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REE characteristics of anhydrite in the Nihe magnetite-apatite deposit and its relation to mineralization, Middle-Lower Yangtze River Valley metallogenic belt

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Nihe is a major magnetite-apatite deposit located in the northwestern part of the Lu-Zong volcanic basin in the Middle-Lower Yangtze River Valley Metallogenic Belt. Anhydrite is extensively developed in the deposit. The anhydrite can be divided into three types on the basis of mineral assemblage and stage: Type I is tabular violet crystals coexisting with diopside, magnetite, pyrite, and apatite; Type II is tabular white crystals coexisting with pyrite; and Type III is equant pink or white crystals in carbonate-anhydrite veins. We present *in situ* LA-ICP-MS geochemical data for the three different types of anhydrite in the Nihe deposit. From fluid inclusion analysis, the three anhydrite forming environments range from high temperature, high-medium salinity, to low temperature, low salinity. Type I and type II anhydrite was precipitated under near-equilibrium conditions. Type I anhydrite coexists with magnetite, and type II coexists with type I pyrite, indicating that fS_2 in the system increased with decreasing temperature. Type III anhydrite formed at less than 200°C with no associated oxide and sulfide minerals. LA-ICP-MS data indicate that type I anhydrite contains a much higher REE concentration than the other two types, and the REE patterns and Eu anomalies are also quite different (LaN/YbN=1.1-466.3, δEu=0.3-2.4). The main factor controlling the pattern of REEs in anhydrite is deposition of the REE-rich minerals (apatite, titanite, epidote). After precipitating the REE-rich minerals, the REE content greatly decreased in the fluid, resulting in a lack of REEs in types II and III, and their REE patterns are flat. In addition, decreasing fluid salinity caused lower Cl^-/SO_4^{2-} ratios in later stages. Furthermore, some type III anhydrite has elevated LREEs, suggesting some late-stage dissolution and reprecipitation of anhydrite due to fluctuating fluid compositions. Addition of abundant anhydrite to the ore-forming fluid increases fO_2, allowing iron to be transported as $FeCl_4^-$ to the magnetite deposition site.