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PRELIMINARY ROCK MAGNETIC AND PALEOMAGNETIC RESULTS FROM A MARINE SEDIMENT CORE

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ABSTRACT

We report preliminary results of lithology, rock magnetic and paleomagnetic studies of a short sediment core collected from the ocean bottom during *Litoral Bonaerense V* Scientific cruiser (Servicio de Hidrografía Naval) during 2012. A short core (135 cm) was collected using a piston core at 100 m water depth. Measurements of intensity and directions of Natural Remanent Magnetization (NRM), magnetic susceptibility, isothermal remanent magnetization, saturation isothermal remanent magnetization (SIRM), back field and anhysteretic remanent magnetization at 100 mT (ARM) were performed and several associated parameters calculated (ARM/k and SIRM/ARM). Also, as a first estimate of relative magnetic grain-size variations, the median destructive field of the NRM (MDF_{NRM}), was determined. The stability of the NRM was analyzed by alternating field demagnetization. The magnetic properties have shown variable values, showing changes in both grain size and concentration of magnetic minerals. It was found that the main carrier of remanence is carried by coarse-grained magnetite grains.

Keywords: marine sediment core, rock magnetism, paleosecular variations,

Geographical Location

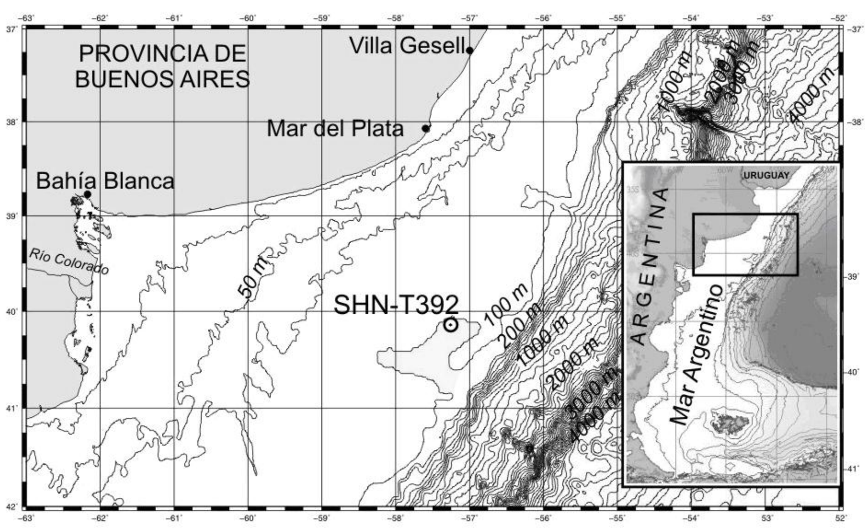

Figure 1. Geographical location showing coring site

Lithology and Setting

Level 1: 135 cm - 124 cm. It is composed of a series of thick layers of silt and clayey fine sand, which lay interbedded; they are internally structured with bipolar ripple cross-lamination and horizontal planar lamination.

Level 2: 124 cm - 111 cm. It shows clayey sand sediments which display moderated bioturbation and its internal structure is massive. It has a low content of bioclastic fragments.

Level 3: 111 cm - 89 cm. It has a sharp basal contact. This level is characterized by a horizontal arrangement of layers composed of bioturbated clayey fine sand with variable content of bioclastic fragments. These layers repeatedly gradate to muddy olive color laminae at 96cm and 107 cm depth; muddy layers show horizontal planar lamination and a conspicuous content of trace fossils.

Level 4: 89 cm - 81 cm. It lays on a sharp erosional basal contact. This level comprises sandy sediments within an irregular arrangement of tabular and lenticular very thin beds that resemble cross-bedding. Sediments have moderate bioclastic content ranging from coarse sand to pebble size.

Level 5: 81 cm - 73 cm. It has a sharp basal contact. It consists of tabular very thin beds bounded by horizontal sharp contacts. Beds are made of medium sand sized sediment, often associated with bioclastic fragments. Sand is sometimes muddy and laminated.

Level 6: 73 cm - 64 cm. It lays on a sharp erosional basal contact. It includes a mostly silt sized sediment record where horizontal sharp boundaries separate massive deposits with high content of pebble sized bioclastic fragments.

Level 7: 64 cm - 10 cm. From 10 cm to 64 cm deep, the record comprises coarse bioclastic sediments, predominantly bivalves, unable to be subsampled.

Level 8: 10 cm - 0 cm. It is composed of 9 cm of an internally massive deposit of fine to medium sand

Methodology

Magnetic measurements were made to characterize sediments and to investigate their response to a variety of applied magnetic fields. The response is mainly driven by the mineralogy as well as concentration and grain-size distribution of magnetic carriers. The procedure used for magnetic measurements was as follows:

1. Core was sub-sampled continuously with cubic plastic boxes (20 mm × 20 mm × 20 mm) that were pressed into the surface of the open core face. A total of 33 samples were obtained.

2. Magnetic susceptibility was measured at low frequency (k low at 470 Hz) and high frequency (k high at 4700 Hz). The difference between both measurements was used to calculate the frequency dependent susceptibility ($F = k_{low} - k_{high} / k_{low}$). This parameter reflects the presence of very fine (< 0.03μm for magnetite) ferrimagnetic grains in the super-paramagnetic state (SP) of the sediment record.

3. Stability of the magnetization was analysed by alternating-field (AF) demagnetization. Samples were demagnetized successively at peak fields of 5, 10, 15, 20, 25, 30, 35, 40, 50, 60, 80 and 100 mT.

Additional studies were carried out in a group of pilot samples:

1. Acquisition of the anhysteretic remanent magnetization (ARM) was carried out with a direct field of 0.05mT and an alternating field between 2.5 and 100 mT.

2. Acquisition of isothermal remanent magnetization (IRM) was determined in growing steps until 1.2 T reaching the saturation isothermal remanent magnetization (SIRM) and in growing steps back until cancelling the magnetic remanence. These measurements were used to calculate the S_{ratio} (IRM_{-300mT} / SIRM),

After each treatment, the samples were AF demagnetized using the same steps as for the NRM.

Combined magnetic parameters were calculated (ARM/k, ARM/SIRM and SIRM/k). Also, and as a first estimate of relative magnetic grain-size variations, the median destructive field of the NRM (MDF_{NRM}) was determined.

A JR6A Dual Speed Spinner Magnetometer was used for the measurements of remanent magnetization. Magnetic susceptibility was measured using a Bartington MS2 Susceptibilimeter, and an alternating field demagnetiser Molspin Ltd. was used to separate components of magnetization. A pulse magnetizer IM-10-30 (ASC Scientific) and alternating field demagnetizer (Molspin Ltd.) with an ARM device were used for IRM and ARM acquisition experiments, respectively.

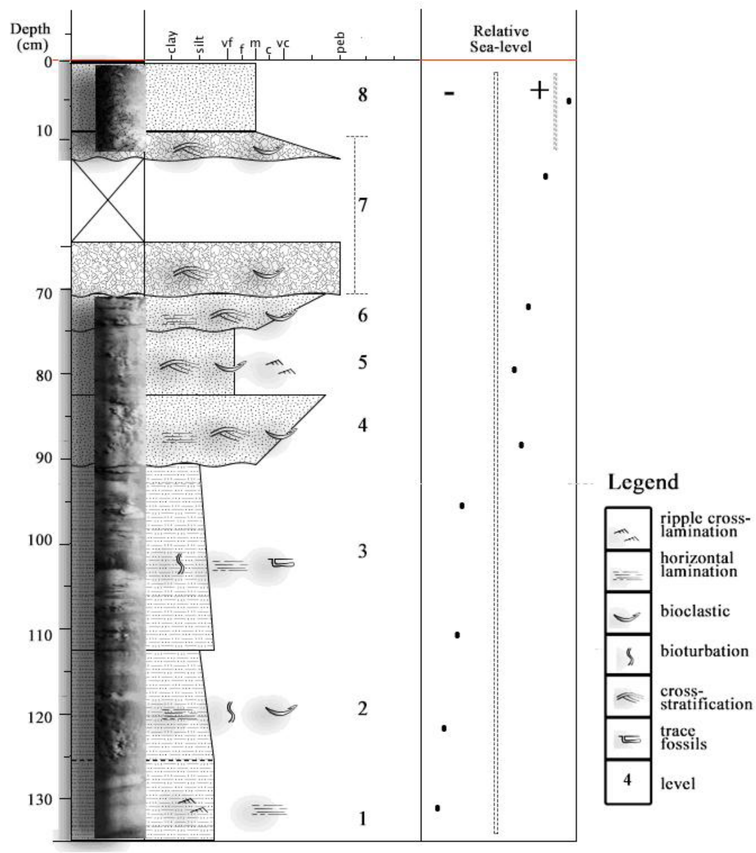

Figure 2. Log of lithology of T392

Results

The magnetic susceptibility oscillates between 12.6×10^{-5} and 98.3×10^{-5} SI. Values of F are below 2%, which indicate that super-paramagnetic grains do not control the assemblages of magnetic grains (Bartington Instruments Ltd., 1994).

Figure 2 shows the stepwise acquisition of isothermal remanence in fields up to 1.2 T for a group of pilot samples. All samples display similar results documenting that about 90% of the SIRM is obtained between 300 and 400 mT. Progressive removal of SIRM by back-field demagnetization indicates that B_{CR} varies between 82 and 97mT (Fig. 2). The S_{ratio} reflects the proportion of low-to-high coercivity minerals in a sample. Values close to 1 denote the dominance of low-coercivity minerals like (titano-) magnetite or greigite while higher values denote the presence of high-coercivity minerals (e.g. hematite, goethite). S_{ratio} is about 0.8 along the sequence which suggest that both low- (ferrimagnetic) and high-coercivity (antiferromagnetic) components are present and the ferrimagnetic component dominate the magnetic characteristics.

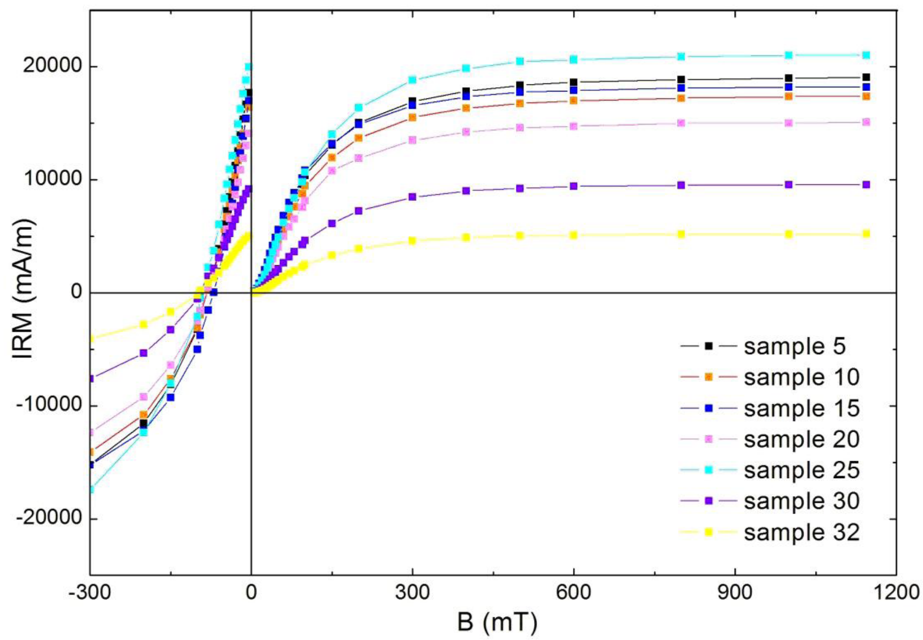

Figure 3. IRM acquisition curves of a group of pilot samples

Age control

Age control for the core sediments was determined by two ^{14}C ages previously obtained by Violante el al. (submitted). To create a sedimentation model, a linear function can be fitted to the data using the Origin 8 program, it was determined that the formula for the depth- age relationship would then read:

$$Age = 8136 + 50.8*depth$$

Consequently, sedimentation rate is about 20 cm/kyear.

Paleomagnetic studies

Representative examples of demagnetization plots are documented in Figure 3. Most of the samples show no systematic change in the direction of their remanent magnetization during AF demagnetization (sample 32). Only a few of them show a small viscous magnetization, which could easily be removed by AF demagnetization at 5 or 10mT (sample 5). Directions of the stable remanent magnetization were derived using principle component analysis (Kirschvink, 1980) with successive demagnetization steps. In order to exclude the viscous magnetization, demagnetization steps from 0 to 10 mT were not used for the vector analysis in those samples where viscous magnetization was evident. Since the cores were not drilled orientated relative to magnetic north, the D values for each core was centred on the average declination. The values of MDF_{NRM} obtained from all samples vary between 4 and 32 mT.

In order to create the curves of paleosecular variation, the inclination and declination records obtained from the investigated core were adjusted with regard to the transformation function depth-age presented and transformed into time series.

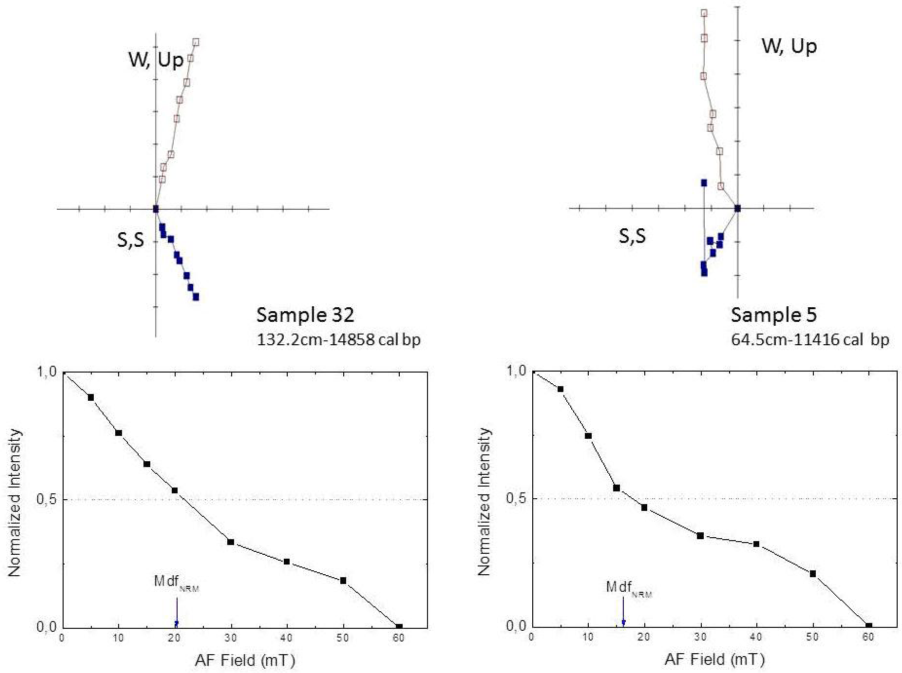

Figure 4. Typical AF demagnetization behaviour for samples 15 and 32. Zijderveld diagrams: open and closed symbols represent projections on the vertical and horizontal planes, respectively. Normalized intensity decay plots: numbers indicate the peak AF field.

Acknowledgments

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