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REE Mobility and Fluid Evolution at the Magmatic-Hydrothermal Transition of the Lemitar Carbonatite, New Mexico

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The Lemitar Mountains carbonatite rare earth element (REE) deposit in New Mexico comprises more than one hundred surface exposures of carbonatite dikes intruded into Proterozoic mafic and intermediate rocks [1]. The mineralized carbonatites display grades of up to 1.1% total REE and show variable degrees of hydrothermal overprinting [2]. Magmatic minerals in the carbonatite comprise calcite, dolomite, phlogopite, magnetite, and apatite [1]. The carbonatites are crosscut and overprinted by hydrothermal calcite (cal), fluorite (fl), and quartz (qz) veins [3]. Alteration surrounding carbonatites includes potassic fenitization, hematization, Ca-F-metasomatism, chloritization, and silicification. The goal of this project is to determine a mineral paragenesis to highlight the magmatic-hydrothermal transition in the Lemitar Carbonatite.

Cathodoluminescence imaging shows three distinct calcite textures including (Fig. 1a-b): cal-1 forming zoned fragments; cal-2 displaying luminescence absent euhedral crystals, and cal-3 forming large, zoned fragments. Apatite occurs in the fine-grained carbonatite matrix and exhibits dissolution textures and cross-cutting relationships with cal-3 (Fig. 1c). Veins show cal-2 crosscut by cal-3 and subsequently quartz and fluorite (Fig. 1c). Four fluid inclusion types were observed in thick sections including type-1 vapor-poor and type-2 vapor-rich liquid-vapor inclusions, type-3 vapor-poor and type-4 vapor-rich multiphase inclusions (Fig. 1d, e, f, g). Inclusion types-1, 2, and 4 occur in apatite crystals along with melt inclusions (Fig. 1g). Type-1 and 3 inclusions occur in cal-1, type-2 and 3 inclusions in cal-2, and type-2 and 3 inclusions in cal-3. Fluorite and quartz exclusively exhibit type-1 inclusions. Microthermometric data of fluorite-hosted type-1 inclusions show ice melting temperatures at -1.2±0.1°C and apatite-hosted type-2 and 4 inclusions show melting temperature at -5.8±0.2°C. Preliminary data analysis indicates a decrease in salinity and homogenization temperatures for fluid inclusions between apatite and fluorite from early to late in the paragenetic sequence. Conclusions from this research project will aid exploration efforts for REE in carbonatites by determining key mineralogical features and fluids in carbonatite systems, yielding a more comprehensive understanding of these economically significant deposits.

[1] McLemore (1987), J.Geol. 2, 255-270 p.

[2] Haft et al. (2022), NMGS, 72nd Ann. Field Conf., 365-373 p.

[3] Perry (2019), Ph.D. Thesis, CSM, 105 p.