Fossil iron-oxidizing lithotrophs preserved in Paleoproterozoic phosphorites: Implications for early phosphogenesis

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The Aravalli Paleoproterozoic phosphorites of Jhamarkotra India, comprised of phosphatic stromatolites, are among the earliest and most phosphorus-rich phosphorites known [1] though the processes involved in enriching these stromatolites in P are not well understood [2]. We present fossil evidence of iron-oxidizing bacteria preserved as twisted-stalk filamentous iron-oxides within these stromatolites and suggest that their presence indicates conditions conducive to phosphate deposition via microbial polyphosphate utilization as a strategy for dealing with alternating redox regimes.

The oceans of the Paleoproterozoic are believed to have been generally ferruginous with locally oxygenated conditions resulting from diurnal cyanobacterial O_2 release, and Papineau *et al.* (2013) cite geochemical evidence of steep and alternating redox gradients in the Aravalli stromatolites, similar to those inhabited by extant neutrophilic iron-oxiding bacteria. In the modern, some chemolithotrophs in marine sediments are known to preferentially store phosphate internally as polyphosphate under oxygenated conditions – then under anoxic conditions, hydrolyze it, release orthophosphate, and drive pore waters to supersaturation with respect to apatite or its precursors [3].

Recent evidence suggests that some marine iron-oxidizing bacteria accumulate polyphosphate [4]. Moreover, the presence of iron oxidizing bacteria in the Jhamarkotra phosphatic stromatolites suggests the presence of steep and fluctuating oxygen gradients that select for polyphosphate accumulating bacteria of the kind that are associated with phosphorite formation in the modern [5].

[1] Cook *et al.* (1990) *Geo Soc London Spec Pub* **32**, 1-22. [2] McKenzie *et al.* (2013) *PreCambrian Res* **238**, 120-128. [3] Schulz & Schulz (2005) *Science* **307**, 416-418. [4] Singer *et al.* (2011) *PLoS ONE* **6**, e25386. [5] Crosby *et al.* (2014) *Geology* **42**, 1015-1018.