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Insights into Selective Enrichment of Heavy Rare Earth Elements in Apatite associated with Carbonatitic Breccia - An example from Mongra, Northwest of the Amba Dongar Complex, Gujarat, India.

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The association of volcanic carbonatitic breccias with carbonatites is a common occurrence globally and suggests the presence of early-formed carbonatitic bodies that were brecciated and picked up by later ascending carbonatite melts. One such example is the occurrence of an early carbonatitic breccia along with carbonatites in the Amba Dongar Complex (ADC) as well as in the adjoining region of Mongra (Fig.1). These breccias at the ADC exist as discrete units exposed within the surrounding Bagh sandstone (Turonian) and Deccan basalt (Cretaceous-Eocene), as well as a continuous body along the inner and outer parts of the calcio-carbonatite ring dyke system. The clasts of these breccias are composed of sövites and basement rocks intercalated with a carbonatitic matrix. The carbonatitic matrix is of a mixed Calcite-Dolomite composition with grains of Apatite, Pyroxenes, and Garnet with few Pyrochlores and Magnetites.

Apatite is a common accessory phase of calcite and dolomite carbonatites. The morphology and zoning of these apatites vary greatly, reflecting not only their position in the paragenetic sequence but also a wide range of evolutionary processes from early magmatic fractionation to the interaction of carbonatites with hydrothermal fluids. The Apatites of Mongra are different from ADC both texturally and compositionally with prominent zoning as well as high Heavy Rare Earth Elements (HREE) content present in Mongra. The quantitative electron microscopy (EPMA) and elemental mapping of Apatites from Mongra have given an exceptional composition of Lutetium (Lu) averaging 7.26 wt.% oxide (Fig.2). Negative Yttrium anomaly exhibited by the Mongra Apatites strongly negates the involvement of hydrothermal fluids (Broom-Fendley Sam, et al. 2017). The inference for selective enrichment for HREE in these Apatites can be attributed to the complexing of Lu with a Cl-rich fluid present in the magma. The average concentration of Cl and SO_3 are 0.52 and 0.04 wt.% respectively. This analysis of Mongra Apatites suggests that they are formed in the late stages from a halogen enriched magma. The EPMA results give a better understanding of the preferred transport of REE owing to ligand chemistry and crystal-chemical control on REE substitution into Apatites.

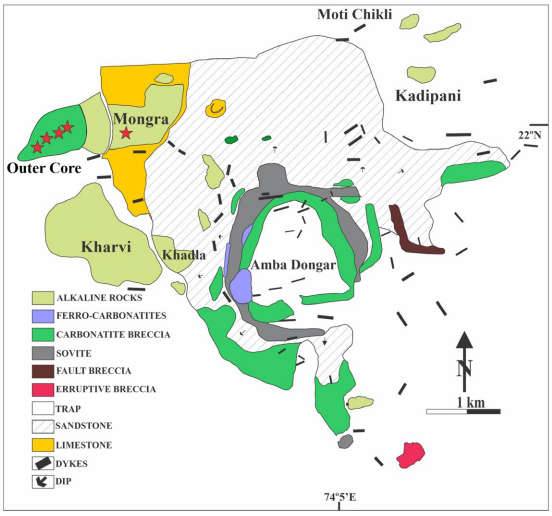

Fig 1. Amba Dongar Carbonatite Complex, Viladar '96

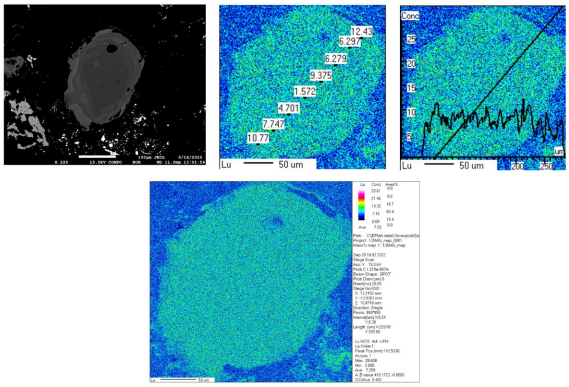

Fig. 2 Elemental Mapping of Apatite with compositional variation of Lutetium throughout the Apatite grain.