2003 Deep Ocean Exploration Institute Project:
Deployment of a High Sample Rate Seafloor Geodetic System Across the Discovery Transform Fault

Final Report

J. McGuire (G+G), W. Witzell (AOPE), and M. Gould (AOPE)

The funds requested here were to finalize the construction of an acoustic ranging system for making continuous seafloor geodetic measurements and to send Nick Witzell on McGuire seismic cruise to the EPR for the initial deployment of the system in deep water. The first goal, the completion and testing of the system, has been achieved with successful results (detailed below). We are now capable of making geodetic measurements on the seafloor that with a daily position accuracy of 1 cm, a level more than good enough to monitor active fault and magmatic systems for major earthquake and eruptive events. The second goal has yet to be achieved because the cruise has been delayed multiple years. However, the demonstration of the equipments capabilities (done with DOEI funding and the Tioga) was sufficient to get NSF funding for the equipment to be deployed whenever the EPR cruise happens (hopefully summer of 2007).

Figure 1 shows the results of our deployment off the Tioga in 2004. It plots the variation in the measured distance between two acoustic transponders deployed about 100m apart. This test was over a very short baseline (100m) owing to the limited water depth south of Martha's Vineyard. However, it demonstrated the ability of our system to make stable measurements at the 1 cm level. In a real experiment, several of these units would be setup in a line across a known fault-zone and if the fault moved in a significant earthquake, it would be detected as a change in the distance between two of the transponders. Thus the more stable the baselines (the flatness of the line and lack of scatter in Figure 1), the smaller of an earthquake that can be detected.

With additional funding from DOEI (2005 award to Mark Behn and McGuire) and the University of Hawaii, we were able to conduct a 9 month long deployment off of Kilauea Volcano. This was our first major deployment for a long period of time with significant (500-1000m) baselines. Initial data analysis indicates that the instruments functioned as stable geodetic monuments with daily baseline precisions of 1 cm and little long term drift. We are now preparing the instrumentation for our anticipated deployment on the Discovery Transform of the EPR in 2007.

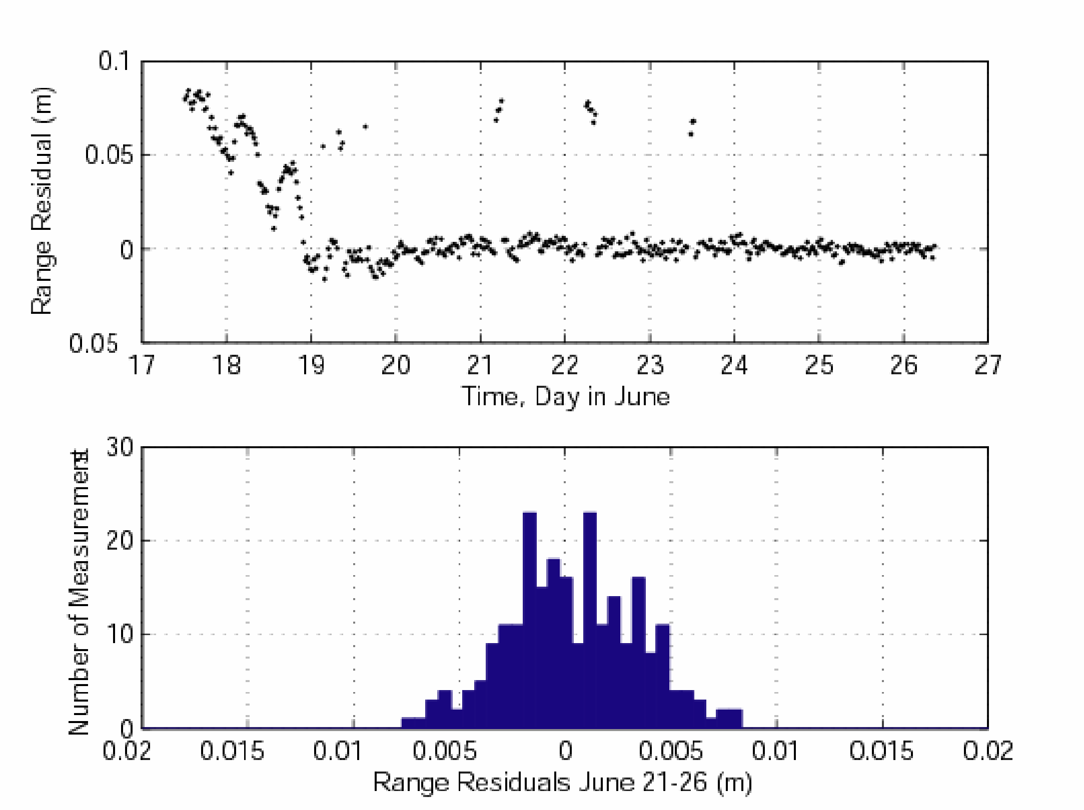

Figure 1. Results of a 10 day deployment of our acoustic ranging system in Buzzards bay for a 100 m baseline. A) Range residuals in meters as a function of time during the deployment. The nominal range (calculated with a constant sound velocity) has been corrected for the measured temperature variations and the mean has been removed. The distrance betweenthe transceiver and transponder decreased by about 8 cm during the first two days as the instruments settled, then remained roughly constant for the remainder of the test. B) A histogram of the range residuals for the time period June 21-26. The standard deviation of the range measurements was 3.1 mm, demonstrating both the accuracy of the acoustic ranging technique and the stability of the tripod benchmars in an environment with relatively strong currents. Note that the large temperature change on June 23rd visible in the raw data (Figure 1) has been completely removed from the range measurements by a simple linear correction.