

Phosphorite-Hosted Rare Earth Element Deposits of the Zhijin Region, Guizhou Province, China

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The Zhijin region in Guizhou Province, China, contains a series of phosphorite-hosted rare earth element (REE) deposits. Newly published reports indicate a 3.5 Mt resource of REE₂O₃ with an average grade of 1,036 ppm contained in the region. Remarkably, the deposits in this region are characterized by Y enrichment and this type of REE deposit might be considered as a primary source of HREE with the potential to resolve the HREE supply shortage.

The REE-rich phosphorite occurs in the Early Cambrian Gezhongwu Formation, which mainly consists of dolomitic phosphorite and phosphoric dolomite, with siliceous phosphorite in the upper layer and traces of bioclast dolomitic phosphorite. This formation is characterized by stripped texture that comprises dark-colored dolomitic phosphorite and light-colored phosphoric dolomite. Francolite is dominant in phosphorite and accounts for 40% to 70% of the rock. Other minerals in the rock include dolomite and calcite, and minor barite, quartz, chalcedony, pyrite, and clay minerals. The REEs in phosphorite are almost entirely contained in francolite, and REEs substitute for Ca in the francolite lattice. Less than 3% of the REEs occur in monazite or are absorbed by clay minerals. The REE content in phosphorite ranges from 200 ppm to 1,700 ppm and shows a positive correlation with the P₂O₅ content. The REE distribution is characterized by MREE enrichment, LREE/HREE ratio >1, distinct Ce depletion, slight Eu positive anomaly, and Y enrichment.

The REE content and negative Ce anomaly are similar to those of seawater REE. The element ratios, As and Sb concentrating coefficients, Zr-Cr and U-Th relationships, and REE distribution patterns indicate hydrothermal features for the REE-rich phosphorite from the Zhijin region. Many researchers suggest that phosphorus and REEs were deposited from normal seawater involving hot water, but the role of the hot water and the origin of REEs are unknown. The Fe isotope composition of phosphorite and Fe-carbonate shows redox-stratified oceanic conditions during the Early Cambrian, and the upwelling of phosphorus-rich anoxic deep water resulted in the formation of phosphorite deposits in Zhijin region. Deep-sea mud contains a large amount of REEs, and therefore the REEs might have come from deep-sea mud with the upwelling. Biological effects have also been considered one of the causes for deposit formation.

Because the genesis of these deposits is still controversial, further analyses of the distributions and geochemical characteristics of Zhijin phosphorite-hosted REE deposits are needed and more microanalyses are proposed, such as Secondary Ion Mass Spectrometry and Laser Ablation Plasma Mass Spectrometry. Furthermore, comparative studies with other phosphorus deposits, including the Kunyang phosphorus deposit in Yunnan Province and Kaiyang phosphorus deposit in Guizhou Province, are required to investigate the similarities and differences.