The Val gabbro plutonic suite, Kerguelen Archipelago: Evolution of a volcanic feeder system in an oceanic island

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The petrology, composition and Sr-Nd-Pb-Hf isotopic geochemistry of basic and felsic rocks from the Val gabbro plutonic suite on the Kerguelen Archipelago constrain differentiation processes in sub-volcanic magma chambers and the role of variable magma flux rates in the formation of a major oceanic island. The 4 km^2 Val gabbro was forcefully emplaced at 24.25 ± 0.15 Ma (U-Pb zircon) into volcanic rocks of the Lower Miocene series on the Southeast Province. Cumulate gabbroic rocks are the dominant lithology, with horizontally layered olivine- and clinopyroxene-rich peridotitic cumulates at the base, overlain by coarse-grained olivine and/or clinopyroxene-rich gabbros and vertically layered finer grained equigranular gabbros. The Val gabbro was formed by repeated injections of crystal-rich and crystal-poor magmas into a magma reservoir where the main differentiation process was the segregation of earlier crystallized, dense mafic crystals. Striking geochemical similarities between the fine-grained intrusive rocks from the Val gabbro and the mildly alkalic basalts of the Lower Miocene series indicate that they were all derived from similar alkalic basaltic parental magmas that reflect the enriched Kerguelen mantle plume component. Prior to 25 Ma, magma flux rates associated with formation of the transitional flood basalts on the Kerguelen Archipelago were sufficiently high to prevent the establishment of sub-volcanic magma chambers capable of undergoing significant differentiation. At 25 Ma, the change to mildly alkalic basaltic volcanism was associated with deeper melting (garnet peridotite), lower extents of melting, and a lower total magma flux rate, which led to the formation and stabilization of high-level intrusions such as the Val gabbro plutonic suite.

New (U-Th)/He age constraints on the emplacement of kimberlite pipes in north-eastern Kansas

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Twelve kimberlite pipes, identified by geological and geophysical exploration, are located above the mid-continent rift system in Riley and Marshall Counties, Kansas. Previous geochronological work on these rocks has yielded inconclusive estimates for their age. This study presents new data about kimberlite emplacement suing (U-Th)/He dating of apatite, titanite, and zircon from the Stockdale, and Tuttle kimberlites. Zircon from the Tuttle pipe and titanite from the Stockdale pipe give cooling ages of 105±10Ma and 101±15Ma respectively. These data are consistent with our Rb-Sr analysis of phlogopite megacrysts that give a 5 point isochron age of 106.5±3.8Ma. This demonstrates that (U-Th)/He thermochronometry provides reliable timing constraints on the cooling of common xenocrystic phases. Apatite (U-Th)/He ages range from 67.3±5Ma for the Stockdale pipe to 61.2±8Ma for the Leonardville pipe, suggesting a thermal pulse in latest Cretaceous to earliest Tertiary time. Fuid-inclusion data from calcite-magnetite veins cross-cutting the kimberlites records fluid temperatures of ~150-200°C (above apatite, but below zircon/titanite closure). Apatite (U-Th)/He analyses from nearby sandstones give Jurassic cooling ages, demonstrating that there was no regional thermal event after kimberlite emplacement. These observations, coupled with (U-Th)/He and Rb-Sr age data, suggest that the kimberlites were emplaced at ~105 Ma and subjected to local reheating by fluids at ~65 Ma.