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Direct evidence for the source of uranium in the Baiyanghe deposit from accessory mineral alteration in the Yangzhuang granite porphyry, Xinjiang Province, northwest China

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Abstract

Circumstantial evidence for the sources of uranium in ore deposits may be drawn from the study of deposit geochemistry and mineralogy. However, direct evidence supporting uranium leaching from source rocks has rarely been found. This study investigates the source of uranium in the Baiyanghe deposit in the Xiemisitai Mountains, northwest China. The main uranium ore bodies occur as fracture-fillings along contact zones between the Yangzhuang granite porphyry and the Devonian volcanic rocks. Zircon, thorite, columbite-(Mn), and bastnäsite are the dominant accessory minerals that host uranium in the granite porphyry. In situ columbite-(Mn) LA-ICP-MS U-Pb dating yields a weighted mean $^{206}Pb/^{238}U$ age of 310 ± 4 Ma, suggesting that the Yangzhuang granite porphyry was emplaced during the Late Carboniferous. Backscattered electron (BSE) images reveal that various degrees of alteration of these same accessory minerals may be observed in the granite porphyry, and the altered domains of these minerals have lower BSE intensities compared to the unaltered domains. Results indicate that the altered domains of zircon grains have lower concentrations of Zr, Si, and U, and higher concentrations of Y, Fe, Ca, and P relative to the unaltered domains, and the altered domains of columbite-(Mn) grains are enriched in Ti and Fe and are depleted in Nb, Ta, Mn, U, and Zr. The altered domains of thorite grains have higher concentrations of Zr, Fe, Ca, Nb, and P, and lower Th and U compared to those of the relict domains. The petrochemical data indicate that the granite porphyry experienced losses in U, Be, F, Ba, Sr, Pb, Zr, Mo, Nb, Ta, and Hf during alteration. These results suggest that the past-magmatic hydrothermal fluids might be responsible for the mobilization of uranium form minerals in the granite porphyry. It is concluded that U-bearing accessory minerals in the granite porphyry were the primary source of uranium, and that post-magmatic hydrothermal processes caused remobilization and significant localized enrichment of the uranium to form high-grade ores as fracture-fillings along its contacts.

Keywords: U-bearing accessory minerals, hydrothermal alteration, element maps, uranium source, Yangzhuang granite porphyry, Baiyanghe volcanic deposit