Understanding the diversity of mantle sources sampled by hotspots is essential to unraveling the origin and evolution of magmas erupted onto the surface of Earth. Ocean island volcanoes erupt lavas derived from the mantle; studying the geochemical signatures reflected in these lavas is necessary in determining the spatial and temporal scales associated with mantle stirring and mixing occurring by convection and partial melting. These mixing mechanisms leave geochemical imprints on lavas erupted at ocean island basalt (OIB) locations.

Trends in the geochemistry observed in OIBs define a branching array of five mantle source end-members. These end-members may be the product of mixing mantle compositions with materials introduced via subduction. Mantle plumes ‘sample’ this recycled geomaterial, however, uncertainty lies in the mechanisms that generate the OIB end-members in terms of initial magma compositions contributing to the source region and the style of mixing and partial melting. Many extant geochemical models assume, ab initio, the extent of partial melting and mineral proportions that contribute to the melt. A more rigorous approach is to use thermodynamic phase equilibria calculations. The main thrust of this work is to incorporate, self-consistently, phase equilibria constraints to obtain better estimates of major and trace element concentrations as well as isotopic ratios of mantle partial melts contaminated by subducted material. This study initially focuses on mechanisms generating the enriched mantle 2 (EM2) source, widely considered to be generated by mixing of subducted terrigenous sediment with depleted mantle. The ultimate goal is to complete a thorough computational analysis of mixing mechanisms that could generate the geochemistry observed in the remaining mantle end-members (e.g., EM1, HIMU, etc).

Over the summer of 2016, two thermodynamic, phase equilibria partial melting models were generated under specific parameterizations (e.g., temperature, pressure, oxygen fugacity, volatile concentrations) in order to evaluate possible mixing and partial melting mechanisms that could generate an EM2 signature. Illustrative calculations were performed for mixing of upper continental crust-type (UCC) compositions with depleted MORB mantle (DMM)\(^2\). Results were compared with data from the archetypical locality for sediment contamination, the Samoan Islands. Preliminary results suggest between 4% and 12% sediment likely contaminates the mafic source composition of the Samoan mantle plume. The mode of melting/mixing is closer to a scenario of sub-solidus mixing of two compositions prior to partial melting rather than mixing of two partial melts. In an evaluation of batch melting (sequential removal of melt from its source) of a UCC + DMM mixture, as the extent of UCC contamination and frequency with which partial melts are removed from the source rock increases, trace element predictions converge and become almost indistinguishable from one another. These results illustrate the importance in determining self-consistently the extent of partial melting and contamination from a thermodynamic, phase equilibria perspective. This work has provided an affirmation of concept; future work will include a further evaluation of the EM2 signature as well as the remaining mantle source end-members using the same methods described above.