Final Project Report

Evaluating the Substrate for Ultramafic Hosted Hydrothermal Activity at the Mid-Cayman Rise

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The goal of this project was to support the ongoing work of WHOI senior scientist Chris German on ultramafic-hosted hydrothermal deposits in the Cayman Trough. The P.I. proposed to write an assessment of mantle rocks previously collected form the Cayman Trough during earlier WHOI cruises in 1976 and 1977. These included a large suite of samples collected by the RV Knorr in 1976. The funding provided for this work was limited, and the P.I. intended to base his report largely on existing analytical and petrographic data from the 1977 Alvin and Oceanus diving and dredging program in which he participated and had an existing database from his previous mineral and petrographic work. However, the project also involved an assessment of an extensive dredge collection recovered by the RV Knorr on cruise where he did not participate, and consequently had not previously examined.

At the present time, Dr. German has not requested the report on the Cayman mantle rocks that was the objective of the project proposal. Seeing little point in writing that until it is requested, the P.I. has done the assessment of the previously collected materials. This material included numerous olivine-plagioclase rich rocks know as troctolites whose existence the P.I. was not aware of. These appear to come from the crust-mantle transition zone, or were emplaced in the shallow mantle beneath the crust. These ae an exceptional suite suitable for studying the processes that shape the composition of Mid-Ocean Ridge Basalt (MORB) prior to eruption.

It was previously thought that MORB formed at depth by melting within the mantle, and then was transported with little modification through the shallow mantle beneath an ocean ridge, to feed a crustal magma chamber, where its evolution would be largely shaped by simple fractional crystallization. Recent work has indicated that such is not the case. Magma chambers at slow spreading ridges

are ephemeral and apparently rarely present based on seismic studies of the lower crust. Scientists' view of how MORB evolved has largely based on conjecture, and simple assumptions about how it forms in the mantle, is transported to the crust, and is then modified. With the scarcity of magma chambers at slow spreading ridges, where much of MORB evolution was supposed to occur, , the uniform global nature of MORB becomes hard to explain as the Pacific crust is underlain by melt lenses that could represent such chambers.

The answer to this puzzle then is that the composition of erupted MORB is little affected by processes in a shallow magma chamber. Instead, it is likely that this occurs at the base of the crust and in the shallow mantle. This then makes the study of troctolites a high priority, as it is these rocks that are the likely residues of the processes that control the composition of erupted magmas at ocean ridges.

The problem, however, has been a scarcity of troctolitic rocks on which to work. Thus, the finding of a large collection of these in the WHOI collections, led the P.I. to write a proposal with WHOI scientist Glen Gaetani to work on them. While the initial proposal did not get funded, the program manager suggested that we resubmit, which we will do for the February 15th, 2013 Marine geology and geophysics panel. Thus, the results of this small project are quite exciting, and will likely be a continued focus of the P.I.'s work for some time to come.