

Mobility of fluoride in fluids influenced by hydrothermal alteration of sediment

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Fluoride in hydrothermal systems plays an essential role as a ligand for the mobility of rare earth elements (REE) [1], but its behavior during fluid-rock interactions in sediment-influenced/hosted systems remain largely uncharacterized. Previous experimental work showed temperature-dependent precipitation-dissolution processes during simple heating of seawater alone [2]. We build upon earlier efforts with experiments using a Au-TiO₂ flexible cell apparatus with the aim to better understand F-behavior during hydrothermal alteration of sediment. Two sediment types, Guaymas Basin (GUAY) and Arctic Mid-Ocean Ridge sediments (KNIP) were heated in the presence of artificial seawater. KNIP was heated to 250-330-250°C (35MPa), while GUAY was heated to 250-330-360°C (35MPa). Fluid samples were extracted at various time points and analyzed for F and other dissolved species. At 250°C, both experiments show similar F depletion to persistent low values relative to seawater (70 µmol/kg). In contrast, higher temperatures of 330°C and 360°C resulted in elevated concentrations of F relative to seawater. These consistent trends suggest a strong degree of equilibrium control, most likely related to precipitation-dissolution of F-bearing mineral phases.

To test our observations, we also analyzed for F abundances in various sediment-influenced/hosted hydrothermal fluids which are characterized by diverse temperatures - Guaymas Basin (172-299°C), Middle Valley (40-187°C), Escanaba Trough (210°C), Loki's Castle (43–316°C) and Ægir (282°C). Elevated concentrations of F relative to seawater were measured in some of these fluids, with the hotter fluids at Guaymas and Escanaba having the highest concentrations (84–130 µmol/kg). However, Middle Valley and the sediment-influenced Loki's Castle and Ægir fluids were depleted relative to seawater values, resembling observations from earlier studies that have measured F in bare-rock hydrothermal systems lacking sediment influence [3]. Our results overall indicate that both fluid-sediment interactions and temperature play complex roles in regulating dissolved F during hydrothermal sediment alteration.

[1] Craddock *et al.* (2010) *Geochim. Cosmochim. Acta* 74, p5494–5513