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Major and trace element abundances, and Sr and Nd isotopic composition of Carbonatites from Amba Dongar, Gujarat, India

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Despite significant progress during the last decade, the petrogenesis of carbonatites is still highly debated regarding the exact mechanism of carbonatite magma generation (fractional crystallization of carbonated-silicate magmas, liquid immiscibility of carbonated-silicate magmas, partial melting of carbonated mantle peridotite or carbonated lherzolitic mantle) and its evolution. The Amba Dongar carbonatite complex in Chhota Udaipur district, Gujarat is the youngest Indian carbonatite complex, which intruded into the $\sim$ 90 Ma Bagh sandstones and limestone and 68-65 Ma Deccan flood basalts. The emplacement age (^{40}Ar/^{39}Ar age of 65$\pm$0.3 Ma; Ray and Pande, 1999) coincides with the age of main pulse of Deccan flood basalts at ca. 65 Ma. We report new geochemical data (major oxide and trace element abundances, and Sr and Nd isotopic ratios) on 23 carbonatite samples from Amba Dongar.

The Amba Dongar carbonatite complex consists of carbonatite (sövite, and ankerite), and associated nephelinite, phonolite, and both pre- and post-carbonatite basalts. Detailed minerology of carbonatite include dominant calcite along with pyrochlore, apatite, magnetite, aegirine-augite and accessory phases. Apatite crystals are observed in carbonatite as well as in nephelinite. In sövites, apatite occur in various forms including cumulus, clusters and scattered within and along the boundary of calcite crystals. Two generation of apatite crystals are commonly observed in sövite and nephelinite; textural changes suggest presence of different five pulses of sövitic magma during the emplacement of the sövite ring dike.

Bulk major oxides and trace element (including REEs) compositions of carbonatites and associated silicate rocks are determined by WD-XRF and ICP-MS, respectively. Major oxides abundances are consistent with the already available data on the Amba Dongar carbonatite complex. Trace element concentrations for the sövite reveals high concentrations of Sr (929-7476 ppm), Ba (344-52072 ppm) and Nb (35-2115 ppm). The ankeritic carbonatites are extremely enriched in the incompatible trace elements (e.g., $\sim$7-32 times higher Ba, highest REE $\sim$40,000 ppm and $\sim$600 ppm of Th). Chondrite-normalized REE patterns show high degree of LREE enrichment suggesting low-degree partial melting of the source. The chondrite normalized La/Yb ratio of sövite and ankeritic carbonatite vary in the range 70-411. The radiogenic Sr-Nd isotopic composition of sövites (^{87}Sr/^{86}Sr: 0.7055-0.7066; ε_{Nd}: -6.0 to -2.2) and ankerites (0.7058-0.7081; -3.8 to -1.9) reveal more isotopic variability compared to the available data (sövites 0.7054-0.706; -2.5 to -1.5; ankerites 0.7056-0.7065; -2.5 to -1.5). It is likely that EM I and II type sources are involved in the generation of Amba Dongar carbonatite complex. More data on carbonatites and associated silicate rocks will be helpful to establish the composition of parental carbonatite melts, depth of generation (lithosphere vs asthenosphere), their spatial relation with associated silicate rocks, and the evolution of the primary carbonatite melt over time.