Towards a chronostratigraphic timescale for all Earth history

Graham Shields*[1]

[1]University College London (UCL) – Department of Earth Sciences, Gower Street, London WC1E 6BT, United Kingdom

Abstract

The international geological time scale before 720 Ma uses rounded absolute ages (GSSAs) rather than specific events recorded in rocks to subdivide time. This has led increasingly to mismatches between subdivisions and the features for which they were named. A recent review by a working group of the International Commission on Stratigraphy (Shields et al., 2022) led to the following conclusions:
1) Division of Earth's history and geological record can be intuitively divided into its current four eons (Hadean, Archean, Proterozoic and Phanerozoic), whereby the Hadean-Archean boundary is taken to represent the onset of the terrestrial rock record at c. 4.0 Ga, pending establishment of a GSSP.

2) Two first-order (*Archean and Proterozoic eon*) and six second order (*Paleoarchean, Mesoarchean, Neoarchean, Paleoproterozoic, Mesoproterozoic, Neoproterozoic era*) stratigraphic intervals continue to provide intuitive subdivision of post-Hadean to pre-Phanerozoic time.

3) Major transitions in Earth's tectonic, biological and environmental history occurred at approximately 2.5-2.3, 1.8-1.6 and 1.0-0.8 Ga. Rock-based Proterozoic eras would therefore likely begin at or after c. 2.45 Ga, c. 1.8 Ga and c. 1.0 Ga, respectively, based around these major transitions, all of which occurred following orogenic peaks and during times of waning zircon production (post-acme, but not yet zenith) in line with major Phanerozoic boundaries.

4) A new Paleoproterozoic Era would therefore contain only three periods (instead of the current four), beginning at or after c. 2.45 Ga, c. 2.3 Ga and c. 2.05 Ga, respectively, so that the era begins near the end of major Archean BIF deposition, the onset of widespread glaciation and the Great Oxidation Episode, but ends close to the onset of a prolonged period of cratonic, climatic and isotopic stability.

5) As a result, the Statherian Period, currently the last period of the Paleoproterozoic Era, would likely become the first period of the Mesoproterozoic Era. The Siderian Period, currently the first period of the Paleoproterozoic Era, could be renamed the *Skourian* Period, after the Greek word for rust; while 'Siderian' could be retained for the final period of the Neoarchean Era.

6) A revised Mesoproterozoic Era would therefore contain four periods (Statherian starting at c. 1.8 Ga, Calymmian at c. 1.6 Ga, Ectasian at c. 1.4 Ga and Stenian at c. 1.2

*Speaker

Ga) so that it begins after major orogenic climax, but before putative eukaryote-grade fossil assemblages, in the form of ornamented acritarchs and megascopic fronds, and ends after the Grenville Orogeny near to the final amalgamation stages of the Rodinia supercontinent.

7) A revised Neoproterozoic Era would likely contain four periods: a pre-Tonian period starting at c. 1.0 Ga, Tonian at c. 0.80 Ga, Cryogenian at c. 0.72 Ga and an Ediacaran Period, which has a ratified GSSP, dated at c. 635 Ma, so that it begins around the final amalgamation of Rodinia and ends traditionally at the Ediacaran-Cambrian boundary. The pre-Tonian period could be named the *Kleisian* Period, for closure, relating to the final amalgamation stages of Rodinia.

These and other proposals could be considered by future expert working groups or subcommissions to cover the 1) Tonian and Cryogenian periods, 2) Mesoproterozoic, 3) Paleoproterozoic and 4) Archean. Establshing a chronostratigraphic timescale, and essentially replacing all GSSAs with GSSPs, is not only a matter of academic interest for geologists. A robust, coherent and intuitive stratigraphic nomenclature will be of great importance for improving understanding of Earth's history in schools, universities and the wider community, too.

Shields, G.A., Strachan, R.A., Porter, S.M. and 33 others (2022) A template for an improved rock-based subdivision of the pre-Cryogenian timescale. Journal of the Geological Society, 179 (1), jgs2022-222.

Keywords: Geologic timescale, Precambrian, pre, Cryogenian, Chronostratigraphy