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Inwards-younging of the annular Twihinate carbonatite-aillikite complex (Southern Morocco)

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Twihinate, situated in the Oulad Dlim Massif on the northwestern margin of the West Africa Craton, is an excellent example of a ring-shaped carbonatite complex with an outer calcite carbonatite ring and a core of dolomite carbonatite and aillikite. Calcite carbonatite tends towards higher proportions of biotite, magnetite, diopside ± andradite towards the boundary between calcite carbonatite and granitic gneiss host rock ("antiskarn"). Here, we employ a variety of targeted spatially constrained geochronologic tools (mica Rb-Sr in calcite carbonatite and antiskarn, apatite U-Pb in antiskarn, zircon U-Pb in syenite, and perovskite U-Pb in aillikite) to investigate the sequence of events and timeframe of emplacement of Twihinate. Antiskarn and calcite carbonatite ages at Twihinate range from 89.0 ± 1.3 to 83.5 ± 1.3 Ma, younging towards the centre of the complex. Aillikite from a dyke crosscutting the dolomite carbonatite in the centre of Twihinate is dated at 82.6 ± 3.1 Ma. Crosscutting relationships show that dolomite carbonatite dykes crosscut calcite carbonatite, therefore broadly constraining dolomite carbonatite emplacement between aillikite and calcite carbonatite (although there were probably several batches of dolomite carbonatite). The inwards-younging trend of carbonatite and aillikite at Twihinate is interpreted as resulting from repeated pulses of carbonatite and aillikite melt injected into the same lithospheric pathway over ca. 7 million years and implies that liquids are channelled towards the centre of annular carbonatite structures. Global carbonatite complexes with similar geometry might have been constructed through a similar process of repeated pulses of carbonatite and related melts, younging inwards.