Phosphogenesis of the Kunyang Deposit in Yunnan Province: Implications for Environmental Change at the Beginning of the Cambrian

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The Kunyang phosphate deposit is located at about 45 km southwest of Kunming city, the capital of Yunnan province, China. Phosphorite ores are hosted in the early Cambrian Zhongyicun Member and are high grade, with >25 wt % P_2O_5. Lower and upper phosphorite beds are separated by a thick, 535 Ma tuff layer. Samples from the lower phosphorite bed consist of >60 vol % grains cemented by honey brown collophanite. The grains show oolitic textures with organic matter in the core and concentric zonings in the rim. Random orientation and small size of apatite crystals grains are consistent with rapid precipitation within zones rich in microorganisms, indicating microbially mediated accretion of phosphate in early stages. Oolitic texture and sorting clastics in the lower phosphorite bed are diagnostic features of high energy reworking process in a tidal zone.

The upper phosphorite bed is banded, consisting of laminated and massive phosphorite layers. Collophanite in the laminated layers occurred as honey brown cement which bonds the clastic grains, indicating that it was buried early and escaped later reworking processes. Massive phosphorite occurs as 0.2 mm grains. Ripple marks along the boundary of laminated and massive phosphorite is clear evidence of the reworking process. Concentrations of V (ca. 31 ppm) and Cr (ca. 41 ppm) in the upper phosphorite bed are higher than those in the lower phosphorite bed (ca. 11 ppm and 12 ppm, respectively), and are indicative of a relatively oxygen deficient environment. Pb and Zn are preferentially absorbed on Fe-oxides and enriched in the upper phosphorite bed with high average values of 112 and 412 ppm. We attribute petrographical and geochemical differences between the lower and upper phosphorite beds of the Kunyang ore deposit to sea-level change, biological activity, and environmental variation.

The tuff layer between lower and upper phosphorite beds is causally linked to ~535 Ma hydrothermal event and C isotope excursions revealed by sediments deposit in the deep Yangtze basin. Large amounts of fossils are preserved in cherty layers at the bottom of the tuff layer, suggesting that the hydrothermal event led to a significant extinction of life. Stratigraphic correlations reveal that Erjie, Meishucun, Laolin, and Gezhongwu phosphorite sections in the southwest Yangtze block were deposited on a large continental shelf with increasing depth. Variations of C_{CaCO3} values are mainly ascribed to decomposition of organic matter and hydrothermal injections.