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Geology and Genesis of the Nam Xe Carbonatite-Associated REE Deposit in NW Vietnam

Yue Sun[1], Hao Hu[2], Jian-Wei Li[1, 2], Xuan Dac Ngo[3]
1. School of Earth Resources, China University of Geosciences, Wuhan, China, 2. State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences, Wuhan, Wuhan, China, 3. Department of Mineral Resource Prospecting and Exploration, Hanoi University of Mining and Geology, Hanio, Vietnam

Carbonatite-associated rare-earth element (REE) deposits are the world's most important source of REE, as best represented by Bayan Obo Fe-REE-Nb deposit in Northern China and the Maoniuping REE deposit in Southwestern China, but their genesis remains hotly debated. The Nam Xe deposit in NW Vietnam (7.8 Mt of TREO) is hosted in carbonatite dykes and associated alkaline intrusions that were emplaced along the NW-striking Ailao Shan-Red River shear zone. However, the nature, age, and genesis of REE mineralization remain poorly understood. Here we present geological, mineralogical, and geochronological data to place new constraints on the formation of Vietnam’s largest REE deposit.

Field relationships suggest an intrusive sequence from calciocarbonatite through magnesiocarbonatite to ferrocarbonatite. Both calciocarbonatite and magnesiocarbonatite have been extensively altered by carbonate-rich fluid, forming Ba- and carbonate-rich REE ores grading at 11.5-15.6% TREO. REE-minerals in the ores mainly consist of monazite, REE-fluorocarbonate, and minor donnayite-(Y), which are associated with gangue minerals dominated by Sr-Ba-Mg-Ca carbonate and barite. Ferrocarbonatite has been extensively altered by sulfate-rich fluid to form Sr- and sulfate-rich, high-grade REE ores containing 14.0-15.6% TREO, with REE-fluorocarbonate and baric-celestite being the major minerals.

Ferrocarbonatite contains 7,624-14,903 ppm REE, which is slightly higher than precursor calciocarbonatites (3,400-11,898 ppm). This observation indicates that differentiation of the parental magmas had limited contributions to REE accumulation in residual melts. Rather, hydrothermal alteration of carbonatites has played a critical role in the formation of high-grade REE ores at Nam Xe. Monazite grains from Ba-rich REE ores yield a Th-Pb age of 34.82 ± 0.41 Ma (2σ). This age is consistent with REE mineralization ages (34–11 Ma) of Maoniuping and other REE deposits that are part of the 270-km-long Mianning-Dechang REE metallogenic belt in SW China. This age consistency suggests that carbonatite-associated REE deposits in NW Vietnam and those of the Mianning-Dechang metallogenic belt in SW China likely represent different portions of an extended REE metallogenic belt generated under a Cenozoic post-collisional extension setting, related to the Indo-Asian collision.