The LREE-depleted apatite: tracker of anhydrite oversaturated magmas

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Giant porphyry Cu-Au-Mo deposits are not only the large metal anomalies but also the huge sulfur anomalies in crust. They have genetic link with oxidized magmas, in which sulfur mostly exists as S^{6+} or SO_4^{2-}. Magmatic anhydrite, the product of sulfate saturation, should be a common minerals phase in such oxidized sulfur-rich magmas. However, magmatic anhydrite is rarely reported in porphyry Cu-Au-Mo deposits since it is easily erased or removed by late hydrothermal fluids. In this study, we provide an example of tracing anhydrite oversaturation in magma related to giant porphyry-epithermal Cu-Au-Mo system in the Zijinshan ore field, South China

An diorite vein, containing over 10 vol.% magmatic anhydrite, is found in the Zijinshan ore field. The diorite has similar zircon U-Pb age with mineralized porphyry. Its trace element composition is consist with arc-magmas that characterized by LREE enrichment. However, the apatite from such anhydrite-enriched diorite has LREE-depleted patterns, which is distinct greatly from the bulk rock. Given that magmatic anhydrite prefer to accommodate LREE, the early anhydrite crystallization, which suggested by anhydrite inclusions in apatite, would consume LREE in melt. The apatite crystalized hereafter inherits LREE-depletion from the anhydrite-oversaturated melt. This result highlights that apatite REE patterns could record whether anhydrite oversaturation occur in magmas or not. Our result provides a new method to trace anhydrite-oversaturated magmas, which could contribute abundant sulfur in the formation of giant porphyry ore systems.