Goldschmidt 2024 Abstract
https://doi.org/10.46427/gold2024.23384

Co-evolution of life and environments throughout Earth's history from the perspective of biogeochemical modeling of global nutrient cycling

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Despite remarkable fluctuations in atmospheric chemistry and climate, the interplay between life and its environment has persisted on Earth for nearly 4 billion years. Understanding this history represents a fundamental challenge in Earth and planetary sciences, and the insights gained have significant implications for understanding the Earth system evolution (and habitable planets more broadly). One of the overarching goals of Earth system science is to better understand this interacting relationship to unravel the coupled evolution of life and the Earth’s environment.

The availability of nutrients in the environment exerts fundamental controls on the size and scope of the biosphere, which in turn influence the atmospheric and oceanic chemistry and climate by affecting global nutrient cycles. Considering the important role of essential elements in atmospheric and oceanic chemistry, we can expect that a critical aspect of the regulation mechanism of the Earth’s sustained habitability likely lies in the stability and dynamics of nutrient cycling in the Earth system. However, the history of nutrient availability throughout Earth’s history remains weakly constrained by available geologic evidence. Consequently, theoretical models are needed to help interpret and organize the evidence within a quantitative mechanistic framework to understand the coupled evolution of life and the Earth.

This talk will review key advances and future directions in biogeochemical models of large-scale nutrient cycles, with a particular focus on a critical nutrient, phosphorus.