

Eifelian-Famennian Conodont succession in the Villech sections

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Locality - In the left bank of Cabiscol stream, about 3 km south from the locality of Martinet heading the Villech village in the local road LV-4055.

Lithostratigraphic unit - Top of Villech Fm., Comabella Fm and La Mena Fm.

Age - Eifelian-Famennian (Middle-Upper Devonian).

What to see - Transition between the Villech and Comabella Formation (Compte Subfacies in the Segre Valley), the Givetian/Frasnian boundary and a Frasnian breccia.

How to get there

The Eifelian-Famennian sections of the Villech area are located south of the Martinet village, approximately 3 km following the local road LV-4055 heading the Villech village, sited along the road in the left bank of Cabiscol stream and in the eastern slope of a hill north of Villech. The Sections described here crop out in the slopes of a hill and in two quarries (Fig. 1).

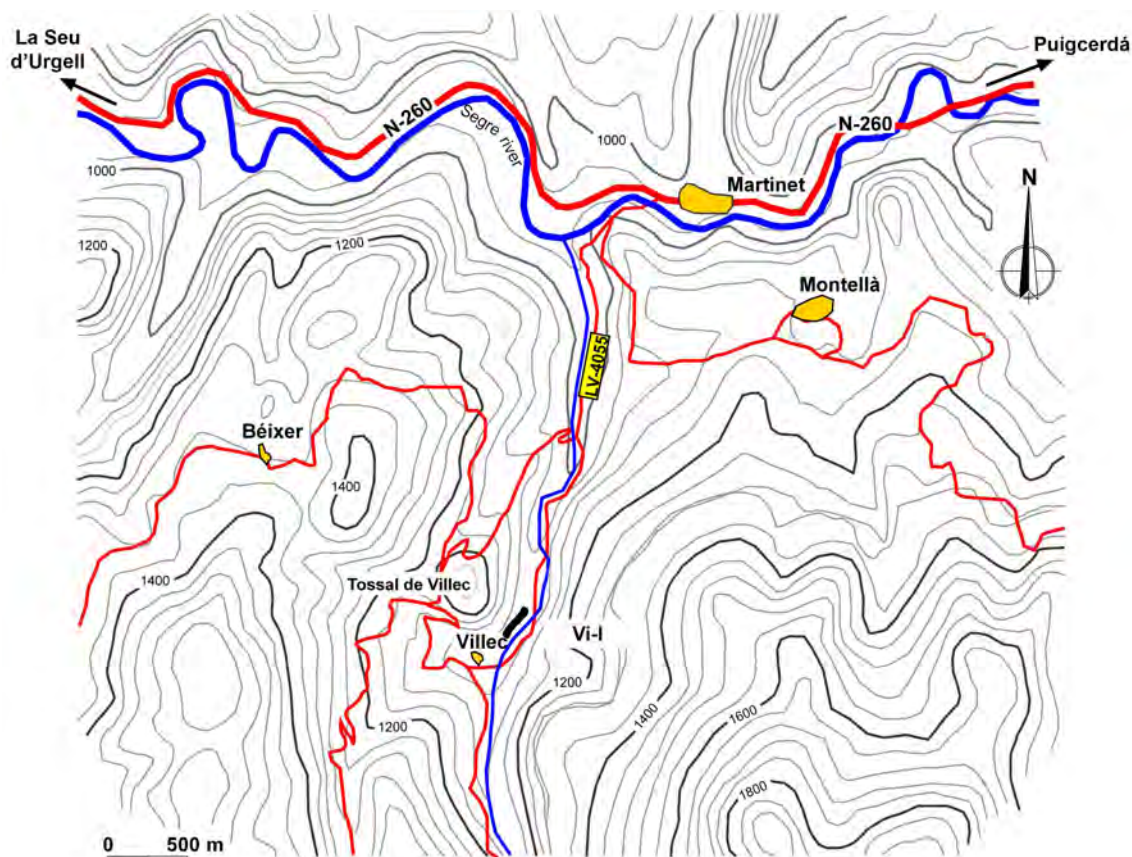


Figure 1. Location map of Villech sections (Vi-I).

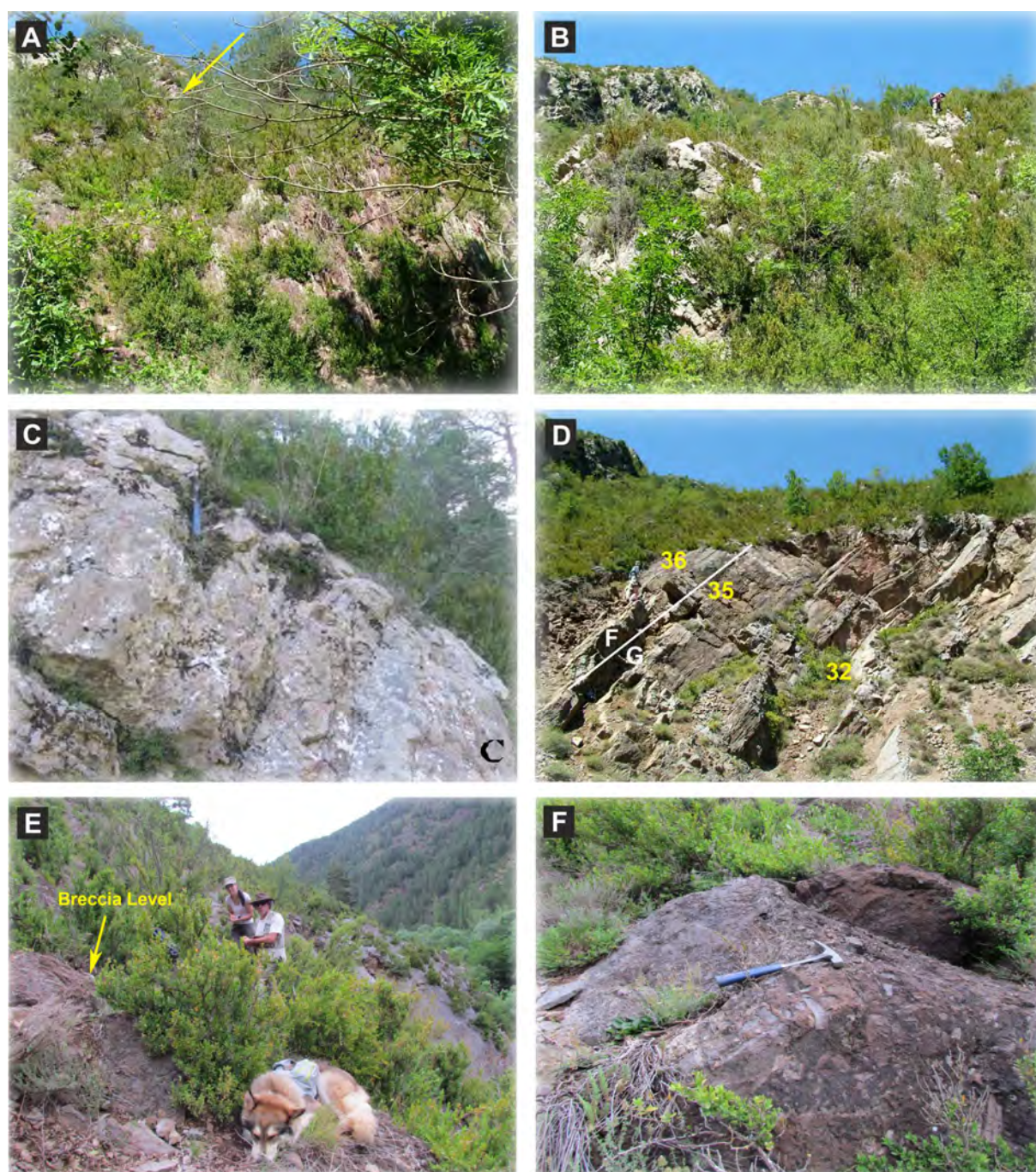


Figure 2. General view and details of the Eifelian to Frasnian strata in the Villech section.

A. Lowermost part of the section, contact between the Vilech Fm. (red marly shales) and Comabella Fm. (light colour limestones) (yellow arrow). **B.** Field general view of the Eifelian part of the section. **C.** Detail of the *costatus* Zone, lower part (Beds 2-5). **D.** Upper Givetian and lower Frasnian strata in the first quarry; the Middle/Upper Devonian Series and the corresponding Givetian/Frasnian boundary is traced within Bed 36 (sample 36A). **E.** Field view of Frasnian levels below the brecciated level (41). **F.** Details of the thick breccia level (up to 135 cm thick).

Historical outline

The earliest conodont study in this area was carried out by Boersma (1973), who recognized the Villech Formation and what he called the Compte Formation and recorded conodonts from the *Polygnathus kockelianus* Zone to the *Palmatolepis quadrantinodosa* Zone, which then, were placed from the upper Eifelian to the middle Famennian. The sections were later sampled by Valenzuela-Ríos

in the course of a Geological Survey, improving the initial dating of Boersma over the entire Villech section and providing a basic data base for further studies. Subsequently, Gouwy et al. (2013, 2016) has provided a detailed stratigraphic, petrologic and conodont biostratigraphy for the Eifelian to Lower Frasnian strata of the Villech section, showing the relevance of this section for establishing the local composite Pyrenean standard based on conodonts Gouwy et al. (2016).



Figure 3. General view of Famennian strata in the second quarry, field view of La Mena Fm. Double-ended arrow marks the tentative interval for the Lower/Middle Famennian boundary, defined by the base of the *Palmatolepis marginifera marginifera* Zone of Spalletta et al. (2015).

Lithology and fossil content

The section is partly exposed near the road on the eastern slope of a hill and partly in two abandoned quarries along the road close to Villech. Three lithological formations are exposed in a series of almost continuous outcrops. The Villech Fm., Comabella Fm. and La Mena Fm. The two first formations crop out in an almost continuous traverse through the slopes of the hill and the first (north) quarry (Fig. 2). The latter formation crops in the second quarry out and are separated by a covered (and probably faulted) interval (Fig. 3).

The Villech Fm. is composed of nodular and argillaceous limestones with different amounts of red and green shales. The overlain Comabella Fm. consists of nodular reddish limestones and condensed red beds in the lowermost part followed by condensed pinkish-greyish limestone's with hard-ground and syndimentary tectonics especially in the uppermost part of the section. In this part a Frasnian breccia is also observed (Fig. 4). This part of the sequence measures about 64 m. The La Mena Fm. consists of nodular red condensed limestone, some beds are pinkish and develop hard-grounds. This part is about 13 m thick (Fig. 5).

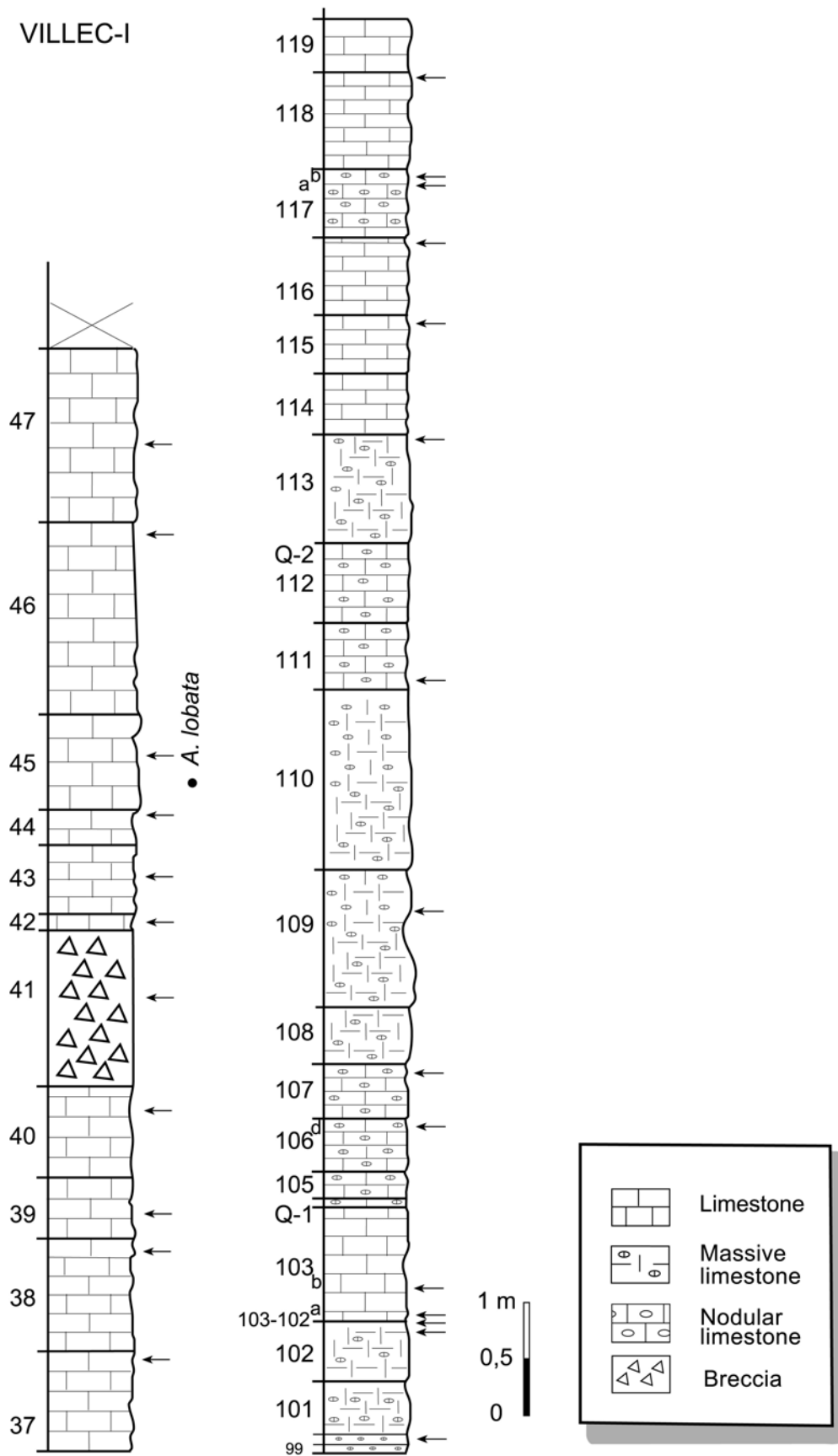


Figure 4. Stratigraphic column of the Frasnian and Famennian part including the breccia with position of some relevant conodont records.

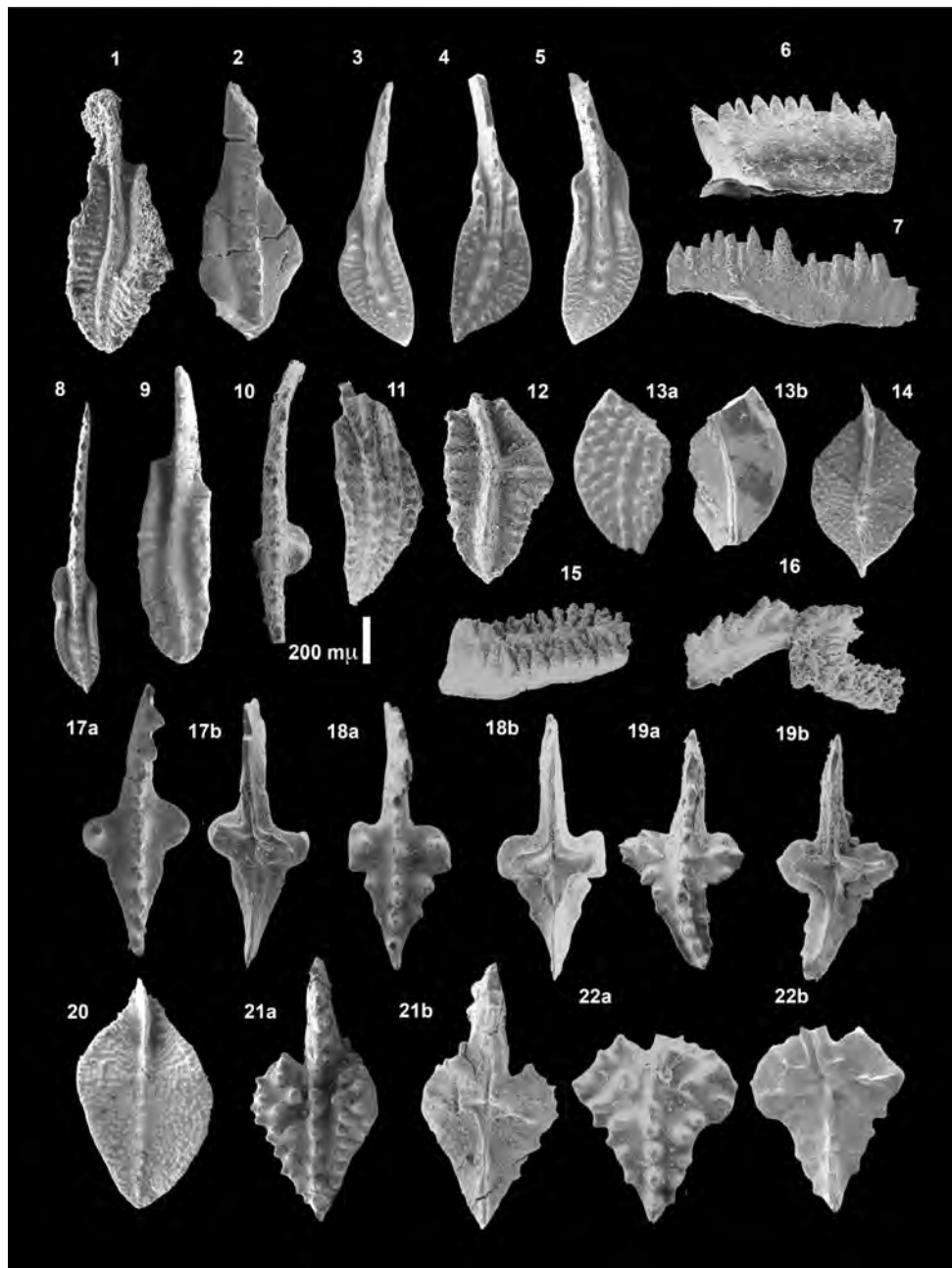


Figure 6. continued.

sannemanni proxima Pollock, Pa element MGUV6038, upper view, sample Vi-I/35. **11.** *Sch. wittekindti* Ziegler, Pa element MGUV6039, upper view, sample Vi-I/35. **12.** *Sch.* aff. *Sch. hermanni* Ziegler, Pa element MGUV6041, upper view, sample Vi-I/33. **13.** *Pol.* Cf. *Pol. cristatus cristatus* Hinde, Pa element MGUV6034, 13a upper view, 13b lower view, sample Q-1/2 (= within Bed 33). **14.** transitional form between *Klapperina disparilis* (Ziegler & Klapper) and *Kl. disparalvea* (Orr & Klapper), Pa element MGUV6035, upper view, sample Q-1/2. **15.** *Skelethognathus norrisi* (Uyeno), Pa element MGUV6048, upper-lateral view, sample Vi-I/35. **16.** *Sk. norrisi* (Uyeno), Pb element MGUV6051, lateral view, sample Vi-I/35. **17.** *Ancyrodella binodosa* Uyeno, Pa element MGUV6049, 17a upper view, 17b lower view, sample Vi-I/36. **18.** *Ancyrodella pristina* Khalymbadzha & Chernysheva, morphotype 2 of Sandberg et al., Pa element MGUV6047, 18a upper view, 18b lower view, sample Vi-I/36. **19.** transitional form between *An. binodosa* Uyeno and *Anc. pristina* Khalymbadzha & Chernysheva, Pa element MGUV6046, 19a upper view, 19b lower view, sample Vi-I/36. **20.** *Mesotaxis falsiovalis-ovalis*, Pa element MGUV6040, upper view, sample Vi-I/36A. **21.** *Anc. rotundiloba* (Bryant) late form of Klapper, Pa element MGUV6044, 21a upper view, 21b lower view, sample Vi-I/36. **22.** *Anc. pristina* Khalymbadzha & Chernysheva transitional form with *Anc. rotundiloba* (Bryant), Pa element MGUV6045, 22a upper view, 22b lower view, sample Vi-I/36.

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Palaeoenvironment

The microfacies analysis of the Comabella Fm indicates that the depositional setting of this formation at Villech was most probably a pelagic marine environment located in an outer carbonate platform or ramp. The presence of small fenestrae-like fabrics and hardgrounds indicate a very calm environment and occasionally the sedimentation rate was very low, even with interruptions in the sedimentation. The presence of coarse micritic matrix together with abundance and diversity of bioclasts suggest a more turbulent environment. Some pulses from a more energetic to a calmer environment are inferred in several stratigraphic intervals. The La Mena condensed red nodular limestones ("Griotte") corresponds to a hemipelagic condensed carbonate ramp.

Conodonts

112 conodont samples have been collected from this section (Figs. 4-6), in all cases from limestone beds. Abundance is variable from 0.2 to 56.6 elements per kilogram. The preservation is moderate; conodonts are not deformed but many are broken. Conodont colour is dark brown, corresponding to a Color Alteration Index (CAI) of 4-4.5.

75 taxa belonging to ten genera (*Polygnathus*, *Icriodus*, *Tortodus*, "Ozarkodina", *Schmidtnathus*, *Mesotaxis*, *Klapperina*, *Skeletognathus*, *Ancyrodella* and *Palmatolepis*) have been identified (Fig. 7).

Biostratigraphy

The conodont record reveals an Eifelian to middle Frasnian age for the sampled interval of the Comabella Fm. and a lower-middle Famennian age for the sampled interval of La Mena Fm.

The lowest record of *Pol. angustipennatus* in the basal bed of the Comabella Fm. placed this sample in the lower part of the Eifelian. Above successive records of the taxa depicted in Fig. 6 allows recognition of the Emsian *kockelianus* and *eiflius* Zones. The interval comprising the Eifelian/Givetian boundary is covered, and the next Givetian sample was initially positioned either in the *timorensis* or the *rhenanus/varcus* Zone. Subsequent establishment of the local composite standard placed this sample in the *timorensis* Zone (Gouwy et al., 2016). Succeeding zones are recognizing by their respective indexes: *ansatus*, *semialternans*, *hermanni*, *disparilis*, *norrisi* and F1. The lowest record of *Anc. lobata* in Bed 43, correlates this level with F6 Zone in the middle Frasnian.

The La Mena section yielded conodonts spanning from the *Palmatolepis glabra pectinata* to the *Pa. mg. marginifera* Zones in the new zonation of Spalletta et al. (2015).

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