

Three-Dimensional Slowness Images of the Upper Crust Beneath the Lucky Strike Hydrothermal Vent Sites

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In June-July 2005 we carried out the SISMOMAR cruise, as part of the MOMAR project (Monitoring the Mid-Atlantic Ridge). Within this cruise, we conducted a 3D seismic reflection survey over an 18 km x 3.8 km area covering both the Lucky Strike volcano and hydrothermal vents field. In order to have a full coverage inside the 3D box, shots continued for 2.25 km on either side of the box and extended out to the median valley bounding faults. To complement the streamer measurements 25 Ocean Bottom Seismometers (OBS) were placed in an 18 km x 18 km area. 11 OBS positions lie inside the 3D box and can be used to determine a very detailed image of the 3D velocity structure beneath the Lucky Strike volcano and hydrothermal vents field. For the 3D box a tuned array of 14 air guns (2600 cubic inches) was fired at an interval of 37.5 m for a total of 39 lines. We will present the first results of the OBS measurements near the Lucky Strike volcano. As a first step towards a joint 3D travel time and slowness (the inverse of velocity at turning depth) tomography, we present the 3D slowness function (latitude, longitude, offset), which can be considered as a 3D brute stack velocity image of the sub-surface (c.f. Barton and Edwards, 1999). The presence of fluid in the upper crust due to hydrothermal circulation should appear as a low velocity anomaly beneath the hydrothermal vents. In the next step the OBS measurements will be used to corroborate the reflection images of layer 2A observed in the streamer data for the 3D box. The OBS inside the 3D box recorded turning ray arrivals from the upper crust at a very fine sampling interval (37.5 m x 100 m) over a large azimuth. This provides the unique opportunity for jointly inverting travel time and slowness. Hence the measurements contain information on local gradients and should provide a very detailed velocity model of the subsurface, including information on hydrothermal systems and a possible anisotropy (e.g. Cherret and Singh, 1999).

References: P. Barton, R. Edwards: Velocity imaging by tau-p transformation, LITHOS Science Report, 1999, 1, 67-75. A. Cherrett, S. Singh: 3D anisotropic models from multi-component data, LITHOS Science Report, 1999, 1, 29-34.