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Mineral and Whole Rock Chemistry of Matrix in Volcanic Carbonatite Breccia from the Northwestern region of the Amba Dongar Carbonatite Complex, Gujarat, India: Assessing the Niobium and Rare Earth Element Potential

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Volcanic carbonatitic breccia is the most prolific carbonatite formation found in the Amba Dongar Complex (ADC), Gujarat, India at the present level of erosion. These breccias are present in both the inner ring dyke of the ring complex of ADC and the northwestern region of Mongra-Padvani which is termed outer breccia. This is the first report of the combined chemistry of apatite along with whole-rock geochemistry of the matrix from volcanic carbonatitic breccia of Mongra-Padvani from ADC. The matrix is predominantly composed of calcite and dolomite, and ankeritic masses. The apatite morphology and chemistry are distinct as compared to ADC apatites with significantly larger concentrations of rare earth elements ($\sum REE_2O_3$= 2.95 wt.%). The trace element concentration of the carbonatitic matrix closely resembles that of ADC, with the anomalously high Nb and larger content of high field strength elements (HFSE) (e.g., Zr, Ta and Hf) potentially linked to the significant presence of pyrochlore. Petrographically, the breccia mainly consists of a calcite-dolomite-ankeritic matrix, with apatite, pyroxene, garnet, and Fe-phases. Pyrochlore is largely distributed throughout the rock, and REE-bearing phases have been identified via scanning electron microscopy.

Comparing the HFSE dataset with a global carbonatite dataset, the Niobium exceeds the average global concentration levels from the worldwide carbonatites. The breccia exhibits strong HREE depletion, high $(La/Yb)_{CN}$ values, and moderate $(La/Sm)_{CN}$ values, consistent with ADC carbonatites. The subtle negative Y-anomaly in all samples is observed, which is attributed to the natural character within the carbonatitic system of ADC. Integrating field observation, mineral chemistry, and bulk composition we propose that the ADC carbonatites have largely evolved as a late-stage magma derived from a single magma chamber.

The purpose of this study is based on mineral chemistry and whole rock examinations to provide a better understanding of the outer breccias in assessing strategic minerals and their concentrations within the carbonatitic matrix which is the predominant rock type of this complex. The outer breccia is a promising location for more research since it has a large potential to host economically viable mineral deposits, such as the Niobium.