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16. Data Report: Evidence of the Dissolution of Fine-Grained Magnetic Minerals from Measurements of Natural and Laboratory-Induced Remanent Magnetizations at Site 1077[1]

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INTRODUCTION

During Ocean Drilling Program Leg 175, cores were taken off the west coast of Africa in the Angola-Namibia upwelling system. The sediments at these sites have a high total organic carbon content and a very low concentration of ferrimagnetic material (Wefer, Berger, Richter, et al., 1998). The weak magnetic susceptibility is dominated by paramagnetic and diamagnetic minerals with a negligible contribution from ferrimagnetic minerals. In addition, Yamazaki et al. (2000) shows that severe postcoring diagenesis caused a loss of up to 90% of the remanent magnetization by the dissolution of fine-grained magnetic minerals during storage.

Environmental rock-magnetic studies of marine sediments often recover paleoenvironmental information through composition, concentration, and grain-size variations of magnetic minerals contained in the sediment (Colin et al., 1998; Hounslow and Maher, 1999). However, in sediments with high organic carbon content, preservation of magnetic minerals is often poor (Richter et al., 1999; Roberts et al., 1999). For Site 1077, the latter is the case, with severe dissolution of fine magnetic grains both in situ and postcoring, preventing the use of magnetic remanence measurements for paleoenvironmental studies.

[1]Solheid, P.A., and Yamazaki, T., 2001. Data report: Evidence of the dissolution of fine-grained magnetic minerals from measurements of natural and laboratory-induced remanent magnetizations at Site 1077. *In* Wefer, G., Berger, W.H., and Richter, C. (Eds.), *Proc. ODP, Sci. Results,* 175, 1–10 [Online]. Available from World Wide Web: <http://www-odp.tamu.edu/publications/175_SR/VOLUME/CHAPTERS/SR175_16.PDF>. [Cited YYYY-MM-DD]
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METHODS

Natural remanent magnetization (NRM) was measured at 5-cm intervals on a 2-G three-axis cryogenic magnetometer aboard the *JOIDES Resolution* for all archive-half split-core sections from Site 1077. Alternating-field (AF) demagnetization was done using the 2-G three-axis AF demagnetizer at 10 and 20 mT to remove overprinting from the coring process. U-channels were collected from the composite splice for Site 1077 from 0 to 40 meters composite depth (mcd) and measured 16 months postcruise. Natural and laboratory-induced remanent magnetizations were measured at 1-cm intervals on a 2-G three-axis cryogenic magnetometer at the Geological Survey of Japan. NRM was measured after AF demagnetization at 20, 30, 40, 50, 60, and 80 mT using the three-axis AF demagnetizing coils on the 2-G magnetometer.

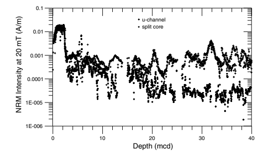
Several laboratory-induced magnetic remanences were also measured on the U-channels. Anhysteretic remanent magnetization (ARM) was applied in a 100-mT demagnetizing field with a 0.1-mT direct current (DC) biasing field. Saturation isothermal remanent magnetization (SIRM) was applied using a 1.8-m-long solenoid 2-G pulse magnetizer with fields of +1 and –0.3 T with measurements taken after each treatment.

RESULTS AND DISCUSSION

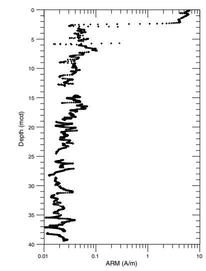
Measurements of NRM after 20-mT demagnetization agree very well with shipboard measurements for the top 3 m (Fig. F1). Below 3 mcd, the measurements begin to diverge and below 12 mcd, the intensity of the U-channels is an order of magnitude weaker than that of shipboard measurements, indicating severe postcoring alteration. This decrease in intensity is attributed to the dissolution of fine magnetic grains during storage (Yamazaki et al., 2000).

ARM is sensitive to fine magnetic grains (0.05 to ~1 µm) of low-coercivity minerals such as magnetite and maghemite. At 3 mcd, a severe two-orders-of-magnitude drop in ARM is observed (Fig. F2). SIRM at 1 T is a measure of the total content of remanence-carrying grains (magnetite, maghemite, and hematite, for example). Again, the sharp drop at 3 mcd is evident (Fig. F3). By applying an isothermal remanent magnetization (IRM) of –0.3 T, the low-coercivity grains such as magnetite and maghemite are magnetized in the opposite direction of the high-coercivity grains (hematite and goethite) (Fig. F4). The S-ratio (SIRM [+1 T]/IRM [–0.3 T]) is a measure of the downcore variations in high- and low-coercivity minerals. High S-ratio values indicate more low-coercivity minerals such as magnetite, whereas lower values indicate more high-coercivity minerals. The S-ratio is above 0.9 from 0 to 2.5 mcd, spikes sharply to 0.5 at 2.5 mcd, and ranges from 0.8 to 0.85 below 2.5 mcd. (Fig. F5). This is consistent with the loss of fine-grained magnetite as noted by Yamazaki et al. (2000). Further evidence of this loss can be seen by normalizing ARM (sensitive to grain-size and concentration) to SIRM (sensitive to concentration) to get a parameter sensitive to grain-size. Figure F6 shows a 50% drop in the ARM/SIRM parameter, indicating a loss of fine-grained material. This intense dissolution of fine-grained magnetic material inhibits paleoclimate interpretations from these measurements.

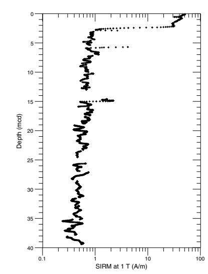
F1. Intensity of natural remanent magnetization, p. 5.



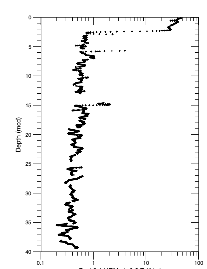
F2. Measurements on U-channels of ARM, p. 6.



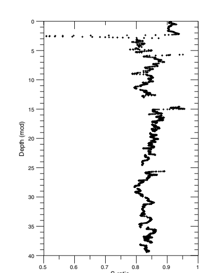
F3. Measurements on U-channels of SIRM, p. 7.



F4. Measurements of a backfield IRM, p. 8.



F5. S-ratio calculated from SIRM(+1 T)/IRM(–0.3 T), p. 9.



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F6. ARM/SIRM parameters, p. 10.

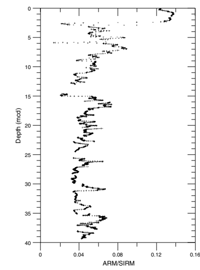

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Figure F1. Intensity of natural remanent magnetization (NRM) after 20-mT AF demagnetization for Site 1077. Open circles = half-core sections measured aboard ship. Crosses = U-channels measured at the Geological Survey of Japan 16 months postcruise. mcd = meters composite depth.

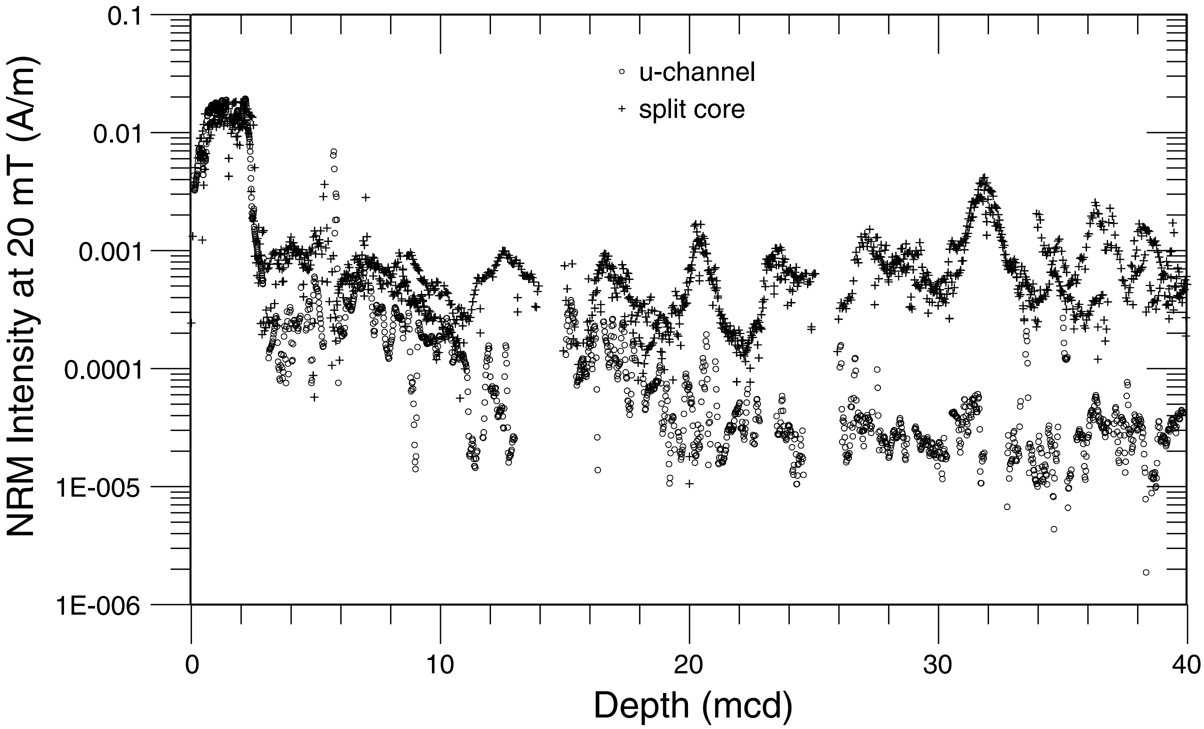

Figure F2. Measurements on U-channels of anhysteretic remanent magnetization (ARM) applied in a 100-mT demagnetizing field with a 0.1-mT DC biasing field. mcd = meters composite depth.

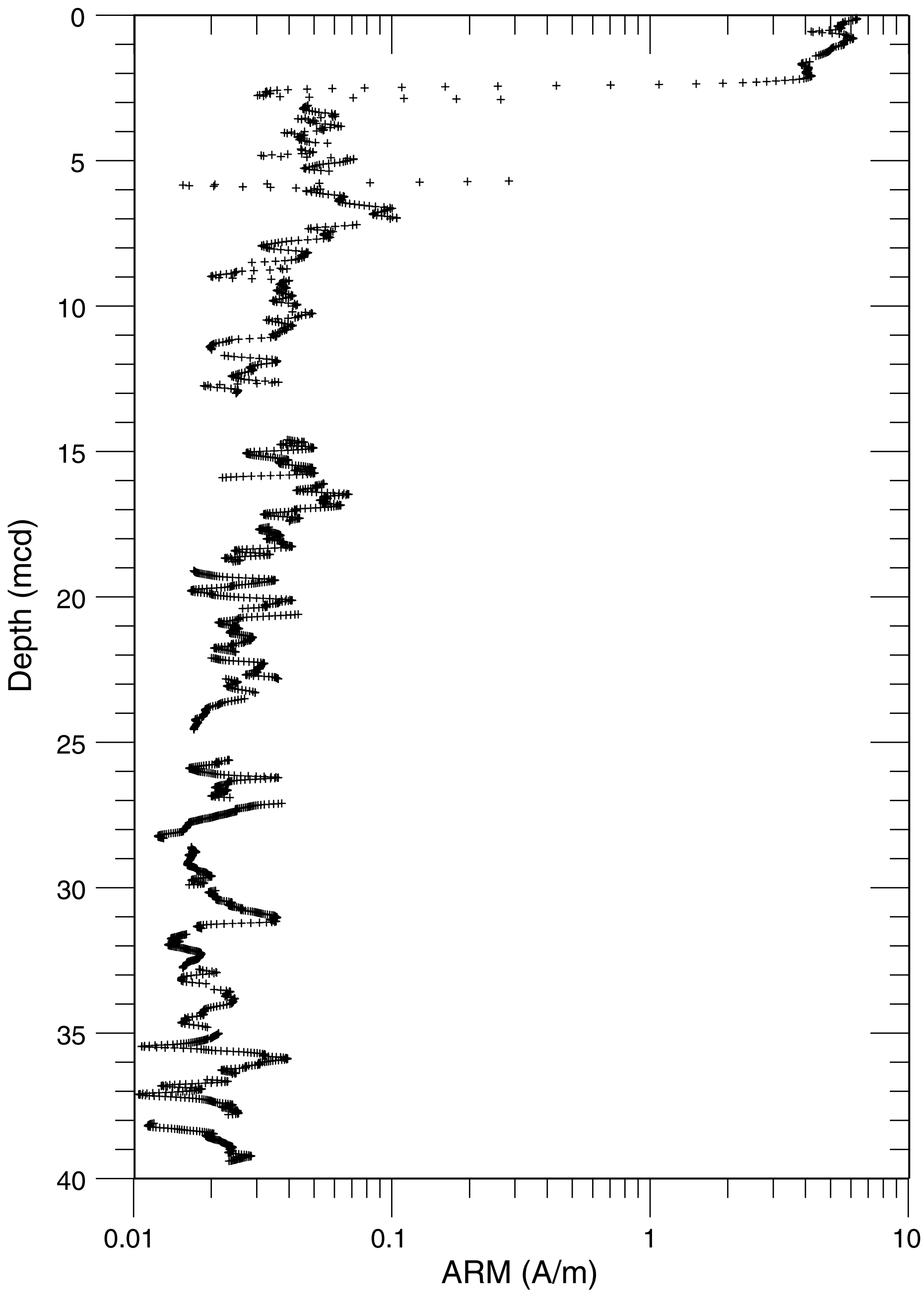

Figure F3. Measurements on U-channels of saturation isothermal remanent magnetization (SIRM) applied in a 1-T saturating field. mcd = meters composite depth.

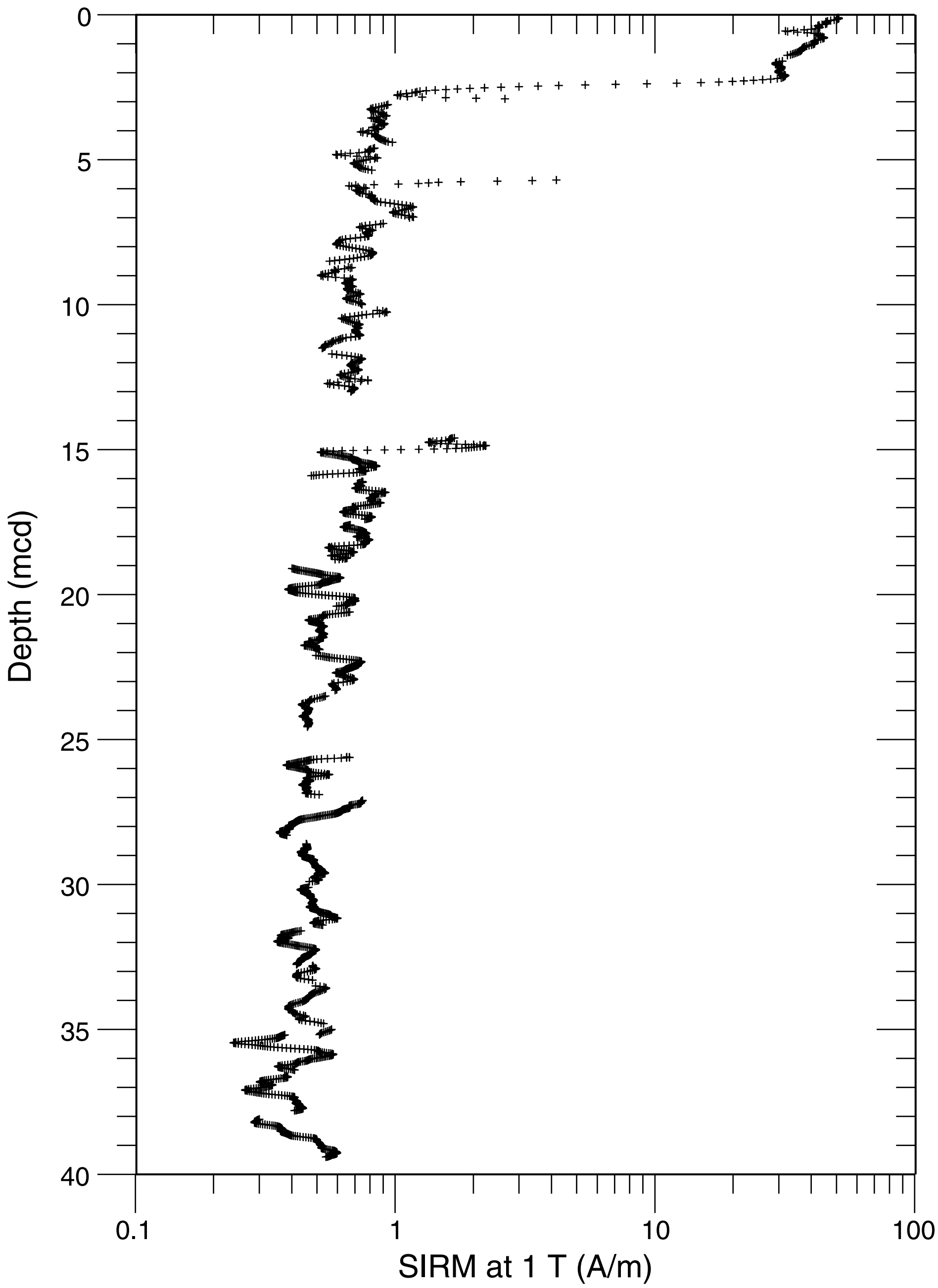

Figure F4. Measurements of a backfield isothermal remanent magnetization applied in –0.3-T magnetizing field. mcd = meters composite depth.

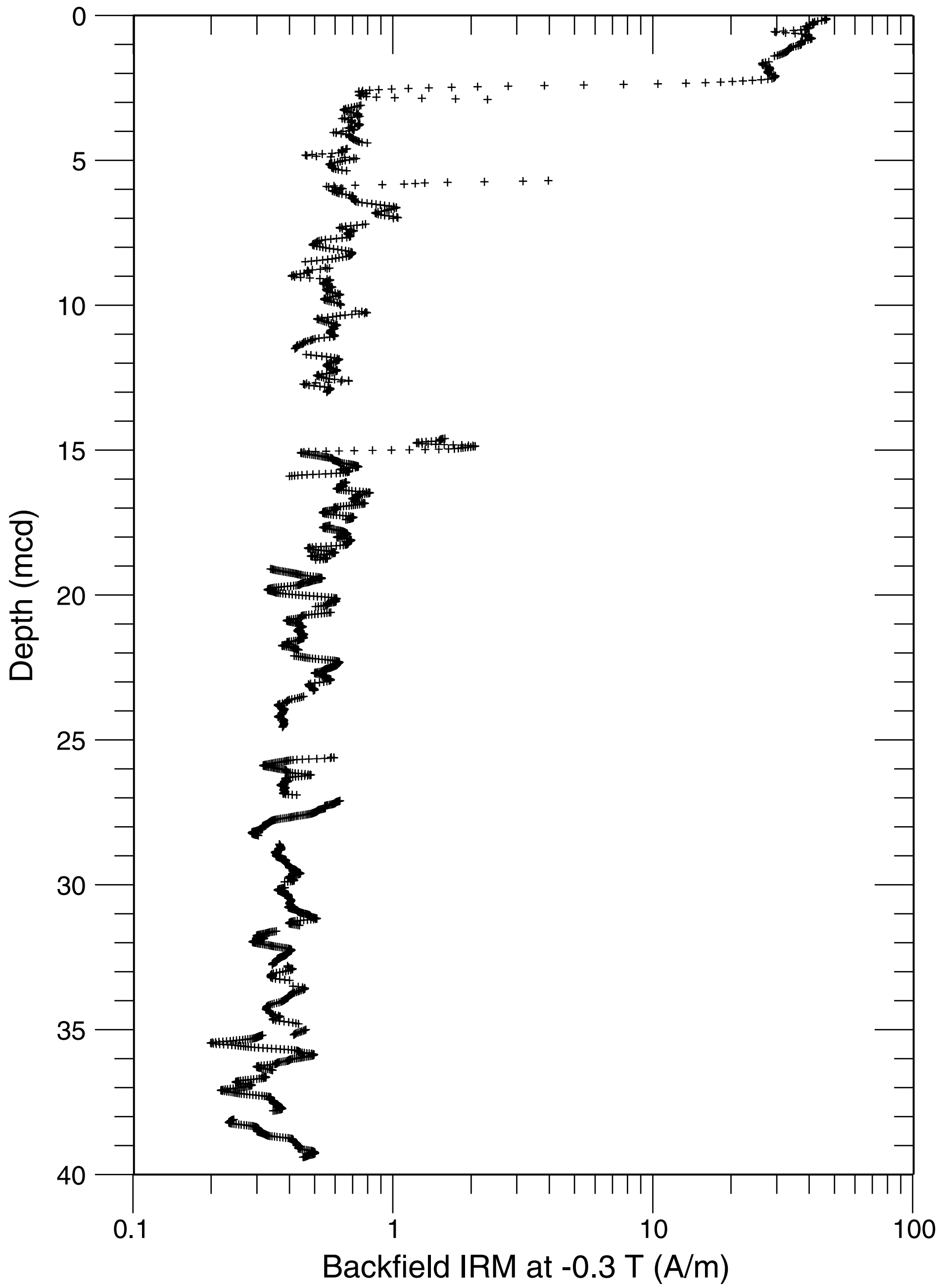

Figure F5. S-ratio calculated from SIRM(+1 T)/IRM(–0.3 T). mcd = meters composite depth.

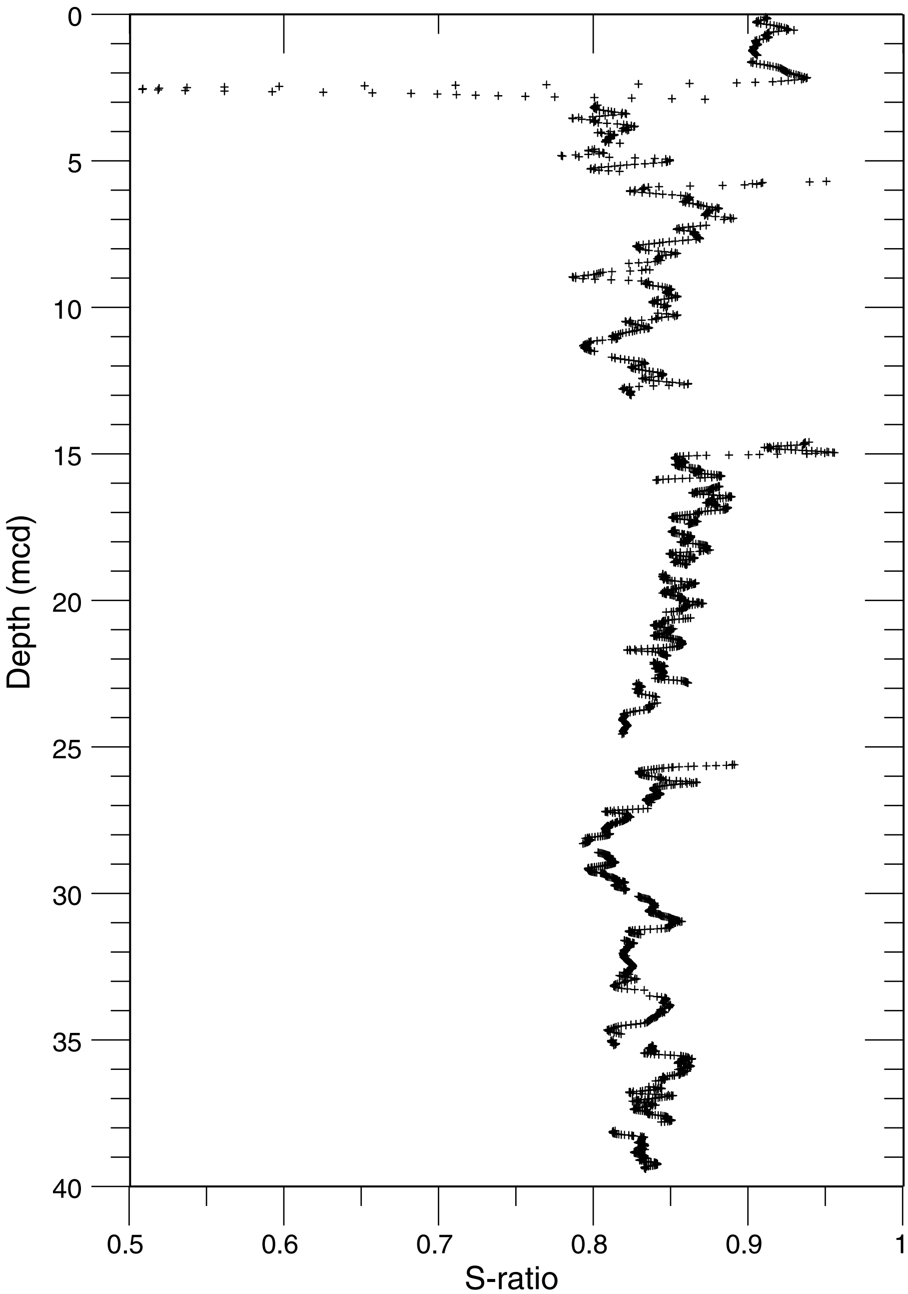

Figure F6. ARM/SIRM parameters, indicating the grain size of magnetic particles in the sample. Higher ratios indicate finer grains. The 50% drop at 3 mcd indicates the loss of fine-grained magnetite due to dissolution. mcd = meters composite depth.