.

1-7. *Amorphognathus* sp. 1: upper view of Pa element IPUM 27544, sample 309 top, refigured after Ferretti and Schönlaub (2001); 2: lateral view of Pb element IPUM 29023, sample 309; 3: lateral view of Pb element IPUM 29024, sample 309 top; 4: lateral view of Sa element IPUM 27549, sample 309 top, refigured after Ferretti and Schönlaub (2001); 5: lateral view of Sb element IPUM 27547, sample 309 top, refigured after Ferretti and Schönlaub (2001); 6: lateral view of Sc element IPUM 27548, sample 309 top, refigured after Ferretti and Schönlaub (2001); 7: lateral view of Sd element IPUM 27550, sample 309 top, refigured after Ferretti and Schönlaub (2001).

8-9. *Amorphognathus ordovicicus* Branson and Mehl, 1933b. 8: posterior view of M element IPUM 29025, contact sample 309/Silurian; 9: posterior view of M element IPUM 27551, sample 309, refigured after Ferretti and Schönlaub (2001).

10. *Amorphognathus duftonus* Rhodes, 1955; postero-lateral view of element IPUM 29026, sample 309/Silurian.

11-14. *Hamarodus brevirameus* (Walliser, 1964). 11: lateral view of M element IPUM 29027, contact sample 309 top/Silurian; 12: lateral view of Pb element IPUM 29028, sample 309 top; 13: lateral view of Sa element IPUM 29029, contact sample 309 top/Silurian; 14: lateral view of Sc element IPUM 29030, contact sample 309 top/Silurian.

15. *Panderodus gracilis* (Branson and Mehl, 1933b); element IPUM 29031, contact sample 309 top/Silurian.

16. ?*Drepanodus* sp., element IPUM 29032, contact sample 309 top/Silurian.

17. *Pseudooneotodus* sp., upper view of element IPUM 29033, contact sample 309 top/Silurian.

18. *Decoriconus costulatus* (Rexroad, 1967); element IPUM 29034, contact sample 309 top/Silurian.

19. *Dapsilodus mutatus* (Branson and Mehl, 1933b); element IPUM 29035, sample 309 top.

20. *Birksfeldia* sp.; lateral view of Sb element IPUM 29036, contact sample 309 top/Silurian.

21. *Eocarniodus gracilis* (Rhodes, 1955); element IPUM 29037, contact sample 309 top/Silurian.

22. *Scabbardella altipes* (Henningsmoen, 1948), element IPUM 29038, sample 309 top.

23-25. *Walliserodus amplissimus* (Serpagli, 1967); elements IPUM 29039-29041, contact sample 309 top/Silurian (IPUM 29039-29040) and sample 309 top (IPUM 29041).

26-27. *Plectodina alpina* (Serpagli, 1967). 26: inner lateral view of Pb element IPUM 27561, sample 309 top refigured after Ferretti and Schönlaub (2001); 27: lateral view of Pa element IPUM 29042, contact sample 309 top/Silurian.

Plate 2

Selected Silurian conodonts from the Rauchkofel Boden Section.

1. *Ozarkodina sagitta rhenana* (Walliser, 1964); upper view of P1 element 2016/014/0045, sample 313, *Oz. s. sagitta* Zone. Refigured after Schönlaub (1980).

2. *Zieglerodina remscheidensis* (Ziegler, 1960); lateral view of P1 element MDLCA 30384, sample 7A, Upper *Oul. el. detortus* Zone.

3. *Wurmiella excavata* (Branson and Mehl, 1933a); lateral view of P1 element MDLCA 30385, sample 6, Lower *Oul. el. detortus* Zone.

4. *Ozarkodina sagitta sagitta* (Walliser, 1964); upper view of P1 element MDLCA 30386, sample K, *Oz. s. sagitta* Zone.

5. *"Ozarkodina" eosteinhornensis* s.s. (Walliser, 1964); upper view of P1 element MDLCA 30387, sample 4A, Lower *Oul. el. detortus* Zone.

6. *Pterospathodus pennatus procerus* Walliser, 1964; upper view of P1 element MDLCA 30388, sample O/S, *Pt. am. amorphognathoides* Zone.

7. *Polygnathoides siluricus* Branson and Mehl, 1933a; upper view of P1 element MDLCA 30389, sample 2, *P. siluricus* Zone.

8. *Kockelella variabilis ichnusae* Serpagli and Corradini, 1998; upper view of P1 element MDLCA 30390, sample 2003-22, *A. ploeckensis* Zone.

9. *Pterospathodus amorphognathoides amorphognathoides* Walliser, 1964; upper view of P1 element MDLCA 30391, sample O/S, *Pt. am. amorphognathoides* Zone.

10. *Kockelella variabilis variabilis* Walliser, 1957; upper view of P1 element MDLCA 30392, sample 324, *A. ploeckensis* Zone.

11. *Dapsilodus obliquicostatus* (Branson and Mehl, 1933a); lateral view of element MDLCA 30393, sample K, *Oz. s. sagitta* Zone.

12. *Pseudooneotodus linguicornis* Jeppsson, 2003 (in Calner and Jeppsson, 2003); lateral view of element MDLCA 30394, sample K, *Oz. s. sagitta* Zone.

13. *Wurmiella? posthamata* (Walliser, 1964); upper view of P1 element MDLCA 30395, sample X, *A. ploeckensis* Zone.

14. *Kockelella maenniki* Serpagli and Corradini, 1998; upper view of P1 element MDLCA 30396, sample 2, *P.siluricus* Zone.

15. *Wurmiella* sp. A; lateral view of P1 element MDLCA 30397, sample 3X, *Oz. snajdri-Pe. latialata* interval Zone.

16. *Ozarkodina crispa* (Walliser, 1964); upper view of P1 element MDLCA 30398, sample 2F, *Oz. crispa* Zone.

17. Anomalous element with a branched process; lateral view of element MLCDA 30399, sample RKB 2, *P.siluricus* Zone.

18. *Kockelella ortus absidata* Barrick and Klapper, 1976; lateral view of P1 element MDLCA 30400, sample 2003-22, *A. ploeckensis* Zone.

19. *Pedavis latialata* (Walliser, 1964); upper view of P1 element MDLCA 30401, sample 2F, *Oz. snajdri-Pe. latialata* interval Zone.

20. *Kockelella crassa* (Walliser, 1964); upper view of P1 element MDLCA 30402, sample 323-2, *K. crassa* Zone.

21. *Kockelella* sp.; upper view of P1 element MDLCA 30403, sample 324, *A. ploeckensis* Zone.

Plate 3

Selected Devonian conodonts from the Rauchkofel Boden Section.

1. *"Ozarkodina" malladai* Valenzuela-Rios, 1994; lateral view of P1 element MDLCA 30404, sample RKB 10, *Ad. transitans* Zone.

2. *Zieglerodina eladioi* (Valenzuela-Rios, 1994); lateral view of P1 element MDLCA 30405, sample RKB 11, *Ad. trigonicus* Zone.

3. *Zieglerodina* sp. A Corriga et al., 2016; lateral view of P1 element MDLCA 30406, sample 7A, *Icr. hesperius* Zone.

4. *Flajsella schulzei* (Bardashev, 1989); upper view of P1 element MDLCA 30407, sample 11, *Ad. trigonicus* Zone.

5. *Flajsella stygia* (Flajs, 1967); upper view of P1 element MDLCA 30408, sample 11, *Ad. trigonicus* Zone.

6. *Flajsella stygia* (Flajs, 1967); upper view of P1 element 2016/014/0024, sample 213, *Ad. trigonicus* Zone. Refigured after Schönlaub (1980).

7. *Icriodus woschmidti* Walliser, 1964; upper view of P1 element 2016/014/0064, sample 201, *Icr. hesperius* Zone. Refigured after Schönlaub (1980).

8. *Ancyrodelloides asymmetricus* (Bischoff and Sannemann, 1958); upper view of P1 element 2016/014/0082, sample 220, *Ad. trigonicus* Zone. Refigured after Schönlaub (1980).

9. *Pandorinellina optima* (Moskalenko, 1966); lateral view of P1 element 2016/014/0069, sample 201D, *Icr. postwoschmidti* Zone. Refigured after Schönlaub (1980).

10. *Kimognathus delta* (Klapper and Murphy, 1980); upper view of P1 element 2016/014/0078, sample 218, *Ad. trigonicus* Zone. Refigured after Schönlaub (1980).

11. *Pedavis gilberti* Valenzuela-Rios, 1994; upper view of P1 element 2016/014/0088, sample 224d, *Pe. gilberti* Zone. Refigured after Schönlaub (1980).

12. *Ancyrodelloides carlsi* (Boersma, 1973); upper view of P1 element 2016/014/0070, sample RKB 201G, *Ad. carlsi* Zone. Refigured after Schönlaub (1980).

13. *Ancyrodelloides* cf. *transitans* (Bischoff and Sannemann, 1958); upper view of P1 element MDLCA 30409, sample RKB 13, *Ad. trigonicus* Zone.

14. *Ancyrodelloides transitans* (Bischoff and Sannemann, 1958); upper view of P1 element MDLCA 30410, sample 13, *Ad. trigonicus* Zone.

15. *Zieglerodina* sp.; lateral view of P1 element 2016/014/0001, sample 204, *Ad. carlsi* Zone. Refigured after Schönlaub (1980).

16. *Pedavis* sp.; lateral view of coniform element 2016/014/0025, sample 213, *Ad. trigonicus* Zone. Refigured after Schönlaub (1980).

17. *Pseudooneotodus beckmanni* (Bischoff and Sannemann, 1958); upper view of element MDLCA 30411, sample 13, *Ad. trigonicus* Zone.

18. *Lanea telleri* (Schulze, 1968); upper view of P1element 2016/014/0033, sample 216, *Ad. trigonicus* Zone. Refigured after Schönlaub (1980).

19. *Pelekysgnathus serratus serratus* Jentzsch, 1962; lateral view of P1 element no. 2016/014/0013, sample 237, *Pe. serratus* Zone. Refigured after Schönlaub (1980).

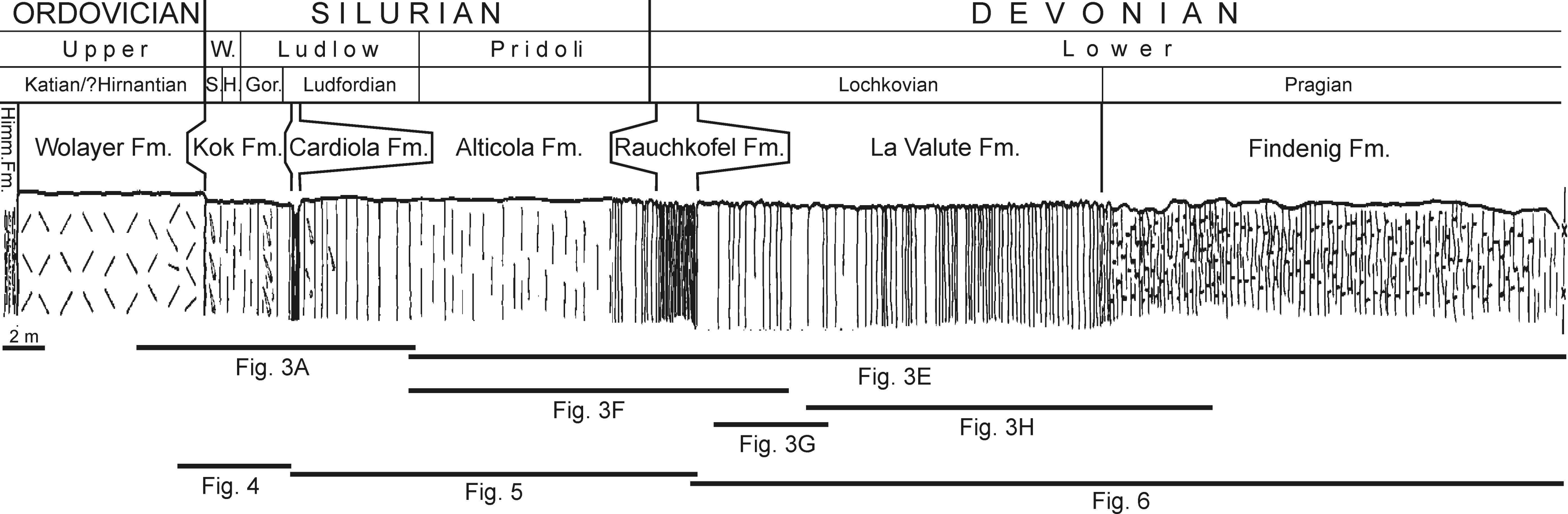
20. *Lanea omoalpha* Murphy and Valenzuela-Rios, 1999; upper view of P1 element MDLCA 30412, sample 9, *Ad. transitans* Zone.

21. *Ancyrodelloides trigonicus* (Bischoff and Sannemann, 1958); upper view of P1 element 2016/014/0084, sample 222, *Ad. trigonicus* Zone. Refigured after Schönlaub (1980).

22. *Wurmiella wurmi* (Bischoff and Sannemann, 1958); lateral view of P1 element MDLCA 30413, sample 10, *Ad. transitans* Zone.

23. *Pedavis robertoi* Valenzuela-Rios, 1994; upper view of P1 element 2016/014/0085, sample 224a, *M. pandora* β Zone. Refigured after Schönlaub (1980).

Wolayer Lake
2780
M. Coglians
(Hohe Warte)
Pso di M. Croce Carnico
(Plockenpass)
Koderhohe
2228
AUSTRIA
Hermagor
Timau
2198
Cuestalta
(Hoher Trieb)
Passo di Pramollo
(Nassfeld)
Osternig
2228
0
5km
M. Zermula
2143
1941
M. Cocco
Paluzza
Paularo
A
I
ITALY
Pontebba
Ugovizza
RAUCHKOFEL
2158
2460
436
P
L
*
2238
436
Valentin-Törl
403
403
Ed.-Pichl-Htt.
1959
Bimbaumer
Törl
Wolayer See
1951
2109
CIMA LASTRONS DEL LAGO
SEEWARTE
2595
2554
2147
Pso Volaia
Wolayer P
Rif. Lambertenghi
Romanin
1955
M. COGLIANS
HOHE WARTE
2780
2492
144
1900
500 m


ORDOVICIAN
SILURIAN
DEVONIAN
Upper
W.
Ludlow
Pridoli
Lower
Katian/?Hirnantian
S.
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Ludfordian
Lochkovian
Pragian
Himm.Fm.
Wolayer Fm.
Kok Fm.
Cardiola Fm.
Alticola Fm.
Rauchkofel Fm.
La Valute Fm.
Findenig Fm.
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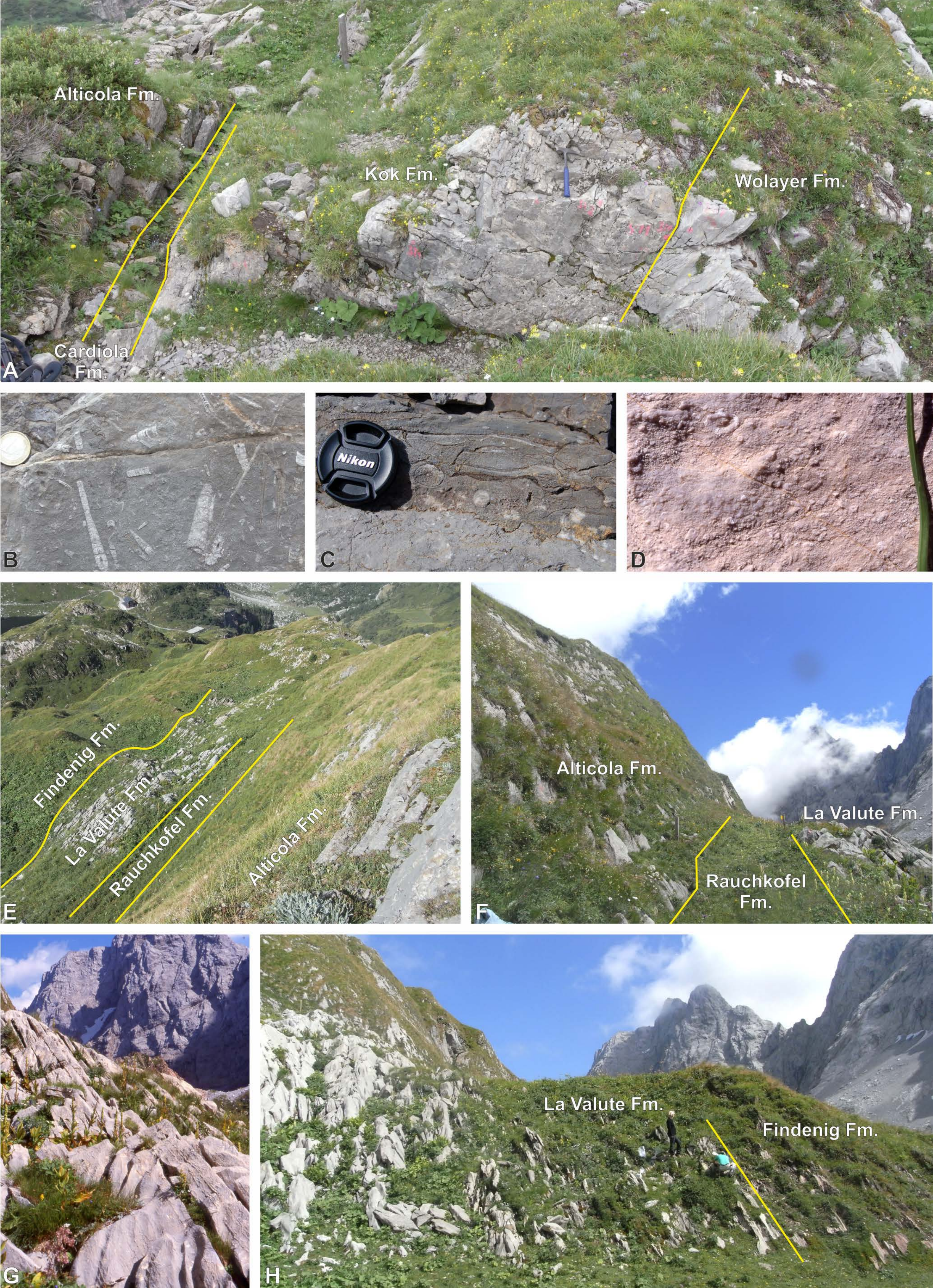
Fig. 3A
Fig. 3E
Fig. 3F
Fig. 3H
Fig. 3G
Fig. 4
Fig. 5
Fig. 6



Alticola Fm.
Kok Fm.
Wolayer Fm.
Cardiola Fm.
A
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D
Findenig Fm.
La Valute Fm.
Rauchkofel Fm.
Alticola Fm.
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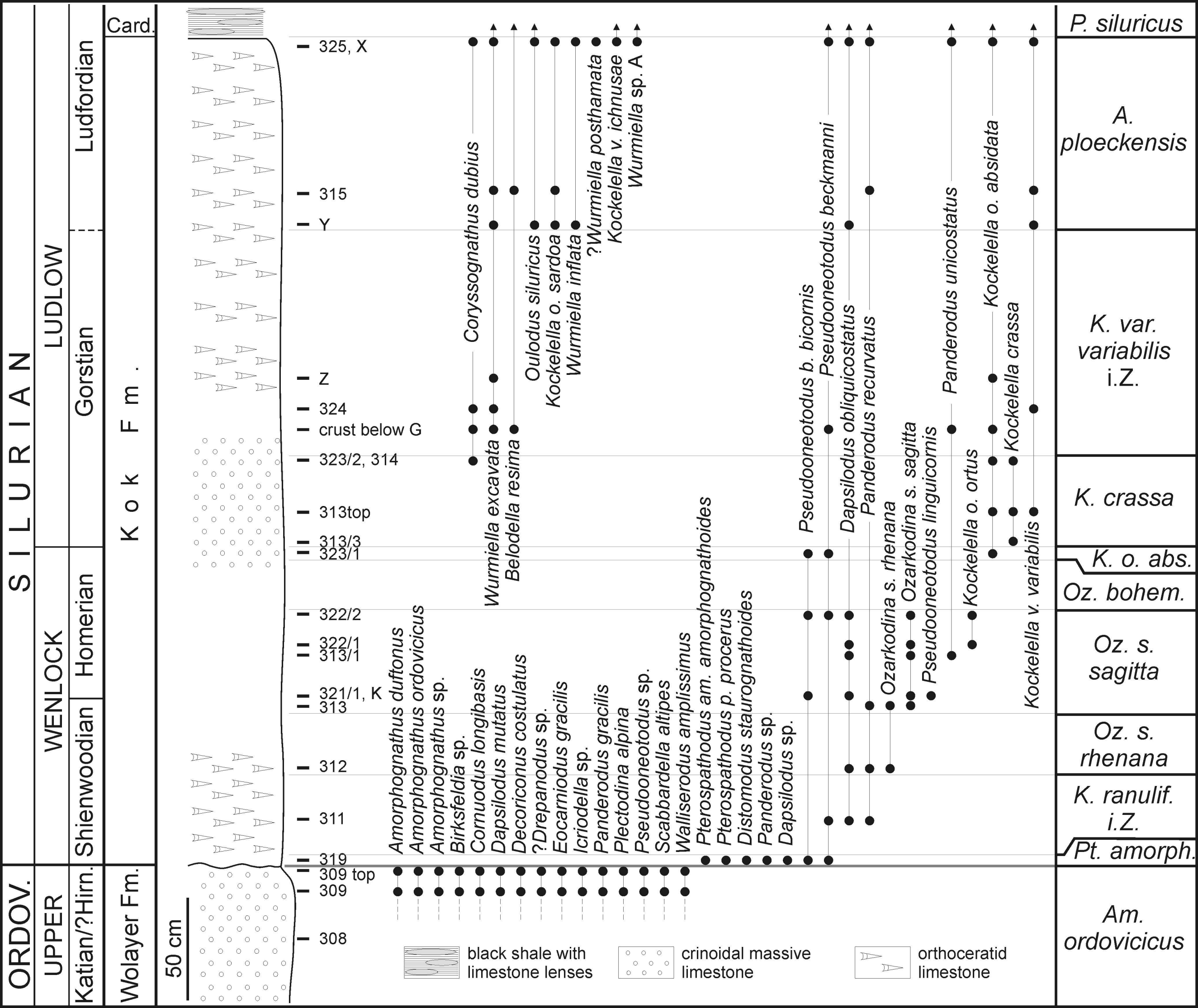
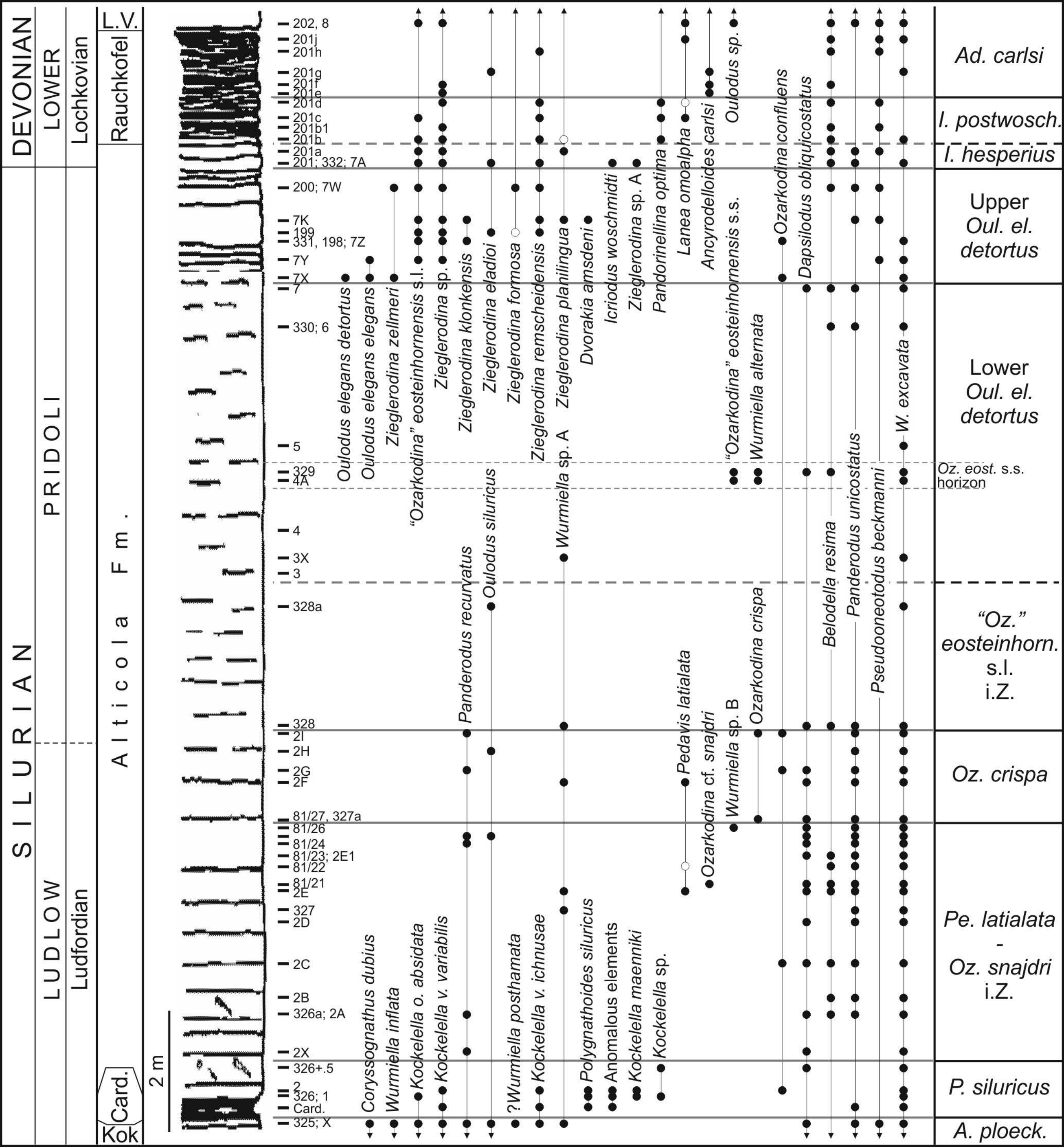
Findenig Fm.
H


SILURIAN
ORDOV.
LUDLOW
WENLOCK
UPPER
Ludfordian
Gorstian
Homerian
Shienwoodian
Katian/?Hirn.
Card.
Kok Fm.
Wolayer Fm.
50 cm
325, X
315
Y
Z
324
crust below G
323/2, 314
313top
313/3
323/1
322/2
322/1
313/1
321/1, K
313
312
311
319
309 top
309
308
Coryssognathus dubius
Wurmiella excavata
Belodella resima
Oulodus siluricus
Kockelella o. sardoa
Wurmiella inflata
?Wurmiella posthamata
Kockelella v. ichnusae
Wurmiella sp. A
Pseudooneotodus b. bicornis
Pseudooneotodus beckmanni
Dapsilodus obliquicostatus
Panderodus recurvatus
Ozarkodina s. rhenana
Ozarkodina s. sagitta
Pseudooneotodus linguicornis
Panderodus unicostatus
Kockelella o. ortus
Kockelella o. absidata
Kockelella crassa
Kockelella v. variabilis
Amorphognathus duftonus
Amorphognathus ordovicicus
Amorphognathus sp.
Birksfeldia sp.
Cornuodus longibasis
Dapsilodus mutatus
Decoriconus costulatus
?Drepanodus sp.
Eocarniodus gracilis
Icriodella sp.
Panderodus gracilis
Plectodina alpina
Pseudooneotodus sp.
Scabbardella altipes
Walliserodus amplissimus
Pterospathodus am. amorphognathoides
Pterospathodus p. procerus
Distomodus staurognathoides
Panderodus sp.
Dapsilodus sp.
P. siluricus
A. ploeckensis
K. var. variabilis i.Z.
K. crassa
K. o. abs.
Oz. bohem.
Oz. s. sagitta
Oz. s. rhenana
K. ranulif. i.Z.
Pt. amorph.
Am. ordovicicus
black shale with limestone lenses
crinoidal massive limestone
orthoceratid limestone



DEVONIAN
LOWER
Lochkovian
Rauchkofel
L.V.
SILURIAN
PRIDOLI
LUDLOW
Ludfordian
Alticola Fm.
Card.
Kok
2 m
Ad. carlsi
I. postwosch.
I. hesperius
Upper Oul. el. detortus
Lower Oul. el. detortus
Oz. eost. s.s. horizon
"Oz." eosteinhorn. s.l. i.Z.
Oz. crispa
Pe. latialata - Oz. snajdri i.Z.
P. siluricus
A. ploeck.
Oulodus elegans detortus
Oulodus elegans elegans
Zieglerodina zellmeri
"Ozarkodina" eosteinhornensis s.l.
Zieglerodina sp.
Zieglerodina klonkensis
Zieglerodina eladioi
Zieglerodina formosa
Zieglerodina remscheidensis
Zieglerodina planilingua
Dvorakia amsdeni
Icriodus woschmidti
Zieglerodina sp. A
Pandorinellina optima
Lanea omoalpha
Ancyrodelloides carlsi
Oulodus sp.
"Ozarkodina" eosteinhornensis s.s.
Wurmiella alternata
Ozarkodina confluens
Dapsilodus obliquicostatus
Panderodus recurvatus
Oulodus siluricus
Wurmiella sp. A
Pedavis latialata
Ozarkodina cf. snajdri
Wurmiella sp. B
Ozarkodina crispa
Belodella resima
Panderodus unicostatus
Pseudooneotodus beckmanni
W. excavata
Coryssognathus dubius
Wurmiella inflata
Kockelella o. absidata
Kockelella v. variabilis
?Wurmiella posthamata
Kockelella v. ichnusae
Polygnathoides siluricus
Anomalous elements
Kockelella maenniki
Kockelella sp.
202, 8
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81/27, 327a
81/26
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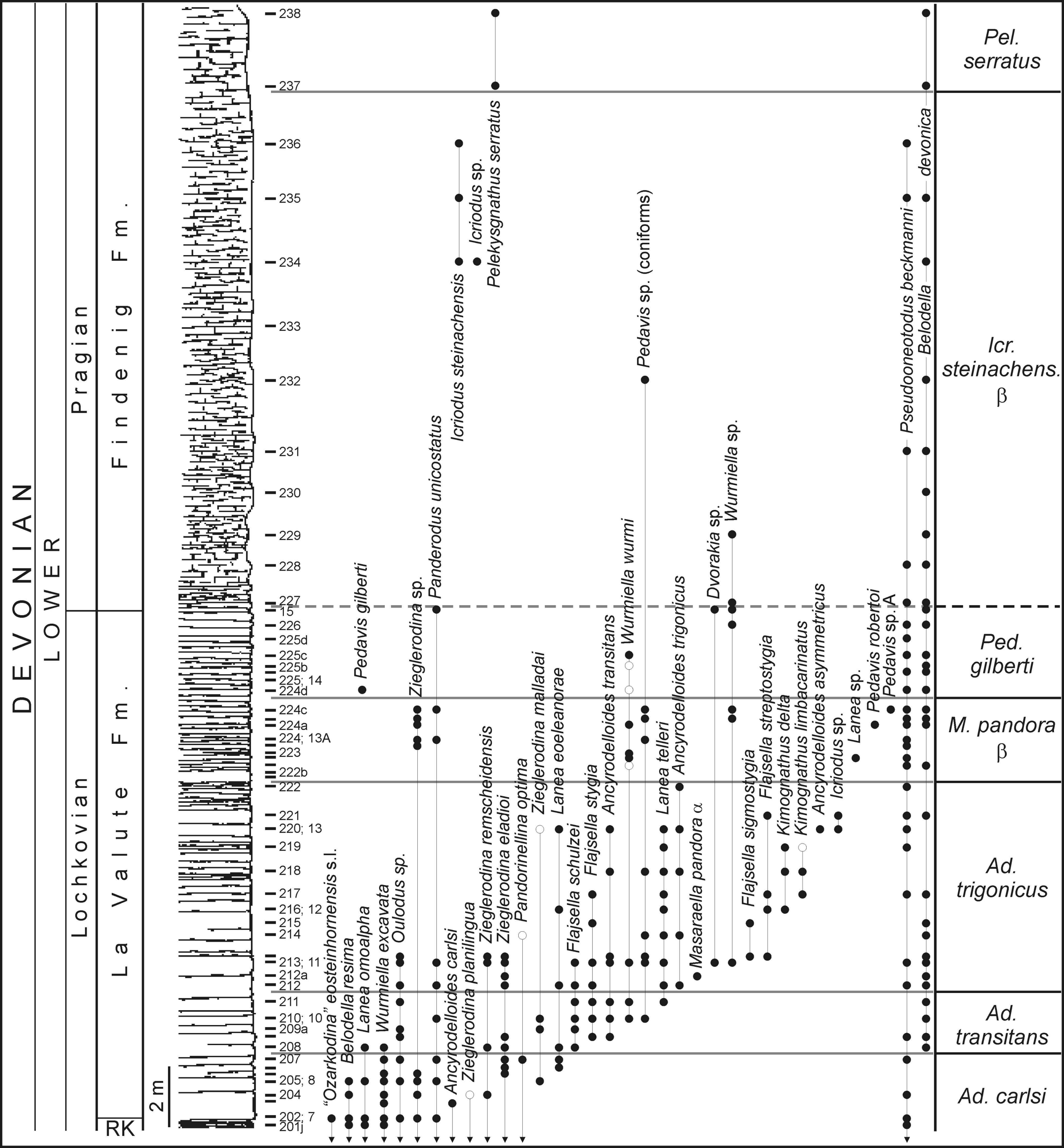
DEVONIAN
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Pragian
La Valute Fm.
Findenig Fm.
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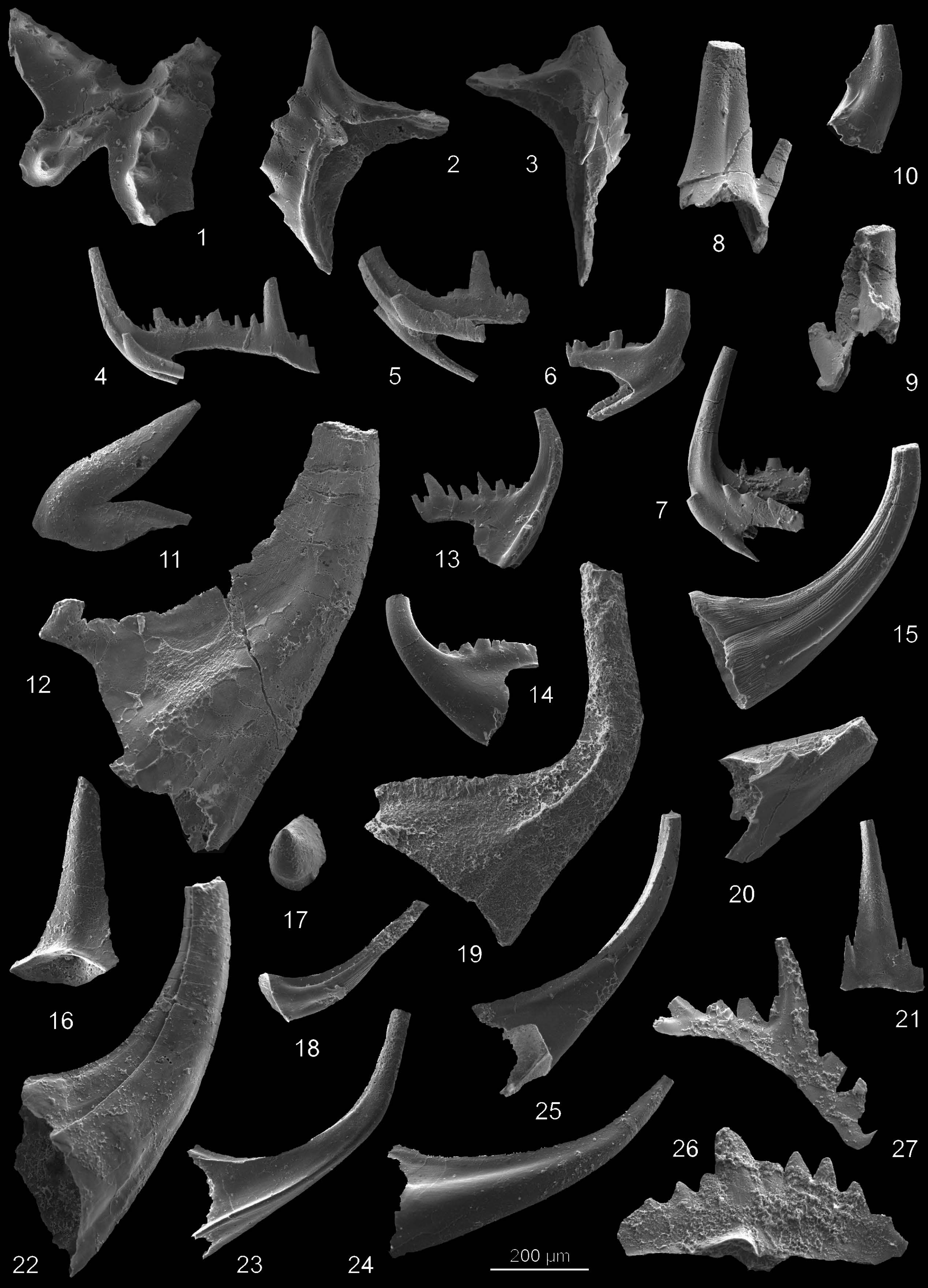
"Ozarkodina" eosteinhornensis s.l.
Belodella resima
Lanea omoalpha
Wurmiella excavata
Oulodus sp.
Zieglerodina sp.
Panderodus unicostatus
Ancyrodelloides carlsi
Zieglerodina planilingua
Zieglerodina remscheidensis
Zieglerodina eladioi
Pandorinellina optima
Zieglerodina malladai
Lanea eoeleanorae
Flajsella schulzei
Flajsella stygia
Ancyrodelloides transitans
Wurmiella wurmi
Pedavis gilberti
Icriodus steinachensis
Icriodus sp.
Pelekysgnathus serratus
Pedavis sp. (coniforms)
Lanea telleri
Ancyrodelloides trigonicus
Masaraella pandora α
Dvorakia sp.
Wurmiella sp.
Flajsella sigmostygia
Flajsella streptostygia
Kimognathus delta
Kimognathus limbacarinatus
Ancyrodelloides asymmetricus
Icriodus sp.
Lanea sp.
Pedavis robertoi
Pedavis sp. A
Pseudooneotodus beckmanni
Belodella devonica
Pel. serratus
Icr. steinachens. β
Ped. gilberti
M. pandora β
Ad. trigonicus
Ad. transitans
Ad. carlsi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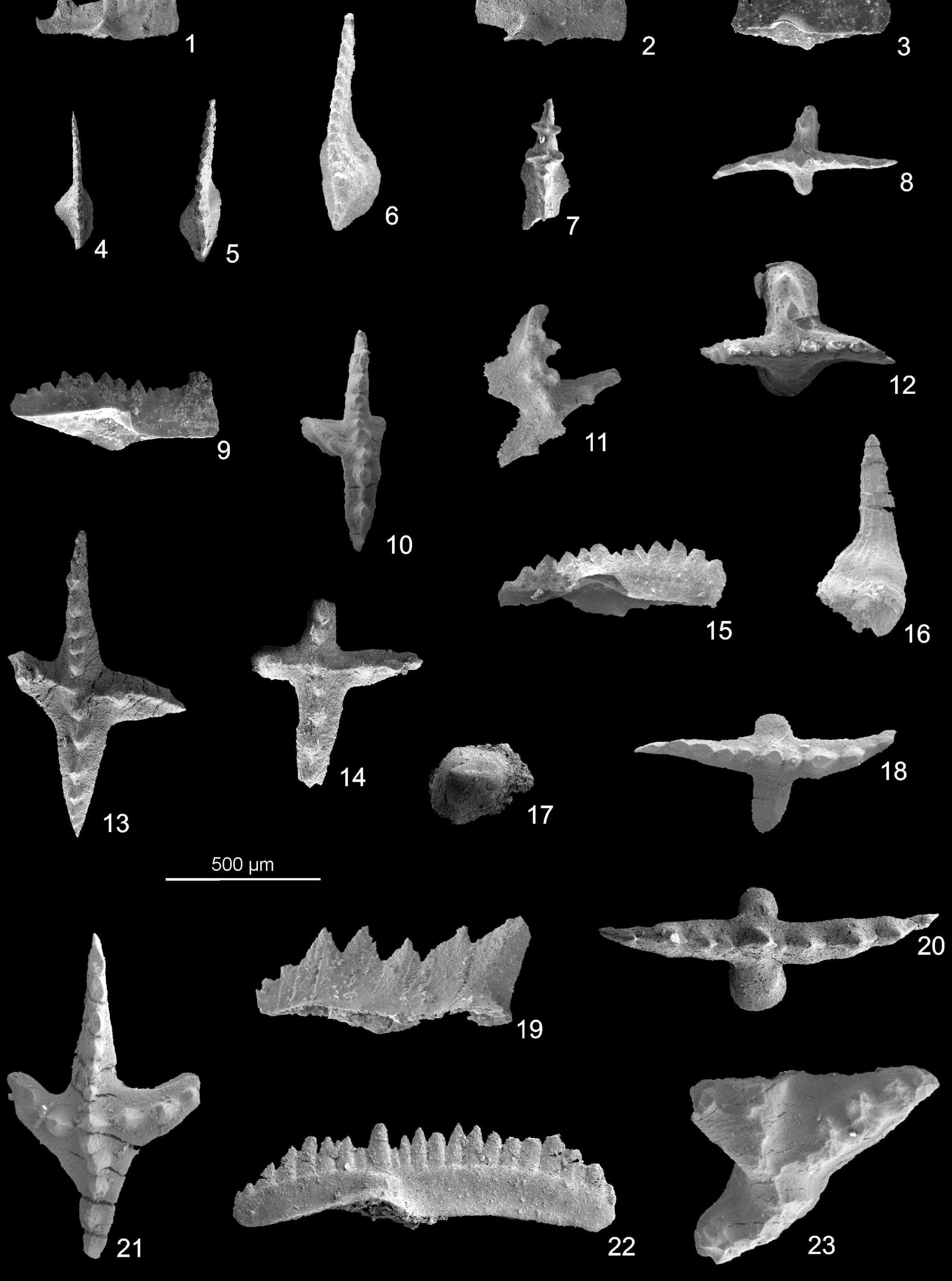
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NEWSLETTERS ON
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- Author Guidelines
- Privacy Statement

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Smith, J.P., Elbrächter, H.I. Gudmundsson, S., 2001. Planktonic foraminifera from the Neogene of the Los Valles Basin, Argentina. Marine Micropaleontology 24, 111-126.
Wareland, A.B., 2000. Spatiotemporal relationships in paleosols from the Upper Permian of Southwest England. Ph.D. Thesis, Agricultural University of London, London, Great Britain, 245 p.
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