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In-situ Sr isotope analysis of apatite from Kamthai and Amba Dongar carbonatite complexes, Western India: link with Deccan Large Igneous Province

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The Kamthai (Rajasthan) and Amba Dongar (65±0.3 Ma [1], Gujarat) carbonatite complexes are geographically linked to the Deccan Large Igneous Province (LIP, 65 Ma [2]). The in-situ Sr isotope data of apatite for carbonatites and associated silicate rocks are rare in the context of Indian carbonatites. This study reports for the first time, the $^{87}Sr/^{86}Sr$ isotope ratios of apatite from Amba Dongar (calciocarbonatites and phonolite), and Kamthai (fenitized nephelinite with thin carbonatite veins) measured using LA-MC-ICPMS. The data is used to constrain the petrogenetic relationship between these rocks, and the nature of hydrothermal fluid responsible for their alteration. Apatite is a common accessory mineral in these rocks, and shows oscillatory zoning and core-rim textures in cathodoluminescence images. In carbonatites from Amba Dongar, it occurs as cumulate and disseminated crystals associated with calcite. The $^{87}Sr/^{86}Sr$ ratio of oscillatory-zoned apatite from Kamthai ($^{87}Sr/^{86}Sr$: 0.7041–0.7046), and Amba Dongar carbonatites (0.7055–0.7058) and phonolites (0.7059–0.7063) show mantle signature, and are similar to the uncontaminated Ambenali Formation ($^{87}Sr/^{86}Sr_i$: 0.7044±0014) of the Deccan LIP [3,4]. The $^{87}Sr/^{86}Sr$ ratios of apatite from Amba Dongar lie well within the range of bulk rock $^{87}Sr/^{86}Sr_i$ (at 65 Ma) of calcio- (0.7055–0.7066), and ferro-carbonatite (0.7058–0.7076), as well as nephelinite (0.7062) [4]. Similar $^{87}Sr/^{86}Sr$ ratios of core (0.7055–0.7058) and rim (0.7050 and 0.7058) regions of apatite indicate the involvement of magmatic hydrothermal fluid in the late-stage hydrothermal alteration of the carbonatite complexes. The presence of magmatic apatite having similar mantle $^{87}Sr/^{86}Sr$ composition in Amba Dongar carbonatite, and associated phonolite suggest their generation from a common parental carbonated silicate melt, and early nucleation of apatite in the parental melts. We conclude that apatite from carbonatite complexes are useful tracers for constraining the petrogenetic relationship between carbonatites and associated silicate alkaline rocks and to constrain the nature of hydrothermal fluids.

References: [1] Ray & Pande (1999), *Geophys. Res. Lett.* 26, 1917-1920. [2] Schoene et al. (2015), *Science* 347, 182-184. [3] Lightfoot et al. (1990) *J. Petrol.* 31, 1165-1200. [4] Chandra et al. (2019), *J. Petrol.* 60, 1119-1134.