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Tracking Carbon in the Subcontinental Lithospheric Mantle

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Carbon (C) abundance, distribution, and speciation in the mantle remain poorly known, with "primitive" mantle carbon estimates varying from 100 to 1000 ppm.

We examined approximately 100 mantle peridotite xenoliths (spinel facies) hosted in alkali basalts from nine suites sampled worldwide. These xenoliths sampled Proterozoic and Phanerozoic sub-continental lithospheric mantle domains. They are harzburgites and lherzolites showing different degrees and types of metasomatism (modal to cryptic and stealth[1] , ‘hydrous’ to ‘carbonatitic’). C concentrations for whole-rock and constituent mineral fractions were measured using two complementary methods: (*i*) Elemental Analyzer (EA), providing bulk measurements at ∼1700°C, and (*ii*) Simultaneous Thermal Analyser coupled with a Quadrupole Mass Spectrometer (STA/QMS) to obtain high-resolution thermograms of volatiles release between 50°C and 1300°C.

Preliminary results indicate that: (*i*) bulk rock [C] content ranges from 30 to 1250 µg/g, with ~ 70% of samples between 100-500 µg/g, ~ 10% less than 100 µg/g and ~ 20% more than 500 µg/g; (*ii*) STA analyses mostly released C (80-90%) between 200 to 700°C, indicating that most of the C is not stored in the mineral lattice of the primary silicates (olivine, orthopyroxene, clinopyroxene(cpx)) nor in metasomatic minerals. Indeed, C-bearing metasomatic phases have distinct C-release temperatures higher than 700°C. Carbonates have a release peak at ca 780±80°C, while apatite releases C at 1100±50°C and 1250±50°C. Graphite is oxidised and degases over 900°C. These results strongly suggest that C in the lithospheric mantle assemblages is mainly hosted in inclusions, crystal defects, grain boundaries and/or interstitial components. Amphiboles(amp) and phlogopite have a significantly higher C content (449±131 ppm and 820±93 ppm, respectively) than coexisting silicates (e.g., $[C]_{Cpx}$= 231±116 µg/g), where Apatite contain approximately 5000 ppm of carbon.

Carbon is strongly linked to the geochemical distribution of large-ion lithophile elements (LILE), such as Ba and Sr, in cryptically, modally and stealth metasomatised samples. The relationships between $^{87}Sr/^{86}Sr$ and C in the whole-rock and minerals (amp, cpx) may be used to fingerprint different enrichment processes by melts/fluids with distinct sources and compositions.

[1]O’Reilly and Griffin, 2012. Mantle Metasomatism. In *Metasomatism and the Chemical Transformation of Rock*, DOI 10.1007/978-3-642-28394-9_12. Springer-Verlag.