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Deep-sea magnetic and acoustic surveys using AUVs in the Bayonnaise knoll and Myojin knoll calderas

HONSHO, Chie[1*] ; KIM, Kangsoo[2] ; URA, Tamaki[3]

[1]IRIDeS, Tohoku Univ., [2]National Maritime Research Institute, [3]Center for Socio-Robotic Synthesis, Kyushu Institute of Technology

The Bayonnaise knoll and Myojin knoll calderas in the Izu-Ogasawara arc have been noted for large sulfide ore deposits called the Hakurei and Sunrise deposits. We conducted deep-sea magnetic and acoustic surveys in the two calderas on board the AUV Urashima during the cruises YK14-10 and 11 by the R/V Yokosuka (JAMSTEC) in June 2014. Two dive surveys were carried out in the Bayonnaise knoll caldera (travel distance of 46 km in total) to complete mapping the magnetic anomalies inside the caldera together with results of previous surveys. Other two dive surveys were conducted in the Myojin knoll caldera (52 km in total), which were the first AUV surveys in the caldera, and data were successfully obtained in the Sunrise deposit, the central cone, and a part of the northern caldera wall.

A high-resolution bathymetric map of the Bayonnaise knoll caldera created from the multi-beam data shows many tectonic landforms which are probably associated with the back-arc rifting. A large north-south fault cutting the caldera rim in the southeast, a landslide landform in the central cone, a tabular, north-south trending scarp of the central depression, and an explosive fault north of the central depression seem to link in a north-south direction. In addition to the crater row in the western caldera floor, many northwest-southeast striking faults have been found in the caldera rim in the northwest of the crater row. These features indicate the existence of an extensional field in a northeast-southwest direction, which is different from the nearly east-west direction of the rifting. Results of magnetic analyses show that a small hill in the northern caldera floor is strongly magnetized, in contrast to dacitic central cones which possess low magnetization. The hill is considered to belong to a basaltic knoll chain going through the caldera. It appears that the topography of the caldera has been rapidly changing due to tectonic and volcanic activities associated with the rifting. The magnetic structure is generally characterized by a north-south trending high-magnetization belt associated with the knoll chain going through the caldera. Local low-magnetization zones appear in the southeastern caldera wall including the Hakurei hydrothermal field, around the central depression, and in the northeastern caldera wall. The topography near the top of the eastern wall of the central depression is characterized by rough and uneven surface, and some constructions are clearly cone-shaped. Considering that the area is associated with low magnetizations, they are possibly hydrothermal constructions.

Bathymetric survey in the Sunrise field of the Myojin knoll caldera has revealed that several ridges with chimneys on top grow in a direction perpendicular to bathymetric contours in the caldera wall. Hydrothermal plumes were clearly captured in side-scan sonar images. On the other hand, magnetic anomalies are generally small in this area and show no particular features in the hydrothermal field. The central cone is covered with several lava flows going down 500-800 m distance from the top. There are many corrugations and small projections on the surface of the lava flows, which contrasts to smooth surfaces of the caldera floor. High magnetization is localized on the top of the central cone, and zones of relatively high magnetization continue almost along the lava flows.

A common feature among the Hakurei and Sunrise deposits is that sulfide mounds tend to grow in a direction perpendicular to local bathymetric contours. The Hakurei site is clearly associated with low magnetizations, while no particular magnetic feature is recognized in the Sunrise deposit. It may because silicic host rocks originally have low magnetization, and therefore, the effect of demagnetization due to hydrothermal alteration is not significant. However, data in a wider area over the Sunrise deposit is required to come to a conclusion on the magnetic structure of the Sunrise deposit.

Keywords: hydrothermal deposits, AUV