Structural interpretation of the hydrothermal activity area by the Multi-source ACS survey method

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Seafloor Massive Sulfide (SMS) deposits have been recognized to be formed at the hydrothermal vent site in the submarine volcano. They typically show abundant chimney structures, massive sulfide mounds and highly hydrothermal altered host rock. Active seafloor hydrothermal systems, related to forming the SMS deposits, are good natural laboratories for understanding the genesis of ancient Volcanogenic Massive Sulfide (VMS) deposits. While studies on these active hydrothermal sites have been progressing, the inactive hydrothermal sites are not well studied because of few efficient methods to detect and characterize them.
Therefore, we proposed a multi-source Autonomous Cable Seismic (ACS) survey system using a deep-towed autonomous cable and multiple sound sources with different acoustic characteristics. With this high-resolution acoustic survey system, we focused on the detection of physical (e.g., density) anomaly in volcanic sediments caused by hydrothermal alteration. The main objective of this study is to identify the variations in the acoustical characteristics of volcanic sediments with respect to SMS deposits and hydrothermal alteration.
Izena Hole is one of the most studied fields of SMS deposits around Japan. We conducted the multi-source ACS survey in the Izena Hole, using the Koyo-maru, in November 2016. We used three different sound sources of air gun, sparker and Sub-Bottom Profiler (SBP) in order to demonstrate the resolution and efficiency of our technique and describe the hydrothermal alteration of different stages and their acoustic characteristics. We obtained seven profiles running through the hydrothermal active/inactive area, caldera floor and outside of caldera wall. As a result of the survey, we obtained a cross-section of the internal caldera that enabled us to study the area from the viewpoint of seismic stratigraphy, and the resulting classifications of sedimentary features on the section suggested the possibility of restricting fluid circulation. In addition, penetration of high frequency components of sound sources suggested the potential existence of low-porosity layers in the shallow part of the sub-seafloor. From these results and discussion, it was suggested that the hydrothermal alteration zone in the volcanic caldera could be identified by the seismic data.

Keywords: Seafloor Massive Sulfide (SMS) deposits, multi-source Autonomous Cable Seismic (ACS) survey, hydrothermal alteration zone

