Rock Magnetic Properties of Oman Drilling Project Cores BA1B, BA3A, BA4A and Its Implications on Iron Oxide Alteration

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The primary objective of our study is to investigate the magnetic properties of Oman Drilling Project cores BA1B, BA3A, and BA4A drilled from Wadi Lawayni, Oman; and to compare them with the mineral structure to find evidences of Iron Oxide alteration during serpentinization. The cores mainly consist of heavily serpentinized Harzburgites and Dunites with gabbroic dikes densely populated within the strata. The initial measurements, including bulk magnetic susceptibility and thin section observations, were done onboard D/V Chikyu during Oman Drilling Project phase 2. Further studies regarding natural remanent magnetism (NRM) during alternating field (AF) and thermal demagnetization were done at the University of Iceland.

In general, significant correlations are observed between the induced magnetic data and petrology of the cores. In the case of volume normalized magnetic susceptibility the magnitude remains mainly low (<0.02 SI) throughout most of the depths of all 3 cores, with dunitic areas showing higher values compared to Harzburgite dominant sections. Such behavior is perceived to be normal for serpentinized peridotite, and is considered to be because of the difference in Fayalite content. However, we have found that the bulk magnetic susceptibility is unusually high (>0.03SI) for rocks near the surface (0-50m depth) and Olivine Gabbro dikes (normally within 5m). The degree of anisotropy mostly remained low throughout all 3 cores, with occasional peaks observed near gabbroic dikes. Though it is unclear whether such phenomenon is directly related to magma contact and its resulting heat conduction, it may still reflect that the magnetic minerals and their magnetic signatures have been physically affected by magmatic intrusions.

Based on the analysis on induced magnetism onboard D/V Chikyu, further investigations on NRM were done to reveal the differences in both magnetic and mineralogical features between surface and deeper near-dike domains. NRM intensity tends to be high around magma intrusions, but remains relatively low for surface rocks. While the magnitude of both induced and remanent magnetism correlate with the magnetite content within the mineral mesh, demagnetization behaviors differ significantly between surface and lower depths. In addition, unusual positive NRM inclination was observed along the 0-50m depth range of core BA3A and some Harzburgite dominant sections of BA1B, indicating that partial remagnetization occurred along these areas. Notable differences were observed in stepwise thermal demagnetization patterns as well, showing significantly lower median destructive temperature (MDT) at the surface of BA3A core. This implies that the formation mechanism of the magnetite may vary among the BA cores, and such diversity might reflect that significant Iron Oxide mineral alterations have been induced by magma and fluid intrusions. To clarify the hypothesis, future studies will emphasize on further classification of magnetic minerals upon chemical and crystallographic attributes using SEM observations and intense geochemical investigations, aiming to specify how magnetic minerals and their magnetic signatures originated.

Keywords: rock magnetism, Iron Oxide alteration, serpentinization, magmatic intrusion