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Assimilation of Halite by Mid-Ocean Ridge Basalts

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High chlorine contents in mid-ocean ridge basalts (MORB) are most likely due to assimilation of hydrothermally influenced materials. Most studies have considered the role of dense brines in surrounding rocks as the source of the elevated chlorine in MORB. Experimental studies of phase separation of seawater together with variable salinities in hydrothermal vent fluids support the creation of dense brines in rocks overlying magma chambers. I propose here that halite assimilation, in addition to (or instead of) brine assimilation may play an important role for high chlorine in MORB, and discuss the implications.

Depleted basalt through dacite glasses from Galapagos Spreading Center (85°W) range from 8% to 1% MgO, and contain up to 4000ppm Cl. Their H_2O/Ce (172-213) is similar to Pacific MORB and is not correlated with MgO. After adjusting for assimilation of saline brine (50 wt.% NaCl), H_2O/Ce ratios are unrealistically low (79-154) and are correlated with MgO. A similar brine subtraction for fresh, high-Cl tholeiitic flood basalt glasses from the Cretaceous Nauru Basin results in *negative* H_2O contents. These two cases best constrain the role of H_2O because they involve depleted, low-H_2O glasses which are sensitive to hypothetical correction for brine. Halite saturation has been proposed for continental copper porphyry hydrothermal systems, where it might decrease permeability for fluids, and lead to metal deposition [1]. The pressures of stability of halite and brine [2] suggest that a halite-only (brine-free) system would only exist at low pressures: <500 meters below the seafloor. It is likely that both brine and halite are present in mid-ocean ridge hydrothermal systems, although they may end up in different locations. Some implications of halite assimilation by MORB are that:

- H_2O/Ce ratios will be too low if adjusted for brine.
- The use of Cl, Br, and I and their ratios to rule out assimilation in MORB or OIB may not be straightforward.
- Some hydrothermal systems and perhaps their underlying magma chambers maybe be at very shallow levels in the oceanic crust.

[1] Lecumberri-Sanchez, P. et al., Geology 2015, 1063-1066.

[2] Driesner, T and Heinrich, CA, 2007. Geochim. Cosmochimica Acta 71, 4880-4901.