Precambrian phosphorite accumulation in the Paleoproterozoic Baraga Group, Michigan, USA

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The Paleoproterozoic Baraga Group of northern Michigan is an ~1200 m thick sedimentary succession of marine clastic, iron formation, and phosphatic sedimentary rocks that accumulated during the world's first phosphogenic episode. Vertical and lateral lithofacies stacking patterns are interpreted to record the inundation and flooding of the Nuna continental margin during two sea level cycles. The base of the first sequence is marked by a transgressive lag directly on Archean basement. This lag is transitional into a highstand accumulation of tidal sandstone. Supratidal phosphatic chert with numerous subaerial exposure surfaces characterizes the bottom of the second cycle. This chert grades upwards into transgressive subtidal deposits composed of interbedded organic-rich mudstone and delta deposits. The top of the second cycle is formed of a thick highstand accumulation of laminated mudstone that is overlain by progradational deltaic sandstone.

The precipitation of sedimentary apatite is interpreted to be the result of iron-redox pumping in conjunction with the microbial degradation of organic matter just below the sediment-water interface within lowstand cherts and transgressive deposits at the base of the second cycle. Such shallow-water phosphorite accumulation contrasts many Phanerozoic depositional systems where phosphogenesis occurs in a mosaic of middle and distal shelf environments. This fundamental difference likely reflects the dissimilarity in the oxygenation state of the seafloor. In the Phanerozoic, phosphorite forms in the full spectrum of shelf environments because the entire seafloor is generally well-oxygenated. In the Precambrian, iron-redox pumping and thus, phosphogenesis, was restricted to shallow-water settings where photosynthetically produced oxygen oases impinged on the seafloor.