Rock magnetic study applied to characterization of back-arc volcanism in the southern Okinawa Trough

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The Okinawa Trough is a back-arc basin located behind the Ryukyu arc-trench system. Its southern part is characterized by active rifting structures and complex arc–back-arc volcanism along the depression and is believed to represent a transition from a rifting stage to initial spreading [e.g., *Sibuet et al.*, 1987]. The southern Okinawa Trough has a unique key to understand the first stage of oceanic lithosphere evolution, however the spatial distribution of the volcanism as well as their magma type remains unclear. It is needed to conduct extensive geophysical mapping such as magnetic anomaly in which signal is sensitive to volcanic edifices due to the rich magnetic minerals (mainly titanomagentite) within volcanic rock. In order to establish a useful benchmark for understanding magnetic anomalies associated with arc–back-arc volcanism, we performed comprehensive rock magnetic analysis and petrological studies of seafloor rock samples collected in the southern Okinawa Trough. The measurements were conducted for basalt from the Yaeyama Ridge (YR) and Irabu knolls (IKs), dacite from the Hatoma knoll (HK), and rhyolite and pumice from the Tarama Knoll (TK).

The natural remanent magnetization intensity shows 0.3–175.2 A/m in the YR, 0.8–214.4 A/m in the IKs, <0.1–3.8 A/m in the HK, and 3.1 A/m for dacite and 0.1–0.2 A/m for pumice in the TK. The magnetic susceptibility of all samples is too low to induce magnetic field under geomagnetic field intensity comparing with NRM intensity; all samples shows Koenigsberger ratio (Q) much higher than 1. The NRM intensity of volcanic rocks may vary in relation to several factors such as the geomagnetic field strength at the timing of remanence acquisition, amount and type of magnetic minerals, grain chemistry such as Ti content of titanomagnetite, magnetic domain state controlled by grain size distribution, and the degree of low-temperature oxidation. Therefore, we carefully examined magnetic properties, petrography, and geochemical signatures for understanding rock-to-rock NRM variation.

Thermomagnetic curves of volcanic rocks with low NRM (<1 A/m) from the YR, IKs, and HK show irreversible and complex Curie temperatures, suggesting these samples have been affected by hydrothermally alteration and/or oxidation which considerably decreases the NRM [e.g., *Gee and Kent*, 1994]. Low NRM of pumice samples from the TK is likely explained by low amount of titanomagneite due to lack of iron oxide minerals. The NRM difference between rhyolite and basalt is certainly explained by difference of iron content, which is diluted by the silica content in magma evolution. A rhyolite sample from the TK (HPD#1109R01) contains titanomagnetite as the magnetic carrier with a Curie temperature of 490°C (equivalent to $x = 0.15$ in $Fe_{3-x}Ti_xO_4$) and shows coercivity ration (Hcr/Hc) of 2.42 and remanence ration (Mr/Ms) of 0.16, which is regarded as the magnetic domain state of pseudo single domain (PSD). One basaltic rock from the IKs (HPD#1330G02) shows similar Curie temperature of 480°C (equivalent to $x = 0.16$), and PSD siganture (Hcr/Hc = 2.64 and Mr/Ms = 0.10). In addition, both samples show reversible thermomagnetic curves, suggesting that they have not been affected by low-temperature oxidation (maghemitization); very fresh. Therefore, the acquisition timing of their thermal remanent magnetization is considered to be almost the same, and the effect of geomagnetic field strength as well as the degree of low-temperature oxidation can be ignored for explanation of NRM intensity variations. The titanomagnetite amount of HPD#1109R01, at 0.9 wt.%, is about one-third that of HPD#1330G02, at 3.1 wt.%. This result is consistent with the bulk rock geochemistry showing that iron content of

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HPD#1109R01 as Fe2O3 at 3.2% is about one-third that of HPD#1330G02, at 11.2% [T. Nozaki, personal communization]. The NRM intensity of HPD#1109R01, at 3.1 A/m, is also about one-third that of HPD#1330G02, at 9.4 A/m. These results indicate that the lower NRM intensity of rhyolite from the TK was caused mainly by a smaller titanomagnetite content owing to low iron content diluted by the silica content.

Keywords: Back-arc volcanism, Okinawa Trough, Rock magnetism

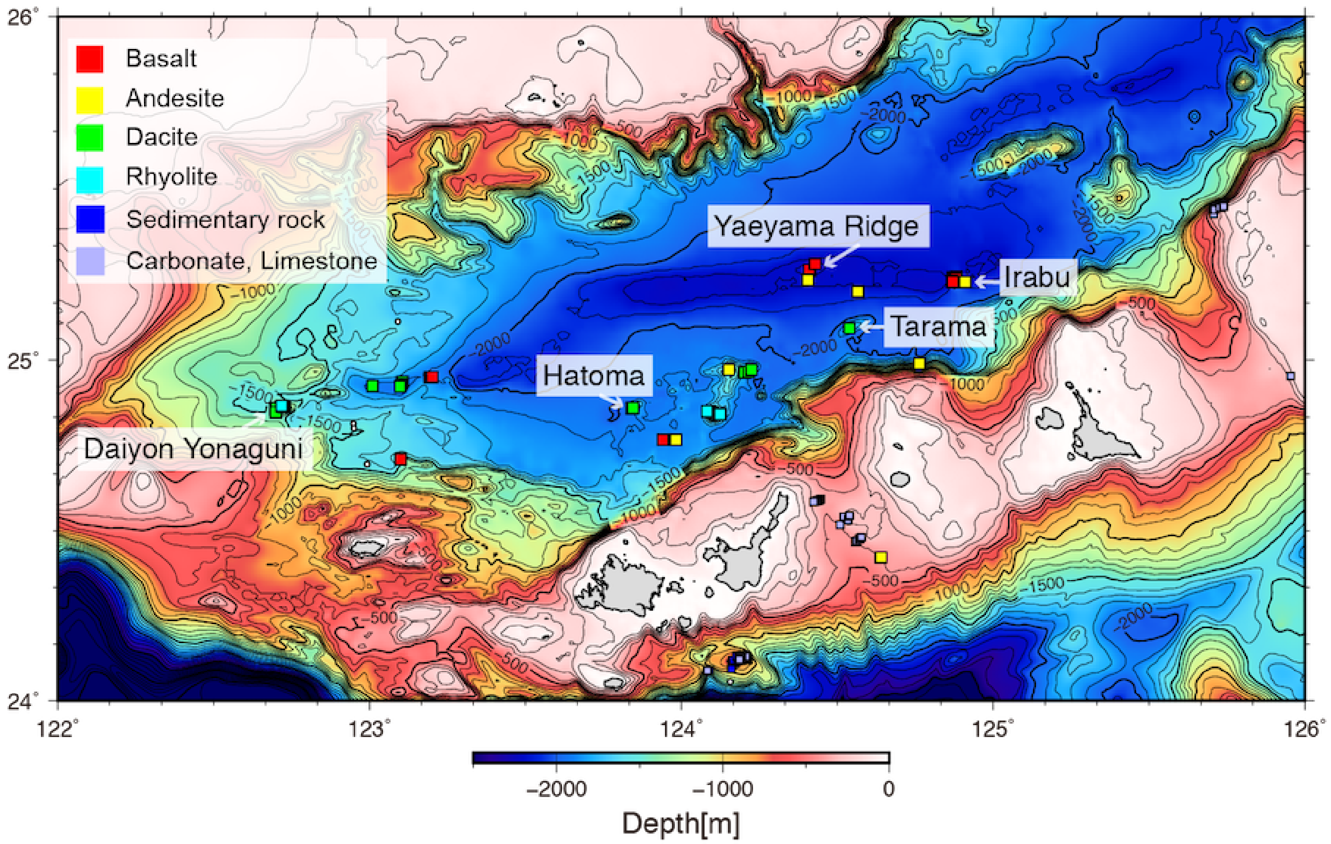

Figure. Seafloor bathymetric map of the southern Okinawa Trough. Squares show rock type of collected samples including basalt (red), andesite (yellow), dacite (green), rhyolite (sky blue), sedimentary rock (blue), and carbonate and limestone (light blue). Data of rock type and location from the GANSEKI database (http://www.godac.jamstec. go.jp/ganseki) managed by JAMSTEC.

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