Letters of Intent: Lau Basin
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Magma production and mantle flow patterns beneath the Eastern Lau Spreading Center from a deployment of ocean bottom seismographs

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Two of the fundamental questions posed in the R2K Science plan deal with melt formation and transport, and its relationship to mantle flow patterns and composition. The R2K Lau Integrated Study Site along the Eastern Lau Spreading Center (ELSC) offers an excellent opportunity to image mantle structure beneath a spreading center, due to the high level of natural seismicity immediately beneath the ridge. The ELSC also shows pronounced along-strike changes in chemistry, petrology, and ridge morphology which may be related to deep structure and mantle flow patterns. We propose a combined passive-active source deployment of 60 ocean bottom seismographs (OBS) to study the melting and mantle flow processes in the upper mantle.

The goal of the active-source survey is to obtain a detailed map of the melt distribution and mantle flow immediately beneath the Moho. The active-source experiment will be centered on the bull's-eye of the ISS and will extend about 125 km along strike. We will use seismic velocity anomalies of Pn arrivals, and Sn waves if they are observed, to map km-scale variations in the distribution of melt just beneath the crust along the ridge axis. We will use the magnitude and orientation of azimuthally-varying anisotropy in Pn velocities to constrain the direction of mantle flow. The experiment will also image the overlying crustal structure in three-dimensions, allowing us to compare maps of melt distribution at mantle depths to crustal thickness and the melt distribution in the crust. The active survey will occur prior to the passive survey using the same OBSs and the R/V Ewing airgun array.

The passive survey will consist of 60 OBSs deployed for nine months along a 250 km section of the ELSC. OBSs will be concentrated near the "bull's-eye" and along a magma-starved ridge segment near the center of the ELSC to investigate the role of mantle structure and mantle flow patterns in localizing magma production and influencing ridge morphology. The spatial proximity of the island arc is thought to control many aspects of the ridge geochemistry. Therefore the OBS arrays will extend across the active Tonga Volcanic arc to allow imaging of possible interaction between the backarc ridge magma source region and fluid rich regions near the slab and arc magma source. The seismic data will be analyzed using body and surface wave tomographic methods and shear wave splitting analysis to obtain seismic P and S wave velocity images, seismic attenuation images, and constraints on seismic anisotropy throughout the upper 400 km of the mantle. These results will be compared to predictions of flow models incorporating temperature-dependent viscosity, where seismic anisotropy is computed from the orientation distribution of modeled olivine/enstatite aggregates. The full suite of seismic results will be integrated with geochemical and petrological results, again using the flow/melt production models and elasticity measurements as a guide.