Preliminary results on geophysical investigation of hydrothermal circulation at the Rainbow area of the Mid-Atlantic Ridge

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The ocean covers about 71% of the Earth's surface, which accounts for about 96.5% of the entire water present on the Earth. Thus, it is very important to study fluid flow due to the heat energy that is continuously released from the interior of the Earth. The solid surface of the Earth can be separated by lithospheric plates, which interactively move along plate boundaries on the asthenosphere. In particular, as the divergence boundary between two plates, mid-ocean ridge extends ~80,000 km across all the oceans. As the new tectonic plate is constantly created along the mid-ocean ridges, the hot materials inside the Earth are transported to the surface. Thus, the additional thermal energy supplied at the mid-ocean ridges can affect the crust-ocean-atmosphere thermal feedback system. Since hydrothermal circulation at the mid-ocean ridge system is the most effective mechanism to release deep-seated thermal energy, studies of hydrothermal circulation in the deep oceans are crucial to understanding the complex feedback system of the Earth. In this study, we utilize multi-channel seismic reflection data to image water columns disturbed by hydrothermal flow at the Rainbow area of the Mid-Atlantic Ridge. Changes in the water layer, such as hydrothermal circulation or methane gas emissions to date, have been observed only in acoustic data with high frequencies. On the other hand, in the case of seismic oceanography using seismic data with a frequency that is slightly lower than that of underwater acoustic data, imaging results on the surface seawater change pattern have been mainly reported. Therefore, seismic oceanography appears to be highly dependent on the frequency of the energy source used in the exploration. Despite these constraints, previous studies have shown that temperature differences of 0.03 °C can be distinguished by seismic oceanography techniques. For the Rainbow hydrothermal vent, the hot water temperature is ~350 °C. In water column, these high-temperature hydrothermal fluids may dissipate rapidly as they mix with the surrounding seawater, but it is likely that the temperature distribution in the water column may be affected in areas where hydrothermal ejection occurs continuously. Here, we report our preliminary results to image micro-changes in the water layer close to the sea floor, induced by hydrothermal activities in the Rainbow area, by using a newly developed seismic imaging method based on frequency-domain reverse-time migration with analytic Green’ s function.

Keywords: seismic oceanography, hydrothermal circulation, seismic imaging