

## Pragian-Emsian Conodont succession in the Villech IA and IB sections

Carlos Martínez-Pérez<sup>1,2</sup>, José I. Valenzuela-Ríos<sup>3</sup> & Jau-Chyn Liao<sup>3</sup>

<sup>1</sup>Cavanilles Institute of Biodiversity and Evolutionary Biology, Universitat de València. C/Catedrático José Beltrán Martínez nº 2, Paterna, Valencia (Spain), 46980, Spain; carlos.martinez-perez@uv.es

<sup>2</sup>School of Earth Sciences, University of Bristol, Life Sciences Building, 24 Tyndall Avenue, BS8 1TQ, Bristol, UK.

<sup>3</sup>Department of Botany and Geology, University of Valencia, c/Dr. Moliner 50, E-46100 Burjasot, Spain; jose.i.valenzuela@uv.es; jau.liao@uv.es

**Locality** - In the left bank of Cabiscol stream, 2.6 km south from the locality of Martinet heading the Villech village in the local road LV-4055.

**Lithostratigraphic unit** - Top of Castanesa Fm. and Villech Fm.

**Age** - Pragian-Emsian (Lower Devonian).

**What to see** - Transition between the Castanesa and Villech Formation (Compte Subfacies in the Segre Valley), containing the Pragian-Emsian boundary in both, traditional German and current GSSP senses. The lower/upper *nothoperbonus* boundary.

### How to get there

The Pragian-Emsian sections of the Villech area are located south of the Martinet village, approximately 2.6 km following the local road LV-4055 heading the Villech village, sited all of them in the left bank of Cabiscol stream. The sections described here, Vi-IA and Vi-IB, begin about 120 meters north to the bridge that crosses the Cabiscol stream around 2.5 km from Martinet (Fig. 1).

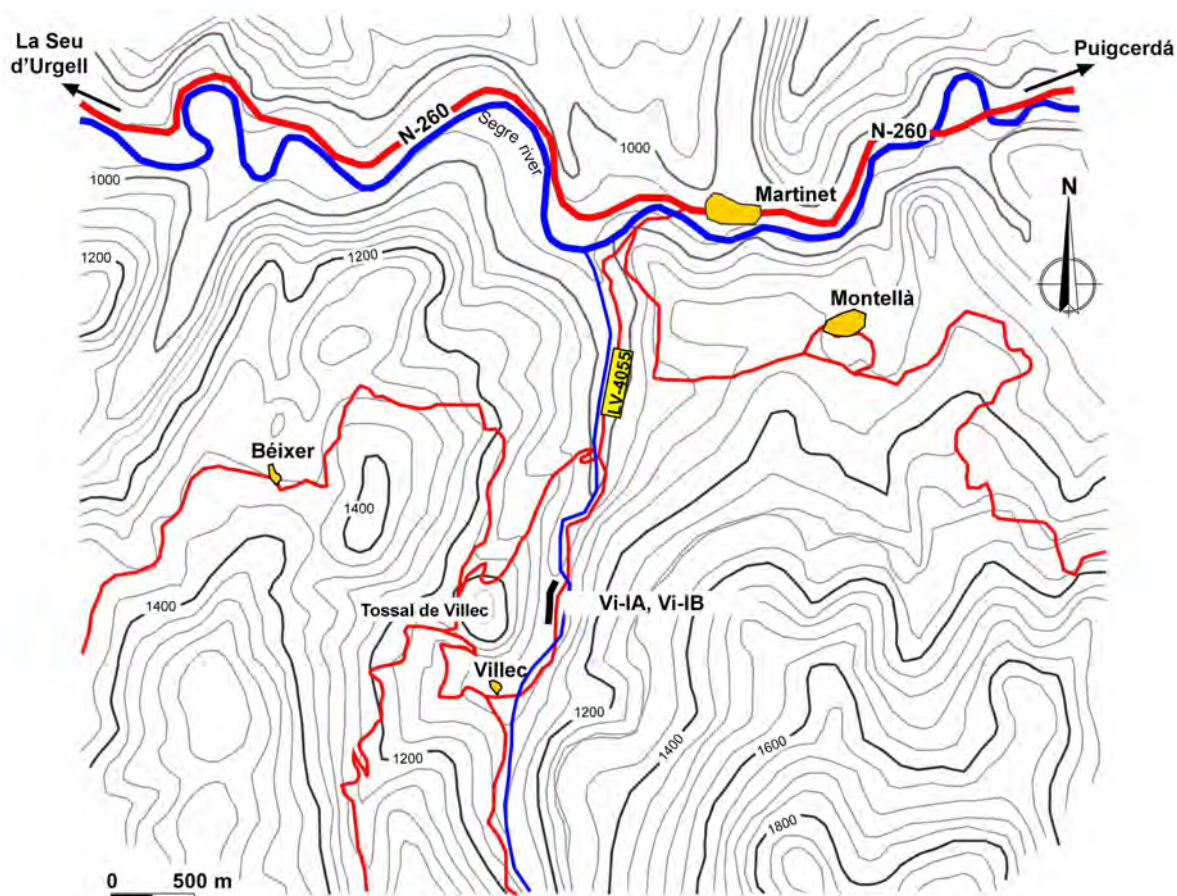
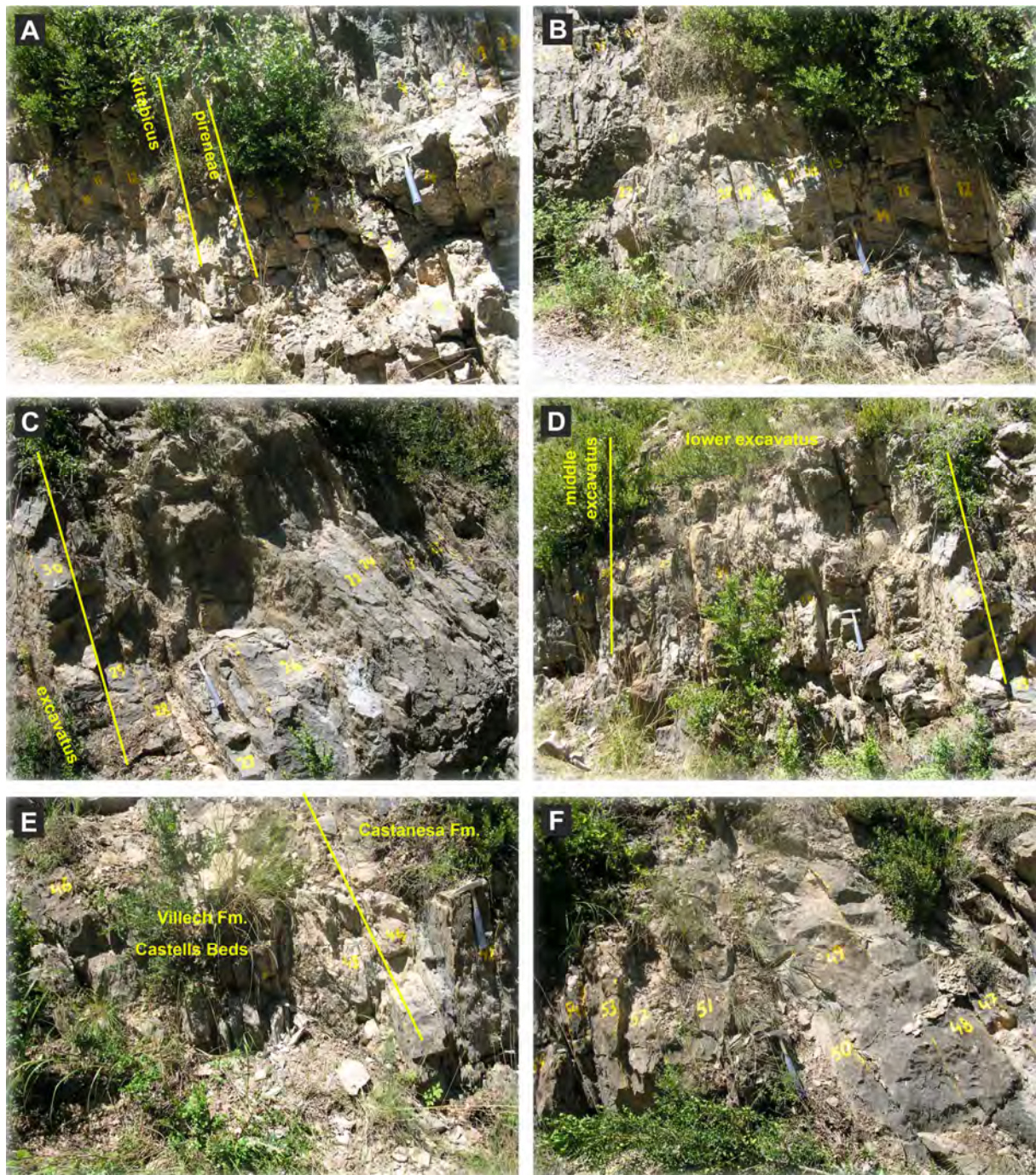


Figure 1. Location map of Villech IA and IB sections.



**Figure 2.** General view and details of the Vilech IA section.

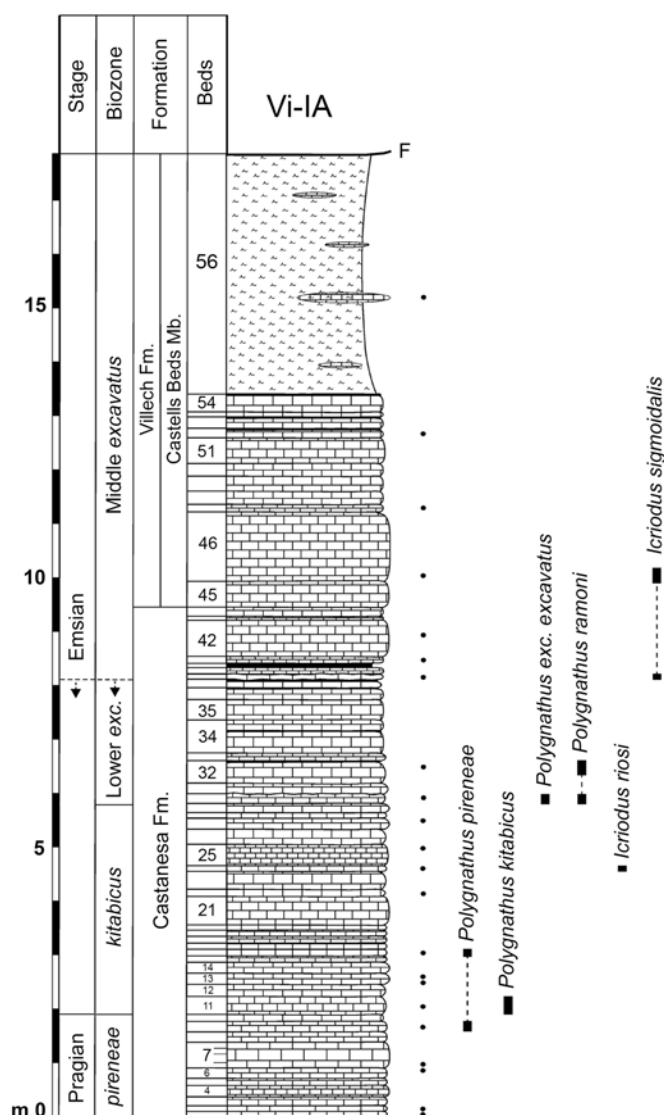
**A.** Lower part of the section (Beds 1-19). The bases of Bed 9 (with *Polygnathus pireneae*) and Bed 11 (the entry of *Pol. kitabicus*) are highlighted. **B.** General view of the *kitabicus* Zone, Beds 12-25. **C.** General view of upper part of the *kitabicus* Zone and beginning of the lower *excavatus* Zone (Bed 30) with the entry of *Pol. exc. Excavates*. **D.** General view of the lower *excavatus* Zone and the suggested position of the base of the middle *excavatus* Zone, traced in the base of Bed 38 with the entry of *Icriodus sigmoidalis*. **E.** Beds 44 (topmost Bed of the Castanesa Fm.) to 46 showing the beginning of the Vilech Fm., Castells Beds in the Vilech area. **F.** Beds 47-55 field view of the Castells Beds in the Vilech area.

### Historical outline

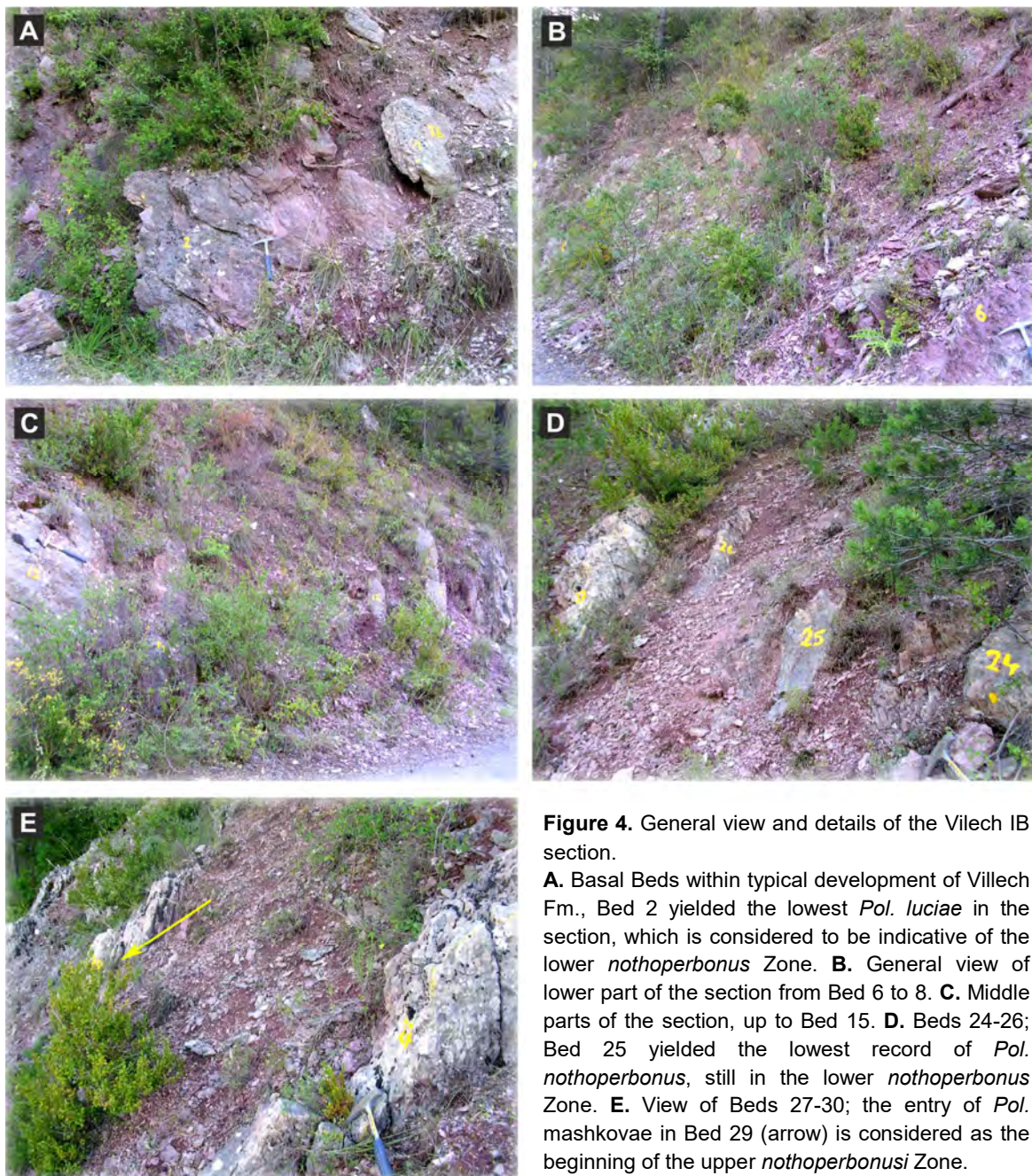
The earliest conodont study in the area was carried out by Boersma (1973), who recognized the uppermost part of the Basibé Formation (*s.l.*), the Villech Formation and what he called the Compte Formation. The sections were later sampled by Valenzuela-Ríos in the course of a Geological Survey, improving the initial dating of Boersma over the entire Villech section. In the last years a more comprehensive study of the whole complex, from the Pragian to the Carboniferous, has pointed out the great potential of the Villech sections for solving important biostratigraphical problems. Regarding the Villech IA and IB, those were first studied in detail by Martínez-Pérez (2010) in his Ph.D. thesis, and later published in several papers, focusing in the relevance of the Vi-IA section in the context of the redefined base of the Emsian (Martínez-Pérez & Valenzuela-Ríos, 2014), and the Vi-IB section for the subdivision of the *nothoperbonus* zone in the lower/upper subzones (Martínez-Pérez et al., 2011).

### Lithology and fossil content

Vi-IA section is oriented N-S and it has been described in the southern flank of a synclinal fold, whose beds are heavily inclined and slightly inverted. The total thickness of the section is 17.5 m where 56 levels have been recognized (Figs. 2, 3). The section shows the transition between the top of the Castanosa Fm, characterized by greyish-blue platy limestones; and the Villech Fm, with an increasing in marls contents, showing a brownish platy limestones, which could be interpreted as belonging to the lower Castells Beds Mb. of the Villech Fm. The top of the Vi-IA section is characterised by 4.5 meters of brown-redish marls, with intercalation of calcareous lens 10-20 cm thick, ending the section in a fault. The Vi-IB section has been described 35 m above of the top of the Vi-IA section, being the base defined by a fault. The whole Vi-IB section has been described within the Villech Fm., characterized by abundant marly intervals with interbedded, decimetric to metric, limestone and red nodular limestones. The section has an approximate thickness of 29 m, where 39 levels have been recognized (Figs. 4, 5). Fossil macro remains are very scarce in both sections but their conodont content have been shown very important.



**Figure 3.** Stratigraphic column of the Villech IA section and conodont distribution (based on Martínez-Pérez, 2010). It contains both basal Emsian boundaries, the current SDS-official one with the entry of *Pol. Kitabicus* in Bed 11 and the intended redefined one, which roughly coincides with the traditional German one and is correlated with the base of the middle *excavatus* Zone.



**Figure 4.** General view and details of the Vilech IB section.

**A.** Basal Beds within typical development of Vilech Fm., Bed 2 yielded the lowest *Pol. luciae* in the section, which is considered to be indicative of the lower *nothoperbonus* Zone. **B.** General view of lower part of the section from Bed 6 to 8. **C.** Middle parts of the section, up to Bed 15. **D.** Beds 24-26; Bed 25 yielded the lowest record of *Pol. nothoperbonus*, still in the lower *nothoperbonus* Zone. **E.** View of Beds 27-30; the entry of *Pol. mashkovae* in Bed 29 (arrow) is considered as the beginning of the upper *nothoperbonusi* Zone.

### Palaeoenvironment

The Castanesa Fm. was deposited in a carbonate ramp that progressively deepens at the end of the formation, in the lower Emsian. According to Sanz-López (2002) this ramp was drowned below the Vilech Fm and evolved to a hemipelagic mixed ramp.

### Fossil content

22 and 18 conodont samples have been collected from the Vi-IA and Vi-IB section respectively (Figs. 3, 5), in all cases from limestone beds. Abundance is generally low in both sections, except for samples 24, 25 and 30 in the Vi-IA section (where 8 samples were barren). Vi-IB section is shown even poorest, where in the richest sample (Vi-IB/25) just 6 elements were recovered and more than half of the samples (10) were barren. The preservation is moderate; some conodonts are strongly deformed and most of them are broken. Conodont colour is black, corresponding to a Color Alteration Index (CAI) of 5.

11 taxa belonging to two genera (*Polygnathus* and *Icriodus*) have been identified (Fig. 6).

### Biostratigraphy

The first conodont record in VI-IA section comes from the Bed 9, which yielded *Po. pireneae* which upper records goes until the Bed 16, suggesting that the lowermost part of the section belongs to the upper part of the *pireneae* Zone. At Bed 11 we registered the unique record of *Po. kitabicus* in the section, suggesting that this level already represents the base of the *kitabicus* zone, indicating the beginning of Emsian in the SDS sense (Yolkin et al., 1994). Next relevant conodonts come from Bed 30 with the joining record of *Po. excavatus excavatus* and *Po. ramoni*, reaching the latter until the Bed 32; hence this level represents the lower boundary of the lower *excavatus* zone (Martínez-Pérez & Valenzuela-Ríos, 2014). The last relevant conodont record of the section comes from Beds 38 to 46 with the recovery of several elements of *Ic. sigmoidalis*. The lower range of this taxon in the Pyrenees seems to be restricted to the middle *excavatus* zone (Martinez-Perez, 2010), so its presence at these levels would already indicate this biozone, without being able to locate its lower boundary in the section. The lower boundary of the middle *excavatus* zone represents the beginig of the Emsian in the traditional German sense.

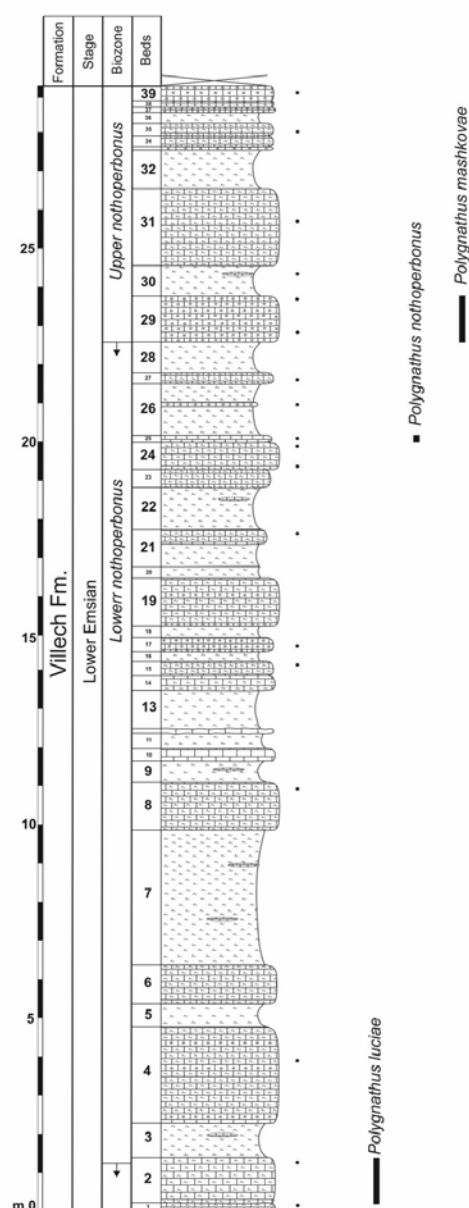
Regarding the conodont record of the Vi-IB section, it is markely poor, with just isolate findings of *Po. luciae*, *Po. nothoperbonus* and *Po. mashkovae* in the Beds 2, 25 and 29 respectively. The first appearance of *Po. luciae* in other Pyrenean sections seems to occur in the lower part of the *nothoperbonus* Zone (Martinez-Perez, 2010), thus, the lower part of this section could belong to this biozone. The next significant conodont records come from Beds 25, with *Po. nothoperbus*, and 29, with *Po. mashkovae*. The record of the latter represents the lower boundary of the upper *nothoperbonus* zone (Martinez et al., 2011), hence indicating that this part of the section would belong to an upper interval within *nothoperbonus* zone.

In summary, these sections contain conodonts indicative of the *pireneae*, *kitabicus*, lower *excavatus*, middle *excavatus*, and lower and upper *nothoperbonus* zones.

In terms of Conodont steps of Carls (1996, 1999) the Vi-IA sequence spans from Conodont step 15 to 17, and Vi-IB sequence spans from the Conodont step 19 to 20.

### Additional remarks

The conodont record of this section is of great significant in the context of redefinition of the base of the Emsian Stage, with the presence in a single section of significant records for both concepts (Martínez-Pérez & Valenzuela-Ríos, 2014), and the proposal of the subdivision of the *nothoperbonus* zone in lower and upper subzones (Martinez et al., 2011).



**Figure 5.** Stratigraphic column of the Villech IB section and conodont distribution (based on Martínez-Pérez, 2010).



**Figure 6.** Conodonts from the Villech IA and IB section. All scale bars = 200 µm.

**1.** *Polygnathus exc. excavatus* Carls & Gandl, Pa element MGUV-20.886, 1a) oral view, 1b) aboral view; Sample Vi-IA/30. **2.** *Polygnathus kitabicus* Yolkin et al., Pa element MGUV-20.926, 2a) aboral view, 2b) oral view; Sample Vi-IA/11. **3.** *Polygnathus mashkova* Bardashev, Pa element MGUV-20.957, 3a) oral view, 3b) aboral view; Sample Vi-IB/29. **4.** *Polygnathus nothoperbonus* Mawson, Pa element MGUV-20.967, 4a) oral view, 4b) aboral view; Sample Vi-IB/25. **5.** *Polygnathus pireneae* Boersma, Pa element MGUV-21.006, 5a) oral view, 5b) aboral view; Sample Vi-IA/16. **6.** *Icriodus sigmoidalis* Carls & Gandl, I element MGUV-21.267, 6a) aboral view, 6b) oral view; Sample Vi-IA/46.

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