Geophysical Research Abstracts
Vol. 12, EGU2010-6226-1, 2010
EGU General Assembly 2010

Implication for horizontally-elongated fluid flow inferred from heat flow measurements in the Iheya-North hydrothermal field, Okinawa Trough back-arc basin

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The Okinawa Trough is a back-arc basin located in the southwestern part of Japan. It is considered to be in the initial stage of rifting of continental crust, and the activity generates volcanic edifices in this area, accompanied by hydrothermal circulation. The Iheya-North is one of the most active hydrothermal fields among them. As a proposed drilling site for the Integrated ocean Drilling Program, extensive geophysical surveys have been carried out including single-channel seismic imaging, and precise side-scan sonar imaging by using autonomous underwater vehicle "Urashima" of Japan Agency for Marine-Science and Technology.

In the recent few years, we have measured heat flow in and around the Iheya-North hydrothermal field to understand the spatial of hydrothermal circulation in detail. 78 measurements show that heat flow is higher than 10 W/m^2 with in 0.5 km of the hydrothermal vent complex, that it gradually decrease eastward to $<$ 1 W/m^2, and that very low heat flow around 0.01 W/m^2 is observed at 1.5 km east from the hydrothermal field. The average heat flow outside of Iheya-North is $\sim$0.1 W/m^2.

The low heat flow to the east is most likely caused by an inward flow of seawater into the formation. Seismic and side-scan sonar images as well as piston core samples suggest an impermeable sediment layer to a few hundreds meters below the seafloor in this area. This sediment layer should work as a hydrological barrier to suppress flow through the seafloor, whereas seawater can penetrate into the formation at 1.5 km east of the hydrothermal field, where sidescan images suggest coars sediments on the seafloor. We infer that the hydrothermal circulation within the Iheya-North involves one with a horizontally-elongated scale ($\sim$1.5 km horizontal vs. $\sim$a few hundreds meters vertical).

We performed numerical calculations of fluid flow and heat transportation to give constraints on the depth of hydrothermal circulation, the magnitude of darcy velocity, and the permeability at depth. The simulated results will be compared with measured heat flow distribution and will be checked for the larger or smaller circulation scale proposed from heat flow or fluid geochemistry data.