

NOAA ship *Okeanos Explorer* (EX): cruise number EX-09-04  
Water Column Exploration Field Trial I  
June 2-12, 2009

Science Summary:

CTD operations:

Scientists Sharon Walker and Ronald Green from the NOAA Vents Program at PMEL utilized the ship's CTD system to conduct an exploratory survey and collect water samples along the Gorda Ridge and Blanco Fracture Zone operating areas. A total of 21 CTD casts were successfully completed, of which 19 were vertical casts to an average depth of 3300 meters, and 2 were tows. Scientist Walker integrated additional PMEL-supplied sensors onto the ship's CTD system: an altimeter to monitor the height of the CTD package above the seafloor, a light scattering sensor (LSS) to measure suspended particle concentrations, and an Oxidation-Reduction Potential (ORP) sensor to detect the presence of reduced chemical species dissolved in the seawater. The altimeter is necessary for conducting CTD tows safely, especially during tows, and the other two sensors are proven techniques for detecting and mapping hydrothermal plumes.

Problems with the two cables for the LSS that Walker brought aboard impacted the quality of the LSS data for the first 3 casts of the cruise (V09D-01, V09D-02 and V09D-03). The ship's ETs were able to repair at least one of the LSS cables and good LSS data was acquired for the remainder of the cruise. The ship's CTD and all other sensors worked well during the entire cruise, however, the plastic tubing and syringes that flush the conductivity cells between casts was accidentally left on during cast V09D-08 resulting in bad conductivity data for that cast. All variables that are derived from conductivity (ie. salinity, potential temperature, and potential density) were also affected. A procedure was implemented to make sure this was not forgotten again.

Scientist Greene brought sampling equipment and supplies from PMEL (set up in the wet lab) and collected water samples for Helium isotopes and total dissolvable trace metals from all CTD bottle samples. The total numbers of each type of sample acquired from each cast is listed in the CTD summary table. Helium samples will be analyzed at the PMEL lab in Newport, OR and trace metal samples will be analyzed at the PMEL lab in Seattle, WA.

The first cast (to 1825 m deep, 23 meters above bottom) was done approximately 25 miles off the coast of northern California where a plume feature was detected in the EM302 water column data from a previous cruise. Due to the LSS cable problems, we did not get good enough LSS data to determine if a suspended particle anomaly was associated with the EM302 plume feature. There was no ORP anomaly, nor was there a temperature anomaly detected during that cast. Helium samples were taken and will be analyzed at the PMEL lab in Newport.

The next 15 vertical CTD casts and 2 tows were completed along the Gorda Ridge section of the operating area. The first two casts (at the southern Escanaba segment) were also affected by the LSS cable problems and did not result in good particle concentration data. All other sensors worked well. No ORP or temperature anomalies were detected during these 2 casts, despite a known high-temperature vent site located near the position of one of these casts (V09D-03).

The Gorda Ridge is a medium to slow spreading rate spreading center with a 600-1400 m deep axial valley. A general feature of the water column along the entire Gorda Ridge is an increase in suspended particle concentration from a depth of about 2000 m (the approximate depth of the east and west ridge crests) to the seafloor. A particle anomaly above this general trend was seen at station V09D-08, possibly continuing through to station V09D-09, but no ORP anomalies were seen during either cast and, due to the tubing/syringe problem, we cannot analyze the data from V09D-08 for a temperature anomaly. There was no temperature anomaly at V09D-09. We will have to wait for analysis of the helium and trace metal samples to determine if other indicators of hydrothermal activity are present.

Station V09D-10, located near the axial high of the Jackson segment of Gorda Ridge, had a very small ORP anomaly about 200 meters above the seafloor (bottom depth ~ 3100 m). No particle anomaly was apparent above the general regional increase in LSS values towards the seafloor, however, there was a density inversion (implying rising fluids) with low-salinity, slightly higher-temperature water below a depth of 3050 m. Hydrothermal vents with less saline, gas-rich, low-particle fluids have been discovered elsewhere. This would be an interesting area for further explorations.

Our first CTD tow was attempted at the site of a documented lava flow erupted in 1996 near the axial high of the North Gorda segment. In 1996, large plumes were generated in this area due to the eruption, but had disappeared within about 3 months. The ship had difficulty maintaining the desired course, but the CTD made a few vertical excursions to near the seafloor before we had to abandon the tow. The area still appears to be absent any new hydrothermal activity. The XO applied what was learned from this experience to the next tow, which was completed without any problems.

Vertical cast V09D-14 was positioned at the Sea Cliff hydrothermal field. Evidence of hydrothermal venting was seen in this area during the first water column survey of the Gorda Ridge in 1985, and high-temperature vents were located at this site with the Navy's Sea Cliff submersible in 1988. The plume was again detected during cast V98D-14. A particle anomaly began as the CTD descended past 2250 m, and increased dramatically along with the onset of the ORP anomaly at 2350 m. The plume was present nearly all the way to the seafloor (2610 m), and density inversions below 2500 m suggest we were sampling within the buoyant plume. All indications are that we were very close to the source, and that this site is still quite active after 25 years. This would be a good site for further evaluation of the EM302 water column capabilities to detect hydrothermal plumes.

The last 3 CTD casts were located along the Blanco Fracture Zone in the East Blanco, Surveyor and Cascadia basins. The NOAA Vents Program has acquired CTD and helium samples from these basins in the past. The casts conducted during this cruise will be interesting to compare with previous data. The East Blanco and Cascadia basins both had particle anomalies. A temperature anomaly and slight ORP anomaly coincided with the particle anomaly at the East Blanco site.

#### Mapping:

Mapping with the ship's EM302 multibeam system occurred along the neovolcanic zone of Gorda Ridge between CTD stations (~260 km). Additional surveys were conducted on the opposite shift from CTD operations and covered previously unmapped areas along the western flank of Gorda Ridge (~308 km) and along the Blanco Fracture Zone (~418 km). Water column data was acquired during all mapping operations and will be analyzed later. No map products were generated during this cruise due to a shortage of personnel and problems with transferring the data to scientists on shore. See the daily Situation Reports for a more detailed description of this issue.