Geophysical Research Abstracts
Vol. 20, EGU2018-16566, 2018
EGU General Assembly 2018

Investigation of the variability in ocean crustal structure at an intermediate-spreading ridge and its implications for geothermal processes

Richard Hobbs and the OSCAR Science Party
University of Durham, Earth Sciences, Durham, United Kingdom (r.w.hobbs@durham.ac.uk)

In 2014/2015 the OSCAR project acquired a joint geophysical, oceanography and heat-flow dataset in Panama Basin to understand the linkages between oceanic crust evolution, hydrothermal heat loss and the impact of this heat loss and fluid mass exchanges on deep ocean circulation. The study focused on the Costa Rica Ridge (CRR) segment of the intermediate-to-fast Cocos-Nazca spreading ridge system, where an axial magma lens was imaged 21 years earlier. The physical oceanography spanned the entire Panama Bain, including the water inflow along the Ecuador Trench. The heat-flow study examined the causes of the deficit from the expected heat-flow from a simple half-space cooling model.

The new seismic reflection data confirmed the presence of a narrow axial magma lens under the western part of CRR axis, bounded to the east by a low velocity zone mapped using 3D seismic re-fraction data that is under a 2nd order small offset ridge discontinuity identified from the swath bathymetry. On the ridge flanks the bathymetry is rugged which suggests the spreading has a significant component of tectonic extension. Mapping of the crustal structure along a transect from the ridge axis to hole ODP 504B shows that there is a correlation between topography and seismic velocity, which we interpret as evidence of temporal variation in the magmatic input. Topography also influences off-axis heat-flow measurements which show evidence of both shallow and deeper circulation cells.

Within the basin the water is well mixed with a weakly stratified bottom boundary layer that in places is over 1000 m thick. Knowing the measured inflow, 0.29 Sv, of cold abyssal water from the Peru Basin and the temperature gain, 0.25°C, of water within the basin, we estimate that geothermal heating contributes over 60% of the deep upwelling in the basin and is the significant driver of the abyssal circulation and flow.. Though the hydrothermal systems along the ridges are the most vigorous they only contribute a small percentage to the total heating budget with the dominant heating, 17 GW, coming from the off-axis regions.

We conclude that the structure of ocean crust is variable over a range of length and time scales. However despite this variation, crustal age provides a valid proxy for off-axis heat flux and support the emerging hypothesis that globally geothermal sources is of equal importance to the heating of the abyssal ocean as the downward diapycnal mixing of heat from the ocean surface.

The OSCAR (Oceanographic and Seismic Characterisation of heat dissipation and alteration by hydrothermal fluids at an Axial Ridge) project is funded by NERC and is also supported by NSF. Data acquisition took place during three research cruises on the RRS James Cook (JC112, JC113 and JC114).