Cruise summary: Geophysics

Scott Nooner (PI) and Spahr Webb (co-PI) from Lamont-Doherty Earth Observatory have a grant to set up a long-term geodetic network at the 2005-6 eruption site. The entire geophysics team included David Gassier (engineer), Lindsey Doermann (technician), Gina Applebee (graduate student), Andrea Applebee (graduate student, outreach person), and Phillip Kelley-Dotson (MATE intern). The backbone of the geodetic network is an array of 10 concrete benchmarks placed on the seafloor to provide a way to precisely occupy the same seafloor location over time to track vertical depth changes. The depth of each benchmark is measured using a mobile pressure gauge (MPR) instrument that was developed by Mark Zumberge at Scripps Institution of Oceanography. The MPR is carried from benchmark to benchmark by the DSV *Alvin*, making 15-25 minute measurements at each benchmark. Repeated measurements at each benchmark constrain the survey uncertainty. A survey will be repeated each year for the next thwo years to track post-eruption deformation associated with refilling of the magma chamber. These long-term deformation measurements will compliment episodic deformation data that is being collected by bottom pressure recorders (BPRs) that were put out along the rise axis in Feb. 2007 by Milene Cormier, Spahr Webb, and Roger Buck. Together these data sets will help to constrain the time-scales and dynamics of this volcanic system.

When the R/V Atlantis reached the site, a tide gauge was deployed by free fall through the water. The tide gauge was connected to an anchor via a burn wire. 5 days into the trip we lost communication with the tide gauge, which is located too far from any dive locations to retrieve it. It remains on the seafloor. Then 10 concrete benchmarks were deployed, with three on axis and the rest forming a line perpendicular to the axis with an extent of 10 km. This line stretches from 9 km east of the ASC to 1 km west of the ASC. Near the axis, the benchmarks are spaced 1km apart, while the three furthest benchmarks (EPR01, EPR02, and EPR03) are spaced 2 km from one another. Benchmarks EPR01, EPR02, EPR03, EPR04, and EPR05 all have acoustic transponder packages on them so that we can locate them more easily in the future. The benchmark locations and transponder frequencies and codes are listed in the Table 1 below.

Pressure measurements were then made on top of each benchmark with the Mobile Pressure Gauge (MPR). The MPR was carried by the submersible Alvin and operated by an observer inside the sub. For each measurement the MPR was place on top of the benchmark and released, decoupling if from the sub. Pressure was then recorded for 15 minutes (25 minutes for the first measurement of each dive for temperature equilibration). At least two measurements were made on top of each benchmark with the exception of EPR03 which had only one measurement. EPR07 was visited 6 times in the 9 dives (see Table 2). These repeat measurements give the repeatability or uncertainty in the estimated depths.

Overall the initial survey was a success. In order to get tide data we recovered a BPR (BPR07) from the survey area, downloaded the data, and redeployed in near EPR09 (Table2). Initial data processing shows that the survey repeatability (and uncertainty) is

about 2.3 cm. This may improve a bit with further processing, however we expected to get a repeatability of ~1 cm, based on work that we've done elsewhere. It is clear that the primary source of error in this survey was that the MPR was taken from the surface to the seafloor and back every day. The temperature changes plus the hysteresis of the gauges adversely effect the measurements. Repeat surveys with an ROV that is capable of staying submerged for the duration of the survey should decrease the uncertainty by a factor of two.

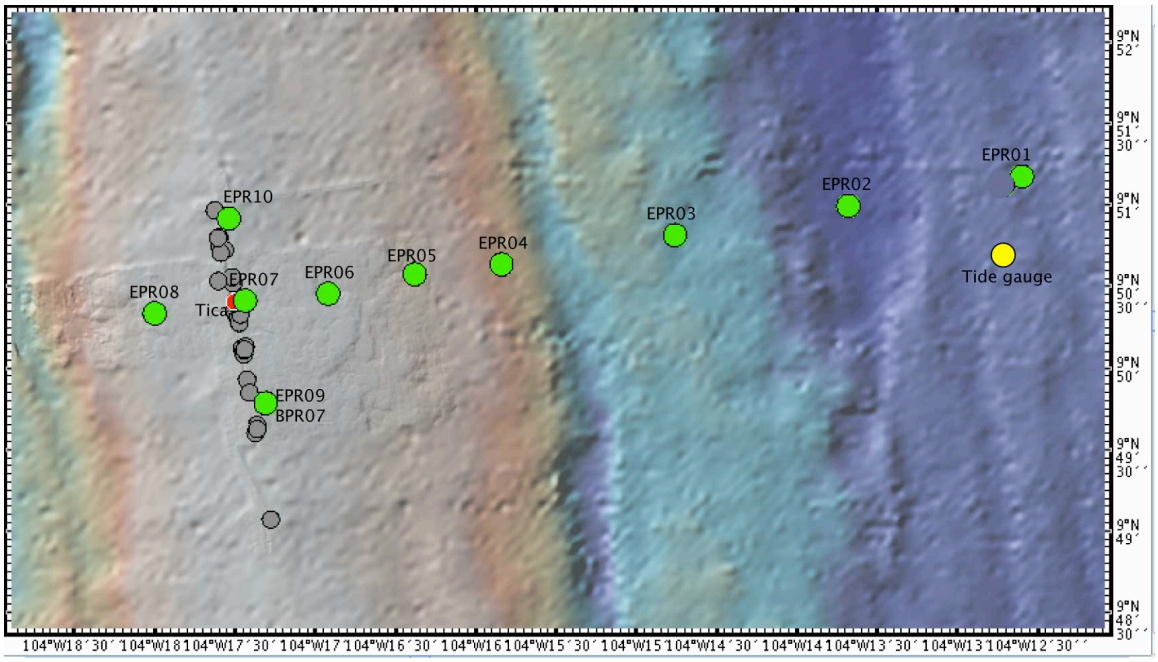

Figure 1. Map of the 9 50 area. Location of the benchmarks are shown as green circles and are labeled EPR01 through EPR10. The tide gauge that we were unable to retrieve is shown as a yellow circle. BPR07 was redeployed at EPR09. The hydrothermal vent Tica is shown for reference as a red circle.

Table 1.

benchmark	# of visits	receive	talk	enable	disable	distance from ASC (km)
EPR01	3	11.5	12.0	6	1	9.0
EPR02	2	10.0	12.0	3	2	7.0
EPR03	1	10.5	12.0	3	2	5.0
EPR04	2	11.0	12.0	12	1	3.0
EPR05	2	11.0	12.0	6	2	2.0
EPR06	2	NA	NA	NA	NA	1.0
EPR07	6	NA	NA	NA	NA	0.0
EPR08	2	NA	NA	NA	NA	1.0
EPR09	4	NA	NA	NA	NA	0.0
EPR10	2	NA	NA	NA	NA	0.0

Table 2.

benchmark	lat (d) (min)	lon (d) (min)	X (m)	Y (m)	depth (m)
EPR01	9 51.203	104 12.597	13563	79634	2787
EPR02	9 51.003	104 13.681	11577	79265	2851
EPR03	9 50.839	104 14.781	9562	78963	2688
EPR04	9 50.646	104 15.833	7634	78608	2611
EPR05	9 50.575	104 16.374	6693	78477	2556
EPR06	9 50.464	104 16.900	5677	78273	2529
EPR07	9 50.404	104 17.438	4693	78163	2501
EPR08	9 50.348	104 17.982	3698	78057	2520
EPR09	9 49.782	104 17.277	4989	77016	2506
EPR10	9 50.928	104 17.526	4533	79127	2509
Tide gauge	9 50.119	104 12.716	13344	77636	2800
BPR07	9 49.786	104 17.301	4945	7702	2506