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The Genesis of Zhijin REE-Phosphorite Deposit in Guizhou Province, China

Yuling Xie, Yunwei Qu, Ziwei Li, Pei Liang

University of Science and Technology Beijing, Beijing, China

The HREEs (heavy rare earth elements) hosted in phosphorite have significant economic importance, but the origin of the P and the REEs of the phosphorite has been controversial for decades. As a typical marine sedimentary deposit, the P of the deposit has been believed to originate from continent detrital material or from the river. Volcanic material involvement has also been proposed, but the key evidence for that is still lacking. Based on micrography, CL (cathodoluminescence) imaging, SEM/EDS (scanning electron microscope/X-ray energy dispersion spectrum), and TEM (transmission electron microscope) results of phosphorite and the silicate volcanic interlayers in the footwall dolomite, this paper discusses the genesis of the Zhijin P-REE deposit.

Our results show that the phosphorus spherulite usually has a layered outer zone, a microcrystal middle zone, and a crystal inner zone. The outer zone shows isotropism character. The middle zone comprises microcrystal dolomite, apatite, and zeolite. The inner zone includes apatites, dolomite, and quartz crystals, with minor barite, zeolite, asphalt, and pyrite. The CL images indicate high-temperature quartz and apatite characteristics. Laser Raman results show increasing crystallinity (informed from FWHM for the 964 cm⁻¹ peak) of apatite from the outer zone to the inner zone. Some round phosphate and sulfate glassy globes can be found in the quartz of the volcanic rock, implying an immiscibility between silicate, phosphate, and sulfate melts. Combining the ore texture and the mineralogical results of phosphorite spherulites and the discovery of the immiscible phosphate and sulfate glassy globe in volcanic interlayers, it can be concluded that the phosphorus spherulites are chilled volcanic droplets of carbonatite-phosphate melt. The carbonatite-phosphate melt originates from the immiscibility between silicate and phosphate melt. The submarine volcanic origin of phosphorite is significant to the P-REE exploration and also provides new insight into global climate change of that time.