Geochronology and REE-rich CO_2 fluids in the giant Bayan Obo deposit, China: implications for REE mineralization

HONG-RUI FAN, FANG-FANG HU AND KUI-FENG YANG

Key Laboratory of Mineral Resources, Institute of Geology and Geophysics, Chinese Academy of Sciences, P.O. Box 9825, Beijing 100029, China (fanhr@mail.iggcas.ac.cn)

The Bayan Obo REE-Nb-Fe deposit hosts 70% world's known light rare earth element (LREE) resource, as well as being a major Nb and Fe producer of China. LREE reserves in the deposit are 57.4 million tons with an average grade of 5.17 to 6.19 wt% REE_2O_3, and Nb reserves are expected at 2.2 million tons with an average grade of 0.126 to 0.141 wt% Nb_2O_5. The deposit consists of replacement bodies hosted in dolomite marble, and of magnetite, REE fluorocarbonates, fluorite aegirine, amphibole, calcite and barite.

Zircon from a carbonatite dyke, analyzed by conventional isotope dilution, yielded an upper intercept age of 1417 ± 19 Ma. This age is confirmed by SHRIMP U-Pb analysis of zircon from the same carbonatite dyke, which gave a $^{207}Pb/^{206}Pb$ weighted mean age of 1418 ± 29 Ma. *In situ* Nd isotope measurements of monazite collected from the carbonatite dyke gave an isochron age of 1275 ± 87 Ma. These results demonstrate that the dyke intruded ~1400 Ma. In view of predecessor's results, it is clarified that the REE mineralization of Bayan Obo ore deposit occurred at ca. 1400 Ma, consistent with the timing of carbonatite dyke intrusion in the region.

Three types of fluid inclusions have been recognized on the base of their appearance at room temperature: two phase aqueous liquid-vapor, two to three phase CO_2, and three phase liquid-vapor-solid. Solid phases trapped in the inclusions contain a complex and varied assemblage. REE-carbonates, halite, sylvite, barite, calcite and pyroxene (?) have been identified on the basis of crystal habit (microscopic and SEM) and EDX analysis. The presence of REE-carbonates as an abundant solid in the ore-forming veins shows that the ore-forming fluids are very richer in REE, and therefore, have the potential to produce economic deposits of REE at Bayan Obo without requiring large-scale convective fluid systems and high water-rock ratios typically envisaged for other magmatic-hydrothermal ore-forming environments.

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