Lowermost Cambrian phosphorites from the Malyi Karatau, Kazakhstan

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The Precambrian-Cambrian (PcC) boundary represents one of the most pivotal intervals in Earth's history, as global changes in tectonics, climate and chemistry of atmosphere and oceans induced the worldwide Cambrian Radiation and a concomitant ecosphere revolution. These events, moreover, correlate with the occurrence of the first widespread "giant phosphorites", which are believed to represent a promising environmental archive of P cycling and availability. However, so far, neither the source of phosphate nor the formation mechanisms of these ore deposits are well understood.

Sedimentary successions of the Malyi Karatau (Kazakhstan) offer unique insights because phosphorites and phosphate-bearing sediments of terminal Neoproterozoic and Early Cambrian age document widespread phosphogenesis amid rapid biodiversification. We investigated samples from several sections along a NW-to-SE transect for their sedimentary facies and geochemistry.

The Malyi Karatau sedimentary apatites consist of carbonate fluorapatite (CFA), are mainly crypto- to microcrystalline, and appear pseudo-isotropic under x-nicols. Phosphate mineralization occurs (1) as phoslithoclast packstones and grainstones; (2) as phoslithoclast rudstones; and (3) as stratiform, microbially mediated phosphatic bindstones. Grain size, sorting and sedimentary structures suggest a very shallow, high-energy nearshore depositional environment. The variability in redox-sensitive trace metal enrichment indicates changes in redox conditions at the seawater-sediment interface. REE abundances largely display a seawater pattern, supporting a model of early phosphatization of carbonates from pore fluids related to ocean water. The deposition of overlying and concordant Fe-Mn carbonates during the Early Cambrian marks the termination of widespread phosphogenesis.