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Phosphorites from the upwelling region off Peru – the inferred role of bacterial activity in mineralization

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The burial of phosphorus and the formation of phosphorites (phosphogenesis) in marine sediments represents an important sink in the global phosphorus cycle. Today, neither the source of phosphate of massive phosphorite deposits nor the importance and function of microorganisms in phosphogenesis is known with certainty. To elucidate this further, we carried out geochemical and petrographic analyses on phosphorite crusts of the Peruvian upwelling region at 10˚S/79˚W. This study provides new insight into an environment where phosphorite formation occurs in association with upwelling.

Peruvian phosphorites predominantly consist of a (1) phosphoooid facies and (2) later phosphoritic laminae. (1) Phosphoooids are typified by a distinct concentric structure consisting of alternating light brown phosphoritic layers showing strong autofluorescence, and dark brown non-fluorescent phosphoritic layers. Within the phosphoooid facies, thin microlaminated phosphoritic crusts separate layers of phosphoooids resulting in a successive sequence. (2) Phosphoritic laminae consist of interwoven light brown, fluorescent laminae, dark non-fluorescent laminae and irregular light grey, strongly fluorescent laminae and lenses. The latter are associated with abundant metal sulfides. In the phosphoooid facies, interstitial sulfides sometimes fill the pore space between phosphoooids.

Geochemical analyses of the phosphoritic laminae show strong enrichments of chalcophilic elements (Fe, Zn, Cr, Cu, Ni) and sulfur in contrast to the phosphoooid fa-

cies. High resolution element measurements, using Laser-ICP-MS, reveal enrichment of chalcophilic elements in sulfidic laminae. This coincides with the occurrence of molecular fossils of sulfate-reducing bacteria in the phosphorites.

Geochemical and petrographic results reveal that (1) organic material is enriched in layers, (2) sulfate reduction takes place in the environment where phosphorites are formed, and (3) the availability of hydrogen sulfide apparently varied in the course of phosphorite formation leading to a precipitation of metal sulfides in layers.