Forum

Simplifying the stratigraphy of time: Comments and Reply

COMMENT

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Zalasiewicz et al. (2004) simplify a fundamental aspect of geology by conjoining the disparate entities of rocks and time. We fail to understand how this will "retain precision of meaning" if the distinction between two fundamentally different concepts is dismantled. Zalasiewicz et al. (2004) argue for the abolition of the distinction between time and time-rock units because: (1) the current system confuses geoscientists and/or obfuscates geologic information; and (2) the advent of global stratotype section and points (GSSPs) renders the distinction meaningless. We argue that many of the supposed drawbacks of the current system are only problematic to those unwilling to distinguish between the fundamentally different entities of rocks and time, and we show how the utilization of GSSPs is fraught with problems.

The distinction between time-rock and geologic-time units should be clear to any member of the geological community. The distinction is not confusing: when referring to rocks, use time-rock units, e.g., Lower, Middle, and Upper or, informally, lower, middle, and upper. When referring to geologic time, use geologic-time units, e.g., Early, Middle, and Late or, informally, early, middle, and late. Rocks are the physical manifestation of geologic processes. Time is an abstraction independent of the rock record. We have successfully taught the distinction between time-rock and time units to several generations of undergraduates. Furthermore, with geoscientists publishing in dozens of languages across hundreds of venues, we suspect it is even more advantageous to enforce the distinction. Neither of us are native Spanish or German speakers, yet we can readily tell whether authors are speaking of rocks (*Cretacico Inferior* or *Untere Kriede*, respectively) or time (*Cretacico Temprano* or *Früh Kriede*).

Geologic maps demonstrate that chronostratigraphic terms are easily applied to nonstratified rocks, to at least the level of system. For example, we can refer to a Permian intrusive (time-rock) that crystallized during Late Permian time. Chronostratigraphy is more readily applied to stratified rocks than unstratified rocks, and numerical age dating will always be easier to perform on crystalline rocks than noncrystalline ones. There is no reason to dismantle a system that works well in stratified rocks because it is more difficult to apply to unstratified rocks.

We do not understand what Zalasiewicz et al. (2004) consider essential about the "simplicity of stratigraphic classification." Some stratigraphic concepts are simple—the oldest birds *(Archaeopteryx)* are found in Upper Jurassic rocks, deposited during Late Jurassic time. Removing the distinction between time-rock and geologic-time units obfuscates these concepts and trivializes the extremely important (and readily grasped) concept of superposition. Integrating time-rock units and time also blurs the distinction between the mutually supporting hypotheses of lithostratigraphy, biostratigraphy, and biochronology.

With the steady attacks on evolution by religious fundamentalists, we need to demonstrate that what we know about time, evolution, and the rock record is not based on circular reasoning—to say that *Archaeopteryx* is a Jurassic bird that blurs the line between reptiles (dinosaurs) and birds is one statement. To demonstrate that detailed global lithostratigraphy and millions of fossils arranged in biostratigraphic order support the hypothesized chronology of bird origins is another. These multiple supporting hypotheses are what prevent the logic of geochronology from being circular.

Finally, the confusion and/or redundancy of the terms geochronology and geochronometry is a semantic issue of no real concern.

Regarding the putative utility of GSSPs, Zalasiewicz et al. (2004) ignore the historical precepts of geology, in particular, and science, in general, by pinning their hopes on golden spikes that we suspect are more like mythical silver bullets. Many of the system boundaries, and thus the tie points between the periods, remain unestablished more than two decades after the inception of the concept of GSSPs. The majority of stage (age) boundaries remain in dispute as well. The placement of each and every established GSSP has been hotly contested, and in all cases valid scientific objections to currently accepted GSSPs have been raised, both prior to their establishment and in light of new data. Furthermore, our experience is that GSSP placement is driven as much (or more) by scientific politics as it is by good science. GSSPs are not immutable, although some seem to think they should be (e.g., Holland et al., 2003). Indeed, in the International Commission on Stratigraphy rules for the establishment of GSSPs, it is stated that "a boundary stratotype point can be changed if a strong demand arises from further important research" (Cowie et al., 1986, p. 6; also see Remane et al., 1996).

As further evidence of the silver-bullet nature of GSSPs, consider the consequences if a proposal like that of Zalasiewicz et al. (2004) were raised to abolish all post-Paleozoic chronostratigraphic names with the advent of a magnetostratigraphic time scale. All rocks, both stratified and unstratified, could have simply been redesignated by chron. According to the logic employed by Zalasiewicz et al. (2004), the entire nomenclature of both chronostratigraphy and geochronology would have been vastly simplified by assigning all time-rock and time units to numerically arranged chrons. However, Cenozoic chron 14 is no longer recognized, so if this had happened a whole class of rocks (and therefore time?) would cease to exist from a nomenclatural perspective.

Similar arguments for dismantling Linnean nomenclature in biology could have been raised when Watson and Crick (1953) demonstrated that DNA had the potential to uniquely identify the evolutionary lineage of organisms. However, a half century later we do not classify life based solely on gene sequences or base pairs, in a large part because of the many complications inherent in deciphering genetic sequences. Similarly, GSSPs remain subject to change and do not necessarily lend insight to field workers studying stratigraphic sections that are not readily correlative to a GSSP.

Thus, no matter what the appeal of a golden spike, especially those based on new analytical methods, there is always great potential for change in scientific thought to dislodge it. With the potential plasticity of GSSPs, and the knowledge that the supposed drawbacks of the current system are hardly such, we conclude that Zalasiewicz et al.'s (2004) reasons to conjoin the dual nomenclatures of stratigraphy and geochronology are without merit.

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