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A Fine Scale, High Resolution, On-bottom Gravity Survey of the East Pacific Rise Integrated Studies Site

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Fresh magmatic material is extruded at ridges, forming new oceanic crust. The magma is believed to be stored in shallow subsurface chambers and is fed to the surface through swarms of feeder dikes. Much remains unknown about ridge structure and dynamics.
High precision gravity measurements are sensitive to subsurface density variations. Time-lapse gravity measurements can reveal vertical deformation, which provides information on the dynamics of the underlying process. We propose a fine scale, high resolution gravity survey on the East Pacific rise at the R2K Integrated Studies Site, in order to address the following questions:

* What is the geometry and extent of the subsurface density structure?
* Is the material supplied in a continuous equilibrium manner or in episodic eruptive events?
* What is the density and porosity of the material, which in turn influences hydrothermal circulation?
* How is deformation partitioned into the horizontal and vertical axes?

Previous gravity observations on or near the seafloor have been used to investigate mid-ocean ridges. The gravimeters were either lowered from the surface or operated inside submersibles. These methods involved tradeoffs in precision, spatial resolution, and extent. For example, Cochran and others collected underway, near-bottom measurements on the East Pacific Rise at 9°50' N in a submersible. Their Bouguer anomaly maps are suggestive of dike swarms lineated parallel to the ridge axis. The data also suggest regions of high density dike intrusions and collapsed and fissured terrain. The data repeatability is 0.3 mGal with a spatial resolution of order 150 m. Thus, small amplitude fine scale structure is not observed.

We have developed a new seafloor gravimeter, the ROVDOG (Remotely Operated Vehicle deployable Deep Ocean Gravimeter). This device is a land gravimeter modified for remote operation inside a pressure case. The sensor can be transported by an ROV, which places the instrument on the seafloor. Approximately 10 minutes of observation are required to sufficiently reduce the uncertainty due to seafloor acceleration noise. Previous deployments have demonstrated a repeatability of 0.019 mGal. On-board precision pressure sensors provide relative depth information with 3-5 cm repeatability. The spatial resolution is limited only by the experimental design. The endurance and mobility of ROVs permit efficient data collection.

We propose to use the ROVDOG system for a fine scale gravity survey at the 9°50'N segment of the East Pacific Rise, and a repeat survey to assess temporal signals. The survey will resolve fine scale, small amplitude gravity signals at the ridge axis. In turn, the data will place new constraints on fine scale structure. We will establish the beginning of a time series for vertical deformation. This work will utilize the JASON II ROV for deployment. Seafloor benchmarks will be deployed for the time-lapse studies. Additional measurements include a micro-bathymetric survey and seafloor tidal pressure time series.