Deep-sea geomagnetic surveys across fracture zones and transform faults

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Water exists in the solid earth and affects solid earth dynamics through its circulation. Oceanic lithosphere would work as a carrier of water into the deep mantle. Our approach is the first attempt to understand the role for fracture zone and transform faults through where the water could be transported from the ocean into the oceanic lithosphere. Our targets are Nosappu fracture zone, Marie Celeste transform fault, and Argo transform fault. Nosappu fracture zone locates in the old Pacific lithosphere just before subducting into the deep mantle at the Kuril trench. Marie Celeste transform fault and Argo transform fault are boundaries of two oceanic lithospheres in Indian ocean with a large age offset. We conducted deep-sea geomagnetic field measurements together with surface geophysical surveys across the fracture zone and the transform faults during YK14-09 Yokosuka and KH-15-5 Hakuho-maru cruises. During YK14-09 cruise, we successfully conducted AUV Urashima geomagnetic surveys and surface geophysical surveys at the Nosappu fracture zone between 38°40'N and 40°40'N. We had four AUV Urashima dives across the fracture zone to obtain geomagnetic data. The length of each survey line is about 17 miles, which contain about 13 miles at the AUV depth of 3300m. The exception is one dive, which was forced to end at the middle of the survey line due to an emergency uplift of the AUV. The surface geophysical surveys allow us to collect multi-narrow beam bathymetry and geomagnetic field data, which cover total 1,200 miles in the AUV Urashima dive area. The surface geophysical surveys contain 17 survey lines across the fracture zone with their length of 40 miles for most, and survey lines along the fracture zone cover 110 miles at each side of the fracture zone. During KH-15-5 cruise, we successfully conducted two deep-tow magnetic surveys together with surface geophysical surveys across Marie Celeste transform fault at 65°15'E and Argo transform fault at 66°07'E. We used our deep-sea geomagnetic field measurement system which consists of a depth meter, a proton precession magnetometer, and flux-gate type magnetometers. The length of each survey line is about 25 miles. The intensity of the geomagnetic field at sea surface and at deep-sea with even height from the seafloor (2500 - 4000 m depth) were obtained. The geomagnetic anomaly field at deep-sea shows 2 - 3 times bigger amplitude and also has shorter wave length anomaly than those at sea surface. Our results from Nosappu fracture zone provide magnetization signature beneath the fracture zone. The magnetic boundary in the fracture zone is not a single boundary as predicted by a simple plate boundary model, but two magnetic boundaries parallel to Nosappu fracture zone are identified by the deep-sea vector geomagnetic anomaly field and by seafloor magnetization solution calculated from the surface geomagnetic anomaly field. We will discuss on magnetic property beneath fracture zones and transform faults as a result of reaction with water.

Keywords: fracture zone, transform fault, Deep-sea geomagnetic survey

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