International Commission on Stratigraphy

Subcommission on Neogene Stratigraphy

October 15, 2008

The case for compromise: coping with the destabilizing impact of the Quaternary as a standard chronostratigraphic unit.

Dr Stan Finney, Chair
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Dear Stan,

This is in response to the request by the Subcommission on Quaternary Stratigraphy, submitted on September 1, 2008, to define the Quaternary in a GSSP at the base of the Gelasian Stage, and furthermore to move the base of the Pleistocene to coincide with this. You have in hand an alternative proposal from our Subcommission for a compromise that minimizes the disruption created by imposing this antique and fundamentally irrelevant term on the established chronostratigraphy. We feel that without such a compromise, the only alternative is complete exclusion of the Quaternary from the formal time scale (Gradstein, et al., 2004). There are three main problems with the SQS request:

1. The SQS request violates the basic principle of hierarchical definition, in creating a boundary for the Quaternary a priori, and then requiring that the Pleistocene, a supposedly basic component, be redefined to fit the preconceived boundary.

2. The SQS request, in proposing a formal GSSP in the marine type section of the Gelasian, justifies this as conforming to a concept for the Quaternary that is expressly rooted in evidence for a traditionally favored climate change in continental lithostratigraphy. This is wholly irrelevant to the standard time scale, which is based on the paleontology of marine deposits. The imposition of the incongruous Quaternary boundary in the relationship proposed by SQS needlessly disrupts standard chronostratigraphy and has a destabilizing effect on the literature.

3. The SQS request fails to recognize that despite a loose consensus following the 1948 IGC, the marine-defined Pleistocene has not been formally established as a hierarchical component of the climate-defined Quaternary (point 1). On the contrary, various formalistic definitions of the Quaternary put forth by SQS and INQUA omit consideration of the Pleistocene, except after the fact, and focuses on the exclusive paleoclimatic meaning instead. The System/Period status of the Quaternary claimed by SQS, which leads to so much conflict, is not justified.

In recognition of the importance of the field of Quaternary studies, and with a sincere desire to end the endless controversy and discord, we have suggested that the Quaternary can be accommodated in a compromise that gives it formal status, with the characteristics and boundary desired by the leaders of the Quaternary community. We sincerely trust that the advantages of such a compromise will be honestly considered.

We would like to take the opportunity below, to address the 13 points advanced by our colleagues Phil Gibbard and Martin Head in support of the SQS request.

Point 1. While the concept of the Quaternary was already recognized by Arduino as the fourth and youngest subdivision of the geological succession in the Apennines (1759/1760), the term Quaternary was not formally introduced until 1829 by Desnoyers for a stratigraphic interval (e.g., marine and fresh water deposits of Touraine and Languedoc region of western France) that approximately corresponds with the current Neogene (Berggren and Van Couvering, 1982; Berggren, 1998). It was immediately modified by de Serres (1830) to refer to Diluvial deposits only. Quaternary, like Tertiary, originated in the outdated Neptunian system that recognized the age of rocks by their degree of lithification - in fact it is still the case that unconsolidated alluvium is automatically mapped as Quaternary. Paleogene and Neogene are subdivision of the stratigraphic record based on paleontology. The two models are unrelated, and precedence is thus irrelevant. The terms Tertiary and Quaternary may predate Paleogene and Neogene, but so also Primary and Secondary predate Paleozoic and Mesozoic.

Point 2. The step by step lowering of the base of the Quaternary over the past decades (see our Fig. 2) has reflected shifting ideas in the Quaternary community as to where the traditional concept of "first glacial climate" should be identified. That there is a present consensus in this regard does not validate this procedure of starting with a preconceived idea and looking for its stratigraphic manifestation. It is inconsistent with first chronostratigraphic principles in which boundaries are objectively derived from stratigraphic features.

Point 3. While Walsh (2008) made the point that Hörnes did not include strata of Recent age in the Neogene, he also admitted (*ibid.*, p. 51) that among the various "Newer Pliocene" deposits that Hörnes specifically did include were some that are now considered to be early, middle, and possibly even late Pleistocene in age, in the heart of the same time interval ascribed to Quaternary paleoclimates. More to the point, Walsh stated that the "meaning of almost all standard global geochronologic names have evolved since they were first used, and *whatever* Moriz Hörnes' original meaning of the Neogene was, this original meaning is *fundamentally irrelevant* to the modern classification of the Cenozoic" (italics ours). While Walsh used this line of reasoning to dismiss the case for the current use of Neogene by the marine community, he should have recognized that it applies with equal force to the case for the current use of Quaternary. In other words, if original definitions are irrelevant, the fact that the "first glaciation" is the traditional criterion for the beginning of the Quaternary does not justify an inflexible adherence to this characterization if it conflicts with an otherwise well-established and functional consensus.

Point 4. Our proposal does not treat the Holocene as a subdivision of the Pleistocene, although that has been a valid option in the past.

Point 5. The Vrica GSSP, contrary to the SQS assertion, is in fact widely correlated (cf. Van Couvering, 1997), in close association with the top of the Olduvai Chron and significant faunal changes in the marine and continental realms (not least the earliest *Homo,* at Olduvai Gorge itself). As for it being arbitrarily selected, the program to define the base of the Pleistocene in a physical reference point was set in motion by the 1948 resolution and continued for over 40 years (!!) in IGCP 41, as detailed in the volume cited above. Whether this level is associated with a climatic change greater or less than that evidenced at the Gelasian GSSP, or indeed at any other level in the Neogene, is irrelevant under the principles of chronostratigraphy.

Point 6. We accept that the base of the Quaternary is now defined at 2.6 (2.588) Ma, while noting that the placement of the boundary is plainly a matter of taste. The phrase "first climatic deterioration", as the basis for the present discussion, was introduced in the resolution of the 1948 London IGC. However, the phrase does not refer to the Italian Pliocene-Pleistocene but to the Italian Neogene (King and Oakley, 1949). In this context the first signs of climatic deterioration are in the Miocene (i.e. *Neogloboquadrina* FO at ~11.78 Ma and the *Globorotalia miotumida*

(=*conomiozea*) group FO at 7.25 Ma), while typical large sinistrally coiled *Neogloboquadrata atlantica*, cited as evidence of major deterioration at 2.72 Ma, in fact invaded the Mediterranean at ~7.9 Ma as well. Prominent glacial episodes between 6.3 and 5.5 Ma have been reported by e.g. Van der Laan et al. (2005) with amplitudes in $\delta^{18}O$ (max 0.8, average 0.5 ^{o}/oo) that are not fundamentally different from the amplitudes reached by Late Pliocene - Early Pleistocene glacial cycles (max 1.0, average 0.6-0.7 ^{o}/oo). The Messinian glacials are marked by repeated invasions of sub-polar dinoflagellate assemblages into middle latitudes and ice-rafted debris, seen in North Atlantic cores. To refer to such clearly evidenced events as these, or to the Mammoth event, as "precursors" merely because climate improved afterward is disingenous. All such events (including the Gelasian event) are cold climate maxima in a fluctuating system.

Point 7. We agree that the Monte San Nicola GSSP is widely correlatable because it is associated with a major paleoclimatic event. The Gelasian global stage was not proposed for this reason, however, but to replace the inadequate concept of Astian with a new unit having a stratotype in direct superpositional relationship with the stratotypes of the Lower Pliocene global units in the same part of Sicily. This was done with the *explicit intention* of creating a unified Pliocene mega-stratotype in one marine sequence. Thus it is absurd to reassign the Gelasian to the Pleistocene.

Point 8. The status of the Quaternary remains open for discussion, like everything else that was "prematurely decided" in 2005 and 2007. It should be stressed that the inclusive compromise of Aubry, et al. (2005) was approved by ICS before being rejected by IUGS. The main objection, lack of hierarchy, has been addressed in the present proposal, but the previous compromise remains available as well.

Point 9. There is no fundamental difference between the SQS and SNS positions on the age of the base of the Quaternary, when this is defined in the Monte San Nicola GSSP.

Point 10. The standard global chronostratigraphic scale is the responsibility of ICS / IUGS. It is to be hoped that the basic principles expressed in the ICS Guidelines will be that basis of the final decision in this controversy.

Point 11. We fail to see why a Quaternary Subperiod would be as disruptive as a Quaternary Series that requires decapitation of the Neogene and redefinition of the Pleistocene.

Point 12. We did not intend to have two separate time scales but, in case an inclusive solution is found undesirable, to have a separate chart for the Quaternary with its own – dominantly - continental subdivision outside the global chronostratigraphic scheme. This solution refers to option 6 in Figure 1 in Pillans and Naish (2004). In our opinion such a chart can have a formal status, like any regional chart, and its basic units will exactly match the marine stages of the global chart.

Point 13. We emphasize that in contrast to the SQS proposal, we favor a solution that addresses the concerns of both the marine and Quaternary communities. We believe that it is possible to find a compromise that incorporates the Quaternary as a standard unit with the boundaries and character essentially as proposed by the SQS, while preserving the basic structure of the established Cenozoic time scale. We repeat that a rejection of such a compromise by the leaders of the Quaternary community, in favor of a rigid and needlessly disruptive arrangement such as the proposal submitted by SQS, will meet with little sympathy from the profession as a whole, and will unquestionably lead to a continuation of the schism that presently divides us.

We are grateful to you, and the ICS, for the opportunity to respond, and for your impartial consideration of our presentation.

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