## Project Summary

*Intellectual Merit*

The Lau basin spreading center, provides an ideal environment to test the influence of subduction-related volatiles on magmatism, petrology, hydrothermal venting and the biological systems that have adapted to this back-arc system. Within the Eastern Lau Spreading Center (ELSC), over a distance of only 50 km, seafloor lavas rapidly vary from tholeitic basalts to more evolved andesite. There is a concomitant change in the character of the subsurface magma chamber reflector which is nearly absent to the north of this transition zone, but is continuous southward as the influence of subduction-related volatiles begin to dominate magmatic processes. Water column measurements and on-bottom exploration across this gradient zone, however, paint a more complicated picture. Vigorous hydrothermal venting spans the transition zone, with high temperature fields sited both within a basaltic segment (Tow Cam field), that appears to have no underlying melt lens to drive the system, and hosted in andesitic substrate (ABE field), where a robust magmatic system is imaged at depth. These competing factors make the transition zone an ideal laboratory to study the general relationship between magma chamber properties (i.e., melt versus mush—> or absence), upper crustal hydrothermal fluid pathways and venting.

To explore linkages between fine-scale 3D crustal structure, magma sill characteristics and hydrothermal venting at the Lau ISS, we propose a 3D multi-channel seismic (MCS) investigation encompassing the transition zone from vent fields Tow Cam to ABE. The PIs will build upon their expertise, gained from the ARAD 3D seismic experiment, to produce accurate 3D images and quantify the properties of magma chamber and crustal structure, using the multi-streamer and multi-array capabilities of the R/V *Marcus Langseth*. We have recently developed a new *synthetic ocean bottom experiment* (SOBE) approach to high-resolution tomography of MCS data that extrapolates sources and receivers to the seafloor; this wave equation approach enables the shallowmost refracted arrivals recorded on the MCS streamer, that heretofore were hidden behind the water wave, to be used for tomographic analysis. Such detailed near-surface velocity structure (10s meters vertical resolution) provides a crucial means for potentially recognizing upper crustal fluid pathways/fractures that are hypothesized to link melt-rich portions of the magma chamber with hydrothermal vents. In cases, such as Tow Cam, where pervasive fracturing is hypothesized to drive hydrothermal vents that do not sit above or near a magma lens at depth, crustal properties are expected to differ and can be documented. This powerful new combination of 3D reflectivity and high-resolution tomography can help illuminate whether the spatial pattern of vigorous hydrothermal activity is related to magma properties within the lens. If we discover an isolated melt lens in the Tow Cam area, the 3D reflectivity volume, combined with our SOBE tomographic analysis, will document the scale spatial decoupling between surface vents and melt/heat reservoir at depth through imaging of upper crustal fractures/pathways. The 3D MCS experiment will complement a funded broader-scale seismic experiment led by Doug Wiens, which is designed to study properties of the mantle wedge, uppermost mantle and bulk crustal structure along a 200+ km corridor centered on the ISS. Our 3D reflectivity and high-resolution mid-upper crustal tomographic images will provide crucial linkage between their large-scale study and a variety of seafloor investigations, moving R2K toward the mantle-microbe goal.

*Broader Impact*

To help educate the academic MCS community, and broaden the potential user-base for the R/V *Marcus Langseth*, we propose an entirely open dataset available to all—immediately after the cruise; an interactive web-page/*blog* will highlight the process of obtaining, processing and visualizing 3D MCS data collected aboard the *Langseth* and should provide a useful resource for others hoping to concurrently process the Lau 3D dataset, or other *Langseth* volumes, in a manner analogous to our ARAD 3D nav programs/scripts, which we distributed to the community a decade ago. Visualization products will be shown to a wide range of audiences at various venues on our campus including the new HD stereo projection theatre at the *Paine Forum*.