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Phosphorus Cycling Through Space and Time

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The cycling of phosphorus, a biocritical element in short supply in nature, is an important Earth system process. Variations in the phosphorus cycle have occurred in the past. For example, the rapid uplift of the Himalayan-Tibet Plateau increased chemical weathering, which led to enhanced input of phosphorus to the oceans. This drove the late Miocene "biogenic bloom." On glacial timescales, phosphorus is quite dynamic. In terrestrial systems, phosphorus soil mineralogy alters rapidly in response to early soil development, and ultimately becomes limited to plant availability in many setting. In marine systems, the loss of the substantial continental margin sink for reactive P occurs during glacial sea-level lowstands, effectively concentrating phosphorus in the deep sea. Finally, in the modern, the phosphorus cycle is dominated by human activity and agriculture, which causes unwanted pollution due to high phosphorus loading and itself poses significant concerns about the ultimate future availability of this nutrient to feed an expanding human population.

This presentation will cover several critical components of the phosphorus cycle, including terrestrial and marine systems, through the lens of geologic time. This perspective reveals the significant changes that have occurred in the availability of phosphorus through time, and how other biogeochemical systems have responded to these changes. Furthermore, the perspective provides some sobering insights into the mechanisms behind the concentration of marine phosphorus into viable sources of phosphate rock. The rarity of high-quality phosphate rock deposits and the limitation of easily minable reserves are becoming critical, as the human demand for fertilizer phosphorus far outstrips the geologic rate of replacement and few prospects exist for new discoveries of phosphate rock.