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Depletion, metasomatism and refertilisation in the Sub-Continental Lithospheric Mantle beneath northern Victoria Land (Antarctica): a review

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Assessing the nature and evolution of the Sub-Continental Lithospheric Mantle (SCLM) is crucial to understand the dynamics of Earth's interior and the global scale tectono-magmatic processes. The study of ultramafic xenoliths brought to the surface in specific context, such as northern Victoria Land (Antarctica), is a key to investigate how the SCLM bear witness of large-scale geodynamic episodes. Indeed, the Antarctica lithosphere was involved into three main tectono-magmatic episodes since Paleozoic, i.e. the 550-110 Ma Ross subduction, the Jurassic (~182 Ma) Ferrar magmatism and the Cenozoic alkaline magmatism responsible for the opening of the West Antarctic Rift System (WARS).

In this study, a review of the petrological and geochemical features of >200 mantle-derived and cumulate xenoliths brought to the surface at Baker Rocks, Greene Point, Handler Ridge, Harrow Peaks, Browning Pass and Mount Overlord enabled us to reconstruct the main depletion and enrichment processes that took place in the Antarctica SCLM. Strong depletion is recorded by Greene Point lherzolites and harzburgites (18-21%), which likely began melting in the garnet facies and terminated in the spinel facies (Perinelli et al. 2006), whereas mild melt extraction in the spinel stability field was hypothesized at Baker Rocks and Handler Ridge (12-16% and 7-13% melting, respectively). The onset of the Jurassic Ferrar large magmatic event is testified by both the refertilisation in Greene Point-Baker Rocks peridotites and the appearance of cumulate orthopyroxenites/olivine-websterites at Harrow Peaks and Baker Rocks. Late enrichment process/es took place in concomitance with the Cenozoic alkaline magmatism of the WARS, resulting in both cryptic and modal metasomatism and overprinting earlier chemical modifications. This metasomatism was particularly effective at Baker Rocks, as shown by the increase of clinopyroxene abundance, its trace element enrichment and the formation of amphibole disseminated and in veins. Clinopyroxene composition in Cenozoic cumulate rocks matches the enrichment path observed in the peridotites, supporting the link between the last metasomatic process and the recent alkaline magmatism.

Among mantle xenoliths populations, Greene Point record the highest T-P (870-1059 °C; 0.8-1.6 GPa) and the least oxidized conditions (fO_2 down to -2/-3 ΔFMQ). Cumulate rocks yield the highest

fO_2 (up to +1.5 ΔFMQ), at T varying between 900 and 1150°C, approximating the conditions of crystallizing melts. No discrepancies in fO_2 emerged between amphibole-bearing and amphibole-free peridotites, ruling out a strict correlation between amphibole stability, H_2O activity and fO_2. Nevertheless, the alkaline metasomatic event, which led to amphibole formation, caused a remarkable increase in the H_2O content of the system. In fact, anhydrous peridotites preserve bulk H_2O contents ≤128 ppm, while lherzolites with disseminated amphibole and hornblendites have H_2O contents as up to 354-1120 ppm and 1.42 wt%, respectively.

Perinelli, C., et al. 2006. Geochemical and O-isotope constraints on the evolution of lithospheric mantle in the Ross Sea rift area (Antarctica). Contributions to Mineralogy and Petrology, 151(3), 245-266.