Brucite-driven serpentinite carbonation at Montecastelli (Tuscany, Italy)

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Tuscany (Italy) is characterized by numerous, large outcrops of ophiolites, i.e. serpentinites, gabbros and basalts, representing remnants of the Jurassic Ligurian Tethys. At Montecastelli (Tuscany), spontaneous CO_2 mineral sequestration is an ongoing process locally affecting serpentinites along fractures and at surface. Here, the ophiolite outcrops are characterized by serpentinized harzburgites hosting discrete brucite-rich serpentinized dunite bodies. Mineralogy and texture of the serpentinized dunites indicate two-stage oceanic serpentinization: an earlier hydration, leading to the formation of a Fe-rich brucite, serpentine and minor magnetite arranged in a typical pseudomorphic mesh texture (type-1a dunite), and a late veining producing serpentine, magnetite and brucite overprinting the previous texture (type-1b dunite). Carbonation of serpentinites is strongly catalyzed by the presence of brucite-rich lithotypes. Serpentinized dunites are pervasively affected by carbonation in form of: i) replacement of Fe-rich brucite by Mg-Fe LDHs (pyroaurite-coalingite) in mesh cores and rims (type 1a) and replacement of brucite by hydrous Mg carbonates (hydromagnesite with minor nesquehonite) in veins (type 1b); ii) precipitation of hydrous Mg carbonates ± Mg-Fe LDH ± aragonite in fractures and at external rock surfaces (type 1a and 1b).

By contrast, the brucite-free serpentinized harzburgites are not significantly affected by carbonation. Coatings and crusts of hydrous Mg carbonates ± aragonite can form on free surfaces of this rock around clasts but they never reach the pervasive effect observed in brucite-rich serpentinized dunites.

We argue, based on all our evidences, that the infiltrated meteoric water produces the dissolution of the Fe-rich brucite and brucite in the dunitic rocks, with consequentely precipitation of Fe-rich LDH and hydromagnesite. The modified rainwaters after the pervasive interaction with the serpentinized dunites - confirmed by their high pH (8.5), high Mg content (55 mg/l) and low Si content - discharge out from the outcrops, precipitating a late hydromagnesite coating at the rock (both dunite and harzburgite) surfaces.