On the isotopic and thermal evolution of Amba Dongar carbonatite alkaline complex: New insights from carbonate clumped isotope geochemistry

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The carbonate clumped isotope thermometry has been applied to readdress the evolution of the isotopic composition of carbonatites of Amba Dongar carbonatite alkaline complex. CO_2 produced from phosphoric acid digestion of ~5 mg rock powder was cleaned and analysed using MAT 253 IRMS for C-O isotopes and Δ_{47}. Role of fractional crystallisation, hydrothermal alteration and meteoric water interaction can be identified from the trend recorded in the stable isotope data. $\delta^{13}C$ in sövites ranges from -5.2 to -2.5 ‰ while $\delta^{18}O$ ranges from 7.3 to 13.4 ‰. Ankeritic varieties are heavier: -4.8 to -1.0 ‰ for C and 14.3 to 26.6 ‰ for O. There is progressive enrichment in C-O isotopes from coarse to fine grained samples. We observed a large grain size variability (0.1-4.4 mm) in calcite: phenocrysts (~1-2 cm) show lighter isotope signature compared to the matrix. We record clumped isotope values, $\Delta_{47(CDES)}$ of 0.325 ‰ (±0.018) to 0.479 ‰ (±0.012) in the sövites, converting to temperatures of 443 – 141 °C and 334 – 125 °C using calibration scales proposed for high temperature calcites [1] and common carbonates [2]. Ankeritic specimen yielded $\Delta_{47(CDES)}$ values >0.468 ‰, suggesting alteration of carbonatites due to fluid action. We compared our observation with a natrocarbonatite sample from Oldoinyo Lengai which yielded $\Delta_{47(CDES)}$ = 0.327 ‰ (±0.012) recording 437 and 331 °C using both calibration equations. Our observations suggest recording temperature >350 °C in carbonates from the carbonatites, which is consistent with earlier studies on high temperature carbonatites [3]. The estimated isotope composition of CO_2 in equilibrium with calcite suggests the assimilation of an enriched carbon during carbonatite emplacement.

[1] Kluge *et al*. (2015) *GCA 157,* 213-227. [2] Bonifacie *et al.* (2017) *GCA 200*, 255-279. [3] Dennis & Schrag (2010) *GCA 74*, 4110-4122