Deepwater Horizon spill effects on fish otoliths by LA-ICP-MS

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The Deepwater Horizon oil spill that occurred in 2010 released an estimated 4.9 million barrels of oil into the Gulf of Mexico. This study uses laser ablation mass spectrometry (LA-ICP-MS) to measure the effects on the otoliths of multiple populations and species affected by the spill to different degrees. Otoliths are often used as ecological markers due to their fast speed of growth, which makes them sensitive to environmental changes.

LA-ICP-MS offers a precise means of directly measuring elemental heterogeneity across a sample that is impossible with aqueous methods. This study utilizes an XYR shutter to further increase the spatial resolution. A NWR193 laser ablation system fitted with a fast washout TruLine cell and attached to an Agilent 7700s is used to track elemental tracers such as V and Ni from the oil through the otolith to determine how the oil was incorporated and test for earlier exposures.

Reactive transport modeling to assess geological CO_2 storage via mineral carbonation in peridotite

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In situ mineral carbonation is a mechanism for safely and permanently storing CO_2 by converting it to carbonate minerals in geologic formations. Reactive silicate formations with high concentrations of divalent cations (e.g., Mg^{2+}, Ca^{2+}, or Fe^{2+}) have an enormous capacity to sequester CO_2: the mantle peridotite in the Samail Ophiolite, Oman alone could sequester $30x10^{12}$ tons of CO_2 [1]. However, the accessible capacity may be much lower, as CO_2-water-rock interaction is limited by porosity, permeability, and reactive surface area, which are relatively low in fractured-rock aquifers such as in peridotite. Sustained mineral carbonation will also depend on how these hydrogeological factors evolve with reaction progress- carbonating peridotite involves a volume increase of over 40%, so secondary mineralization could clog the existing porosity and permeability, and could armor unreacted peridotite from further carbonation. Alternatively, stresses from volume increase could cause fracturing, creating new permeability, porosity, and reactive surface area. This reactive cracking would allow the carbonation front to continue propagating into the formation. Completely carbonated peridotites in Oman are proof that the carbonation reaction can proceed to completion, given the right conditions [1].

Here we present a reactive transport model of *in situ* mineral carbonation in peridotite to help determine ideal carbonation conditions and how they can be met within the confines of an engineered geological CO_2 storage project. The model is constrained by geochemical and hydrogeological data for peridotite aquifers in the Samail Ophiolite collected over five field seasons. It includes reaction kinetics, non-isothermal multiphase flow, and CO_2 injection scenarios to evaluate how to optimize carbonation by adjusting different parameters (formation temperature, fluid pCO_2, injection rate and temperature, etc.), and estimate what extent of carbonation is realistic for a CO_2 storage project employing *in situ* mineral carbonation in peridotite.

[1] Kelemen *et al* (2011). *Ann. Rev. Planet. Sci.* **39**, 545-576

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