SEG 2017 Conference

Rare earth element deposits in China: Characteristics and ore genesis

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China is the world's leading rare earth elements (REE) producer and hosts a variety of deposit types. Carbonatite-related REE deposits are the most significant REE deposit type and the REE-bearing clay deposits, or ion adsorption type REE (IAR) deposits, are second in importance which comprise the main source of heavy REE in China. Other REE resources include those within monazite or xenotime placers, beach placers, alkaline granites, pegmatites, and hydrothermal veins, as well as some additional deposit types in which REE are recovered as by-products.

Carbonatite-related REE deposits in China contribute almost all the light REE resource. Two giant deposits presently are mined in China, Bayan Obo and Maoniuping, the first and third largest deposits in the world, respectively. Tectonically, the carbonatite-related REE deposits in China occur along the margins of Precambrian block, including the north, south and eastern margins of the North China block, and the western margin of the Yangtze block which constrain four REE belts, including Proterozoic Langshan-Bayan Obo belt, Paleozoic-early Mesozoic east Dabie belt, late Mesozoic Chishan-Laiwu-Zibo belt and Cenozoic Mianning-Dechang belt. The mantle-derived carbonatite emplaced in the continental rifts (e.g., Bayan Obo) or trans-lithosphere strike-slip faults (e.g., Maoniuping) in reactivated Precambrian craton margins. The subduction of REE enriched oceanic crust underneath the craton margin during the assembley of continental block lead to the REE enriched mantle source for carbonatite magma. The unmixing between alkaline silicate and carbonatite melt lead to intense REE enrichment in carbonatite magma during the evolution of mantle-derived magma. The primary carbonatite fluid which derived from carbonatite melt is of high temperature, high pressure, dense and SO_4, CO_2, K, Na, Ca, Sr, Ba, REE rich characteristics. The sulfate is the dominant agent for REE transportation. Thus the exsolution of sulfate melt from the primary carbonatite fluid lead to the decrease of sulfate in the ore-forming fluid and bulk REE precipitation The following unmixing process between CO_2 and aqueous fluid takes an other important role in REE precipitation. A dense carbonatite fluid and fast evolution is disadvantageous to long distance fluid migration and distal mineralization. Thus, the carbonatite related alteration and mineralization occur in or proximal to carbonatite dikes, sills and/or stocks. High water solubility in the carbonatite magma and very high REE in primary carbonatite fluids imply that a giant carbonatite body, deep magma chamber and vase fluid flux is not necessary for giant REE deposit formation.

The ion adsorption type REE deposits which mainly situated in the South China block are genetically linked to the weathering of granite and, less commonly, volcanic rocks and lamprophyres. Indosinian (early Mesozoic) and Yanshanian (late Mesozoic) granites are the most important parent rocks for these REE deposits. Late Mesozoic A type granite (eg. alkaline granite or syenite) related hydrothermal alteration plays an important role in REE enrichment in the parent rock. Warm and humid weather, low relief hills benefit the enhance enrichment of

REE in the weathering profile, and the REE are released and absorbed by clay minerals in the weathering profile.