Paleomagnetim of the Lower Oceanic Crust and the Upper Mantle:Results From ODP Leg 176, MODE98 Leg 4, and Oman Semail Ophiolite

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Recent data obtained from ODP Legs.118,147 and176, MODE98, and Oman Semail Ophiolite indicated that the deep oceanic crust and upper mantle possess strong magnetization. Gabbros from Oman Semail Ophiolite showed magnetization substantially lower than those drilled/collected from the ocean floor. Comparison of the drilled samples with those directly collected by Shinkai 6500 confirmed that the drilled samples acquired secondary magnetization during drilling, which was originally suggested by the study of the drilled samples.

A unique 1500 m of gabbroic section which was cored during Legs 118 and 176 performed at Site 735(Atlantis Bank), Atlantis II Fracture Zone (AIIFZ), Southwest Indian Ridge provides the very satisfying picture for the stable magnetization for those rocks: a consistent average stable inclination of ~71o throughout the hole, very stable remanent magnetization against alternating field (AF) and thermal (TH) demagnetization, and commonly very sharp blocking temperatures, which suggests relatively rapid acquisition of thermoremanent magnetization close to the ridge. However, like Leg 118 gabbros, drilling-induced remanent magnetization (DIRM) altered 176 gabbros, so, natural remanent magnetization (NRM) of the rocks of 2.5 - 3.2 A/m cannot be considered as the in situ magnetization of the rocks beneath sea-floor. Though detailed rock magnetic study enables us to estimate the original NRM before DIRM acquisition and the estimated original NRM suggests a significant contribution of oceanic gabbros to the lineated magnetic anomalies, we have longed for the rock samples undisturbed by DIRM. No mantle peridotites were drilled either during Legs 118 and 176. Magnetic structure of the MOHO transition zone is thus still not clear at AIIFZ, so recovery of mantle peridotites at Atlantis Bank is also very important.

MODE98 Leg 4 Shinkai 6500 dives provided us such rocks as well as a unique opportunity to study magnetic properties of the oceanic rocks by allowing successive direct sampling of the rocks exposed on the sea-floor at the water depth from 700 m to 5200 m. MODE98 Leg 4 gabbros indicate NRMs about 1 to 4 A/m, which is consistent with the ODP data. During MODE98 Leg 4, a few peridotite samples were collected, showing NRMs of 0.5 A/m substantially lower than ODP Leg 147 peridotites drilled at Hess Deep, East Pacific Rise.

Massive and layered gabbros from Oman Semail Ophiolite, however, have NRMs of 0.3 to 0.7 A/m much smaller than ODP gabbros, though this NRM intensity is still enough to contribute significantly to the sea-floor spreading magnetic anomalies, assuming 3 to 5 km of gabbroic layer. Kikawa and Ozawa(1992) suggested that magnetization increases by about an order of magnitude as gabbros evolve from troctolite to olivine gabbro during the initial differentiation, which may explain the relatively smaller magnetizations observed from Oman Semail Ophiolite as well as the other ophiolite complexes.

Contrary to the gabbros, NRMs of mantle peridotites from Oman indicate similar NRMs of 1 ~ 9 A/m to those from Hess Deep and Atlantis Bank.

These data, together with the insufficient magnetization of the upper oceanic layers, suggest that the source of the lineated magnetic anomalies must reside in whole oceanic crust and upper mantle.