

# THE PLIOCENE/PLEISTOCENE BOUNDARY-STRATOTYPE AT VRICA (CALABRIA, ITALY) SURVIVED THE LAST CHALLENGE

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## Background

Following a decade of study and discussions by the International Union for Quaternary Research (INQUA) Subcommission 1a on Stratigraphy (Pliocene/Pleistocene Boundary) and International Geological Correlation Program Project 41 (Neogene/Quaternary Boundary), a draft proposal on the choice of a boundary stratotype for the Pliocene/Pleistocene boundary was submitted and approved by the INQUA Commission on Stratigraphy (acting as the Subcommission on Quaternary Stratigraphy of ICS) at the 1982 Moscow INQUA Congress. A formal proposal was subsequently submitted to and approved by the ICS in 1983 and published two years later (Aguirre and Pasini, 1985) together with the announcement (Bassett, 1985) that the content of the proposal had been formally ratified by the IUGS Executive as GSSP of the Pleistocene. The Global Standard Stratotype-section and Point (GSSP) was placed at the base of a claystone unit conformably overlying the sapropelic bed "e" in the Vrica section in Calabria (Southern Italy). In spite of this, a part of the stratigraphic community, including several continental stratigraphers, refused to accept such a definition and continued to argue against it.

After several informal attempts by the Subcommission on Quaternary Stratigraphy (SQS) to change the officially defined Pleistocene GSSP came to nothing, an ad-hoc Committee was established by the IUGS Executive to advise on the matter. The Committee, chaired by A.R. Palmer and including an equal number of advocates on both sides of the question, met in Strasbourg in March 1997 and suggested to submit the possible lowering of the Pleistocene boundary to a postal ballot within the Subcommission on Neogene Stratigraphy (SNS) and SQS and, in case a majority favored the proposed change, within ICS. The committee also agreed that the Gelasian should remain a valid Stage, thus reducing the matter of the ballot to the possible lowering of the Pleistocene GSSP from the Vrica boundary to the base of the Gelasian. The ballot within SNS and SQS was organized by the Secretary General of ICS and took place in October-November 1998. The scientific documentation attached to the voting form consisted of two memoranda (including several papers on the topic), one presenting the arguments in favor of the lowering of the boundary, the other defending the existing, official boundary.

## Results of the ballot

Before reporting the results of the ballot, a few remarks are in order to elucidate the somewhat complicated voting procedures. In fact, due to the different number of voting members in the two Subcommissions (SNS has 31 voting members, compared to the 20 of SQS), it was decided to normalize the vote within each Subcommission, so that each of the two would account for 50% of the total. In addition, the presence of four scientists with a double membership, further complicated the counting procedure (their vote was split in two halves, one for each Subcommission).

We report here below both the overall results of the vote (the simple report of all received votes) and the normalized results of the vote, which is the official outcome of the ballot.

Thirty-four members (72.3%) have cast a vote. Out of these, 13 have voted in favor of lowering the boundary (38.2%), 20 have voted against the lowering (58.8%), with 1 abstention (2.9%). There are "yes" and "no" votes in both Subcommissions, and this speaks in favor of a vote based on objective criteria. However, the general tendency with SQS in favor of a change and SNS against is quite clear. This determines a marked increase of the percentage in favor of the change, when the normalization procedure described above is applied: 50.1% of the normalized votes are in favor of the lowering of the boundary, 47.8% are against it (with 2.2% of abstentions). According to the statutes and guidelines of ICS a majority of 60% of the delivered votes is required for the acceptance of a submission.

The demand to lower the Plio-Pleistocene boundary, abolishing its previous formal definition, is thus rejected. During the ballot, the SQS Chairman (Prof. T. Partridge) distributed a letter asking to interrupt the vote and to put it off for several years, due to the exacerbated atmosphere of confrontation between the two Subcommission. One may argue that the seven non-voters within SQS would have changed the final results of the ballot, should their vote be supposed as in favor of the change. A simple calculation will, however, show that this is not the case. Adding the 7 non-voters of SQS to the votes in favor of the change would increase the normalized percentage to 53.9%, still clearly missing the score of 60% necessary for the acceptance of the change.

#### The GSSP of the Pleistocene Series at Vrica (Calabria, Southern Italy)

The Vrica boundary constitutes the official base of the Pleistocene since the mid-eighties (Aguirre and Pasini, 1985; Bassett, 1985). Thus, there is no point in describing here the overall characteristics of the section which are thoroughly dealt with in several papers (see in particular the monographic volume edited by Van Couvering, 1997).

However, we deem it necessary to briefly analyze the correlation potential of the Vrica boundary. Here below, we summarize the main chronocorrelation tools in order of decreasing precision and accuracy.

Astrocylostratigraphy: the Vrica GSSP has been shown to correspond to precession cycle 176, as counted from the present (Hilgen, 1991; Lourens et al., 1996).

Magnetostratigraphy: the Vrica GSSP has been shown to lie just below the top of the Olduvai Subchron (C2n Subchron of Cande and Kent, 1995) (Zijderveld et al., 1991).

Marine Oxygen Isotope Stratigraphy: the Vrica GSSP has been shown to correlate with the upper part of Marine Oxygen Isotope Stage (MIS) 65 (Lourens et al., 1996). The abovementioned correlation tools allow for the most precise and accurate worldwide correlation of the Vrica GSSP and permit it to be dated accurately to 1.81 Ma (see Hilgen, 1991; Lourens et al., 1996). Magnetostratigraphy and, to a lesser degree, astrocylostratigraphy, allow the Vrica GSSP to be recognized in continental stratigraphy.

Marine biostratigraphy (see Pasini & Colalongo, 1996, and Vai, 1997, for a review): the Vrica GSSP is best approximated in marine sediments of various facies and from different latitudes by the FO (First Occurrence) of the calcareous nannofossil *Gephyrocapsa oceanica* s.l. (normal sized *Gephyrocapsa* spp. of other authors), occurring some 80 ky younger than the boundary age. It is bracketed by the following calcareous nannofossil biohorizons: LO (Last Occurrence) of *Discoaster brouweri* in MIS 72, some 150 ky older than the boundary, and LO of *Calcidiscus macintyreii* some 150 ky younger than the boundary. Among planktonic foraminifera, the first (common) occurrence of left coiling *Neogloboquadrina pachyderma* occurs in MIS 64 (as in the North Atlantic Ocean), practically in coincidence with the boundary; the FO of *Globigerina cariacensis* occurs in MIS 62, some 60 kyrs younger than the boundary.

Continental biostratigraphy: the Vrica GSSP is close to the *wolf* event (Azzaroli, et al., 1986), characterized in the Olivola fauna of the Val d'Arno by a major turnover in large mammals, especially carnivores, that can be followed into Africa and North America. Simultaneously, in Eurasian small-mammal faunas there are continent-scale events associated with the index FO of *Allophaiomys* (Chaline, 1997). This level is also coincident with the evolution of erectus-grade humans and their dispersal outside of Africa (Aguirre, 1997). The same level is recognized by a sharp, permanent decrease in tropical and moist-temperate elements in the pollen spectra of Eurasia (Grichuk, 1997) during the cool, dry climate of the Eburonian phase. In Italy, it is represented in the disappearance of pollen grains of the so called "Tertiary elements" of the Taxodiaceae Group (the "Tiberian boundary" of pollen stratigraphers: see Lona & Bertoldi, 1973); the latter event has been shown to be virtually coincident with the appearance of the so-called "northern guests" (boreal mollusks) in the marine shelf depositional environment of the Mediterranean region. In fact, the appearance of the "northern guests" in the Mediterranean and the disappearance of the Taxodiaceae in the Italian region were historically the criteria for the Pleistocene boundary, and these criteria were included in selecting the globally correlable

lithic level defining the Pleistocene in the marine, deep water continuous Vrica section (see Pasini and Colalongo, 1996).

### Concluding remarks

Despite the clear result of the vote, its acceptance by Quaternary stratigraphers remains uncertain. The fact that there is a formal boundary definition ratified by IUGS and INQUA was not always made sufficiently clear in recent publications. In some cases, the existing boundary was simply ignored and the base of the Quaternary placed at 2.5 Ma. This behavior emotionalized the discussion which became hotter and hotter in the last years.

Now, this official postal ballot within the two Subcommissions, where the relevant arguments of both sides were presented in an exhaustive and clear manner, will hopefully put an end to all the controversies.

We formally ask IUGS to use all its authority to ascertain that this and all formally agreed boundary definitions be respected by the scientific community.

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