The giant Bayan Obo REE-Nb-Fe depsoit, China: Ore-forming process and controversial debate

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Bayan Obo deposit is the largest REE resource, and the second largest Nb resource in the world. Due to the complicated element/mineral compositions and involving several geological events at the north margin of the North China Craton, the REE, Nb and Fe enrichment mechanism and genesis of this giant deposit still remain a topic of intense debate. The ores are mostly hosted in the massive dolomite, and also nearly 100 carbonatitic dykes occur in the vicinity of the deposit. The origin of this ore-hosting dolomite has been proposed for various models, ranging from a normal sedimentary carbonate rocks to volcano-sedimentary sequence, and a large carbonatitic intrusion. The existing petro-geochemical evidences show that the coarse-grained dolomite represents a Mesoproterozoic carbonatite pluton and the fine-grained dolomite resulted from the extensive REE mineralization and modification of the coarse-grained variety. The ore bodies occur as large lenses and underwent more intense fluoritization and fenitization. The fluids involving in the REE mineralization at Bayan Obo might be REE-F-CO_2-NaCl-H_2O system. The traped REE-carbonates solids in the fluid inclusions suggested that the original ore-forming fluids were very rich in REE, and therefore, had the beneficially potential to produce economic REE ores at Bayan Obo. Various dating methods gave different mineralization ages at Bayan Obo, resulting in long and hot debates. Available geochronologic data suggested that the REE mineralization was rather variable with two peaks at ~1400 Ma and 440 Ma. The early and main mineralizing peak closed in time to the intrusion of the carbonatite dykes. A significant thermal event at ~440 Ma resulted the late-stage veining with coarse crystals of REE minerals. The Bayan Obo deposit is a product of mantle-derived carbonatitic magmatism at ca. 1400 Ma, which was likely related to the breakup of Columbia. Some remobilization of REE occurred due to subduction of the Palaeo-Asian oceanic plate during the Silurian, forming weak vein-like mineralization.

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