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Does serpentinite carbonation occur during recharge or discharge of hydrothermal fluids? A case of study from the Newfoundland margin

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Hydrothermal fluid circulation in extensional systems occurrs along the spreading axis of passive, hyper-extended margins and mid-ocean ridges. The most studied feature resulting from hydrothermal circulation is the sub-seafloor chimneys because of their accessibility. Here we focus on the less studied carbonation process of the associated serpentinites. Carbonation of partially to totally serpentinized peridotite i.e. peridotite/serpentinite replacement by carbonate is usually described as a process of veining or matrix formation but not direct replacement of serpentinite. Carbonates that crystallize in veins or as a matrix in a sedimentary setting is known in near-surface environments like Oman (Kelemen et al, 2011), however the processes and timing of carbonation are still not well understood.

This study is examins in detail the onset of carbonation in the footwall of the detachment faults responsible for mantle exhumation in hyper-extended rifted margins. It is based on drilled samples from ODP Leg 210 Site 1277 in the Newfoundland margin. We observed calcite grains in the mesh core replacing serpentine and we measured δ18O from core to rim of the calcite grain using the Secondary Ion Mass Spectrometer (SIMS, SwissSIMS facility, University of Lausanne). Ultimately δ18O measurements lead us to infer the temperature of calcite growth.

We suplement the study with equilibrium thermodynamic modeling in an open system where fluid can be transported either upwards or downwards. The model allows us determining the influence of fluid flow direction, temperature, pressure and fluid/rock ratio on the stability of carbonates and serpentine, and thus to discuss if carbonation occurs during recharge or discharge of the fluids.

Kelemen, P. B., Matter, J., Streit, E. E., Rudge, J. F., Curry, W. B., & Blusztajn, J. (2011). Rates and mechanisms of mineral carbonation in peridotite: natural processes and recipes for enhanced, in situ CO_2 capture and storage. Annual Review of Earth and Planetary Sciences, 39, 545-576.