Abundance and distribution of volatile elements (C, H, N, S) in the sub-continental lithospheric mantle

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Total C,H,N and S contents were determined in this study using an elemental analyzer in a series of alkali basalt-hosted peridotite xenoliths. Volatile contents vary widely (70-8000 ppm C; 50-485 ppm N, 90-830 ppm H, 10-1500 ppm S). Six well-characterized peridotite xenolith suites from alkali basalts were investigated. These xenoliths represent various degrees of melting and metasomatism. Clear correlation between C,H,N,S and robust melt depletion criteria (e.g., Fo%, Al_2O_{3WR}) and metasomatic indicators (La/Sm) suggest that C,H, N and S variability is not related to weathering or alteration but rather was mostly established during mantle processes. However, these relationships are variable between suites. For example, the Ray Pic and Bullenmerri peridotite suites both contain high modal amphibole, however while the former shows H enrichment (up to ≈600 ppm) but low C content (≈120±30 ppm), the latter has low H content (≈ 220 ppm) but clear C enrichment (up to ≈700 ppm), well correlated with amphibole modal abundances. This difference in C and H behaviour is related to the distinctive trace-element patterns and amphibole compositions in each suite. In contrast Borée peridotites, containing no metasomatic amphibole, show high C and H contents. Spitsbergen xenoliths show both high C and S contents in agreement with their well-documented occurrence of sulfide and carbonate-bearing metasomatic-pockets. Despite some scatter N is positively correlated with C concentration and La content in cpx.

Volatile elements have always been considered to be a key component of most metasomatic melts/fluids invoked for modal, cryptic and stealth metasomatism. While mantle petrologists and geochemists have defined various metasomatic agents (including carbonatitic, carbonated, hydrous) with specific geochemical fingerprints, the nature of, and ratio between, the various volatile elements in these melts/fluids are still highly debated. Our preliminary results suggest that it may be possible to more closely constrain the relative abundance and behaviour of volatiles during metasomatic processes.