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Fossil subduction zone origin for magmas in the Ferrar Large Igneous Province, Antarctica: Evidence from PGE and Os isotope systematics in the Basement Sill of the McMurdo Dry Valleys

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Mantle plumes provide an attractive mechanism for generating short-duration, voluminous magmas in large igneous provinces (LIPs) while at the same time providing an explanation for the frequently associated break-up of supercontinents. This model has also been invoked for the Ferrar large igneous province (FLIP) in Antarctica, which zircon and baddeleyite U-Pb dating shows was emplaced over a short duration at 182.7 $\pm$ 0.5 Ma, contemporaneously with fragmentation of the supercontinent Gondwanaland. Here, we present platinum-group-element (PGE) and Os-isotopic data for the Basement Sill in the McMurdo Dry Valleys – a part of the FLIP – that challenge the plume interpretation. The Basement Sill samples studied are cumulate-textured gabbro to norite, and pyroxenite with minor ferro- or leuco-lithofacies with MgO ranging from 2 to 19 wt%. The 187Os/188Os values range from 0.1609 $\pm$ 0.003 (2s) to 8.100 $\pm$ 1.600 (2s); the minimum value overlaps with a previously published estimated initial 187Os/188Os ratio for Ferrar magmas of 0.145 $\pm$ 0.049 (2s). The PGE abundance patterns for the Basement Sill define positive, convex-shaped slopes between the IPGE (Os, Ir and Ru) and PPGE (Pt, Pd and Rh). The most significant feature of the entire data set is the extreme sub-chondritic Os/Ir ratios (< 0.33), values which are atypical of plume-derived magmas. These low Os/Ir ratios are more consistent with the alternative view that FLIP resulted from the decompression melting of mantle with a fossil subduction zone signature along the proto-Pacific margin of Gondwanaland, disaggregated by rifting related to plate rearrangements during supercontinent break-up. We propose that hydrated fossil subduction zones elsewhere on Earth might account for other short-lived voluminous magmatic events that form LIPs. The remarkably short duration of these events may be due to rapid decompression of hydrated mantle allowing instantaneous large-volume melting which then peters out quickly (<1 Myr) as H_2O is expelled from the source rocks and into the melt.