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Magnetic properties of a sediment core from Andvord Drift

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United States Antarctic Program (USAP) Cruise 99-03 of the research ship *Nathaniel B. Palmer* collected several sediment cores from the western Antarctic Peninsula to examine the natural degree of environmental variability in this region during the Holocene (Domack et al. 1999). Here we examine variations in three magnetic parameters along an approximately 3-meter sediment core (Kasten core KC18C), which reflect the composition, grain size, and concentration of magnetic material in the sediments. The purpose of this magnetic study is to characterize the sediment magnetic mineral assemblage and to understand the local sedimentation processes that generate the assemblage.

Core NBP 99-03 KC18C was collected at the mouth of Andvord Bay (figure 1), at a water depth of approximately 427.7 m (64° 46.342, 62° 49.746). This core samples Andvord Drift, which was discovered and mapped during USAP cruise 98-02 of the U.S. research ship *Lawrence M. Gould* (Harris et al. 1999). Subsamples were collected from the core for rock-magnetic analyses performed at the Institute for Rock Magnetism (IRM), University of Minnesota.

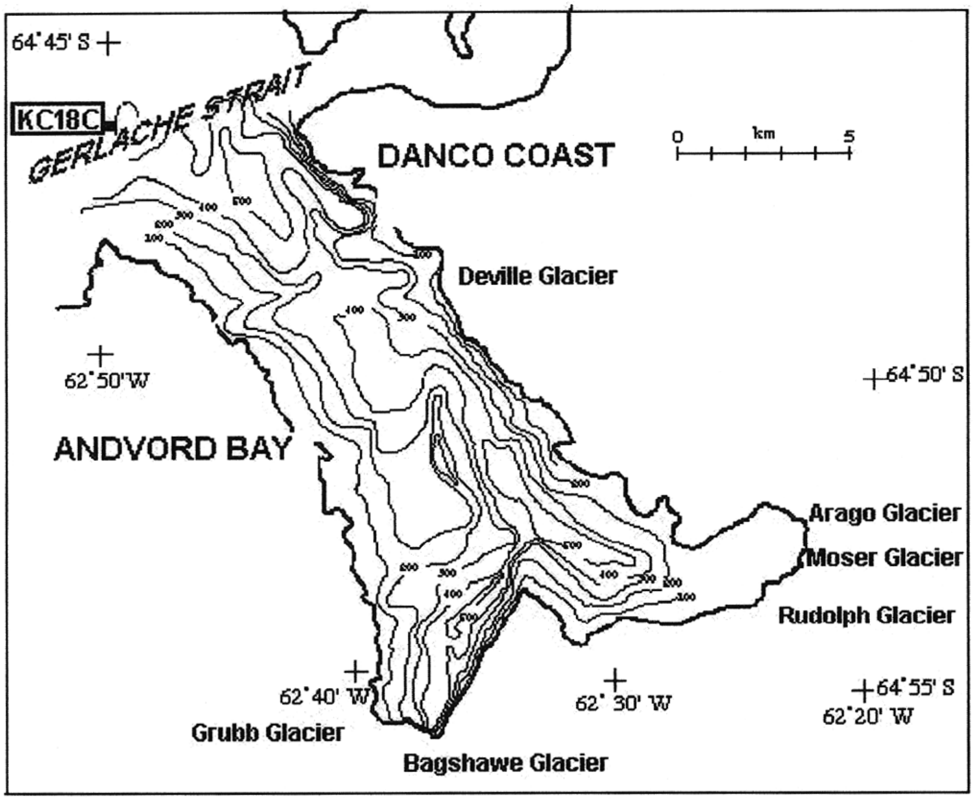

Figure 1. Location of core NBP99-03 KC18C (redrawn after Domack et al., 1993).

Magnetic susceptibility (figure 2) is used as a measure of the concentration of magnetic material. Variations in the concentration of magnetic material, usually derived from terrigenous sources, can be caused by variable dilution by biogenic sediment such as organic carbon or silica. KC18C displays higher average values from 0 to 126 cm followed by a shift to lower values below 126 cm. The high susceptibility interval from 0-126 cm indicates a higher concentration of magnetic minerals, and the low susceptibility interval from 126-266 cm represents a lower concentration likely in response to variations in biogenic silica.

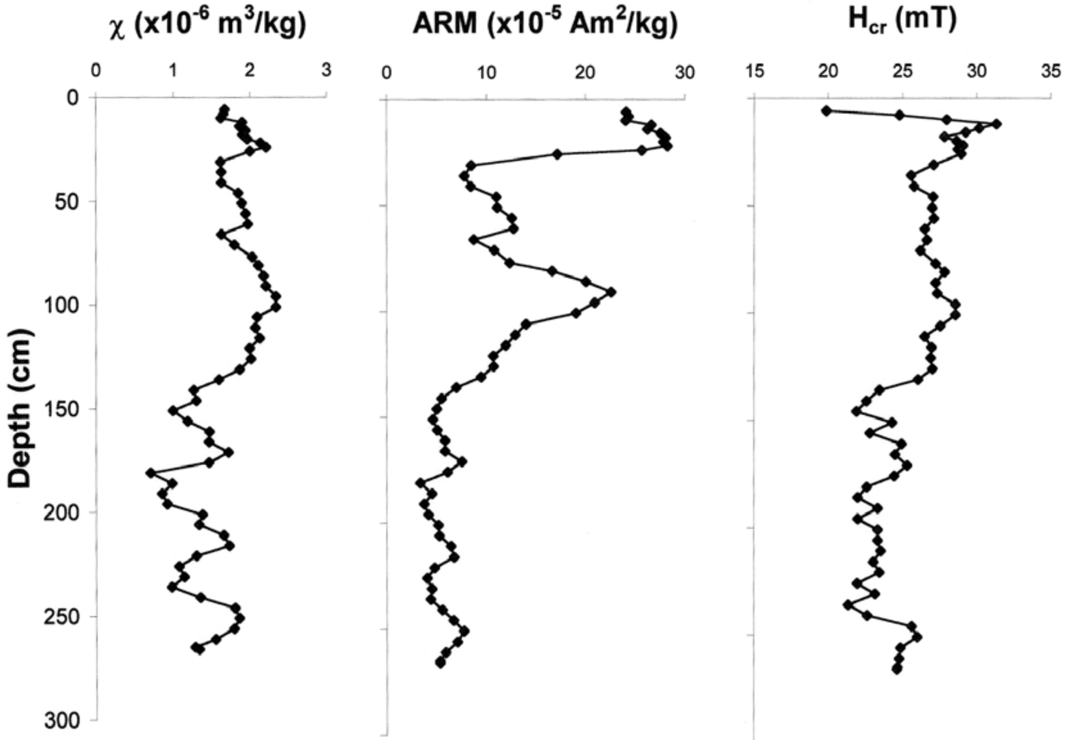

Figure 2. The variations in mass-normalized magnetic susceptibility (χ), anhysteretic remanent magnetization (ARM), and coercivity of remanence (Hcr) down core KC18C. The decrease in all three parameters indicates a change in the magnetic mineral assemblage at 126 cm.

Anhysteretic remanent magnetization (ARM) is a parameter that is sensitive to the concentration of small stable-single-domain (SSD) and pseudo-single-domain (PSD) grains (0.03 to 1 micron and 1 to 10 microns, respectively for magnetite). In addition, paramagnetic (clays) and diamagnetic (silica) material contributes nothing to ARM. Again, we see a change at approximately 126 cm where the ARM decreases (figure 2). There are also two high peaks in ARM around 25 and 90 cm just as there are for susceptibility.

Hysteresis loop parameters were determined for each sample to monitor variations in magnetic grain size down the core. The coercivity of remanence (H_{cr}) (figure 2) shows a clear decrease at 126 cm, which indicates a shift from relatively finer grains in the top half of the core to relatively courser multi-domain (MD) grains at greater depths. These shifts could be a result of dissolution of the finer grains, leaving a course residual assemblage. The shift in grain size may also suggest a change in the provenance, to a source rock with finer-grained magnetic particles.

Magnetic mineralogy was examined using the temperature-dependence of magnetic properties. The low temperature measurements indicate a clear magnetite Verwey transition at 120 K throughout the entire core (figure 3). Additionally, Curie temperature measurements from several depths throughout the core also indicate magnetite as the primary magnetic mineral, with a Curie temperature of 575°C.

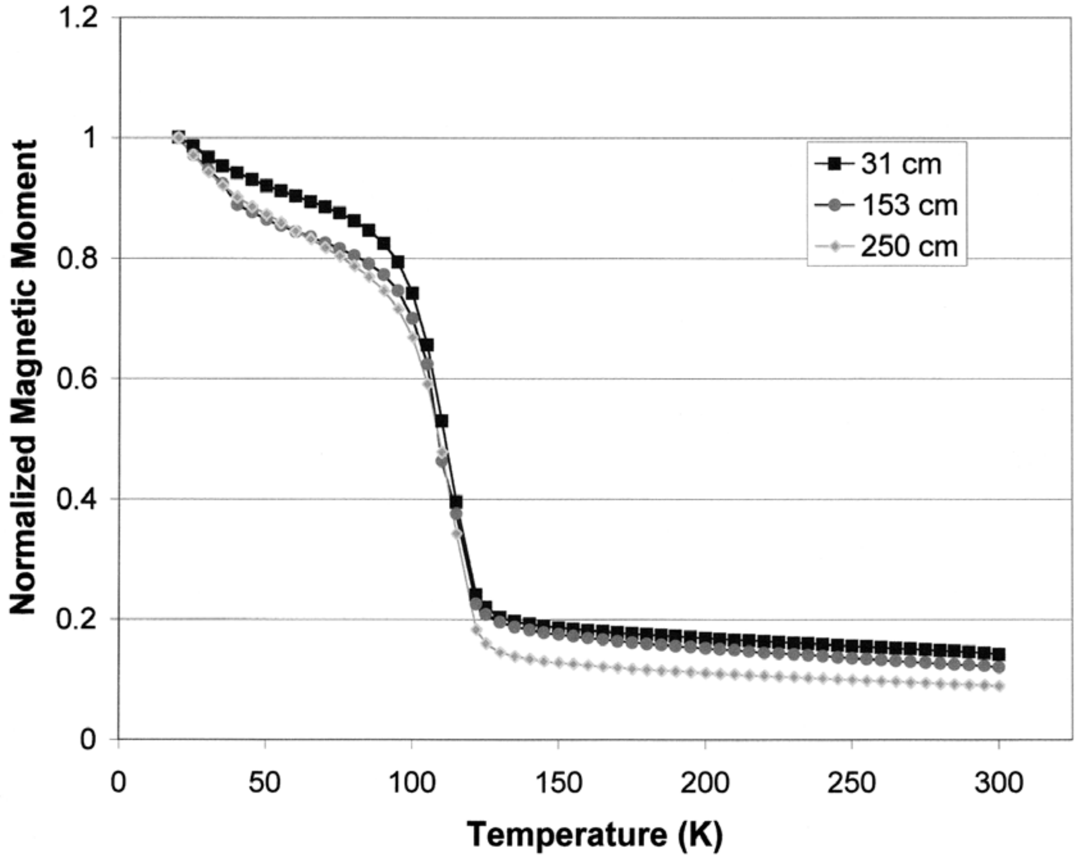

Figure 3. Low temperature measurements on three samples from core KC18C. All depths indicate a magnetite Verwey transition of 120 K.

The concentration, grain size, and composition of magnetic minerals in Andvord Bay sediments yield clues to past depositional processes. The dominant mineral appears to be magnetite. The concentration of magnetite in the Andvord Drift decreases with depth, indicating a change in the flux of terrigenous sediment (Domack, et al. 1993). Magnetic susceptibility highs indicate the sample may contain more terrigenous material, supplied by ice-rafting. Magnetic susceptibility lows reflect increased biogenic silica and possibly higher productivity. The magnetic grain size change at approximately 126 cm could reflect a depositional or diagenetic process.

Examination of the major cations and anions present in interstitial water samples is in progress to look for geochemical boundaries that may coincide with this magnetic feature. In addition, x-ray diffraction and electron microprobe analysis may reveal the presence of diagenetic iron sulfides and reveal subtle variations in magnetic mineralogy that will help us distinguish provenance changes from post-depositional diagenetic alteration.

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