



## **Vertical Cable Seismic (VCS) Survey for SMS exploration in Izena Cauldron, Okinawa-Trough**

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In 2014, the Japanese government started the Cross-ministerial Strategic Innovation Promotion Program (SIP), which includes 'New-generation Offshore Exploration Techniques' as an area of interest. We proposed the Vertical Cable Seismic (VCS) survey technique for this program, especially for the exploration of Seafloor Massive Sulfides (SMS). VCS is a reflection seismic method that uses hydrophone arrays vertically moored from the seafloor to record acoustic waves generated by various acoustic sources. This method is useful to delineate detailed structures in a spatially-limited area below the seabed in the deep sea where conventional surface seismic is not effective. We have been developing an autonomous VCS system with the financial support of the Japanese government since 2009. We have carried out several VCS surveys and completed our VCS system.

Izena Cauldron, Okinawa Trough is one of the most promising SMS areas around Japan. There are two high potential areas, the north and south mound. We carried out the first VCS survey around the north mound in 2011 and the second survey around the south mound in 2013 respectively. The first VCS survey in Izena Cauldron was carried out using a GI gun in September, 2011, with the objective of surveying the large-scale and deeper structure of the hydrothermal system. The water depth was 1,500-1,600m. Four VCS systems were deployed. The shooting lines covered an area of 9 km x 9 km with a shooting interval of about 25m and line spacing of 200m to 400m. In the second survey, we used a high-voltage sparker. The objective is to explore very shallow parts to delineate very thin SMS deposits. The survey area was about 4 km x 4km with a 12.5 m shooting interval and 100m to 200m line spacing. Three VCS systems were deployed in this survey.

The result of the first GI gun VCS survey was a 3D PSDM volume of the subsurface structure. It extends 2,000m horizontally and down to 1,500m in depth. Further, by re-processing the data with a higher resolution to focus the very shallow parts, we found that this survey has enough potential to delineate the SMS deposits itself. In the second high-voltage sparker VCS survey we obtained high resolution field records and a very high resolution 3D volume down to 150m over an area of 400m x 200m. These results successfully delineated sub-seabed structures that suggest the existence of reflections about 30m beneath the seabed. This suggests the top interface of a buried SMS deposit. The detailed results of the both surveys are consistent with the information from a well drilled in the Izena Cauldron by JOGMEC

These VCS survey results provide us useful SMS exploration information, and demonstrate that VCS is a suitable reflection seismic method to obtain high resolution 3D volumes just below the seabed. We consider our VCS system to have high potential to delineate SMS structures. The system will continue to be developed as part of the SIP project, along with other geophysical exploration techniques such as EM, magnetic and gravity.