Geophysical Research Abstracts
Vol. 17, EGU2015-2489, 2015
EGU General Assembly 2015

Controls on volatile content and distribution in the continental upper mantle of Southern Gondwana (Patagonia & W. Antarctica)

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Water content is known to affect many physical and chemical properties of the upper mantle, including melting temperature and viscosity. Water is hosted by hydrous phases, such as amphibole and phlogopite, and also by more dominant, nominally-anhydrous mantle minerals (e.g. olivine and pyroxene). The latter have the potential to incorporate hundreds of ppm of water in point defects, and may explain geophysical observations such as seismic and conductivity anomalies in the upper mantle [1]. However, the significance of the reported concentrations of H_2O in nominally anhydrous minerals in mantle xenoliths is still a subject of debate primarily due to the effects of post-entrainment loss [1,2]. Unlike H_2O and Li, F is less susceptible to post entrainment loss and can potentially be used to constrain the source of volatiles.

We present high-precision SIMS analyses of H_2O, Li and F in mantle xenoliths hosted by recently-erupted (5–10 Ka) alkali basalts from south Patagonia and the Antarctic Peninsula. These two regions formed part of the southern margin of the Gondwana supercontinent, prior to break-up, and were located above long-lived subduction zones for at least 200 M.yr., making them highly-appropriate to investigating long term evolution of the sub-continental lithospheric mantle in this setting. The xenoliths are well characterised peridotites, sourced from the off-craton spinel- and spinel-garnet facies lithospheric mantle (40-80 km). Samples are relatively dry: H_2O contents of olivine span 0-49 ppm, orthopyroxene 150-235 ppm and clinopyroxene 100-395 ppm. West Antarctic samples are more hydrated than Patagonian samples, on average. These H_2O concentrations fall within the global measured range for off-craton mantle minerals [4]. We attribute low H_2O concentrations in olivine to diffusive loss, either by exchange with the host magma, shallow level degassing or during cooling [2]. F shows less variability than H_2O and is most highly concentrated in clinopyroxenes – with one Antarctic sample (a websterite) having abundances of up to 200 ppm. In other samples, values rarely exceed 65 ppm. F/Nd ratios of MORB are around 20.5, with arc magmas displaying higher ratios [4] and while some clinopyroxenes have similar or lower values than MORB, others show F/Nd $>>$ 20.5, implying potential interaction with subduction-related melts. Li concentrations follow similar patterns as F in all minerals.

Slightly higher average H_2O and generally higher F contents in the West Antarctic lithospheric mantle correlate with other indicators of subduction-related metasomatism, and most likely reflect the closer proximity of this region to the continental margin and also a younger, shallower slab than beneath south Patagonia. Here we explore in detail correlations between H, Li, F and other tracers of mantle processes in both localities, in order to determine the primary control on volatile content in the sub-continental lithospheric mantle.

[1] Peslier et al. 2006. EPSL, **242**, 392-319

[2] Plank, T. et al. 2014. AGU Fall V51E-04

[3] Koga, K.T. et al. 2014. AGU Fall V51E-05

[4] Bonadiman et al. 2009., Eur. J. Mineral. **21**, 637–64