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Rock-magnetic properties of the plate-boundary thrust material drilled during IODP Expedition 343 (JFAST)

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During IODP Expedition 343, Japan Trench Fast Drilling Project (JFAST), boreholes were drilled through the prism and across the fault that is thought to have slipped during the 11 March 2011 Tohoku-Oki Earthquake. 74 subsamples of the core recovered from hole C0019E were subjected to rock magnetic analyses to identify magnetic minerals, determine the magnetic-grain size distribution and investigate rock magnetic changes related to fault zone processes.

Magnetic hysteresis curves and backfield DC demagnetization curves of isothermal remanent magnetization were measured using a MicroMag 2900 alternating gradient field magnetometer. Hysteresis parameters (Ms, Mr, Hc, Hcr) were calculated and coercivity spectra were obtained as the derivative of DC demagnetization curves. Thermal demagnetization of low-temperature IRM acquired at 10 K and 5 T after zero-field cooling was performed with an MPMS-XL. Thermomagnetic analyses in 0.4 T and ambient pressure were carried out with a Natsuhara NMB-89 thermobalance.

Samples from the sheared scaly clay zone (Lithologic Unit 4: 820-824 m CSF, inferred to be the plate boundary decollement) clearly have low Hc and Hcr (10-13 and 22-24 mT) compared with the lower part of the frontal prism sediment (Lithologic Unit 3: 688-820 m CSF; Hc = 15-52 mT; Hcr = 45-85 mT) and the brown underthrust sediment (Lithologic Unit 5: 824-832 m CSF; Hc = 13-26 mT; Hcr = 45-85 mT), suggesting a difference in magnetic mineralogy and/or grain size. However, there is no obvious variation in magnetic properties within between the decollement zone.

As for the thermal demagnetization curves of low-temperature IRM, the samples from llithologic Unit 3 show loss of magnetization at ˜120 K, reflecting the Verwey transition of stoichiometric magnetite. In contrast, the samples from the lithologic Units 4-5 do not show significant loss of magnetization at the Verwey transition temperature. For the thermomagnetic curves, the heating branches of some samples from lithologic Unit 3 have humps above ˜400 deg C possibly caused by thermal decomposition of some iron-bearing minerals and formation of magnetic minerals during heating, while the samples from lithologic Units 4-5 do not show any humps on the heating branches. These results imply a difference in magnetic mineralogy between lithologic Units 3 and 4-5 (ie. a difference between hangingwall and fault zone / footwall).

Within Lithologic Unit 4, the lower four samples (822.07-822.48 m CSF) show large magnetization increases in the cooling branches below ˜100 deg C which might reflect the formation of magnetic minerals with low Curie temperatures during heating, compared with the upper four samples (821.54-821.78 m CSF). These samples may correspond to material that generated a peak in the on-board magnetic susceptibility log.

In summary, we found minor magnetic signals at the lower part of the sheared clay zone core sample of fault zone processes resulting from localized variation of magnetic mineralogy within the sheared clay zone samples recovered from the hole C0019E, but the origin and process of the minor magnetic variation should be further examined.