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Connecting flood basalts and intrusions in oceanic plateaus from the Kerguelen Archipelago

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The Kerguelen Archipelago, the largest oceanic island after Hawaii and Iceland, is the emergent part of the 20 km-thick Northern Kerguelen Plateau in the Southern Indian Ocean and it preserves both physical and chemical evidence for vertically extensive intrusive activity in an oceanic plateau. The archipelago is dominated by fractionated low-MgO (<6 wt%) flood basalts that form the upper 8-10 km of the crust. The basalts are tilted exposing a 4-6 km composite section and offer an unparalled opportunity to examine the detailed volcanic stratigraphy, intrusive relationships, and chemical signals of deep-seated cumulates. Alkalinity changes in the lavas and intrusions correlate with variations in magma flux as a result of thickening of the crust and lithosphere since 40 Ma with increasing distance between the Southeast Indian Ridge and the Kerguelen hotspot under the Antarctic plate. Numerous undifferentiated intrusions and sills (microgabbroic) occur within the 26-29 Ma transitional basalts of the central parts of the archipelago where they represent the frozen upper parts, mostly phenocryst-free or crystal-poor, of the flood basalt plumbing system. The gabbroic cumulate complement to the fractionated transitional basalts dominates the lower crust (10-18 km depth) as a thick plateau-wide sill complex of incrementally emplaced and amalgamated intrusions. Reduced extents of decompression melting, at higher pressures, in the Kerguelen mantle plume as a consequence of progressive lithosphere thickening lead to production of the 24-25 Ma mildly alkalic basalts in the eastern and southeastern parts of the archipelago. Differentiated sub-volcanic gabbroic intrusions (layered peridotites, gabbros ± syenites) are temporally associated with these alkalic basalts and their emplacement signals the end of flood basalt volcanism on the Kerguelen Archipelgo. High-pressure fractionation of Al-rich clinopyroxene controlled the geochemical evolution of the mildly alkalic basalts yielding deep pyroxenite-dominant cumulates straddling the crust-to-mantle transition zone at ~18-20 km depth. The variable depth of magma reservoirs in oceanic plateaus, where magmas stall, fractionate, store, and interact with their crystal cargoes, is fundamentally governed by variations in magma flux and crust-lithosphere thicknesses.