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Lochkovian to Emsian conodonts (Lower Devonian) at CP-I section

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Locality - Along the former national road N-260.
Lithostratigraphic unit - Rueda Fm., Castanesa Fm., Villech Fm.
Age - Lochkovian, Pragian and Emsian (Lower Devonian).
What to see - Well-exposed Lochkovian, Pragian and Emsian strata in an almost continuous sequence moderate folded and with several faults.

How to get there

The locality is accessible through the paved road that corresponds to the former National N260 from La Pobla de Segur to Sort. The section is reversed and south to north oriented (Fig. 1).

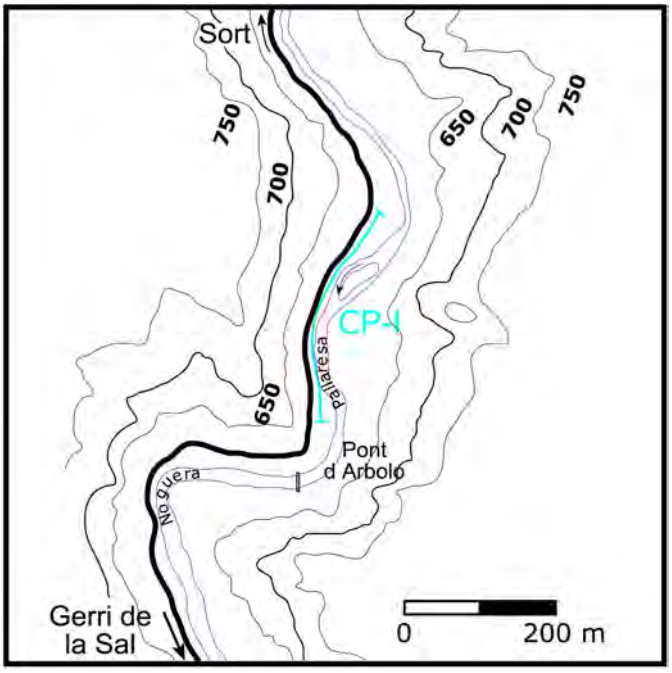

Figure 1. Location map of CP-I section.

Historical outline

Schmidt (1931) drafted a geological scheme of the section that was, subsequently used by Ziegler (1959) in orienting his conodont sampling. However, the latter was able to recognise only Emsian conodonts. Modern studies in the XXI century have demonstrated an almost complete Lochkovian conodont succession, the richness of which highly contrast with the poor Pragian one, and a moderately well represented Emsian sequence (Valenzuela-Ríos et al., 2005, 2015; Valenzuela-Ríos & Liao, 2012; Martínez-Pérez, 2010; Martínez-Pérez et al., 2011; Martinez-Pérez & Valenzuela-Ríos, 2014).
Valenzuela-Ríos & Liao (2012) presented preliminary sedimentological studies from section CP-I. This section was one of the Pyrenean key sections in establishing a direct comparison with Bohemian ones and proposing a global middle and upper Lochkovian zonation (Valenzuela-Ríos et al., 2015). Recently, Slavík et al. (2016) expanded the sedimentological analysis to include magnetic susceptibility and gamma-ray spectrometry and petrological studies and apply them to the complete section CP-I.

Lithology and fossil content

The section has a thickness of about 85 ms, has several faults and minor folded parts and exposes the Rueda Fm., Castanesa Fm.? and Villech Fm. The Rueda Fm. presents a different development here, starting with dark platy limestone with very few and thin clay and marly beds interbedded (Fig. 2). This particular development of the Rueda Fm. makes difficult to distinguish the lower boundary of

the Castanesa Fm. which could starts around Bed 138 when marls and clay limestone seems to be reduced to a few levels. However, the particular facies development of this section warns against a definitive assignation. The Villech Fm. with the clear reddish nodular limestone and marls will start within Bed 210.

Orthoconic nautiloids, fish microremains, bivalves, crinoid ossicles and stems, ostracods, trilobites, dacryoconarids, brachiopods, bivalves and gastropods are often found in this section.

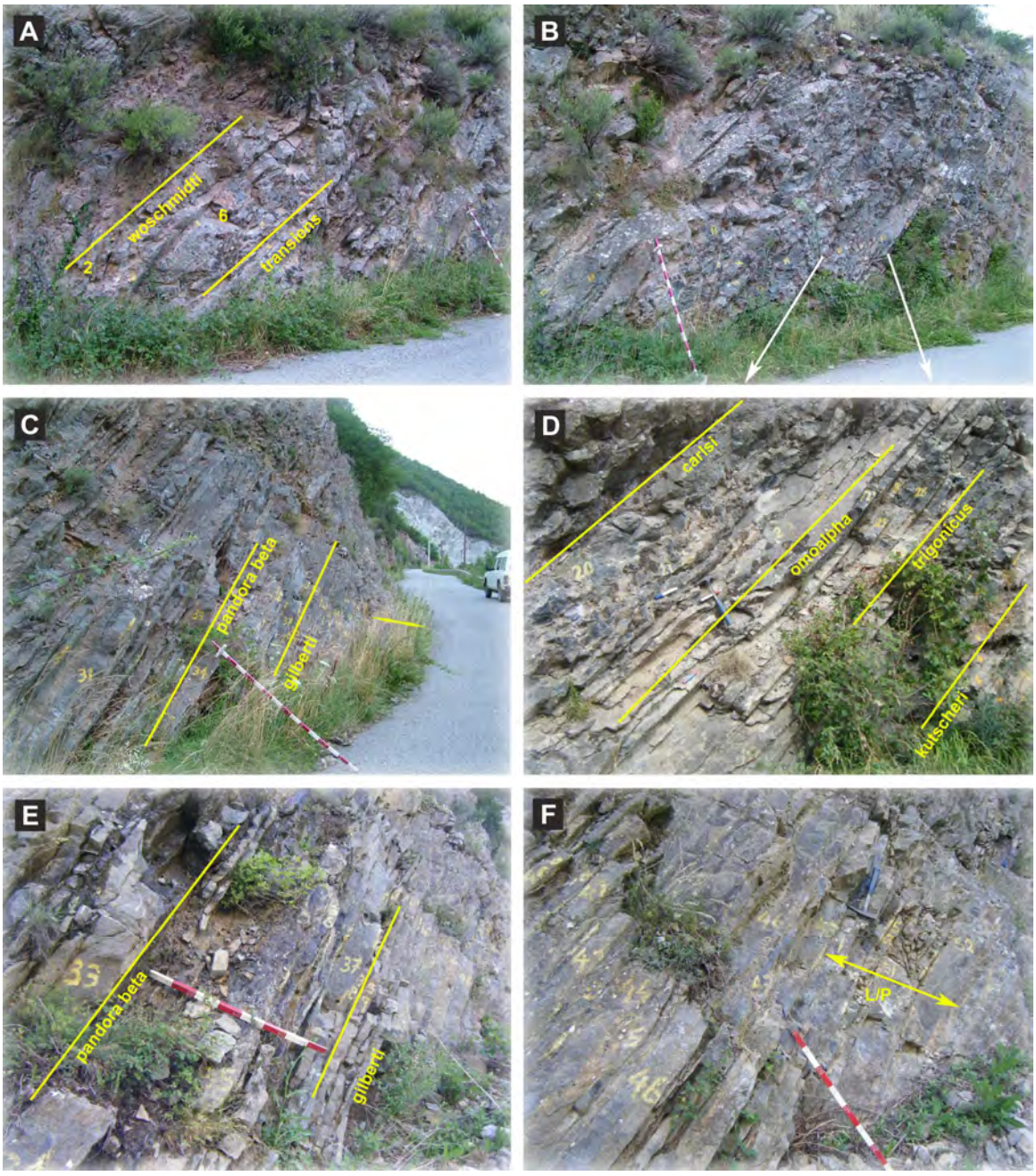

Figure 2. General view and details of the CP-I section, Rueda Fm with ilocation of conodont zones. **A.** Lower part of the section showing the lower Lochkovian *woschmidti* and *transiens* Zones. **B.** general view of upper lower Lochkovian and middle Lochkovian (details in Fig. 2.D). **C.** upper middle Lochkovian, upper Lochkovian with position of the two conodont zones, *pandora* beta and *gilberti*, arrow shows the Lochkovian/Pragian transition. **D.** close up of Fig. 2.B with relative position of lowest entries of the indexes *Anc. carlsi*, *Lanea omoalpha*, *Anc. trigonicus* and *Anc. kutscheri*. **E.** details of the upper Lochkovian and the two zones *pandora* beta and *gilberti*. **F.** close view to the strata around the Lochkovian/Pragian transition.

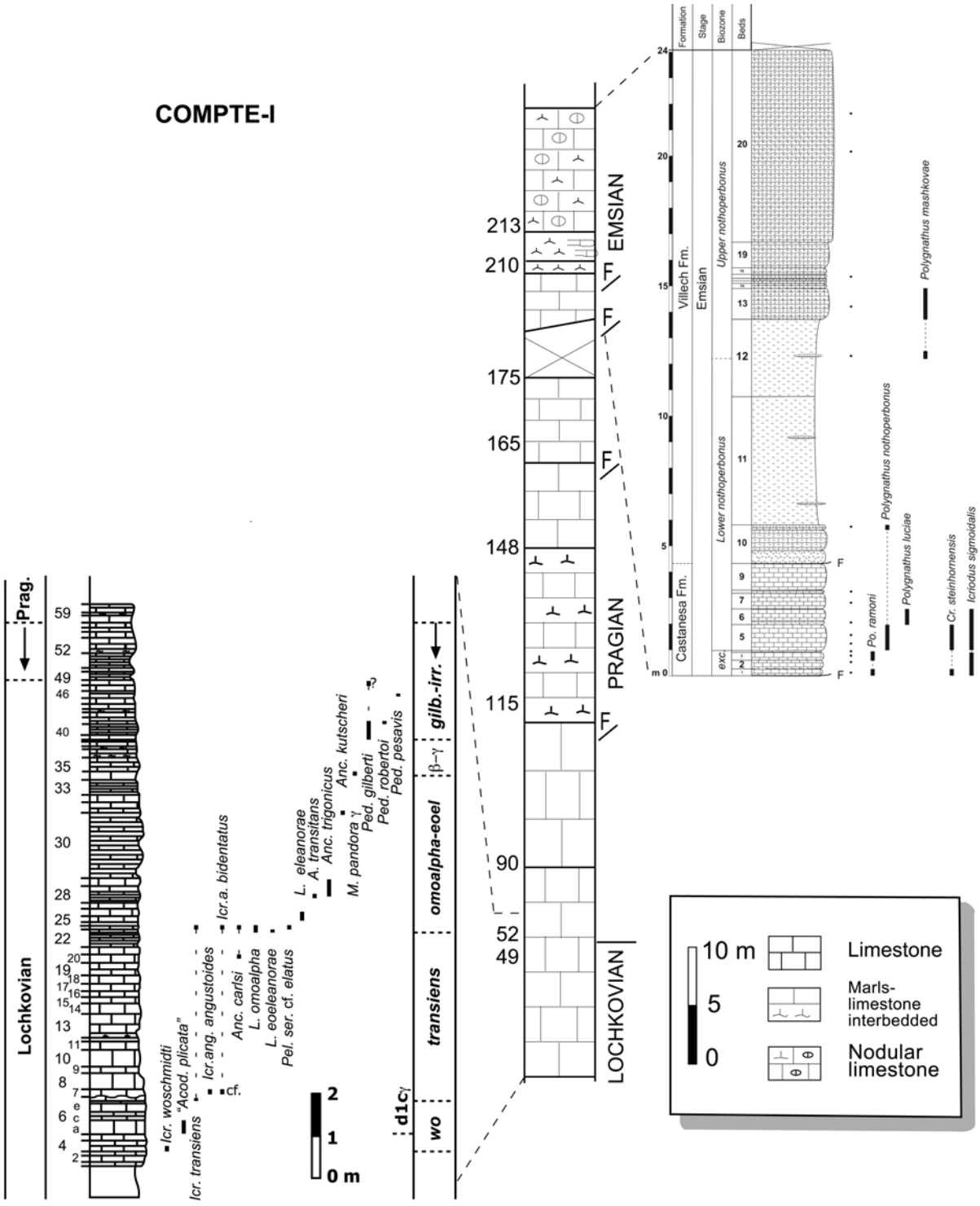

Figure 3. General stratigraphic column of the CP-I section with zooms of the lower and upper part showing the conodont and fish microremains distribution.

Palaeoenvironment

The sediments of the Rueda Fm. were deposited in a hemipelagic carbonate ramp that developed into a carbonate ramp during the Castanesa Fm. (Sanz-López, 2002). Slavík et al. (2016) provided details on the environment that mostly correspond to shallow water facies with a big sea level fall in the Rueda Fm., around the Lochkovian/Pragian boundary and some deepenings thereafter but never

reached the storm wave base. The depositional environment for the Lochkovian and lowermost Pragian would be, in general, quite with low energy (Valenzuela-Ríos & Liao, 2012). The lower to middle Pragian shows a replacement of redeposited shallow-water skeletal material by the pelagic components, suggesting a deepening-upward trend (Slavík et al., 2016). These authors also suggested that the middle to upper Pragian represented a shallowing, and the sediments were deposited probably not below the very deep storm wave base. The carbonate ramp was drowned below the Villech Fm.

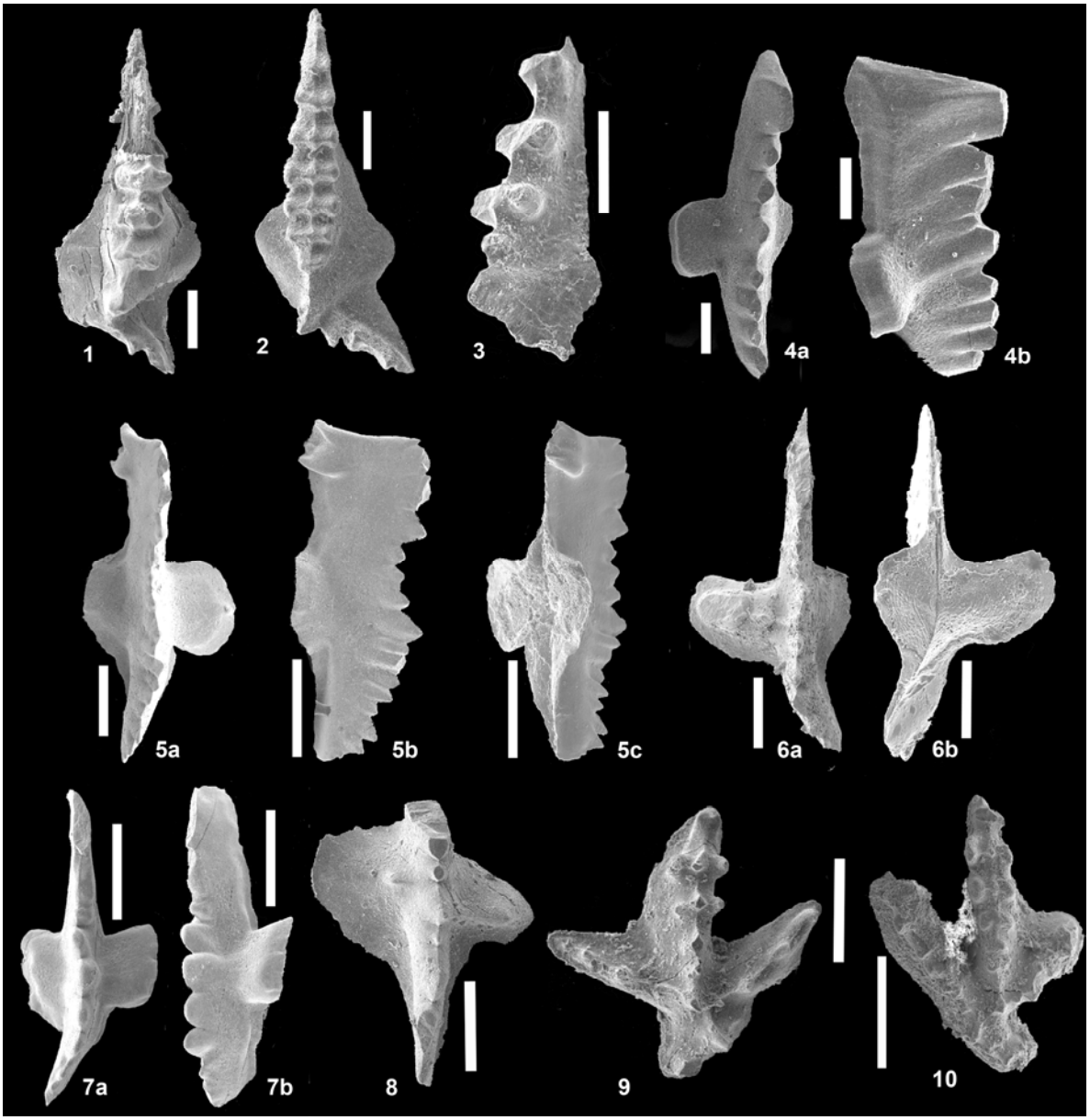

Figure 4. Conodonts from the CP-I section, Lochkovian. All scale bars = 200 µm, except 10 (x 500 µm).
1. *Icriodus woschmidti*, I element MGUV5265, upper view, sample CP-I/4a. **2.** *Icriodus transiens* I element MGUV5267, upper view, sample CP-I/6f. **3.** *Icriodus bidentatus*, I element MGUV5268, lateral view, sample CP-I/7c. **4.** *Lanea eoeleonorae* Pa element MGUV5263, 4a) upper view, 4b) lateral view, sample CP-I/22f. **5.** *Lanea omoalpha* Pa element MGUV5264, 5a) upper view, 5b) lateral view, 5c) lower view, sample CP-I/22f. **6.** *Ancyrodelloides carlsi*, Pa element MGUV5262, 6a) upper view, 6b) lower view, sample CP-I/23. **7.** *Lanea eoeleonorae* Pa element, 7a) upper view, 7b) lateral view, sample CP-I/22f. **8.** *Masaraella pandora* gamma, Pa element MGUV 5269, upper view, sample CP-I/34. **9.** *Pedavis breviramus*, I element, upper view, sample CP-I/40a. **10.** *Pedavis gilberti*, I element MGUV 5271, upper view, sample CP-I/40c.

Figure 5. Conodonts from the CP-I section, Emsian. All scale bars = 200 µm.
1. *Polygnathus luciae* Martínez-Pérez & Valenzuela-Ríos, Pa element MGUV-20.939, 1a) aboral view, 1b) oral view, 1c) lateral view. Sample CP-I/2008-10. **2.** *Polygnathus luciae* Martínez-Pérez & Valenzuela-Ríos transitional to *Po. mashkovae* Bardashev, Pa element MGUV-20.943, 2a) aboral view, 2b) oral view,2 c) lateral view. Sample CP-I/2008-10. **3.** *Polygnathus luciae* Martínez-Pérez & Valenzuela-Ríos, Pa element MGUV-20.942, 3a) oral view, 3b) aboral view, 3c) lateral view. Sample CP-I/2008-10. **4.** *Polygnathus mashkovae* Bardashev, Pa element MGUV-20.951, 4a) aboral view, 4b) oral view, Sample CP-I/2008-13. **5.** *Polygnathus nothoperbonus* Mawson, Pa element MGUV-20.966, 5a) aboral view, 5b) oral view, Sample CP-I/2008-10. **6.** *Icriodus sigmoidalis* Carls & Gandl, I element MGUV-21.256, 6a) oral view, 6b) aboral view, Sample CP-I/2008-1. **7.** *Icriodus sigmoidalis* Carls & Gandl, I element MGUV-21.257, 7a) aboral view, 7b) oral view, Sample CP-I/2008-2. **8.** *Icriodus sigmoidalis* Carls & Gandl, I element MGUV-21.259, 8a) aboral view, 8b) oral view, Sample CP-I/2008-5b. **9.** *Icriodus sigmoidalis* Carls & Gandl transitional to *Ic. fusiformis* Carls & Gandl, I element MGUV-21.262, 9a) oral view, 9b) aboral view, Sample CP-I/2008-6.

Fossil content

212 conodont samples have been collected from the CP-I sections in several campaigns from almost all the limestone levels. The preservation is mostly good. Conodont colour is black corresponding to a Color Alteration Index (CAI) of 5.

28 conodont taxa belonging to 12 genera (*Icriodus, Ancyrodelloides*, *Lanea, Pedavis, Pelekysgnathus, Polygnathus, Zieglerodina, Masaraella, Wurmiella, "Ozarkodina" Panderodus* and *Pseudooneotodus*) have been identified (Figs. 3-5).

Seven fish taxa belonging to three genera (*Nostolepis, Gomphonchus* and *Ohioaspisi*) have also been recorded from section CP-I (Fig. 3).

Biostratigraphy

The Lochkovian and early Pragian detailed biostratigraphy of the CP-I section have been thoroughly described in three papers (Valenzuela-Ríos et al., 2005, 2015; Valenzuela-Ríos & Liao, 2012). The lower Emsian succession has been described in Martínez-Pérez (2010), Martínez-Pérez et al. (2011) and Martinez-Pérez & Valenzuela-Ríos (2014).

The Lochkovian contains the important lower Lochkovian indexes and the biostratigraphical indexes of all middle and upper Lochkovian biozones (Fig. 4). The sequence starts in Bed 2a with the record of *Icriodus woschmidti.* Bed 6f yielded *I. transiens* and allows correlation con unit d1cγ in Aragón. In bed 7c the records of *I. angustoides and I. bidentatus* together with *Icriodus* of the *woschmidti* group are noteworthy. The first record of *Ancyrodelloides* corresponds to a Pb element in Bed 16b; this Bed would be located in a narrow interval between the upper part of the lower Lochkovian and the lower part of the middle Lochkovian. Bed 20 yielded *A. carlsi.* Definitive middle Lochkovian according to Valenzuela-Ríos & Murphy (1997) is in Bed 22f with the lowest record of *Lanea omoalpha* that occurs together with *L. eoeleanorae.* Therefore, the base of the middle Lochkovian has to be sought below this Bed. The entries of *A. trigonicus* (Bed 28) and *A. kutscheri* (Bed 30d) mark the lower boundaries of the *trigonicus-kutscheri* Zone and *kutscheri-pandora* beta Zone respectively. The entry of *Masaraella pandora* gamma in Bed 34 indicates upper Lochkovian. The last Lochkovian *gilberti-steinachensis* beta Zone starts in Bed 39 with the entry of *Pedavis gilberti*.

The combination of conodont and fish records brackets the Lochkovian/Pragian boundary between beds 49-55. Records assigned to the Lochkovian taxon *P. gilberti* end in Bed 48. From here up no biostratigraphically relevant conodonts have been found. Bed 56 yielded *Nostolepis viethae*, taxon that enters above the base of the Pragian (Valenzuela-Ríos et al., 2005). Recent MS-GRS analysis (Slavík et al., 2016) placed the boundary below Bed 52, and therefore narrows the interval where the base of the Pragian has to be sought.

The Pragian is rather poor in conodonts and only *I. steinachensis* beta and *Pseudooneotodus* have been so far recognised. The next well-dated biostratigraphical interval comes from the upper part of the section, around the transition between the Castanesa and Villech Fms. (Martínez-Pérez, 2010; Martínez-Pérez et al., 2011; Martínez-Pérez & Valenzuela-Ríos, 2014). The upper Middle *excavatus* Zone will be represented from Bed 202 to middle parts of Bed 205. The entry of *Polygnathus nothoperbonus* defines the base of the nominal Zone that occupies the upper part of the section. The entry of *P. mashkovae* in Bed 212 subdivides the Zone into lower and upper *nothoperbonus*.

Acknowledgements

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