Characterizing magnetic glasses from IMAGES core MD01-2412 in the Okhotsk Sea using first order reversal curves (FORCs)

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Volcanic glasses, magnetically separated from sediment samples, were characterized using first order reversal curves (FORCs). The vertical variation of magnetic susceptibility for IMAGES core MD01-2412 retrieved in the southwestern part of the Sea of Okhotsk shows numerous spike-like peaks. Some peaks correspond to visually identified tephra layers , but others do not exhibit any significant difference in color or grain size from intervened sediment layers. ARM intensities are also high at the susceptibility peaks and the ratios of ARM over susceptibility are enhanced as suggestive of fine magnetic grain size. Magnetic hysteresis measurements on bulk sediment samples from these peaks indicated exceptionally high coercivity remanence values (sometimes exceeding 100 mT) leading to high ratios of coercivity remanence over coercivity. Using a magnetic finger we could collected a lot of black-colored volcanic glasses from the susceptibility peak layers.

Each grain of the volcanic glass was washed to remove adhering discrete magnetic grains and measured with an alternating gradient magnetometer to produce a FORC diagram. A FORC diagram can be calculated from a class of partial hysteresis curves measured by decreasing a reversal field. From a FORC diagram we can obtain a distribution of coercivity within a single grain of volcanic glass instead of a representative value of coercivity from an ordinary hysteresis measurement. In addition influence of magnetic interaction between magnetic particles can be evaluated. Volcanic glasses show two modes of magnetic particles on the FORC diagrams: single-domain particles having a coercivity distribution peaked at several tens of mT and superparamagnetic particles with almost zero values of coercivity. Closely packed fine (superparamagnetic or single-domain) particles within a volcanic glass exhibit high susceptibility and ARM intensity, and the magnetic interaction between the particles significantly affects the magnetic properties.