Isotope constraints on serpentinite mineral carbonation

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The weathering of serpentinized peridotites, tipically in ophiolite complexes, results in alkaline groundwater that may react with atmospheric or soil-derived CO_2, resulting in rapid precipitation of anydrous and/or hydrous carbonate minerals. The origin and composition of mineralizing solutions associated with natural magnesium carbonate precipitation remain poorly constrained in many geological setting. In this context, we have been studying authigenic hydromagnesite, nesquehonite and associated LDHs (Layered Double Hydroxides, i.e. pyroaurite and coalingite) mineralization, present mainly as coating and efflorescences on ophiolitic rocks of the Northern Apennine, center of Italy. The host rocks have been intensely serpentinized during the oceanic stage. Their peculiarity is their original and present composition that allows an on-going efficient carbonation. They were dunitic in origin and different events of oceanic serpentinization produced a mineral assemblages made of serpentine, Fe-poor/Fe-rich brucite and minor amount of magnetite. Carbonation of Fe-rich brucites produces large amounts of LDHs and less hydromagnesite. Alteration of Fe-poor brucite results in smaller amounts of LDHs. A larger excess of Mg is released, leading to an extensive precipitation of hydromagnesite inside and outside the dunite reactor zone. Hydromagnesite can trap a larger amount of carbon compared to LDHs, increasing the efficiency of CO_2 sequestration.

We use stable isotopes (O, C, H) to help better interpret the potentially complex geological conditions under which these different mineralization formed. $\delta^{13}C$, $\delta^{18}O$ and δD span over a wide range of values indicating different genetic processes, as continuous rainwater infiltration, water/soil interaction, evaporation and condensation.

Overall, isotope constraints indicate multiple fluid pathways, where brucite-rich serpentinized dunite represents an infinite reservoir that triggers the process.