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Early Devonian conodonts from the Černá rokle near Kosoř

Ladislav Slavík[1] & José I. Valenzuela-Ríos[2]

[1]Institute of Geology of the CAS, v.v.i., Rozvojová 269, 16500 Praha 6, Czech Republic; slavik@gli.cas.cz
[2]Department of Botany and Geology, Universitat de València, C/. Dr. Moliner 50, E-46100 Burjassot, Spain; Jose.I.Valenzuela@uv.es

Locality *- The locality Černá rokle lies E of village Kosoř, close to the Radotín Valley in the southwestern border of the city of Prague (Fig. 1), at coordinates are: N 49°98'99'', E 14°33'86''.*
Lithostratigraphic units *- Middle and upper part of the Lochkov Fm. and complete Praha Fm.*
Age *- The middle and upper Lochkovian, entire Pragian and lower Emsian. The conodont zones recorded ranging from* kutscheri-pandora beta, pandora beta-gilberti, gilberti-steinachensis beta *in the Lochkovian and* steinachensis beta-brunsvicensis *in the Pragian (in the sense of Valenzuela-Ríos et al., 2015 and Slavík et al., 2012).*
What to see *- Former stratotype of the Lochkovian-Pragian boundary, (set in 1958), redefined in 1989 (transfered to Praha-Velká Chuchle). Famous paleontological locality since the Barrande's time, very rich faunas. Stratotype of the Dvorce-Prokop Limestone (a Member of the Praha Formation).*

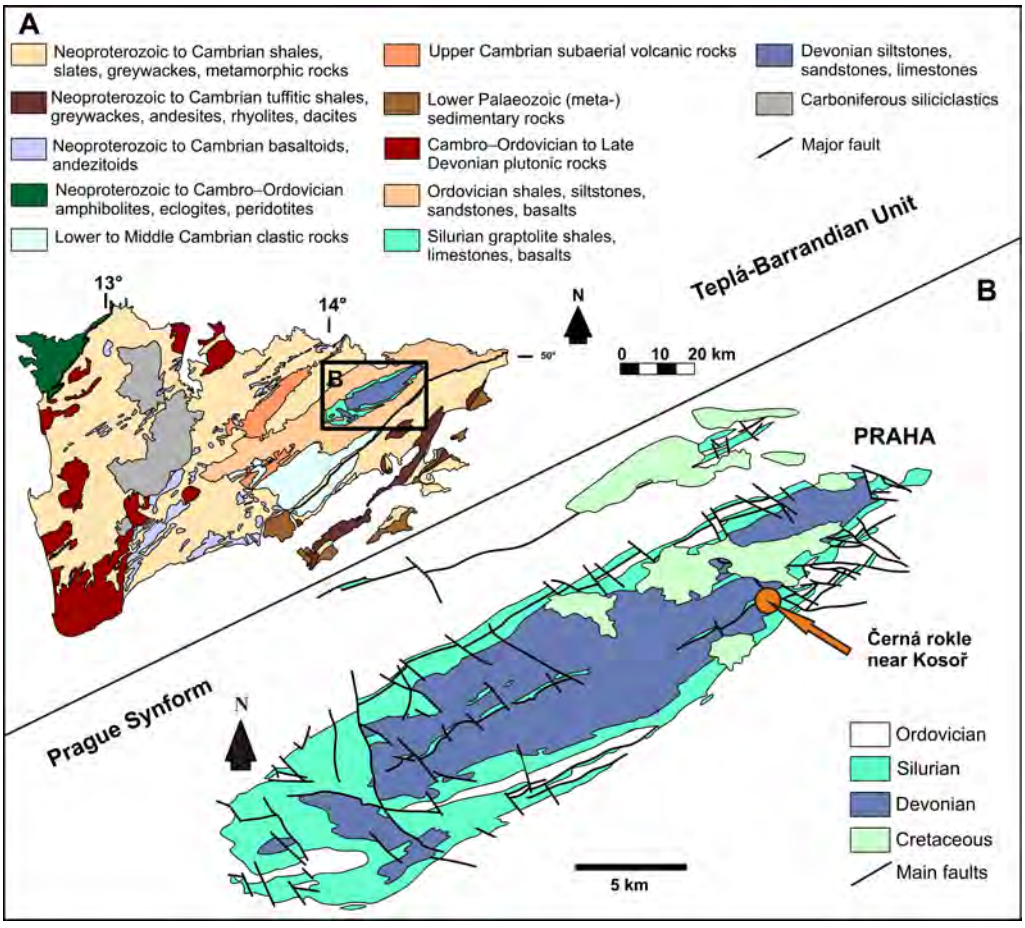


Figure 1. A location of the Černá rokle section in the Prague Synform (i.e. a part of the Teplá-Barrandian Unit).

How to get there
The locality is well accessible from the street V Sudech stemming from the main street K Cementárně in Praha-Radotín. It is approximately 700 meters to the east from the crossroad, following a path to the right upslope.

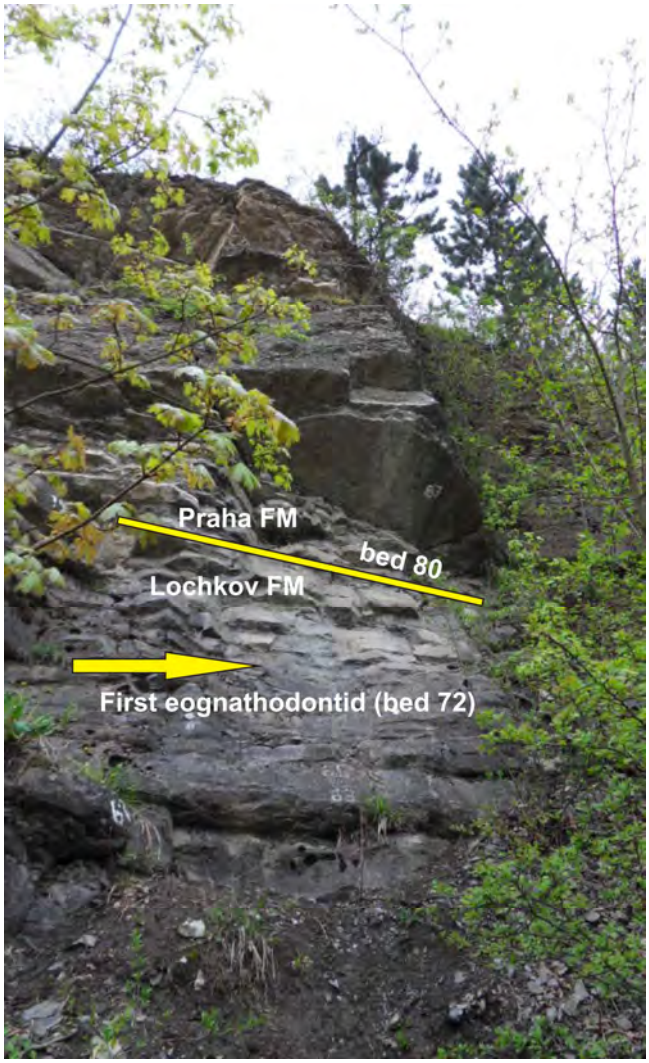


Figure 2. Photo of the Lochkovian-Pragian boundary interval at the Černá rokle section.

Historical outline

The old quarries in the Černá rokle display classical Lower Devonian outcrops and represent a famous paleontological locality since the Barrande's time with very rich faunas. For more detailed information, see Chlupáč (1993). The conodont data were published in Schönlaub (in Chlupáč et al., 1985) and Weddige (1987). In recent years some more conodont data that are important for the position of the Lochkovian-Pragian boundary were obtained (Slavík et al., 2007).

Lithology and fossil content

The upper Lochkovian is characterized by laminated dark grey bituminous packstones up to micritic lime mudstones that alternate with dark calcareous shales and siltstones (i.e. Radotín Limestone, see Figure 2). In some beds, shells of orthoconic nautiloids and dacryoconarids show a sorting and alignment (telescoping). The upper Lochkovian fauna is highly diverse (100 taxa described) and includes abundant orthocone nautiloids, bivalves, gastropods, hyoliths, brachiopods, trilobites, phyllocarid crustaceans, eurypterids and fishes (see Chlupáč, 1993). Apart from conodonts, stratigraphically important are dacryoconarids, graptolites and chitinozoans (see Figure 3).

The Lochkovian-Pragian boundary was originally placed at the lower limit of distinctly lighter and micritic Dvorce-Prokop Limestones of the Praha Formation (upper bedding plane of bed No. 80). The conodont data, however, caused subsequent shifts downwards (bed No. 76 after redefinition in 1989). Later, the first eognathodontid conodont has been found even lower – bed No. 72 (Slavík et al., 2007), it means deep down in the Lochkov Formation. The base of the Dvorce-Prokop member is a significant lithological change that is connected with the global Basal Pragian Event (Chlupáč & Kukal, 1986; 1988).

In the Černá rokle, the overlying Praha Fm is developed in the entire sequence of total thickness of about 160 m. The Praha Fm is developed as grey nodular lime mudstones with burrows of Chondrites (Dvorce-Prokop Limestone). The member in its lower part is rich in diverse benthic, planktonic and nektonic faunas including dacryoconarids, trilobites, large thin-shelled bivalves, nautiloids, gastropods, brachiopods, rugose and tabulate corals and acanthodians.

Palaeoenvironment

The general lithology and fauna indicate a low energy environment with a soft muddy bottom inhabited by burrowers. Fauna shows only few traces of transport (i.e. telescoping of dacryoconarids) and reflect well oxygenated conditions.

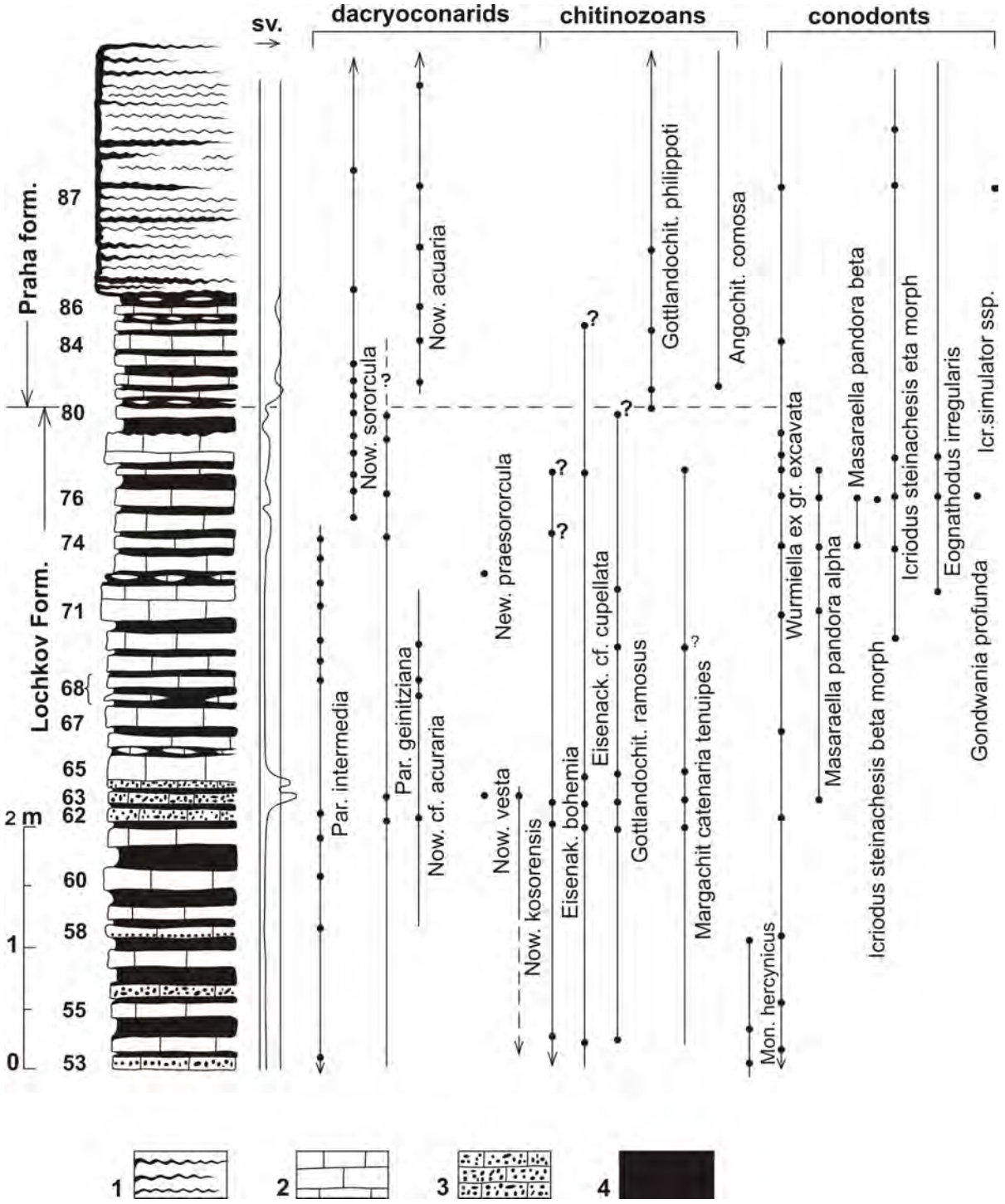
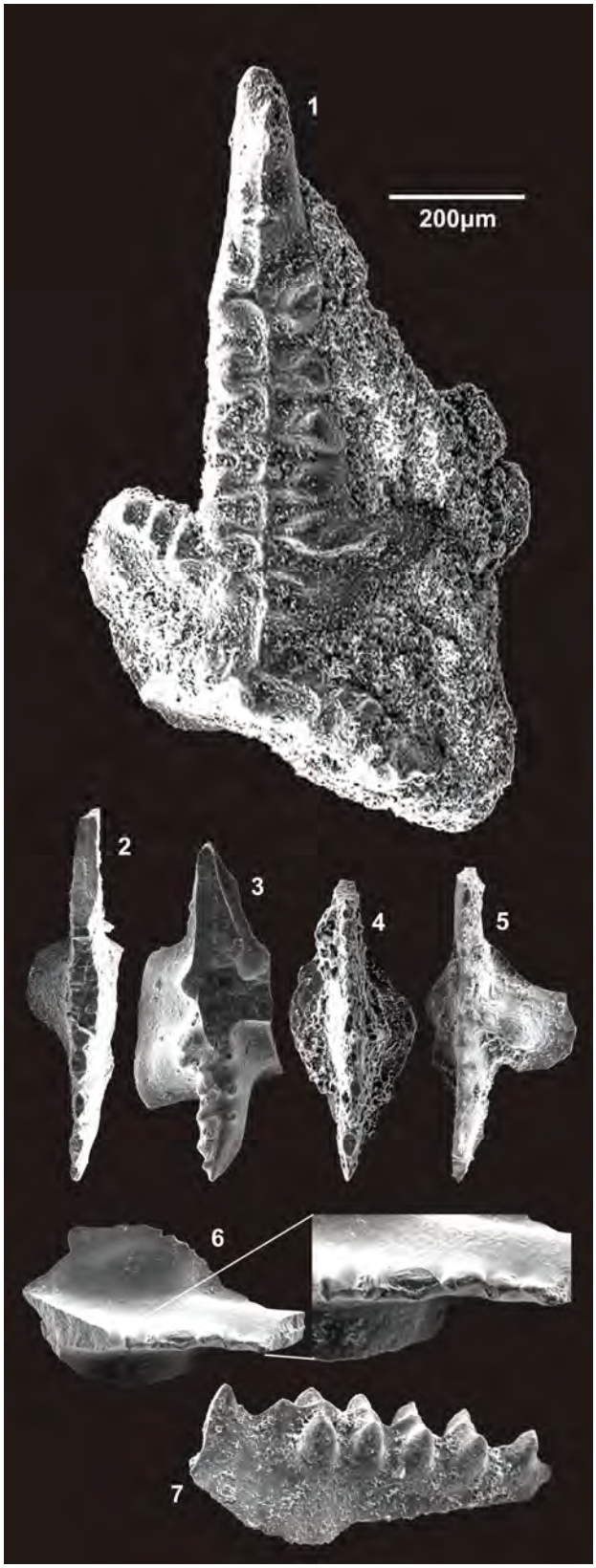


Figure 3. The Lochkovian-Pragian boundary interval at Černá rokle near Kosoř with ranges of selected taxa (modified after Chlupáč 1993) and new conodont data. Lithology: 1. light grey micritic and nodular limestones, 2. dark grey fine-grained bioclastic or micritic limestones, 3. lighter grey and coarser-grained bioclastic limestones, 4. dark calcareous shales and shally limestones.

Conodonts

The conodonts from the Černá rokle section are rather scarce, however, stratigraphically most important taxa have been obtained including the eognathodontid and steinachensis stocks. The conodont record is, herein, focused on the Lochkovian-Pragian boundary (see Figures 3, 4).



Re-sampling (2006) of the auxiliary stratotype section (Černá rokle near Kosoř) furnished an *Eognathodus* with a clear sulcus from bed No. 76 - in the position of the redefined L/P boundary by Weddige (1987). The specimen is broken in upper view, however, it is remarkable that the sulcus reaches almost to the anterior tip of the unit. The basal cavity is distinctly sub-rectangular and the blade, if complete, would have been rather long. Of course, it is hazardous to rely on an incomplete specimen, but it could be related to *Gondwania profunda* Murphy; according to him, *G. profunda* is the index of the second Pragian conodont Zone in Nevada. The evidence that this fairly developed specimen cannot be the oldest in the stock is supported by the appearance of another eognathodontid specimen from bed 72 (about 0.7 m below the redefined L/P boundary in the Černá rokle (near Kosoř) section that already shows an incipient but not really developed sulcus. This specimen is very close to *Eognathodus irregularis*. The record of an eognathodontid specimen that is very close to *Gondwania profunda* near the base of the Praha Formation in the Požáry section, thus, confirms the very early appearance of these 'morphologically advanced' eognathodontids in the Barrandian sections. As a consequence, we cannot be sure neither about the biostratigraphic base of the Pragian according to faunal characterization (whether to use the original 'sulcate' or the recently proposed 'unsulcate' forms by Murphy (2005) as the biostratigraphical criterion), nor about the stratigraphic position of the really oldest eognathodontid in the Barrandian. If we adopt the 'unsulcate' concept—the Lower Pragian boundary should be then moved down deep into the Lochkovian. Biostratigraphical orientation by means of eognathodontids in the Barrandian is problematic because both the specimens with incipient sulcus and morphologically advanced forms occur stratigraphically very close to the traditional Pragian base. Fortunately, in the Barrandian there are other controls besides the

Figure 4. Selected conodonts from the Černá rokle near Kosoř section.
1. *Icriodus simulator ssp.*, upper view of I element, SpNo. 007CR, Černá rokle section, bed No. 87.
2. *Masaraella pandora* Murphy et al. – *Eognathodus*? transition, upper view of broken Pa element, SpNo. 008CR, Černá rokle section, bed No. 76.

lithological change—for example, dacryoconarids (*Nowakia (Turkestanella) acuaria*) and the distribution of typical Pragian macrofauna that help to locate the Lower Pragian boundary. If we look at the distribution of significant conodont taxa in the Barrandian sections, we can infer the stratigraphical importance of the *Icriodus steinachensis* stock. Morphotypes of *I. steinachensis* occur in many sections in the Prague Synform and in many regions of the world, as well (see Slavík et al., 2007). Distinct morphotypes eta and beta were defined by Klapper and Johnson (1980, p. 448) and were subsequently used by many authors. Murphy & Cebecioglu (1984), however, rejected the distinction of morphotypes due to their interfering range in Nevada. It contrasts with the former data of Klapper and Johnson (1980, tables 3 and 4) who pointed out that eta morphotype is older than beta morphotype. Based on the material from Barrandian and Pyrenees, we think that the stratigraphical meaning of both morphotypes is useful in Europe, as they have distinctly different ranges in several European sections.

In sections of the Barrandian and Carnic Alps morphotype eta enters earlier than the morphotype beta. The morphotype beta with a triangular ('carrot') shape of the spindle has never been recorded to enter below the morphotype eta anywhere. It has been proved that the younger morphotype follows the older one rather soon. This eta-beta stratigraphic sequence is seen in the Carnic Alps (Oberbuchach II, Schönlaub in Chlupáč et al., 1985; Schönlaub, 1985) and in the Barrandian (Černá rokle, Velká Chuchle, Cikánka; Schönlaub in Chlupáč et al., 1985; Slavík, 2004). Both in the Barrandian and the Pyrenees, the specimens of *I. steinachensis* are abundant and they occur in the lowermost portions of the Pragian sequences, not reaching very high above the boundary.

Very important is the striking co-occurrence of the eognathodontid specimens with incipient, but clear sulcus with the first beta morphotype of *I. steinachensis* in the Velká Chuchle and Cikánka sections. As it has been pointed out above, we cannot consider the known Barrandian entries of eognathodontid specimens to be necessarily the oldest because of their advanced morphology.

Additional remarks *or* further notes

All the above mentioned remarks point to the fact that the Lochkovian-Pragian boundary became somehow fuzzy due to different concepts and opinions on the evolution of the eognathodontid lineage. Based on our knowledge, we think that early stage of the sulcus development in the oldest eognathodontid taxa is the best future marker of the Basal Pragian boundary.

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Figure 4. continued.

3. *Gondwania profunda* Murphy, upper view of broken Pa element, SpNo. 006CR, Černá rokle section, bed No. 76. **4.** *Masaraella pandora* Murphy et al. alpha morph?, upper view of incomplete Pa element, SpNo. 005CR, Černá rokle section, bed No. 76. **5.** *Masaraella pandora* Murphy et al. beta morph?, upper view of incomplete Pa element, SpNo. 004CR, Černá rokle section, bed No. 76. **6.** *Eognathodus irregularis* (Philip), upper view of incomplete element and the detail of denticulation, SpNo. 001CR, Černá rokle section, bed No. 72. **7.** *Icriodus a. angustoides* Carls & Gandl, lateral view of I element, SpNo. 002CR, Černá rokle section, bed No. 76.

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