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Behaviour of S and Fe during multi-stage metasomatism of oceanic crust as revealed by eclogite xenoliths from the Colorado Plateau

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Lawsonite/zoisite-eclogite and omphacitite xenoliths from the Navajo Volcanic Field resemble tectonically exhumed eclogites from the Franciscan Complex ~700 km to the west, and probably sample the Cretaceous Farallon plate that, after flat subduction, underplated the Colorado Plateau [e.g., 1,2]. The regional lithosphere was massively hydrated by fluids derived from the descending slab (the Great Hydration Event), which also contributed to the geochemical and isotopic signatures in the NVF eclogite xenoliths [3]. $\delta^{18}O$ in garnet indicates isotopically heavy cores inherited from the oceanic crustal protolith, and lighter, MgO-rich rims, suggesting interaction with serpentinite-derived fluids liberated during foundering of the Farallon slab some 40-20 Ma ago [3,4].

Here, 16 new and 5 previously investigated eclogite and omphacitite xenoliths were selected to study redox interactions in deep subduction zones. Bulk-rock sulphide abundances vary from <0.01 to 1.7 vol.% [2] and Fe^{3+}/SFe vary from 0.19 to 0.73 (this study). Both are strongly correlated to SiO_2 and Na_2O contents, and therefore appear to be controlled by omphacite modal abundance linked to siliceous metasomatism. Preliminary results for combined *in-situ* $\delta^{18}O$ [5] and $Fe^{3+}/\sigma Fe$ analyses [6] of garnet show that low-$\delta^{18}O$ garnet overgrowths are characterised by lower $Fe^{3+}/\sigma Fe$ than the high-$d^{18}O$ cores. Furthermore, garnet $Fe^{3+}/\sigma Fe$ not only is strongly negatively correlated to Mg#, but also weakly positively correlated to Ca#, the latter known to affect the partitioning of incompatible trace elements and Fe^{3+} in eclogite [7]. The link of sulphide to omphacite modal abundances - therefore of pre-Great Hydration origin – and lack of evidence for S mobilisation during this event suggest that Fe-S redox interactions are not the cause of low $Fe^{3+}/\sigma Fe$ in Mg-rich garnet rims. Further work is required to understand whether this signature reflects crystal-chemical effects due to lower Ca# in garnet rims and/or whether the serpentinite-derived fluids themselves were Fe^{3+}-poor.

[1] Helmstaedt and Schulze 1991 JGR; [2] Usui et al. 2006 JPet; [3] Schulze et al. 2015 Geology; [4] Hoover et al. 2021 JPet; [5] Ickert et al. 2013 EPSL; [6] Höfer and Brey 2007 CMP; [7] Aulbach et al. 2019 SciRep.