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The heterogeneous nature of the Patagonia lithospheric mantle as evidenced by garnet- and spinel-peridotites

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In several areas of Patagonia, Oligocene-Pliocene back-arc OIB-like alkali basaltic lavas and cinder cones carry spinel and garnet bearing xenoliths. Lack of slab-derived component(s) rules out the participation of a subducted slab in the generation of these basalts.

Xenolith textures evidence that the mantle is moderately to strongly tectonized and recrystallized on both local and regional scale, with predominance of deformed textural types. Variably intensive cryptic and modal metasomatism affected the lithospheric mantle of Patagonia. Metasomatized spinel peridotites from Gobernaor Gregores bear unusually large melt pockets consisting of second generation olivine, clinopyroxene and spinel ± relict amphibole. Textural evidences and consistent mass-balance calculations prove that amphibole breakdown was responsible for melt pocket generation.

Xenoliths from Tres Lagos, situated inboard of the Volcanic Arc Gap (VAG), are samples of a depleted lithospheric mantle and comprise metasomatized and non-metasomatized anhydrous spinel lherzolites and harzburgites. A two-stage partial melting process could be responsible for the origin of these xenoliths, in the first stage a 2% of batch melting taking place in the garnet peridotite field and subsequently the residue experiencing 2–8% batch melting in the spinel peridotite field. The peridotites have not been affected by subduction-related metasomatic processes and they probably represent an old isolated piece of depleted lithosphere, in which metasomatism was not a significant process.

Garnet+spinel and garnet bearing xenoliths are present in southern and northern Patagonia. In the south, fertile lherzolites and depleted harzburgites from Potrok Aike show kelyphitic rims around both garnet and spinel demonstrating break-down of garnet in spinel bearing xenoliths. Clinopyroxenes from the spinel-peridotite facies xenoliths show variable positive Zr anomalies relative to Nd and Sm, which are absent in clinopyroxenes from garnet-spinel peridotites but present in the garnets. These features reflect a gradual transition from the spinel-garnet to the spinel-peridotite stability field.

In north Patagonia, garnet-bearing peridotites from Prahuaniyeu are fertile whereas the spinel-bearing peridotites cover a wide range from fertile to depleted compositions. Whole-rock LREE enrichment in the garnet-bearing peridotites and partly in the spinel-peridotites is consistent with intergranular percolation of the host basalt melt, as hydrous phases are not present and the clinopyroxenes and garnets are not enriched in LREE. In situ clinopyroxene analyses suggest that a group of spinel-peridotites experienced cryptic metasomatism by carbonatitic melts. Non-metasomatized garnet- and spinel-peridotites have experienced fractional melting ranging from 1 to 3% and from 5 to 12%, respectively. The Prahuaniyeu xenoliths lie on an elevated geotherm implying convective heat transport. Apparent internal "ages" between c. 10 and 30 Ma for the two most fertile samples, suggest resetting of the Sm-Nd isotopic system under a high-temperature regime and could reflect the closure of the system following this "high-T" event. This supports the presence of mantle thermal instabilities.

Overall, Patagonia xenoliths indicate a strongly elevated geotherm for this region, similar to the southeast Australia and oceanic geotherms, which is not normal for a continental intraplate tectonic setting. Patagonian xenolith samples are probably related to the presence of rising mantle plume(s) in an extensional tectonic setting.