Multi-stage carbonation of mantle peridotites in the Oman Ophiolite: tracing fluids using halogens and trace elements

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Quantifying the carbon budget of subduction zones and the origins of CO2 in arc magmatism requires an understanding of the lateral trenchward mobility of slab-derived fluids. This can be explored in the Oman Ophiolite where fully-carbonated peridotites overlie the basal thrust fault of the ophiolite and attest to fluxing of the shallow mantle wedge by CO2-rich fluids.

Listvenites, serpentinites and meta-basalts/-sediments from the carbonated mantle section and the underlying metamorphic sole were sampled by diamond wireline coring during the Oman Drilling Project. Eight four samples were analysed for bulk major, trace and volatile elements. Halogen abundances have been measured in a subset of samples spaced across a carbonation reaction zone by a variety of bulk and *in situ* methods (noble gas method, pyrohydrolysis; electron probe, ion probe).

Rare-earth element patterns vary markedly between different listvenite domains and suggest that, prior to carbonation, the mantle section underwent a phase of high temperature infiltration resulting forming amphibole lherzolites. In situ halogen abundances meanwhile indicate two episodes of CO2-rich metasomatism, the latter being Ca- and F-rich and forming dolomite in discrete horizons. Petrographic observations indicate that dolomite-forming fluids came later, and their chemistry suggests that they derive directly from the underlying metamorphic sole.

In-situ serpentine and bulk listvenite heavy halogen compositions lie along a single tight array, suggesting formation by fluids with a common origin. The serpentine endmember of this array is dissimilar from compositions in the wider literature but can be explained by fractionation of the fluid during carbonation. Modelling this process suggests that the initial carbonating fluid composition was CO2-rich and Cl-poor suggesting it derived from deep decarbonation reactions in the slab. This implies that much of the CO2 released from the subducting slab beneath the proto-Oman ophiolite was focussed into the forearc mantle and has important implications for the CO­2 budget of subduction zones through Earth history.