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Sub-series and sub-epochs are informal units and should continue to be omitted from the International Chronostratigraphic Chart

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In June 2016 the Paleogene, Neogene, and Quaternary subcommissions (ISPS, SNS, SQS) of the International Commission on Stratigraphy (ICS) voted on whether to formalize sub-series and their geochronologic equivalents, sub-epochs. The vote required a 60 percent majority for the proposal to be forwarded to the ICS for further consideration. That majority was not achieved, albeit by a narrow margin, hence sub-series and sub-epochs are currently to be regarded as informal, and if used should carry a lower case modifier, as in lower Miocene and early Pleistocene. To accompany the vote, those who favoured continuation of informal usage were asked to prepare a short summary of the main arguments in support of their viewpoint, as were the proponents of the formalization case. Although this statement was not originally intended for publication, it is reproduced here at the request of the Former Chair of the ICS, so as to put it on record.

Introduction

In June 2016, the three Cenozoic Subcommissions (Paleogene-ISPS, Neogene-SNS, and Quaternary-SQS) of the International Commission on Stratigraphy (ICS) were asked by Stan Finney, Chair of the ICS, to vote on the question of whether sub-series and their geochronologic equivalents, sub-epochs, should be formalized, and hence carry an upper case modifier (e.g., Upper Pleistocene vs. upper Pleistocene; Late Miocene vs. late Miocene) (see Finney and Bown, this volume). The vote was intended to help achieve a common approach because the community was evidently divided and various opinions on the issue existed. To facilitate the vote, two position statements (for and against formalization) were prepared by an ad hoc working group and circulated to voting members along with the ballots. According to ICS rules, a 60 percentage majority in favour of formalization was required for the recommendation to be forwarded to the ICS for further consideration. That majority was not achieved, albeit by a small margin: the overall result was 57% in favour of formalization, and of the three subcommissions, only the Quaternary achieved the 60% mark (see Finney and Bown, this volume, for further details).

The position statements were not initially intended to be published. However, because the case for formalization has been developed into a manuscript (Head et al., 2017), and another paper has appeared arguing for formalization and responding to some of the discussion in the ad hoc working group (Aubry, 2016), we (the members of the ad hoc working group who drafted the case against formalization) were asked to publish the statement so as to put it on record. We stress that our case for retaining informal subseries, given below, was never intended to be a definitive, fully researched piece of scholarship nor a balanced review of both sides of the argument. Nor did it necessarily reflect the settled view of the authors at the time of the vote. It was intended as a short and simple summary of one side of the issue to aid voting members in their deliberations, and was to be accompanied by an opposite case.

Aside from the fact that the 60% majority was not reached, the voting process established two important facts: 1) the status quo is that subseries are informal units, and hence take a lower case modifier; this was accepted by all sides and was the reason why a 60% supermajority was required to make the change; 2) a clear precedent has been set that the issue should be resolved by the whole community and not by individual subcommissions. That is necessary to avoid entrenching a mixed usage (formal for some parts of the stratigraphic

column and informal elsewhere) that would, in our opinion, be the worst possible outcome.

The position statement

A case for clarifying the status of sub-series and sub-epochs as informal terms and continuing their omission from the International Chronostratigraphic Chart

Discussion document for consideration by the ICS Subcommissions on Paleogene, Neogene and Quaternary stratigraphy (ISPS, SNS, SQS), prepared by Paul N. Pearson, Bridget S. Wade, Jan Backman, Isabella Raffi, and Simonetta Monechi (September 2015, modified July 2016).

The *International Stratigraphic Guide* recommends the use of five ranks of global chronostratigraphic unit: eonothem / erathem / system / series / stage (plus their geochronologic equivalents: eon / era / period / epoch / age). There are no sub-series / sub-epochs on the International Chronostratigraphic Chart on any part of the timescale, hence these units are best regarded as informal and, following long established convention, as informal units they should continue to take a lower case initial letter.

Sub-series and their geochronologic equivalents, sub-epochs (henceforth, for convenience, we refer just to sub-series) have been widely, although not universally, accepted and used informally for many years. For instance, this has been the long-standing policy adopted by the International Ocean Discovery Program (IODP) and its predecessors the Deep Sea Drilling Project (DSDP), Ocean Drilling Program (ODP) and Integrated Ocean Drilling Program (IODP) which collectively have made enormous contributions to Cenozoic stratigraphy. In the current style guide (IODP, 2012, no page numbers) under the section "Do not capitalize" it specifically lists "modifiers early / middle / late or upper / middle / lower unless formally defined by the International Commission on Stratigraphy" (ICS) which, it states, only applies to subdivision of certain full series such as Jurassic and Cretaceous. This usage has been constant and rigorously enforced since the 1960s, and has thereby influenced very many stratigraphers including us, and has been used in a very large body of literature. Similarly, the current United States Geological Survey (USGS) style guide, in use for a quarter century, states that for the Cenozoic subdivisions "modifiers (lower, middle, upper or early, middle, late) when used with these terms are informal divisions of the larger unit; the first letter of the modifier is lowercase" (Hansen, 1991, p. 59) and it goes on to give specific examples of the "late Paleocene" and "early Oligocene" (Hansen, 1991, p. 62). Influential timescales such as Berggren et al. (1995) (cited over 3500 times according to *Google Scholar*, accessed February 2016) consistently use lower case modifiers.

The use of sub-series terms for the Cenozoic has a long history, stretching back at least to Lyell (1833, p. 54), who, incidentally, consistently used a lower case modifier as in "lower Pliocene" and "older, middle and newer" when referring to time. In later works he used capital letters but the issue is not of great significance because of course a clear distinction between formal and informal stratigraphic units had not been laid out at that time.

Today, despite being widely regarded as informal, the usage of sub-series is very widespread, and the terms have developed a relatively stable meaning. No doubt their popularity is at least partly because that meaning is more obviously apparent than the formal geographic stage names that form the backbone of the chronostratigraphic chart (e.g., 'upper Eocene' is easier to appreciate and understand than 'Priabonian'). Gradually, as the bases of the stages were formally defined by Global Stratigraphic Sections and Points (GSSPs), so the sub-series took on fixed definitions. A situation thereby developed where the terms became semi-formal and to a large extent they now circulate in competition with the formal stage names. Our sense is that the stages are more frequently used by terrestrial and shallow marine workers whereas sub-series are more prevalent in deep-sea stratigraphy. This has produced a degree of confusion regarding their status and we think it would be of benefit for the ICS to clarify.

In passing, we address an apparent historical anomaly regarding ICS policy of not recognizing sub-series, namely the "Global Stratigraphic Chart of 1989" (Cowie and Bassett, 1989) which was published by the International Union of Geological Sciences as a detachable supplement in the journal *Episodes* to accompany the International Geological Congress of that year. This shows sub-series for the Neogene but not the Paleogene, hence gives a mixed picture. Sub-series did not, however appear on any subsequent ICS chart, which are now updated almost every year (see "http://www.stratigraphy.org/index.php/ics-chart-timescale"), nor on the "Geological Time Scale 1989" of Harland et al. (1989). According to *Google Scholar* (accessed February 2016), Cowie and Bassett (1989) has been cited only 12 times compared to over 4500 citations for Harland et al. (1989) which makes it a rather obscure basis for claiming that sub-series were once sanctioned by the ICS.

Some individuals passionately argue that sub-series should be formalized, while others argue the opposite case with equal conviction; probably the vast majority do not have strong views but would appreciate consistent guidelines. In our opinion, the current majority usage (with formal stages and informal sub-series tolerated) satisfies the needs of the community and we suggest that the ICS produces a statement affirming this to clarify the situation for end users. In this way we aim to gently encourage use of the stages without seeking to suppress the informal sub-series. When / if, in the future, the *International Stratigraphic Guide* is revised, careful thought should be applied to the wording of what constitutes formal and informal usage with respect to the five major subdivisions of international chronostratigraphy as opposed to local units such as beds, members, formations, etc., for which the guide is much clearer.

Specific points in favour of maintaining sub-series as informal are as follows:

- The status quo (e.g., the policy of the ICS over decades, as followed by IODP and its predecessors, and the USGS) should be maintained unless there is a compelling reason not to do so.
- The International Stratigraphic Guide states, in reference to the canonical five ranks of the International Chronostratigraphic Chart: "If additional ranks are needed, the prefixes Sub- and Super may be used with unit-terms when appropriate, although restraint is necessary to avoid complicating the nomenclature unnecessarily" (Murphy and Salvador, 1999, p. 256). Hence, the guide allows, but discourages, the use of sub-series unless needed, which they are not.
- There is little to be gained in terms of stratigraphic resolution by adding a new level of hierarchy to the International Chronostratigraphic Chart to accommodate Cenozoic sub-series because most of them (11 of 16) are stratigraphically synonymous with a single

formal stage whereas the others coincide with just two stages. Such a system is only semi-hierarchical and has a very high level of redundancy.

- The use of formal stages has deep roots in the history of stratigraphy and is fundamental to the construction of the timescale and definition of the GSSPs. Maintaining the stage as the only formal rank below the series helps affirm the methodological / philosophical primacy of the stage in the definition of stratigraphic units.
- Formalizing sub-series might hinder the more widespread adoption of the stages, leading to future divergence of practise rather than convergence.
- The subdivisions Early / Middle / Late or Lower / Middle / Upper are used in the Mesozoic and Paleozoic at the series / epoch rank in a formal sense with capital letter. In the Quaternary there is currently a formal Upper and Middle Pleistocene at the stage / age rank (although that may change). To use the same modifier terms at a third distinct rank on the same chart for the Paleogene and Neogene would be to further complicate the nomenclature and potentially cause confusion.
- For novices and students the geological timescale is notorious for being complicated and difficult to learn and is off-putting to some. Adding a new semi-hierarchical level to the formal nomenclature will only make it seem more complicated.
- To admit sub-series may provide a precedent for splitting other parts of the chart to make way for everyone's 'pet scheme', resulting in a cluttered and complex chart, and not just in the Cenozoic. The current chart has a pleasing and hard-won economy of content and uniformity of style throughout the Phanerozoic and beyond (the Carboniferous sub-systems excepted; but we all know that is a historical compromise between virtually irreconcilable opinions, and should not be cited as a precedent). The case of Cenozoic subseries, which we believe to be favored strongly only by Quaternary workers, is not sufficiently compelling to upset this.

In summary, we recommend that the ICS maintains a disciplined, clear and simple international standard based on the five canonical stratigraphic subdivisions eon / era / period / epoch / age. We suggest that it releases an agreed statement / explanatory note such as:

"Clarification of the informal status of sub-epochs / sub-series in Cenozoic stratigraphy

The International Commission on Stratigraphy does not recognize sub-series / sub-epochs (e.g., 'lower Miocene' / 'early Miocene') as formal stratigraphic units, hence they do not appear on the *International Chronostratigraphic Chart*. For subdivision of the Cenozoic epochs / series, the use of the formal ages / stages (e.g., Danian, Messinian, Calabrian) is encouraged. Nevertheless we recognize that the use of sub-epochs / sub-series is widespread in the community. If used, they should have a lower case first letter to emphasize their informal status."

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