The strongest crustal magnetic field generated by back-arc basaltic volcano in the Okinawa Trough

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Magnetic minerals in the upper lithosphere generate magnetic fields when the minerals are in a cooler environment than their individual Curie temperatures. These magnetic fields have been utilized for studying crust and mantle dynamics such as most widely known example of seafloor spreading through the recognition of magnetization stripes on the ocean floor (e.g., *Vine and Matthews*, 1963). In addition, the application to detect volcanic edifices and hydrothermal alteration zones has been recently developed by using underwater vehicles, which enable to acquire near-seafloor magnetic anomaly (e.g., *Fujii et al.*, 2015; 2016). In 2014, we got a new discover of strongly magnetized basaltic volcanoes, known as the Irabu knolls, formed in the back-arc rift of the Okinawa Trough. Magnetic anomalies obtained by the ship and autonomous underwater vehicle around the Irabu knolls shows variation amplitude of 760 nT at sea-surface (summit water depth of 1630 m) and >10,000 nT at an average altitude of 100 m. Inverted magnetization intensity assuming 1-km magnetized layer shows ~18 A/m from sea-surface anomaly and ~60 A/m from near-seafloor anomaly. These values are considerably large compared with that of mid-ocean ridges (MORs), which are typically several A/m or less even on younger seafloors (*Dyment et al.*, 2015). These results imply that the Irabu knolls generate the strongest crustal magnetic field in the Earth. However, the cause of this extremely high magnetization intensity is still unknown.

In order to determine the source of these strong magnetic anomalies, we conducted rock magnetic and petrological studies of collected samples in the Irau knolls. Fourteen seafloor extrusive rocks including basalt, basaltic andesite, and andesite were obtained by the underwater vehicle *Hyper Dolphin* during YK00-06_leg2 NT11-20, and KY14-02 cruises. To characterize in rock magnetic properties and petrological signatures, we made a comprehensive data set of rock magnetic properties including natural remanent magnetization (NRM) intensity, magnetic susceptibility, grain density, coercivity, magnetic domain state (equivalent to magnetic grain size), Curie temperature (T_Q), Ti content (x) of titanomagnetite grain ($Fe_{3-x}Ti_xO_4$), titanomagnetite content (m), and mineral texture.

All samples contain titanomagnetite as main magnetic carrier and have not been affected by low-temperature oxidation (maghemitization). One sample shows the highest NRM value of 214 A/m. This sample shows single higher T_Q = 460°C and lower x = 0.19 compared with MOR basalts, and indicates a magnetic domain state of complete single-domain (SD) with m = 0.8 wt.%. The other samples with complete SD also show relatively high NRM of 38–116 A/m and similar m = 0.7–1.1 wt.%. In contrast, samples with pseudo-single-domain (PSD) or multi-domain (MD) show small NRM intensities of 7–10 A/m but larger m = 2.5–3.2 wt.%. Low NRM intensity of 8 A/m was also observed for one sample with the contributions of superparamagnetic (SP) grains. This sample shows m = 0.2 wt.%, which is small compared with that in other samples with SD and MD grains, suggesting that crystal growth of titanomagnetite is insufficient due to the rapid cooling rate or reduction of pressure. These results demonstrate that the contribution of SD grains rather than abundant MD grains is clearly important for acquisition of strong NRM, and that rapid crystal growth inhibits the creation of titanomagnetite and enables the formation of SP rather than SD grains. Proper crystal growth rate forming a lot of SD grains is important for the acquisition of high NRM values. To conclude, we propose that the high magnetization of the Irabu knolls reflects accumulation of non-oxidized (fresh) low-Ti lava flows containing abundant

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SD-titanomagnetite grains, formed under proper crystal growth rates.

[References]
Vine, F. J., and D. H. Matthews (1963), Nature, doi:10.1038/199947a0.
Fujii, M., K. Okino, C. Honsho, J. Dyment, F. Szitkar, N. Mochizuki, and M. Asada (2015), Journal of Geophysical Research: Solid Earth, doi:10.1002/2014JB011714.
Fujii, M., K. Okino, T. Sato, H. Sato, and K. Nakamura (2016), Earth and Planetary Science Letters, doi:10.1016/j.epsl.2016.02.018.
Dyment, J., Y. Choi, M. Hamoudi, V. Lesur, and E. Thebault (2015), Earth and Planetary Science Letters, doi:10.1016/j.epsl.2015.08.002.

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