Micro-reactors: a novel *in situ* tool to monitor chemical reactions

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Our newly developed experimental methodology uses synthetic fluid inclusions (SFI) in ultramafic minerals as micro-reactors to monitor and quantify, *in situ* and in real time, chemical reactions relevant to serpentinization and carbon sequestration environments.

Several experiments tested the impact of temperature, fluid composition and salinity (activity of H_2O) on reaction rates. First, we trapped SFI with aqueous fluids of different compositions ($NaCl-MgCl_2 \pm CO_2$) in olivine and pyroxene at elevated P-T where the minerals were in equilibrium with the fluids. Then, after detailed petrographic investigation, wafers of the crystals were incubated at temperatures relevant to serpentinization (150 to 450ºC) or carbonation (50 to 100ºC) reactions. After a few days of reaction time, small clusters of secondary minerals (serpentine + brucite ± magnetite and magnesite) formed inside the SFI. In the serpentinization experiments, reaction progress was monitored by low temperature microthermometry measuring the changes in the salinity of the SFI as a proxy of H_2O consumed by the reaction $2Ol + 3H_2O = Srp + Brc$. For the carbonation experiments, reaction progress was monitored by measuring changes in the splitting of the Fermi diad of CO_2 through time using Raman spectroscopy to assess how much CO_2 is consumed by the reaction $Ol + 2CO_2 + 2H_2O = 2Mgs + H_4SiO_4$.

Results of the ongoing experiments show that the rates of serpentinization are very sensitive to changes in the water activity so they slowed down significantly after small increases in salinity (NaCl) and also after increases in $MgCl_2$ and CO_2. The rates of reaction and chemical composition of the reaction products obtained here are comparable to previous studies at the same conditions. Future experiments will test different fluid compositions, hosts (pyroxenes), and the backward reactions (dehydration) at subduction temperatures. The applications of this technique are manifold, this is a promising tool to monitor fluid-rock reactions *in situ* and in real time, and can be applied to a wide variety of host minerals, reaction products, temperatures, and starting fluid compositions.