Experimental modeling of subduction zone flow and anisotropy

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C. Kincaid[1], K. Fischer[2]

[1]*University of Rhode Island;* [2]*Brown University*

Seismological and geochemical observations and 3D modeling suggest that subduction-induced wedge circulation has more spatial and temporal complexity than previously predicted in 2D modeling studies. In this recently funded project, we plan to carry out laboratory experiments that model 3D subduction zone flow and anisotropy and to compare their results to seismic data. One set of experiments will investigate how mantle flow is driven by a variety of physical subduction zone parameters related to plate motions and the subducting slab (along-strike slab dip variations, trench roll-back, slab edges and tears, and upper plate morphology and deformation). In a second set of experiments, we will consider how wedge material with anomalous viscosity and/or buoyancy interacts with flow and alters predicted anisotropy; sources of such material include hydrated or partially melted mantle from the slab-wedge interface, volatile depleted mantle produced by decompression melting or enriched mantle entrained into the wedge. Flow models will be tested through comparison with seismic anisotropy observed in subduction zones around the globe, with a particular focus on Nicaragua-Costa Rica and the Marianas. Specific questions to be addressed include: 1) What effect does along-arc slab morphology and sinking mode have on flow in the wedge? 2) Can combinations of these parameters and upper plate shape and deformation produce 3D flows that are consistent with observed anisotropy (e.g., arc-parallel fast directions)? 3) How do altered or chemically distinct regions of mantle wedge interact with 3D, subduction-induced flow? 4) Do these interactions produce LPO patterns that are consistent with observations? 5) How do they change with density/viscosity contrasts between ambient and altered mantle reservoirs and what are the implications for geochemical models of arc magmagenesis?

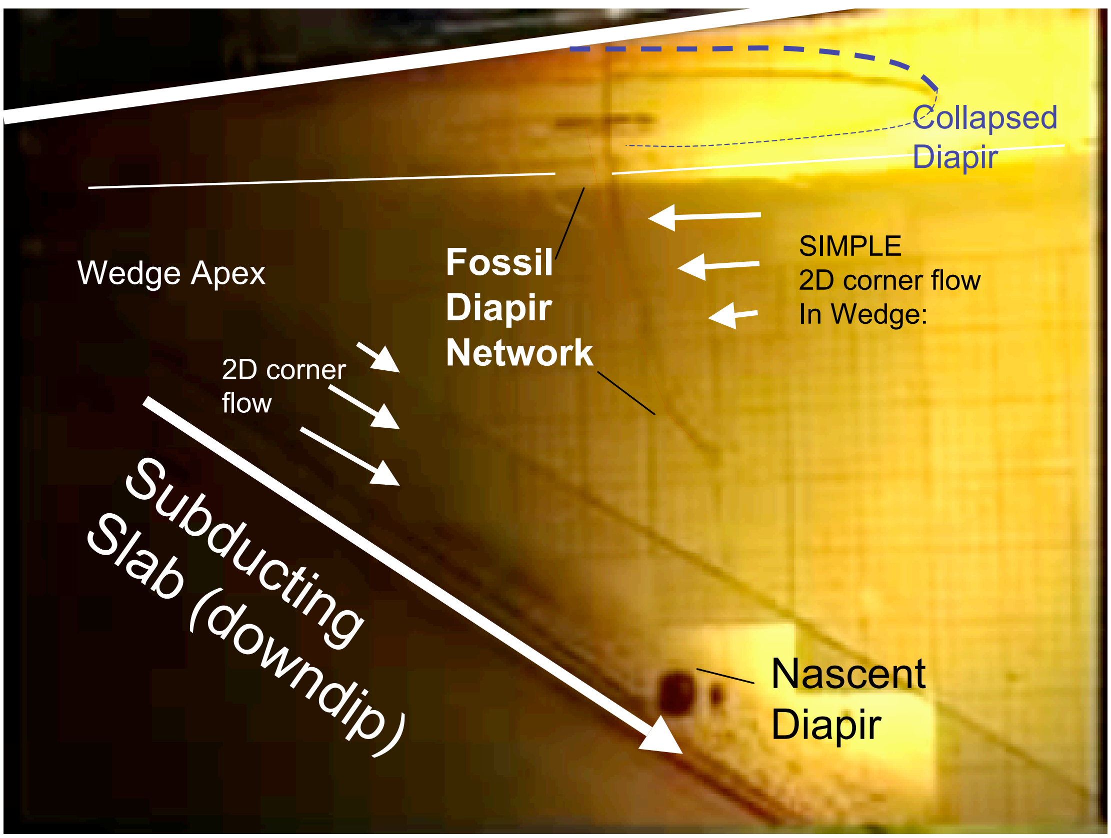

Figure: 2D subduction zone flow (Hall and Kincaid, 2001). The new lab apparatus planned for this project will model the evolution of buoyant flow networks within the wedge influenced by 3D flow structures driven by rollback subduction.