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Quaternary: status, rank, definition, survival

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The long controversy over the term 'Quaternary' as a chronostratigraphic unit may be reaching an apotheosis, judging from recent papers (Pillans and Naish, 2004; Gibbard et al., 2005; and references therein). The debate is no longer centered on whether there should be a place in the geological time scale for a unit termed 'Quaternary' — despite its dubious past, it cannot be denied that a large body of earth-historical research is strongly identified with this term. The challenge now concerns an appropriate rank and definition of Quaternary with regard to other chronostratigraphic units. Several options have been proposed (Pillans and Naish, 2004), and Gibbard et al. (2005) encourage a debate on these before decision is reached. In this brief note, we describe an arrangement not previously considered that seems advantageous. It is instructive, however, to first review the Pleistocene Series and Neogene System, the two units that are directly affected by introduction of the Quaternary into the chronostratigraphic hierarchy.

Nomenclatural clarification

The conceptual differences between Pleistocene, Neogene and Quaternary are still unclear to many workers despite years of debate. An acceptable resolution must take into account the principles and history behind these terms.

Quaternary and Pleistocene

Discussions on the status of the Quaternary, over the past 150 years or more, have been primarily a tug-of-war between the disparate concepts of Pleistocene and Quaternary, as the most recent arguments (Gibbard et al., 2005) clearly demonstrate.

The *Quaternaire ou Tertiaire récent* was added by Desnoyers (1829) to the Primary-Secondary-Tertiary trilogy to designate rocks demonstrably younger than the classic Tertiary of the Paris Basin. The concept of 'Quaternaire' was quickly and sequentially modified, first by Marcel de Serres (1830), who saw it synonymous with Buckland's Diluvium, and then by Reboul (1833) who differentiated it from the Tertiary as containing only fossils of living taxa. The Treatise of d'Archiac (1849) and Morlot's (1854, 1856) introduction of the term in the German literature led to its wide acceptance.

The terms 'Quaternary' and 'Pleistocene' only became intertwined when Lyell (1857a,b) wrote that his 'Newer Pliocene'—which was subsequently renamed Pleistocene—was equivalent to the "*terrain quaternaire, diluvium and terrains tertiaires supérieurs*" of continental Europe. The connotation of a glacial epoch had earlier been given to the Pleistocene (over Lyell's objection) by Forbes (1846), based on Lyell's own discussion of glacially influenced strata in the 'Newer Pliocene'. By transference, but not by original definition, continental glaciation then became the *cheval de bataille* of Quaternary geologists, who today continue to define the beginning of the Quaternary as marked by "a significant intensification of the cooling that transformed the landscape, and processes of sedimentary deposition, across large parts of the globe, especially in the northern latitudes" (Gibbard et al., 2005, p. 3).

The succession of Cenozoic series is now entirely formalized (Gradstein et al., 2004). The base of the Pleistocene, according to Lyell's studies of fossil invertebrates in marine strata of the Netherlands and the Mediterranean, is defined by the GSSP of the Calabrian Stage at Vrica, Calabria (Van Couvering, 1997). On the other hand, the first evidences of marked climatic deterioration in the temperate Northern Hemisphere are now dated to a time well before that (see below).

Neogene and Quaternary

The history of the term Neogene has been recently reviewed by Berggren (1998, 2005). The concept was developed by Hörnes (1853, 1864), based on his observation that invertebrate faunas from upper Tertiary strata had closer affinities to one another than to the Eocene faunas. For this reason, he preferred to assign them collectively to the Neogene. In creating this term, Hörnes referred specifically to the stratigraphic subdivisions of the *Molasse Gebirge*, which had been introduced earlier by Bronn (1834–1838) to be more or less equivalent to Lyell's Miocene and Pliocene (sensu largo), and which included as the youngest subdivision, the *III. Molassen Gruppe*, containing *Alluvial und Quartär-Gebilde zum Theille* (i.e., today's Recent). Thus, in defining the Neogene, Hörnes included numerous strata that are now dated to Pleistocene age, specifically including glacial deposits, and extending to the present day. Hörnes' Neogene was, in fact, very close in scope to Desnoyer's 'Quaternaire', which also extended well into the modern Miocene. The current misunderstanding regarding the span of the Neogene stems from Gignoux (1913), who used Neogene as an undefined synonym for Miocene and Pliocene in the modern sense, and later promulgated this view through his textbook (Gignoux, 1955), contra Denizot (1957). Once this unjustified usage is set aside (Berggren and Van Couvering, 1974) and the Neogene is restored to its original meaning, we must agree that we are presently still living in the Neogene Period.

Nomenclatural Realignment

From the review above, it can be concluded that much of the debate about the place of the Quaternary stems from the fact that it is based on a different concept than other late Cenozoic units. This is not a reason to deny it status: although paleoclimatology is not chronostratigraphy (Aubry et al., 2000), the Quaternary (as understood today) stands for a period of time characterized by distinctive features of the global stratigraphic record. This being so, a physical reference point that relates appropriately to the concept of the Quaternary, so understood, can be legitimately proposed as a chronostratigraphic boundary. As it happens, the presently preferred location of a Quaternary boundary, on "first glacial climate" grounds, is much older than Lyell's concept of the Pleistocene based on marine mollusca. Because the Quaternary has been defined by the Pleistocene, Quaternary workers have fought unceasingly to have the base of the Pleistocene lowered to fit—most recently (Gibbard et al., 2005) by redefining the base of the Pleistocene from the Calabrian GSSP at Vrica (1.8 Ma) to the

Table 1 Proposed hierarchical relationships of Tertiary, Quaternary, Neogene, Pliocene and Pleistocene. Boundary ages (Gradstein et al., 2004) shown in italics. Not to scale.

Era *Erathem*	*Sub-era* *Sub-erathem*	*Period* *System*	*Epoch* *Series*
CENOZOIC	**Quaternary** *2.59* Ma	**Neogene** *23.03* Ma	**Pleistocene** *1.81* Ma
			Pliocene *5.33* Ma
	Tertiary *65.5* Ma		Miocene
		Paleogene	Oligocene
			Eocene
			Paleocene

GSSP of the Gelasian Stage at Monte San Nicola (2.6 Ma). Defenders of the Pleistocene have countered that the Quaternary is a relic of antiquity and should not even exist (i.e. Berggren, 1998). An enduring reconciliation of this dispute has not been found, to date.

To bring the Quaternary into the time scale also creates a second problem—that of its level in the hierarchy. The view of Gibbard et al. (2005) is that Quaternary should properly be a period (system), at the level of Paleogene and Neogene. However, the Neogene extends to the present, and thus its time span covers Quaternary-age strata. Furthermore, the recognition of climate change during Neogene time (Berggren and Van Couvering, 1974) does not alter the fact that Neogene and Paleogene were defined according to the percentage of living taxa in marine invertebrate faunas, with the same logic used by Charles Lyell. This is entirely inconsistent with the essentially continental, paleoenvironmental concept of Quaternary. This means that superimposing the Quaternary at the system level is not simply a matter of renaming a portion of the Neogene. Replacement of the later Neogene with the incompatible concept of Quaternary would violate the meaning of the Neogene, and furthermore, taken together with the redefinition of the Pleistocene to satisfy the Quaternary concept, it would unquestionably meet with overwhelming resistance from the marine community. It is therefore necessary to consider the introduction of the Quaternary into the chronostratigraphic framework from other angles.

If Quaternary is to be accepted as a formal chronostratigraphic unit, it is clear that its preferred definition must not disrupt the existing structure. Convincing reasons are given by Pillans and Naish (2004) and Gibbard et al (2005) for linking the base of the Quaternary to the base of the Gelasian Stage at c.2.6 Ma. In order to reconcile this definition with the existing time scale, a consensus has developed to decouple the Quaternary from the Pleistocene, and thus to end an unhappy 150-year old relationship for the good of both parties. In the hierarchical structure of the geological time scale it is, of course, unusual to define a unit independently, but in fact it is not unheard of (Aubry et al., 1999). The great benefit of making this exception, for the sake of an appropriate boundary, is that it allows the unquestionably valuable concept of Quaternary to stabilize as a widely used chronostratigraphic unit.

As to the question of appropriate level for the Quaternary, Pillans and Naish (2004) proposed to eliminate conflict with the Neogene by making Quaternary a solitary "subsystem". Although this is scientifically plausible, it is not attractive because this isolated position reinforces the image of an irregular, not-quite-real status. In addition, such a structure is not acceptable to Quaternary researchers because the formerly independent Quaternary Subcommission of the ICS would then logically fall under the jurisdiction of the Neogene Subcommission. Naumann's (1866) subdivision of the Cenozoic into Tertiary and Quaternary suggests another possibility—to link the Quaternary with a revived Tertiary, rather than with the Neogene, in a natural relationship. We note that although there has been little opposition to removing Tertiary from modern time scales (e.g., Cowie and Bassett, 1989), strong interest has been expressed to resurrect it (e.g., Salvador, 2005; F. Gradstein, personal commun., 2005).

The option of placing Tertiary and Quaternary at the "subsystem" level, while allowable in theory, is undesirable because of the objection noted above to a Quaternary subordinate to Neogene, and because Tertiary would be in an illogical relationship as a subdivision of both Paleogene and Neogene. The decoupling of Quaternary from Pleistocene, however, has a second benefit, in that it allows this unit, together with Tertiary, to rise to the level of "sub-era" as primary subdivisions of Cenozoic (Table 1), as earlier recommended by Harland et al. (1990). We believe that in this proposed alignment the Quaternary sub-era, with a stratigraphically defined T/Q boundary of global significance linked to the Gelasian GSSP, will be able to develop as a major conceptual element in the geological time scale, with the option of an independent internal organization that is appropriate to its emphasis on paleoenvironmental studies.

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Hutchison 'Young Scientist' Fund

William Watt Hutchison, "Hutch" to his many friends around the world, was a Scots-born Canadian geologist who served Canada and the IUGS in myriad dynamic and creative ways. Most notably, he served as the IUGS Secretary General (1976–1980) at a pivotal time in its history, and as IUGS President (1984–1987). The same boundless energy, enthusiasm, skill in communications, and ability to foster teamwork that characterized his work with the IUGS also carried him to preeminent scientific administrative positions in the Canadian Government, where he served as Director General of the Geological Survey of Canada and as Assistant Deputy Minister of Earth Sciences. His distinguished career was terminated in 1987 by his untimely death at the age of 52, following a painful struggle with cancer.

One of Hutch's last wishes was to establish under IUGS auspices a memorial foundation intended to promote the professional growth of deserving, meritorious young scientists from around the world by supporting their participation in important IUGS-sponsored conferences. The first 3 beneficiaries of the ***Hutchison "Young Scientist" Foundation*** attended the 28th International Geological Congress (IGC) in Washington, D.C., in 1989.

Initially, earned interest on the funds available to the Hutchison Foundation were insufficient to sustain comparable grants every four years without seriously eroding the principal. For that reason, the IUGS made no grants from the Foundation for the 30th IGC (1996), preferring instead to strengthen the fund by allowing it to earn interest for a longer period of time and by appealing for donations from the international geologic community. Grants from the Foundation again supported deserving young scientists beginning with the 31st IGC (2000), and should continue for future Congresses. The IUGS would like to expand the resources of the Foundation to make it possible also to offer support to deserving young scientists to attend other important IUGS-sponsored scientific meetings. The ***Hutchison "Young Scientist" Foundation*** is a worthy cause that honors a fine, caring man and a distinguished, public-spirited scientist and administrator. The foundation also celebrates and promotes those things that gave Hutch the most professional satisfaction: geology, international scientific collaboration, and stimulating young minds.

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