The lithospheric mantle: a 'sink' & 'source' in global volatile cycles?

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The lithospheric mantle represents one of Earth's most long-lived and ancient chemical reservoirs. It potentially acts as both a major 'sink' and 'source' for volatiles (CO_2, H_2O, S, F, Cl, Li) and thereby plays a critical role in modulating their flux from our planet's deep interior to its atmosphere (via volcanism). Nevertheless, the volatile inventories of this major reservoir and their variability beneath the continents and oceans are poorly constrained. Of the most abundant, nominally volatile-free mantle phases clinopyroxene is the major host of H_2O and F, but has a limited capacity to store Li and Cl. Our new high-precision *in-situ* (SIMS) analyses show that partitioning of volatiles into olivine and pyroxenes in the lithospheric mantle is primarily controlled by compositions of infiltrating metasomatic melts and sub-solidus re-equilibration. Both of which vary according to tectonic setting.

We calculate bulk-rock concentrations of H_2O, F, Cl and Li in oceanic, continental on- and off-craton mantle using our new and published data. We combine these bulk concentrations with new estimates of the global volumes of oceanic, continental on- and off-craton mantle (from surface wave tomography) to obtain the first volatile inventories for these different reservoirs. Because the volume of lithospheric mantle beneath the global cratons vastly exceeds that beneath continental off-craton and oceanic regions, this is the greatest sink for H_2O (8.55×10^9 Mt), CO_2 (3.53×10^9), F (1.77×10^9) and Li (8.13×10^7 Mt). Off-craton mantle is, however, most likely to be remobilised during major heating and extension events and act as a more significant volatile source.

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