

Fracture formation due to growth of hydrous carbonates

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In situ carbonation of ultramafic rock has been suggested as an option for long term sequestration of anthropogenic CO₂[1]. It is in this respect critical to know whether the growth of carbonate minerals will clog pore space, and thus limit further transport of CO₂ into the rock, or whether the carbonate growth will exert enough stress on the host rock to make it fracture, thus forming new fluid pathways.

In this work, we utilize a novel modelling technique to combine the thermodynamics of carbonate precipitation and pore fluid flow with a discrete element model that describes brittle fracture formation. The thermodynamics is based on evaporation of water from a solution, thus gradually increasing the supersaturation with respect to carbonate minerals. The initial water chemistry in the simulations is based on analysed surface and mine waters from a sub-arctic serpentinized dunite in the Feragen Ultramafic Body (FUB) in eastern Norway. The evaporation leads to precipitation of hydrous magnesium carbonates, which generate crystallization pressures that may exceed the strength of the rock[2]. Our results are compared with observed fracture formation and carbonate infill in fractures in the FUB.

We achieve an improved understanding of the evolutions of stress and damage, and the crack propagations induced by minerals precipitating from supersaturation. This improves our ability to determine whether industrial scale mineral carbonation is a viable option for long term storage of CO₂.

[1] Kelemen, P. B., and Matter, J. (2008), *P. Natl. Acad. Sci. USA* Vol. **105(45)**, pp. 17295 – 17300. [2] Beinlich, A., and Austrheim, H. (2012), In situ sequestration of atmospheric CO₂ at low temperature and surface cracking of serpentinized peridotite in mine shafts. *Chem. Geol.* **332**, pp. 32 – 44.