Fluid-rock Interactions in Oceanic Settings Frieder Klein Woods Hole Oceanographic Institution

Image credit S. Zankl[©]

Hydrothermal Systems

Kelley and Elend

Petersen et al. (2009)





- mechanically strong
- dry
- weakly oxidized
- dense (~3.3 g/cm³)

- >12 wt% water (1m³, 325 kg)
- less dense (~2.6 g/cm³)
- mechanically weak
- strongly oxidized (>66% Fe^{III})
- volume increase ~40%









What are the proportions of mafic and ultramafic rocks in ridge flank / off-axis environments in the Atlantic, Arctic, and Indian Oceans?

Intermediate- to superfast-spreading ridges



• (Ultra-)Slow spreading ridges

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profile

Cannat et al (2019)





How deep does aqueous alteration extend below the seafloor and how does that change offaxis? Weathering of altered basal





& serpentinite



Seawater Chemistry & Alkalinity Production



- 1. What is the magnitude of alkalinity production from seafloor weathering of (ultra-)mafic rocks?
- 2. What is the net Mg/Ca resulting from high- and low-T alteration of (ultra)mafic rocks?

Plate Tectonics & Global Geochemical Cycles



- 1. How much serpentinite and altered gabbro is there in the Pacific?
- 2. How deep does aqueous alteration extend below the seafloor and how does that change off-axis?

• mCDR, Geologic Hydrogen, Carbon Sequestration, & Critical Elements

What can we learn from natural processes?



Fluid-Rock Interaction Processes: Needs

- New seafloor drilling platforms
 - drill ship for deep drilling (e.g., IODP X399)
 - seabed drill (improved MEBO, RockDrill2)
- Full-ocean depth reconnaissance and sampling capabilities
 - ROV >6500m
 - AUV >6000m
 - dredging (increased safety factors limit conventional dredging to ~5000m)

Opportunities for Partnerships

- NASA: Astrobiology, Solar System Workings, Habitable Worlds
- NSF: P&G, OPP
- DOE: ARPA-E
- Industry: mCDR & carbon sequestration, H₂ economy, critical elements
- Foundations: Schmidt, Ocean Exploration Trust, OceanX,...
- International: ERC, IODP³,...