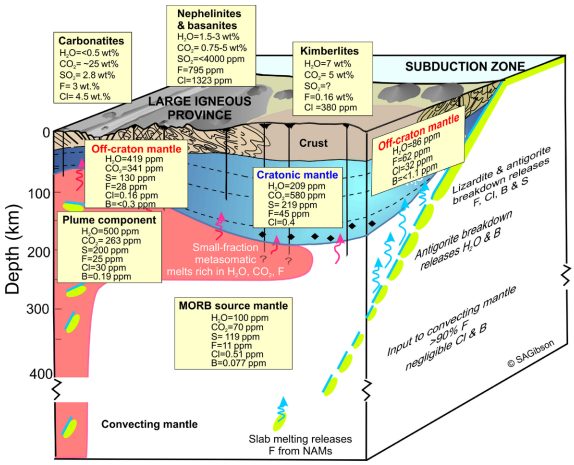
Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.19747

Abundance and behaviour of volatiles in the continental lithospheric mantle

SALLY A GIBSON, CHARLOTTE JACKSON AND JAMES C. CROSBY

University of Cambridge

Presenting Author: sally@esc.cam.ac.uk



The lithospheric mantle forms a rigid laterally-continuous reservoir that modulates the flux of volatiles from the convecting mantle to Earth's surface via volcanism and thereby plays an important role in global cycles of C, H, F, Cl, S, He, B etc. The capacity of this large reservoir (2.55×10^{10} km^3)[1] to sequester and release volatiles varies according to tectonic setting, and is dictated by the nature and composition of metasomatic agents, PT conditions and oxygen fugacity. These all control the concentrations of volatiles and their incorporation mechanisms into the most abundant mantle phases (e.g. olivine and pyroxenes) and account for their differences in on- and off-craton settings. While the budgets for multiple volatiles in the lithospheric mantle at different tectonic settings have now been estimated[1] constraining the processes involved in volatile transfer remains an outstanding challenge.

In order to improve constraints on the origin and flux of volatiles to the lithospheric mantle, we have undertaken high-precision analyses of multiple volatiles (H_2O, F, Cl, B and He) in co-existing phases (olivine, orthopyroxene and clinopyroxene) from well-characterised mantle peridotites, entrained by global intraplate magmas in both on- and off-craton settings. When combined with the results of published studies, these datasets reveal the long and complex history of volatile depletion and sequestration by the continental mantle. The relative roles of subduction-related fluids and small-fraction metasomatic melts in volatile transfer may be distinguished by combining petrological information with volatile and non-volatile elements. These are most clearly observed in cratonic mantle, which at some locations has experienced re-fertilisation by F-rich proto-kimberlite melts with variable H_2O/CO_2 ratios and reactive percolation by H_2O-rich melts and fluids with variable F/Cl ratios and B from subducted slabs. While the sequestration and build-up of volatiles associated with pulsed intraplate magmatism (e.g. kimberlite activity in the Kaapvaal craton) is potentially rapid, longer-term and more widespread volatile sequestration occurs above subduction zones (e.g. Colorado Plateau). Importantly, metasomatised continental lithospheric mantle can host volatiles for billions of years and so plays a major role in global volatile cycles.

[1]S. A. Gibson, D. McKenzie, EPSL, 602, 117946 (2023).