

Decision on the Boundary Stratotype for the Middle/Upper Devonian Series Boundary

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(with comments by John W. Cowie)

The Middle-Upper Devonian Series Global Stratotype Section and Point (GSSP), which defines the basal boundary of the Upper Devonian Series and the Frasnian Stage, has now been agreed upon. It is exposed at Col du Puech de la Suque section in the southeastern Montagne Noire, France. Full details are given in the following contribution. (J.W. Cowie, Chairman, International Commission on Stratigraphy)

Middle/Upper Devonian Series Boundary

The boundary between the Middle and Upper Devonian Series is coincident with the lower boundary of the Frasnian Stage. The exact position of the Series boundary was chosen by the Subcommission on Devonian Stratigraphy in 1982 to coincide with the lower boundary of the Lower *asymmetricus* Zone, defined by the first occurrence of *Ancyrodella rotundiloba* (Bryant) and referred to as the Lower *asymmetricus* Boundary. The Lower *asymmetricus* Zone is a zonal subdivision of the conodont standard zonation that was established in the early 1960s (Ziegler, 1962) and revised in the early 1970s (Ziegler, 1971).

Boundary Stratotype

The stratotype of the Lower *asymmetricus* Boundary is in the exposure at Col du Puech de la Suque section E in the southeastern Montagne Noire, France (Fig. 1). The section is located on the eastern slope of the hill 358, about 50 m ENE from the crest, at 1.1 km SE of St. Nazaire-de-Ladarez (1:25,000 Sheet St. Chinian, x = 660.67, y = 133.95). Col du Puech de la Suque section E is primarily a natural outcrop (Fig. 2) that has been enhanced by excavation of some formerly covered beds; the sequence of beds is overturned, dipping about 60° to the west.

Section E is characterized by a sequence of predominantly red and grey pelagic calcilitites, punctuated by hardgrounds that are mainly in the part of the sequence above the boundary level (Fig. 3, and see Fig. 5 of Feist and Klapper, 1985). The section has been described in detail, including location maps, columnar diagrams and a section profile, by Feist and Klapper (1985, p. 3-5, Figs. 2 and 5), House and others (1985, p. 6, Figs. 1 and 2), and Klapper (1985, Fig. 2). The proposal that this be the boundary stratotype section for the Middle/Upper Devonian Series boundary was published by Feist and others (in Ziegler and Werner, 1985).

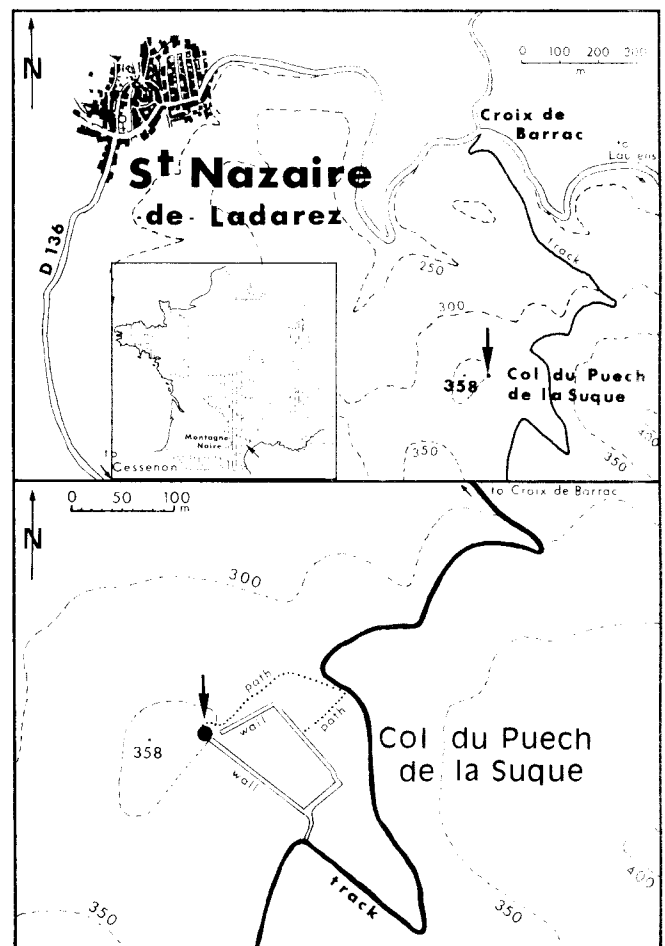


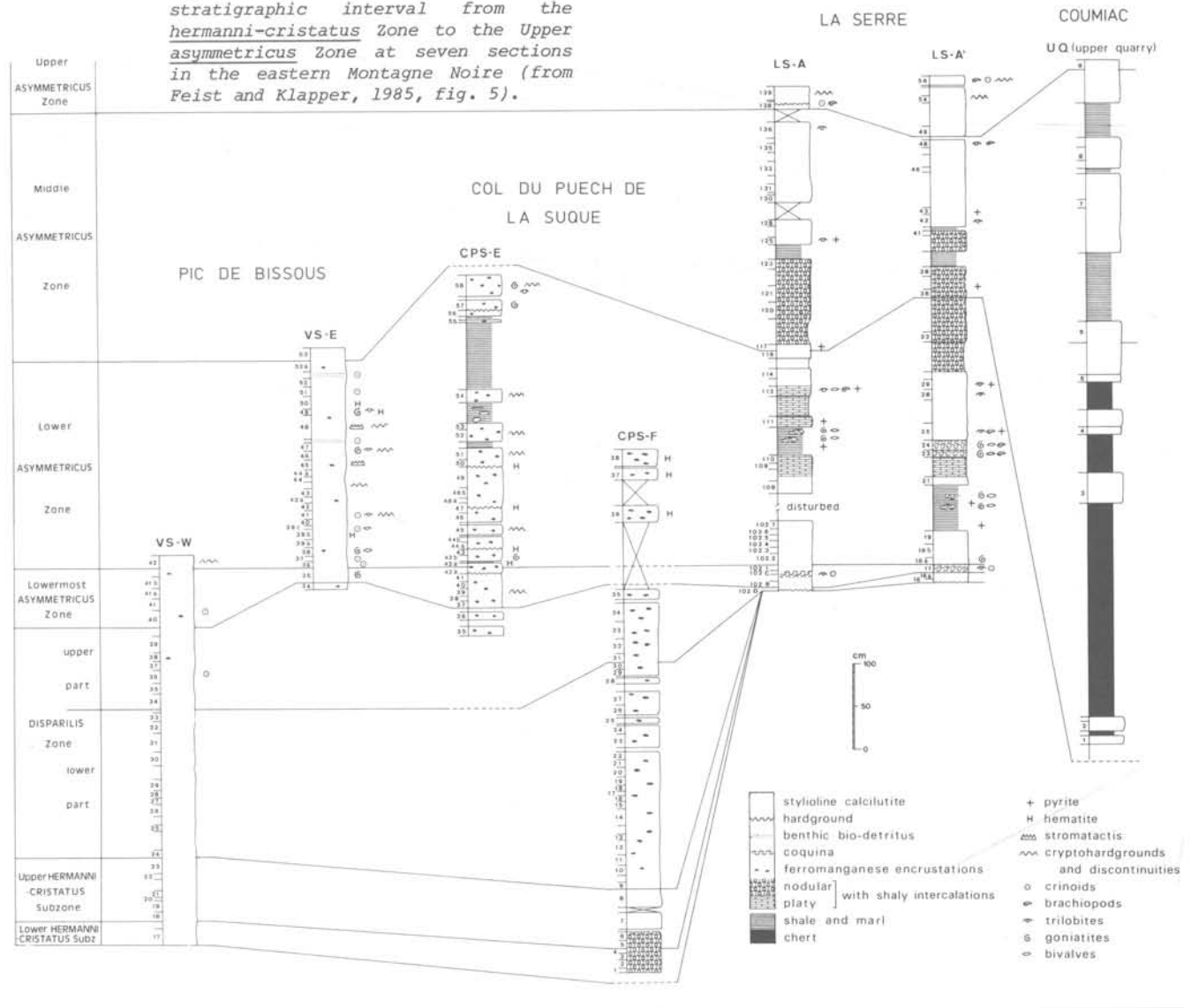
Figure 1: Location of the site of the boundary stratotype section for the Middle/Upper Devonian Series boundary, at Col du Puech de la Suque, France.



Figure 2: A. Stratotype section at Col du Puech de la Suque section E showing the boundary beds cropping out adjacent to the end of the wall on the eastern slope of hill 358 (in the background). Hammer is on beds 39-41. B. Close-up of overturned Middle/Upper Devonian Series boundary beds

shown in A. The base of the Upper Devonian Series, the Frasnian Stage, and the Lower asymmetricus Zone is at the base of bed 42a'. Hammer (28 cm long) is at same position as in A, and the end of its handle is slightly above the top of bed 41.

Figure 3: Cross section of the stratigraphic interval from the hermanni-cristatus Zone to the Upper asymmetricus Zone at seven sections in the eastern Montagne Noire (from Feist and Klapper, 1985, fig. 5).



Col du Puech de la Suque section E has been sampled for conodonts at a fine scale in a nearly continuous manner (Figs. 3, 4). The lowest occurrence of *Ancyrodella rotundiloba* is at a level 8-11 cm above the base of a 13-cm bed, which was divided for sampling purposes into an 8-cm thick bed (42a) and a 5-cm layer (42a'; Figs. 2, 4). There is no obvious hiatus, hardground, or sampling gap associated with the entry of *Ancyrodella rotundiloba* within the 13-cm bed. The Global Stratotype Section and Point (GSSP) is at the base of bed 42a'.

There is no problem of access to the section, either politically or logistically. The section is situated above an abandoned vineyard that is enclosed by thick, stone walls; it is adjacent to the northwestern corner of the enclosed area (Fig. 1). The land containing the stratotype section is owned by the commune of St. Nazaire-de-Ladarez and permission to visit the outcrop can be granted.

Criteria for Recognition and Correlation of the Lower Asymmetricus Boundary

The lowest occurrence of *Ancyrodella rotundiloba* defines the lower boundary of the Lower asymmetricus Zone. The predecessor species is interpreted to be *Ancyrodella binodosa* Uyeno (see Bultynck, 1982a; Ziegler and Klapper, 1985, p. 107), and its lowest occurrence is in the upper part of the subjacent Lowermost asymmetricus Zone, as developed for example in the Belgian and western Canadian sequences. Thus, the recognition of these two zones is supplementary to the identification of the Lower asymmetricus Boundary.

The Lowermost asymmetricus Zone in the Montagne Noire is characterized by a distinctive conodont association of *Polygnathus norrisi*, *Polygnathus asymmetricus* (in some sections), *P. pennatus*, *P. collieri*, and *P. cristatus*? (for detailed discussion, see Feist and Klapper, 1985, p. 12-15). All of these species are present in the zone at Col du Puech de la Suque section E (Fig. 4). The goniatite *Pharciceras* sp. occurs in the Lowermost asymmetricus Zone at the same section, and *Pharciceras* aff. *kiliani*, *Ponticeras* cf. *kayseri*, and *Pseudoproboloceras* cf. *nebechense* occur in the same zone at Pic de Bissous, VS-W, as documented by House and others (1985, Fig. 13; and see Fig. 5 this article).

The phylogenetic development of the early species of *Ancyrodella* within the Lower asymmetricus Zone in the Montagne Noire is the most detailed yet published (Klapper, 1985). Five associations are recognizable, in ascending order: 1) an interval in the lowest part of the zone characterized by the early form of *Ancyrodella rotundiloba*; 2) an interval with both early and late forms of *A. rotundiloba*; 3) an interval with the early form of *A. alata* and the late form of *A. rotundiloba*; 4) an interval with *A. rugosa* and the late forms of *A. alata* and *A. rotundiloba*; and 5) an interval with *A. africana*, *A. pramosica*, the late form of *A. alata*, and *A. rugosa* (only in the lower part). This sequence is well displayed at Col du Puech de la Suque section E and Pic de Bissous, VS-E (Klapper, 1985, Figs. 2 and 1, respectively). In addition to the phylogenetic development within the early species of *Ancyrodella*, a diverse sequence of species of *Polygnathus*, including those of the *Palmatolepis* biofacies, is well represented within the Lower asymmetricus Zone in the Montagne Noire (Klapper, 1985, Figs. 1 and 2; Feist and Klapper, 1985, Figs. 8 and 9).

Major segments of the *Ancyrodella* phylogeny have been found in the same order within the Lower asymmetricus Zone in Belgium (Bultynck, 1982b), New York (Kirchgasser et al., in Ziegler and Werner, 1985, Table 4), western Canada (Uyeno, 1974), and central Nevada (Johnson et al., in Ziegler and Werner, 1985, Table 6, but see version in Corrigenda). The occurrence of *Ancyrodella rotundiloba* itself is widespread in major Devonian sequences throughout the world (Bultynck, 1982a).

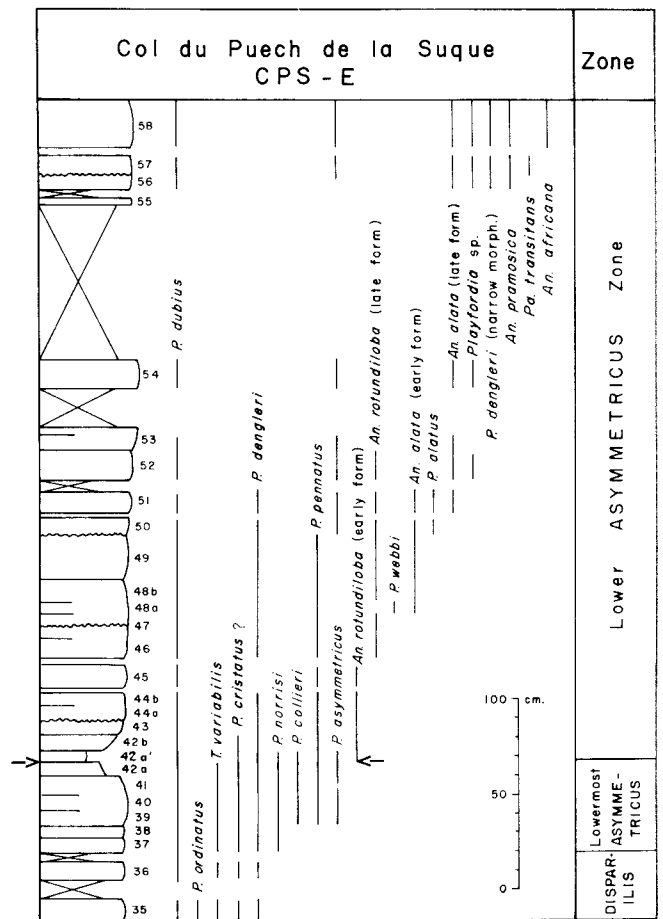


Figure 4: Ranges of conodont species from the *disparilis* Zone to a position near the top of the Lower asymmetricus Zone at Col du Puech de la Suque section E. Generic abbreviations are as follows: P. = *Polygnathus*, T. = *Tortodus*, An. = *Ancyrodella* and Pa. = *Palmatolepis*. From Klapper (1985, fig. 2).

The new level for the Middle/Upper Devonian boundary falls within the old goniatite zone of *Pharciceras lunulicosta* (formerly equal to zone Ia on Figure 5), the base of which represents one of the major breaks in goniatite evolution. Recent work on the faunal subdivision of the old *Lunulicosta* Zone has enabled correlation with the new boundary. At the Montagne Noire stratotype section pharciceratids are common below the boundary but rarer above. *Proboloceras* first appears low in the Lower asymmetricus Zone at Col du Puech de la Suque section E, within the first interval described above (Fig. 5). *Koenenites*, represented by *K. lamellosus* and *K. sp.*, appears high in the zone and in the fifth interval at the same section (House and others, 1985, Fig. 13), and *Hoeninghausia* is known a little higher at La Serre. Probably most significant is the new form *Petteroceras feisti*, which occurs in the lowest part of the Lower asymmetricus Zone. This appears to represent a stable-lobed descendant of *Petteroceras errans*, known in North Africa from rather older levels.

The stratotype section in the Montagne Noire is thin and reduced. In the thicker New York sequence a more detailed goniatite succession is known (Kirchgasser and House, 1981, Kirchgasser et al., in Ziegler and Werner, 1985), which shows the entry of *Koenenites* and *Proboloceras* in the first interval of the Lower asymmetricus Zone and also *Hoeninghausia* in the upper interval (House and Kirchgasser, unpublished), thus confirming the sequence of the stratotype.

In addition to conodonts and goniatites, trilobites, tentaculites, and brachiopods (at some levels) occur in the Montagne Noire sections shown in Figure 3. These latter three groups are presently under study.

Discussion

At the 1982 Subcommittee meeting, when the Lower *asymmetricus* Boundary was adopted as the biostratigraphic level for the Series boundary by a nearly unanimous vote of the attending titular members, it was also agreed that the boundary stratotype section should be selected in a pelagic facies sequence. Thus, the type Frasnian section in the Ardennes, which is in a neritic facies sequence, was suggested as a possible candidate for an auxiliary stratotype.

In addition to the pelagic sequences in the Montagne Noire, those in southern Morocco were also proposed as candidates for the boundary stratotype at the 1983 and 1985 meetings of the Devonian Subcommittee. The Moroccan sections were given serious consideration because they represent demonstrably better exposures and contain more abundant and better preserved goniatites at many levels, as compared with those in the Montagne Noire. Nonetheless, all of the considered sections in Morocco (Bensaid et al., in Ziegler and Werner, 1985) have deficiencies in the conodont and/or goniatite record at the apparent position of the lower boundary of the Lower *asymmetricus* Zone.

For example, in the condensed bed just above the boundary at Bou Tehrafine I (Bensaid et al., *ibid*, Fig. 2) *A. rotundiloba* occurs together with *A. alata* at the base of the bed and *A. pramosica* first occurs only slightly above the base. This indicates that the lower part of the Lower *asymmetricus* Zone is not represented, according to the sequence developed in the Montagne Noire. Another section, El Atrous (Bensaid et al., *ibid*, Fig. 6) has an evidently consequential gap in the conodont sequence between the highest sample of the Lowermost *asymmetricus* Zone and the lowest productive sample of the Lower *asymmetricus* Zone, which again contains *A. alata* indicating that it does not represent the base of the zone. Furthermore, the section lacks goniatites in the Lower *asymmetricus* Zone.

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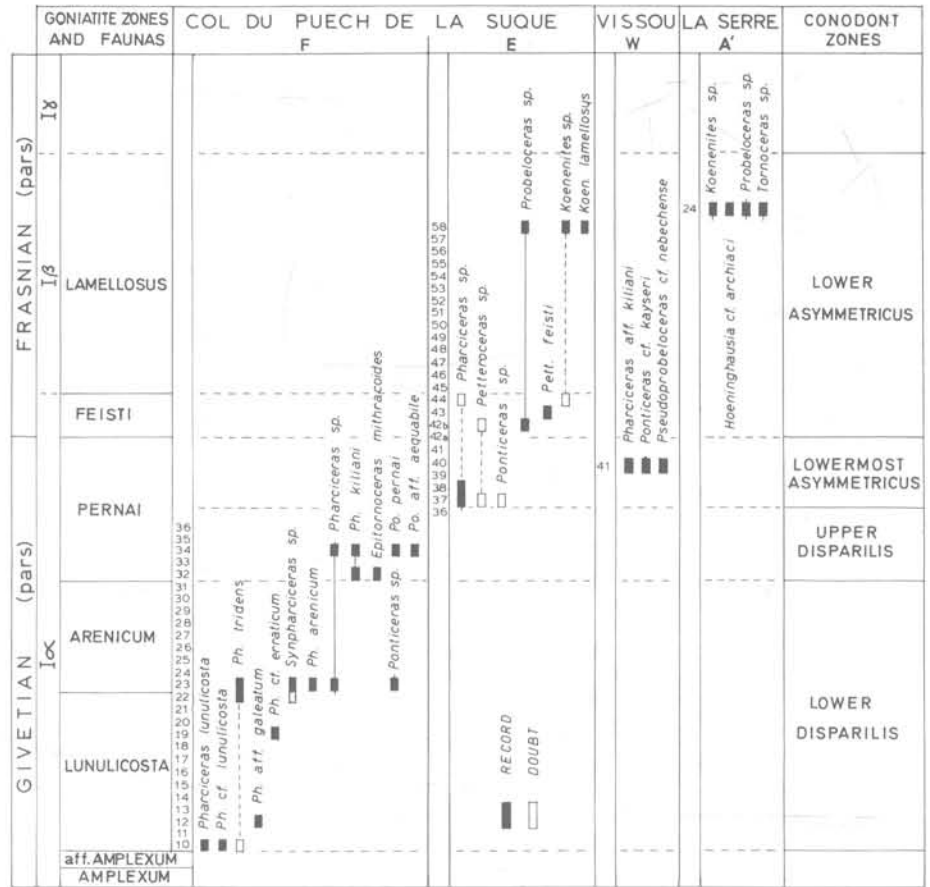


Figure 5: Range chart of goniatites in the principal sequences studied across the Givetian-Frasnian boundary in the Montagne Noire (from House et al., 1985, fig. 13).

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The precise Point of the GSSP is defined in the foregoing at the base of Bed 42a' (Fig. 2B; note the tick above the a in the Bed number - an essential feature). Bed 42a' is a stratum 5 cm thick, part of a pelagic calcilitite succession. There is no obvious hiatus, hardground or sampling gap associated with this part of the succession and the GSSP coincides with the first appearance of Ancyrodella rotundiloba (Bryant). The first arrival datum (FAD) of this conodont species is the biostratigraphic guidance used in the selection of an appropriate GSSP (a point in rock), which is referred to as the basal Lower asymmetricus Boundary. The Lower asymmetricus Zone is a subdivision of the conodont standard zonation that was established by Ziegler (1962, 1971).

The underlying zone of the Middle Devonian Series and of the Givetian Stage is known as the Lowermost asymmetricus Zone. The GSSP at the base of the Frasnian Stage (described above) automatically defines, in line with ICS procedure (Cowie et al., 1986, p. 8), the top of the Middle Devonian Series, also the top of the Givetian Stage as well as the top of the Lowermost asymmetricus Zone.

Voting ('titular') members of the Subcommittee on Devonian Stratigraphy accepted this GSSP by a vote YES - 16, NO - 3, No opinion 1, no response 1. The International Commission on Stratigraphy approved this definition with a vote of YES - 19, NO - 1, Abstentions 2. Ratification by the Executive of IUGS was granted in February 1987.

A global overview of Devonian Subcommittee boundary decisions and their wide usefulness has been edited by Ziegler and Werner (1985).

The brief check-list for criteria (1-9) used in selection of a Global Stratotype Section and Point

(GSSP) under ICS Guidelines (Cowie et al., 1986, p. 10) is here considered for this GSSP. Other publications deal with the topic in detail.

1. "Explicit motivation for the preference": Ancyrodella rotundiloba is an easily recognizable species that is part of a well-documented phylogeny and predecessors and transitional forms permit additional means of identification of the Lower asymmetricus Zone. A. rotundiloba is a widespread taxon ecologically, occurring widely in both neritic and pelagic facies and is well known from all relevant Devonian areas in the world.
2. "Correlation on a global scale": in addition to A. rotundiloba, other conodonts, goniatites, trilobites, tentaculitids and brachiopods occur and global correlation seems assured.
- 3-6, 8. The criteria, 3. "completeness of exposure," 4. "adequate thickness of sediments," 5. "abundance of well preserved fossils," 6. "favourable facies for widespread correlation" and 8. "amenability to magnetostratigraphy and geochronometry" are all satisfied by the GSSP. Comment is needed on criteria 7 and 9, however.
7. "Freedom from structural complication and metamorphism." The unmetamorphosed succession is overturned, but mapping and section-measuring remove any doubt as to the true succession and the straightforward interpretation of the lithostratigraphy.
9. "Accessibility and conservation." There is no problem of access to the section, either politically or logistically. It is adjacent to a vineyard owned by the commune of St. Nazaire-de-Ladarez, and permission to visit the section can be granted, and conservation/preservation is at present assured.

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