R004-06
C 会場 ：11/6　AM1 （9:00-10:30）
10:15～10:30

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Rock magnetic study of exposed oceanic crust and mantle

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Marine magnetic anomalies have been utilized to understand geomagnetic field reversals and fluctuations recorded in spreading seafloor since the 1960s. Recent advances in dense sea-surface and high-resolution near-bottom surveys provide further information on oceanic lithosphere processes such as lava accretion, hydrothermal circulation, and complex faulting. However, the relationship between the anomaly signal and geological ground truth still remains poorly understood. In particular, rock magnetic data of deeper sources and temporal variation are essentially limited because of sampling difficulty. Here, we newly demonstrate a more comprehensive dataset of rock magnetic analysis studied on serpentinized peridotites and gabbroic rocks as well as basaltic rocks with a variety of localities on the global scale.

The samples were collected from several abyssal geological outcrops during mainly Japanese research expeditions of the R/V Yokosuka, R/V Hakuho-maru, and R/V Kairei; Yokoniwa Rise, Central Indian Ridge; Near Rodrigues Triple Junction, Central Indian Ridge; Vulcan Fracture Zone, Mid Atlantic Ridge; Cape Verde Fracture Zone, Mid Atlantic Ridge; Rainbow Massif, Mid Atlantic Ridge; Atlantis Bank, Southwest Indian Ridge; Gakkel Ridge, Arctic Ocean; Seamount B (Antarctic rift margin), Southern Ocean; Mado Megamullion, Philippine Sea; Suishin Megamullion, Philippine Sea; Mariana Forearc slopes close to the Challenger Deep; Shinkai Seep Field, Mariana Forearc.

Results of serpentinized peridotite show a negative correlation between grain density and magnetic properties are commonly observed in different geological settings of mid-ocean ridge, back-arc basin, wedge mantle, and continental margins. Furthermore, it is clear that highly serpentinized rocks with low density are mainly magnetic, but also include a variety of weak to intermediate properties. Results of the gabbroic rock show that the oxide gabbro has high magnetic susceptibility, and its induced magnetization may contribute significantly to marine magnetic anomalies. Extensive data of basaltic rocks from different areas and ages demonstrate that time-dependent change (e.g., reaction with seawater), as well as initial magma composition and grain size distribution (cooling rate), could be the main cause for controlling remanent magnetization intensities.