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How much serpentine at oceanic transform faults?

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Oceanic transform faults (OTF) and their associated fracture zones have long been hypothesized to be sites of enhanced fluid flow and of biogeochemical exchange. In this context, the serpentine forming interaction between seawater and cold lithospheric mantle rocks is particularly interesting. Mantle serpentinization results in the hydration of oceanic plates and is a mechanisms of abiotic hydrogen formation, which can support archeal and bacterial communities at the seafloor. The timing, mechanisms, and extents of mantle serpentinization at OTFs remain, however, poorly constrained. Here we use a joint model-data approach to address these questions.

In this presentation, we will review the existing geophysical, geological, and petrological observational constraints on mantle serpentinization at OTFs, show insights from 3-D geodynamic model simulations on the interrelations between deformation, fluid flow, and hydration reactions, and will finally present OTF evolution scenarios consistent with and constrained by both models and data.

Our modeling results show that the extent and rate of mantle serpentinization should scale positively with fault offset and that at ultraslow to slow slip rates most mantle hydration should occur close to the ridge, while at intermediate slip rates significant off-ridge mantle hydration may occur. Very limited mantle hydration occurs at fast slip rates. To ground truth these predictions, we will compare model predictions for selected ridge-transform systems against independent constraints including earthquake locations, seismic data, gravity anomalies, and direct seafloor observations. A preliminary joint-data analysis supports the concept of OTFs being sites of substantial fluid flow and biogeochemical exchange.