Dynamic Proterozoic surface environments, co-evolving life, and possible tectonic and deep-Earth drivers

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After an extended period of relatively high O_2 following initial atmospheric oxygenation (the GOE), a return to low biospheric O_2 dominated the mid-Proterozoic (1.8 to 0.8 Ga). Remarkable biological and biogeochemical stasis also characterized that billion-year window — perhaps resulting from limited availability of oxygen and marine nutrients. This stable record was not without exception, however, including major milestones in evolutionary history, such as the earliest emergence of eukaryotic life and multicellularity. Further, diverse geochemical proxy data point to mid-Proterozoic environmental conditions that were less stable than previously assumed, including possible transient oxygenation of the oceans. The connections among mid-Proterozoic biological innovation, environmental change, and tectonic controls remain essential research themes. Hot topics include the formation and breakup of Nuna and how those events might have linked to episodes of elevated mid-Proterozoic oxygenation and eukaryotic diversification against otherwise low baselines. Relevant to this session are possible links to extensive mid-Proterozoic large igneous provinces (LIPs).

Even more impressive are wide-ranging data types that point to unprecedented evolutionary steps among eukaryotes around 800 million years ago, in phase with a coeval increase in surface oxygenation. These relationships are expressed in geochemical and paleontological observations that fingerprint a fundamental environmental and biological transition. Particularly intriguing are putative connections to the breakup of Rodinia and associated LIPs and their potential impacts on the environment, including nutrient delivery, organic production and burial, and associated oxygenation. The latest Neoproterozoic is similarly marked by suggestions of rising and falling O_2 — dynamic behavior perhaps coupled mechanistically to major climatic events, steps in the evolution (and perhaps extinction) of the earliest animals, and the assembly of Gondwana. Looking ahead, rich biogeochemical, chronological, and paleontological datasets spanning the Proterozoic are poised to intersect with next-generation models for their potential tectonic drivers, including the involvement of LIPs.

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