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Lithospheric Mantle Evolution and Plume-Lithosphere Interaction in Marie Byrd Land, West Antarctica: Sr, Nd, Os and Pb Isotopes in Spinel Peridotite Xenoliths

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Marie Byrd Land (MBL) is the largest of a number of allochthonous crustal blocks that comprise West Antarctica, a region spanning some 3-4000 km along its margin. Understanding the formation and geologic evolution of MBL is hampered by the remoteness of the locale, and the expansive cover of ice that limits crustal exposure to coastal sections, and scattered volcanic edifices on the continent. The geologic history inferred from this limited crustal record is Phanerozoic and dominated by a long period of subduction followed by the proposed impingement of two distinct plumes beneath MBL (e.g. LeMasurier and Thomson, 1990; Pankhurst et al., 1998; Storey et al., 1999).

The oldest exposed crustal rocks are ca. 500 Ma orthogneisses (Pankhurst et al., 1998), however a Precambrian history for MBL has been speculated upon on the basis of Proterozoic Nd model ages in granites and gneisses (Pankhurst et al., 1998). Subsequent sedimentation and intrusion of subduction-related granitoids occurred during Devonian to Cretaceous times (e.g. Pankhurst et al., 1998). More recently, a plume with a HIMU signature is believed to have arrived beneath MBL in Cretaceous times facilitating the break up of New Zealand from Antarctica, and is now thought to be present beneath Mt Erebus in the Ross Sea (Storey et al., 1999). From ca. 30 Ma, Cenozoic alkaline magmas related to a second plume have punctuated the lithosphere, producing the large volcanic massifs that make up the Marie Byrd Land Volcanic Province. The mantle composition beneath MBL, as inferred from the basalt geochemistry, involves several compositionally distinct components, including a proposed extensive metasomatised layer within the lithospheric mantle and an underlying a HIMU 'fossil plume' signature imparted by the Mt Erebus plume to mantle beneath MBL and the West Antarctic Rift System (Panter et al., 2000).

Here, we present the first study of lithospheric mantle xenoliths from Marie Byrd Land, in order to investigate the age of formation of the MBL lithospheric mantle and its subsequent evolution. The xenolith suite, entrained in late-stage (ca. 3 -19 Ma) Cenozoic lavas, provides the first direct indication of the composition of the lithosphere beneath a major part of West Antarctica.

The MBL xenoliths come from three volcanic centres: Mt Hampton and Mt Cumming from the Executive Committee Range, and Mt Aldaz from the USAS Escarpment. The suite comprises granular spinel peridotites with no volatile-bearing phases observed. Thirteen Executive Committee Range xenoliths cover a wide range in composition from fertile lherzolites to depleted harzburgites (e.g. CaO = 0.39 - 3.17 wt%, MgO = 37.9 - 46.5 wt%), with variable incompatible trace element enrichment (e.g. (La/Yb)N = 0.7 - 10). By contrast, the four USAS Escarpment peridotites have a limited range in composition (e.g. CaO = 2.47 - 3.38 wt%, MgO = 37.2 - 40.5 wt%) and preserve LREE depletions (e.g. (La/Yb)N = 0.15 - 0.30). Measured Os isotopic compositions for the suite range from $^{187}Os/^{188}Os$ = 0.118 - 0.133, reflecting Paleo- and Meso-Proterozoic melt extraction together with more complex Re and/or Os enrichment processes affecting three samples with chondritic to superchondritic measured Os isotopic compositions. The Os data therefore indicate a Precambrian formation for at least part of the MBL lithosphere, which has significant implications for previous models of formation of MBL which have focused on the exposed Phanerozoic crustal record.

We are in the process of obtaining Sr, Nd and Pb isotopic data for the xenolith suite, which we will present to further characterise the composition of the MBL lithospheric mantle. In particular, we will use the data to investigate the effects of zone processing and plume-mantle interactions on the lithospheric mantle, and if lithospheric mantle comparable to that sampled has played a role in the source of the Cenozoic volcanics in the region.

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