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Near-seafloor magnetic measurements with submersible Shinkai 6500 at the Mariana Trough back-arc spreading center

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富士原 敏也[1*], 浅田美穂[1], 海野進[2], 小池悠己[3], 金松敏也[1]

Toshiya Fujiwara[1*], Miho Asada[1], Susumu Umino[2], Yuki Koike[3], Toshiya Kanamatsu[1]

[1]海洋研究開発機構地球内部ダイナミクス領域, [2]金沢大学理工研究域自然システム学系,
[3]高知大学自然環境科学専攻

[1]IFREE, JAMSTEC, [2]Kanazawa University, [3]Kochi University

Near-seafloor magnetic measurements provide us high-resolution magnetic anomaly that is valuable for the studies of the detailed magnetization structure of ocean crust and paleointensity recorded in the ocean crust. We surveyed the Mariana Trough in the western Pacific to understand detailed crustal formation process of the back-arc basin [Fujiwara et al., 2008]. Magnetic field was measured with a deep-sea magnetometer installed on the Japanese submersible Shinkai 6500. The magnetometer was designed to measure three components of the geomagnetic field. Because the Mariana Trough is situated at low magnetic latitudes, vector components have advantages over using only total field anomaly. The objective of deep-sea magnetic field measurements is to investigate magnetization of lava flows at the seafloor. Magnetization intensities relate to age of lava, therefore magnetic data may provide geophysical evidence for discussion of relative age differences of the lava flows. Three submersible dives were made in the axial valley situated in the spreading center of the 17°N segment. The segment is suggested to be in vigorous magmatic stage. Sheet lava flows, suggesting a high rate of eruption, occupy the seafloor of the segment even the slow spreading with a full-rate of ~3 cm/yr [Deschamps et al., 20 05; Asada et al., 2007]. One of the dives traversed the axial valley a distance of ~2 km across the center of the valley toward off-axis in the east-west direction roughly parallel to the seafloor spreading direction.
The measured magnetic field was affected by motion and magnetization of the submersible. The effects were determined and necessary corrections were applied by using the formulation of Isezaki [1986]. We observed magnetic anomalies with large-amplitude (up to 5000 nT) and short-wavelength (several tens of meters). We evaluated fine-scale across-axis magnetic structure along the dive path from the anomalies. The computed magnetization is regarded as absolute intensity because the short-wavelength anomaly is independent of any assumption on the thickness of the source layer. High magnetization intensity (up to 50 A/m) was estimated at the center of the axial valley, therefore the lava flows in the area was likely young in age. The magnetization intensity decreased toward the off-axis. The result suggests the seafloor age increases toward the off-axis. However the detailed variation of the magnetization distribution did not show simple seafloor age increment in proportion to distance from the spreading center. It implies the complexity of the crustal formation process. There is no clear correlation between the distribution of magnetization intensity along the spreading direction and a compiled dataset of paleointensity variation [e.g. Sint -800: Guyodo and Valet, 1999].

A possible explanation is that eruption of lava flows at the segment was not focused on the fixed volcanic axis, but was dispersed rather broad volcanic zone because of the enhanced magmatic activity. Otherwise ridge jumps at small distances occurred. And/or new sheet lava flows traveled a long distance and overlapped old lava flows, and the lavas overprinted the seafloor magnetization. As the result, the sequential records of the paleointensity variation in the ocean crust of the slow spreading rate were disrupted.

Keywords: deep-sea magnetics, magnetization of ocean crust, submersible, Shinkai 6500,
Mariana Trough, back-arc basin