

## C-O-H metasomatism and redox processes in the mantle at subduction zones

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Although much is known about the oxidation state of the upper mantle as described by oxygen fugacity as an intensive variable, the relationships between  $f\text{O}_2$  and the oxygen extensity still remain largely unconstrained. The equilibria between  $\text{Fe}^{3+}$  and  $\text{Fe}^{2+}$  contents in mantle mineral assemblages may buffer the  $f\text{O}_2$  and the speciation between C, H and S, the most important volatiles in the mantle. Conversely, equilibria between volatile species in an excess-fluid may control the oxidation state of mantle phase assemblages by redox reactions, which depend on the abundance of redox-sensitive elements, such as Fe, and on the moles of oxygen exchanged in the redox equilibria. What exactly controls the  $f\text{O}_2$  in the mantle is still poorly constrained. Also, the determination of the oxidation state of metasomatised garnet peridotites is a demanding task because the  $\text{Fe}^{3+}$  content of all the mineral phases should be considered to obtain reliable quantifications of the oxidation state of the whole rock.

We present two case studies of mantle-derived garnet peridotites from Donghai County (Sulu, China) and from Bardane (Western Gneiss Region, Norway), unique examples of metasomatised mantle wedge that interacted with COH subduction fluid phases up to 200 km depth. Sulu peridotites record a multistage metasomatism by alkali-rich silicate melt, and a subsequent influx of a slab-derived incompatible element and silicate-rich fluid during the Triassic UHP metamorphism. We performed  $\text{Fe}^{3+}/\Sigma\text{Fe}$  flank method and electron energy loss spectroscopy measurements for garnet and pyroxenes, to quantify the  $\text{Fe}^{3+}$  distribution among the peridotite phases and estimate the bulk oxidation state of the peridotite. The results indicate that garnets are zoned, with  $\text{Fe}_2\text{O}_3$  increasing from  $\sim 0.8$  to  $\sim 2.5$  wt.%. Clinopyroxenes contain high  $\text{Fe}^{3+}/\Sigma\text{Fe}$  ratios (0.48 to 0.51) and Na contents. Also orthopyroxene have  $\text{Fe}^{3+}/\Sigma\text{Fe}$  up to 0.10, with important consequences in the study of redox processes in mantle rocks. Peridotites from Norway preserve remnants of crust-derived fluids which precipitated diamond in polyphase inclusions hosted by majoritic garnet. We determined the  $f\text{O}_2$  of the peak mineral assemblage starting from  $\text{Fe}^{3+}$  analyses in majoritic garnet. The  $f\text{O}_2$  values are up FMQ-2 along a trend from arc lavas (FMQ+1.5 – FMQ+3) to mantle wedge garnet peridotites from Sulu (FMQ – FMQ+2).

The  $f\text{O}_2$  determination together with  $\text{Fe}^{3+}$  distribution among the hydrate–carbonate-bearing mineral association of Sulu and Bardane peridotites suggest that slab-derived metasomatic COH fluids are  $\text{H}_2\text{O}-\text{CO}_2$  mixtures, whereby the  $\text{H}_2\text{O}/\text{CO}_2$  ratio increases with increasing pressure. The peculiar composition of majorite-hosted diamond-bearing polyphase inclusions from Bardane and the speciation of its COH component point to an “oxidised” silicate-rich aqueous fluid contaminant from the subducted slab to the mantle wedge which could be regarded as carrier of dissolved oxidised components from the subducted slab to the mantle wedge. Also, the  $\text{Fe}^{3+}$  enrichment of clinopyroxene in the Sulu peridotite is apparently related to a progressive enrichment in Na, as aegerine component, and could be favoured by the influx of  $\text{Fe}_2\text{O}_3$ - and alkali-rich metasomatic fluid phases. Such mechanisms open new possibilities to unravel the redox processes occurring in arc mantle sources and their role in precipitating diamond.