Apatite luminescence and geochemistry record magmatic-hydrothermal evolution of the gaint Dahutang W-Cu ore deposit in South China

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The Dahutang W-Cu ore district is composed of the newly found giant tungsten deposits in South China. Fluorapatite widely occur as a primary magmatic accessory phase in granitic rocks, a product of early hydrothermal alteration, and/or a gangue mineral in high-grade tungsten ore. Magmatic and hydrothermal apatite from this ore district was systematically studied by combined cathodoluminescence (CL) imaging, electron microprobe (EPMA), and LA-(MC)-ICP-MS analyses. Luminescence of magmatic apatite varies from green CL color with almost homogeneous textures in biotite granite, via violet or green color with various textures from zoned or oscillatory to almost homogeneous color in two-mica granite, to yellow or brown CL in muscovite granite. Typical zoned textures are characterized by a violet core and a green rim. Geochemically, from less-evolved biotite granite to more evolved muscovite granite, REE(Y) vary from LREE-enriched negatively sloped ones to flat ones, with a decreasing trend of REE(Y), Sr, U, Th and Pb and Eu_N/Eu^*, and an increasing trend of MnO.

In contrast, hydrothermal apatite from early hydrothermal alteration and high-grade tungsten ore show green or gray CL colors with totally different geochemical features, characterized by the low Mn, Mg, REE and Mn/Fe, the high Sr, the strong positive Eu anomaly, and the highly radiogenic Sr isotopes. The LREE slope negatively correlates with the HREE slope in the $(Ho/Lu)_N$ vs. $(La/Sm)_N$ diagram. Eu anomalies increase with Sr contents. These chemical variations are likely controlled not only by composition of hydrothermal fluids exsolved from magmas with different degree of differentiation, but also by fractionation of REEs by pre-existing and co-precipitating minerals. Hydrothermal scheelite and apatite likely formed as a result of fluid-rock interaction involving breakdown of plagioclase in wallrock, which provided a large amount of Ca, Eu, and Sr for the W-P-F-rich mineralizing fluids. We conclude that apatite could record the subtle chemical variations of magmatic-hydrothermal fluid, and thus provide important insights into tungsten mineralization.