Comments Peter Smolka:

Dear Prof. Hilgen,
Dear SNS members,

having been asked to answer the questions on the status of the Quaternary I answer as follows - mentioning also some aspects that have been discussed on the IGC in Oslo.

1) Stratigraphy is (amongst others) used for dating. That is: We need a framework called time that is independent of the dynamics of the studied processes. Thus stratigraphic boundaries shall not be diachronous ("advancing/retreating of cold environments").

2) The hour-ticks on this "clock" are the GSSPs. They are established after considerable geological review and expertise. These should not be changed unless new geological evidence comes up.

3) The "minutes" and "seconds" on this clock are the short-term fluctuations (in short: orbitally tuned time-series and related). These, also isotope-based (buildup of ice-volume but not advancing of a "cold" environment), are factually worldwide synchronous as such isotope-signals can be seen even in the tropics at sites where the SSTs did not change that much. Thus isotope-shifts, whether in marine or in continental sediments, are, when referring to (globally visible) ice-volume changes a method for dating (and defining) while environmental changes at a certain place are no basis for dating (diachroneity, even as old as Walthers facies law).

When referring to the INQUA positions one should thus, regarding point (3), always keep environmental changes (at "2.6" Ma, impossible for dating), and dating-techniques that may(!) be pulled for grouping(!) time-intervals, such as Gelasian, Pleistocene and Holocene grouped to the Quaternary (worldwide about synchronous isotope-stages at "2.6" Ma, plus environmental changes, usage possible), apart. Grammatically both sound very similar. Geologically it is different.

When coming to a solution one has to be both pragmatical (which grouping of intervals to larger units makes sense) and geological: scientific corner-stones (GSSPs) should not be changed as they are based on geological evidence.

As several solutions exist from the easiest (the INQUA/ICS discussion) to the either more difficult and/or less important:

4a) INQUA/ICS:

Considering the base of the Quaternary at about 2.6 Ma is favored by many. It is a large isotope shift (= something that is not diachronous) both in the marine and the continental realm. Thus this grouping-question one can, either in a vote now or in a vote in 5 years, be handled this way.

My view: Grouping existing time-intervals Gelasian, Pleistocene and, as it is now, Holocene, to the Quaternary is possible and should be this way. Both with respect to the INQUA/ICS discussion and with respect to group "similar units" (Gelasian, Pleistocene, Holocene) with respect to "dissimilar units" ("pre" glacial Pliocene in many areas).

Of course I am aware of NH Pliocene glacial sediments including IRD in the Pliocene Norwegian Sea (ODP Site 642B) and towards the Ochotsk Sea ("SW Bering Sea" and SW of it). There (and not only at these places) is however a pronounced difference between pre 2.6 Ma and post 2.6 Ma sediments.

Note:

==> The grouping keeps(!!!) stratigraphic stability(!): All GSSPs are left as they are<==

4b) All GSSPs ("clock ticks") should be as they are (stability of the stratigraphic framework).

That is:
The base of the Gelasian at "2.6" Ma (with the definition of it)
The base of the Pleistocene at "1.8" Ma (with the deinition of it, e.g. Vrica).
The base of the Holocene at "11.6" ka

This might appear unusual to several INQUA members.

The stability of the fundamental definitions (observations at GSSPs) and the therefore for good reasons established long and careful procedure if a change is proposed, is overall important.

Side aspect: It would even go deep into computer-programs, also well in the future, if the 1.8 Ma of the "base Pleistocene" would by newer datasets/software understood as "2.6" Ma. The change of units (feet/meters or gallons/liters) caused even space-missions to fail and commercial jetplanes (a 767 with quite a lot of passengers on board) to land without fuel.

Even if all developers are encouraged to change their code: It is always possible that some minor "simple" module is not changed (simply because the primary developer did not service it). And: When under time-pressure existing software-modules are grouped together such mistakes, that are quite difficult to find, can always happen.

To avoid mistakes of this kind, which are not yet common in geology, I strongly propose to keep the definitions of GSSPs as they are, e.g. base Pleistocene="1.8" ma but with the base of Quaternary, as wished by many, (including their mentioned evidence to group intervals accordingly) at "2.6" Ma.

I can imagine that the Russian Geoscientific Community and the USGS (both with large countries and large databases) might also fear such problems if the "base of the Pleistocene" is lowered to 2.6 Ma.

Summary: If possible ("by (nearly) all means") keep the definitions of GSSPs as they are, e.g. base Pleistocene "1.8 Ma" and base Gelasian "2.6" Ma.

Having a base of the Quaternary at "2.6" Ma, as many, including many from INQUA wish, is fully consistent with it (grouping of GSSP-defined intervals).

This would mean: Quaternary Present Holocene
11.6 ka Base Holocene
1.8 Ma Base Pleistocene

Quaternary 2.6 Ma Base Gelasian
Pliocene
Pliocene 5.1x Ma
Miocene Top Messinian

This issue, which leaves the definitions of all GSSPs as they are, as said in Oslo: the "hour-ticks" on the clock, can either be voted upon now or in five years, as proposed by Prof. Glandenkov.

Summary: Base Q = 2.6 Ma
GSSPs kept constant Base Holocene "11.6 ka"
Base Pleistocene "1.8 Ma"
Base Gelasian "2.6 Ma"

The quotation-marks are intended to indicate that the precise definition, such as 2.5xx Ma and/or base MIS is meant.

End of the direct answer. Now to related aspects, such as the extent of the Neogene

Other aspects for a possible _later_ vote (in 5 or 10 year):

1) Grouping of units to the Neogene (length of the Neogene)
2) Status of the Holocene, particularly if a new MIS might be introduced data-based, e.g. ongoing climate change, if it shows up in isotope values with respect to past climate changes. Short time-intervals in the Holocene with very high temperatures can also be seen in the Vostok-Curve. If the ongoing climate change is "as persistent as that of other MISes" a new MIS might be introduced. This might then raise the question of the "top of the Holocene" as a possibility of a future discussion.
As this refers to both ongoing developments and ongoing work I regard postponing a vote on such aspects, for example the grouping of the Neogene, as a good idea.

Boundary condition by ICS: Hierarchy of units

Related boundary condition: The Neogene should have the same rank as the Paleogene

And

If a Quaternary exists as a grouping of units (Gelasian, Pleistocene, Holocene) then a Tertiary as a grouping of units (Paleocene to Pliocene) exists as well.

Keeping all this in mind, not much possibilities are left:

Didactical analogon: How would a travel-company distinguish in the catalogue a holiday in a country from the Miocene compared to a "resort" that is "located" in the Oligocene, Paleocene or Cretaceous?
That is: How similar/dissimilar are the units and how, based on such similarities, might they be grouped?

Easy: pre/post K/T, e.g. Cretaceous versus "time after 65 Ma". As not only the large dinosaurs had been affected (polite smile: the "small ones" to be eaten in the Holocene at "Kentucky fried

chicken") but also many other fossil groups having the well-established division Cretaceous/Tertiary makes sense.

With a base of the Quaternary at 2.6 Ma, both marine and continental, we have a grouping Tertiary/Quaternary that is at least as pronounced as Jurassic/Cretaceous.

Plus of course: The rise of fossils that became characteristic to the Holocene, particularly their new ability of "cumulative learning" as Prof. Alvarez (as I remember) pointed out in Oslo. Of course hominid fossils started in the late Miocene. Their "rise to the full extent" appeared in the Quaternary including for example their spread over all continents including (in the Holocene) Antarctica and thus across many environments.

So:
0 Quaternary
2.6 Ma Quaternary
Tertiary
65 Ma Tertiary
Cretaceous

Grouping of the Paleocene to Oligocene (similarity of environments and fossil content) into the Paleogene is sensible.

Note: The "environments" can be pulled for grouping. The definition of GSSPs is "that time at which at the locality condition xyz occurred (such as, but not limited to, fossils)".
See for the "transfer of the meaning" for example the work of Berggren (around 1995).

Grouping of the Miocene and Pliocene makes thus sense as well ("similar" environments, more "modern" appearance of fossils, particularly planktonic Forams).

Here comes the difficult part which, if voting is recommended, might be postponed for some time:

Considering the Quaternary as a "much colder Pliocene plus a fossil genus/species that never appeared before, e.g. one with cumulative learning" is possible.

This, amongst others, would imply: Extent of the Neogene from the Miocene to recent.

That is: To the right of above column.

Considering the definition "Neogene" = "the new what is about to form" this is, particularly regarding the Holocene and the time post 1850 possible.

If one would think in terms of above "didactical analogon" (travel agency that would announce a holiday-resort including "precautionary measures/disclaimers") one could imagine that a holiday in a "Pliocene resort" would in the catalogue not be announced as too different from a "holiday today" except for example a disclaimer regarding "very large sharks" where they occur.

Thus in addition to standard similarities/dissimilarities (fossil content and related) one can feel sympathic with a Neogene up to the present, particularly as right now "quite a lot of environmental change is going on" (Neogene: "the new that is about to form").

==> But: Then the principle of hierarchy as mentioned by the ICS is violated. <=====

Stability of standards is important particularly in times of growing computerization:
See for example symposia/contributions in Oslo with titles like "moving from geological maps to 3D databases". If to such databases through time, software that handles geological processes (dynamics) is added in the future, then stability of "basic definitions" is even more important.

And, often overlooked:

Still many databases are organized hierarchical. They even link computationally stratigraphic units and lithologic units (with certain levels of discretion).
This is an awkwardness of relational databases. Many think this is about "the only" way to handle data (see below, a misconception). As however they exist we have to live with them. Changing basic definitions could mislead internal "serach algorithms" including, where these exist, algorithms for data-correction (such as applying newer definitions in Ma to magnetic boundaries).

Of course geological parameters change independent of each other, e.g. one can have a multitude of stratigraphic units in one lithological unit.

The only larger database system I am aware of that handled it this way (non-relational)e.g. each parameter one entity, boundaries in one parameter may or may not have had anything to do with boundaries in another parameter, was the REGEO system of Shell. Possibly they had been far ahead of their time.

How the system that they employ now handles it I don t know.

For the sake of compatibility, even if one disagrees with the way many current database systems handle geology, one should give the hierarchy-principle of ICS a high priority.

If one database considers the Neogene differently than another and the software is not aware of it, problems occur: These occur particularly if they "expect" a hierarchical organisation so "error-correction routines" might silently change times (non-hierarchical systems do not have such problems as nothing can be expected a priori). Such issues that are well beyond the respected sentence "stability must be maintained" must be considered when changing from hierarchical to non-hierarchical.

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Alternatively one might think about "putting the bracket" left of above column.

This would mean:

Neogene		Holocene
	Pleistocene	
Quaternary		Gelasian

Pliocene
Neogene Miocene
Oligocene
Cenozoic Paleogene Tertiary Paleocene
Mesozoic Cretaceous

This would also not be hierarchical.

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The possibility that is left is the current:

This would mean:
Quaternary Holocene
Pleistocene
Quaternary Gelasian
Neogene Pliocene
Neogene Miocene
Paleogene Oligocene
Eocene
Cenozoic Tertiary Paleogene Paleocene
Mesozoic Cretaceous

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As in the future the Holocene might not be considered "a classical interglacial any more" (see my contribution to the IGC and the respective abstract on the CD, e.g. the data that lead to it) the question will arise:

Is this difference already reflected by the name change, e.g. Pleistocene/Holocene or would, in the future, the Quaternary be considered to exist of Gelasian and Pleistocene?

As regarding this, a variety of questions exist, I propose to postpone voting on "the extent of the Neogene to the present" for some years.

That is: From the geological perspective I myself am sympathic with that position, e.g. Neogene until today.

I consider however also the implications regarding

(a) the stability of ICS principles, such as hierarchy, and
(b) the impact on computational systems particularly as in this field anyway much is in change. In addition well-recognized necessities, such as by the Regeo-System of Shell are apparently widely not implemented (e.g. praise and tribute to Chris Baer of Shell, it had been his views which I found in all aspects fully logical).

Most sincerely,

Peter P. Smolka