Redox conditions across the antigorite dehydration reaction constrained by sulfide-oxide-silicate mineral geochemistry

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Antigorite breakown arguably is the most important dehydration reaction occuring during subduction, thought to release oxidising fluids to the mantle wedge. However, stabilities of oxide and sulfide minerals across this dehydration reaction have remained poorly constrained, despite their importance for the redox state of the slab.

We performed a detailed petrographic and geochemical study of opaque phases in ultramafic rocks from Cerro del Almirez (Spain). Our results indicate that prograde to peak magnetite + pentlandite ± pyrrhotite ± ilmenite coexist in both the antigorite-serpentinites and chlorite-harzburgites. Textural relationships identify multiple mineral growth stages. Anhedral magnetite poor in Cr and Ni is intergrown with pentlandite along with minor ilmenite in antigorite-serpentinite. Polygonal magnetite and subhedral pentlandite is in textural equilibrium with olivine + orthopyroxene + chlorite in chlorite-harzburgite. This magnetite displays decreasing Cr and Mn along with increasing Ni indicating formation rather than consumption of magnetite during antigorite breakdown. Prominent retrogression includes formation of talc after orthopyroxene, and crack-filling low-T serpentine along with ilmenite or ilmo-hematite (both showing exsolution lamellae), pyrite and chalcopyrite.

Neo-formation of magnetite in the antigorite dehydration product mineral assemblage coexisting with pentlandite documents rock-buffered conditions close to the FMQ buffer and demonstrates limited S mobility in dehydration fluids. Observed differences in oxide and sulfide modes between antigorite-serpentinite and chlorite-harzburgite thus likely relate to variations imposed upon variable extents of ocean floor hydration [1]. We conclude that antigorite-dehydration fluids only carry a moderate redox budget and thus may not account for the relatively oxidised nature of arc magmas.

[1] Bretscher, A. et al. (2018). *Earth Planet. Sci. Lett.* 499**,** 173–184.