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# Petrogenesis and REE-fluorite mineralization of the Cenozoic carbonatite in the Pamir Plateau

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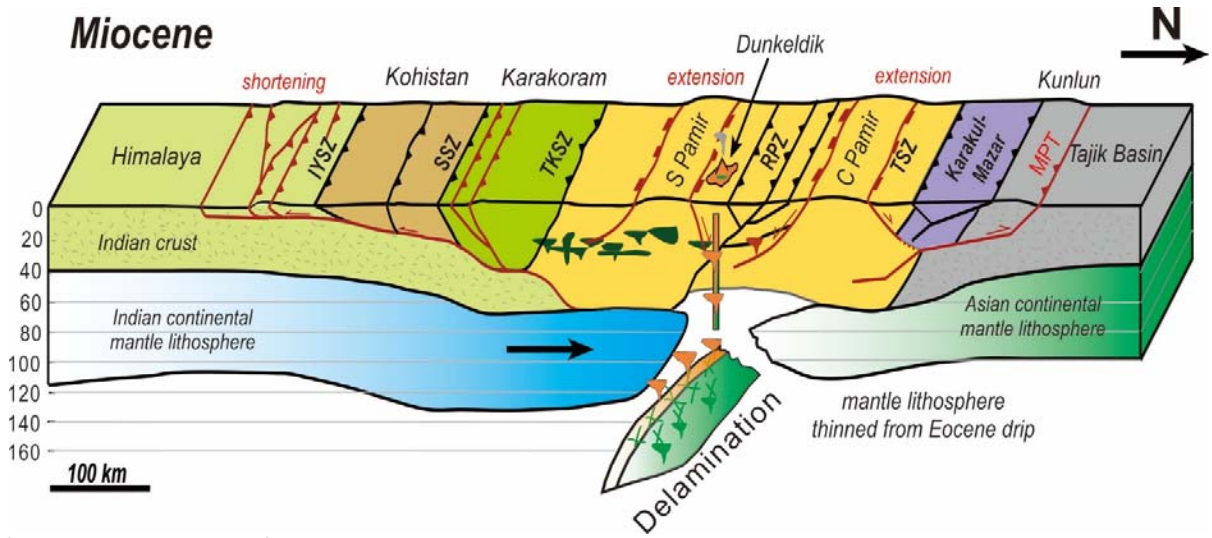
## Summary

The newly discovered Cenozoic carbonatite in the Dunkeldik area of the Pamirs, Tajikistan, is a rear example of a carbonatite emplaced in a collisional orogenic belt. The age and petrogenesis of this uncommon rock type and associated REE-fluorite mineralization still remain uncertain. The NE trending, 1~3 meters wide and more than 25 meters long, occur as a single carbonatite dyke, is associated with syenitic porphyries spatially, which intruded the silty slate of Lower Permian Wuluke Formation. The intrusive nature, fenite alteration halos, and REE minerals occurrence manifest the igneous origin. The carbonatite is composed primarily of calcite with minor apatite, monazite, K-feldspar and magnetite. Fluorite, barite, anhydrite and gypsum were found overlapped on the carbonatite as the sequent stage. In this study, we present LA-ICP-MS zircon dating and in-situ zircon Hf isotope composition for carbonatite and associated alkaline rocks. The dating results suggest that they formed at the same time (~11 Ma), which is one of the youngest carbonatite in the world. The in-situ zircon Hf isotopes show a moderately radiogenic Hf composition (εHf = +0.9 to −7.9). The geochemistry and Hf isotope data indicate that the magmas were derived from thickened lower crust that received an input of enriched mantle-sourced material hybridized by fluids derived from an ancient subducted oceanic slab. We infer that the carbonatite and syenitic porphyries formed in a post-collisional setting during the Miocene. The upwelling of an asthenospheric mantle diapir during the Cenozoic induced the partial melting of metasomatized lithospheric mantle and lower crust beneath the western margin of the Indian–Asian collision zone. The large-scale Karakorum strike-slip fault may have acted as a conduit for the emplacement of the syenite–carbonatite magma.

The similar emplacement ages and trace-element compositions of the spatially associated syenites and carbonatite suggest an origin involving liquid immiscibility. The immiscibility

between the carbonatite and alkaline silicate magma can enrich REE to high level, which owe to the affinity of volatile like F, B, P, REE etc. Therefore, the REE mineralization in the carbonatite of the Dunkeldik area includes both magmatic and hydrothermal type. Based on the field observations and detailed geochemistry and mineralogical study, we conclude that the carbonatite of the Dunkeldik area may have potential for REE, especially LREE, and fluorite mineralization.




Schematic cross-section for the Pamir orogenic system in the Miocene that show the major tectonic events and origin of the Dunkeldik alkaline-carbonatite complex. IYSZ = Indus-Yarlung suture zone, SSZ = Shyok suture zone, TKSZ = Tirich-Kilik suture zone, RPZ = Rushan-Pahart zone, TSZ = Tanymas suture zone, MPT = Main Pamir thrust. (Modified from Chapman et al., 2018)

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