Latinmag Letters, Volume 3, Special Issue (2013), PD01, 1-5. Proceedings Montevideo, Uruguay

# PRELIMINARY ROCK MAGNETIC AND BIOPROXIES RESULTS FROM A SHORT SEDIMENT CORE OF LAGUNA LA BARRANCOSA (BUENOS AIRES, ARGENTINA)

Romina Achaga[1*], Claudia S. Gogorza[2], Francisco Cianfagna[3], Fernanda Montes de Oca[3], Sofía Plastani[3], María J. Orgeira[4], Cecilia Laprida[3]

[1] Facultad de Ciencias Exactas, Universidad Nacional del Centro de la Provincia de Buenos Aires, Tandil, Argentina

[2] Centro de Investigaciones en Física e Ingeniería del Centro de la Provincia de Buenos Aires, (CIFICEN-CONICET), Tandil, Argentina

[3] Instituto de Estudios Andinos "Don Pablo Grober" (IDEAN-CONICET), Universidad de Buenos Aires, Buenos Aires, Argentina

[4] Instituto de Geociencias Básicas, Aplicadas y Ambientales de Bs. As (IGEBA-CONICET), Universidad de Buenos Aires, Buenos Aires, Argentina

## ABSTRACT

We present preliminary results of rock magnetic and paleomagnetic studies, and bioproxy analyses of short sediment cores collected from the bottom of Laguna La Barrancosa (36.95° S 56.85° W). Two short cores (TBBA1, 81 cm; TBBA2, 66 cm) were collected using a Livingstone piston corer during the 2012 southern summer. The cores show centimetre-scale lamination and frequent textural variations. 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, SIRM/ARM 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. Rock magnetic analysis suggests that the main carriers of magnetization seem to be ferrimagnetic minerals, predominantly pseudo single domain magnetite. Bioproxy analyses allow inferring that hydric balance has increased over the last 100 years, and especially since 1990 AD.

**Keywords**: rock magnetism, magnetite, hydric balance

## Lithology

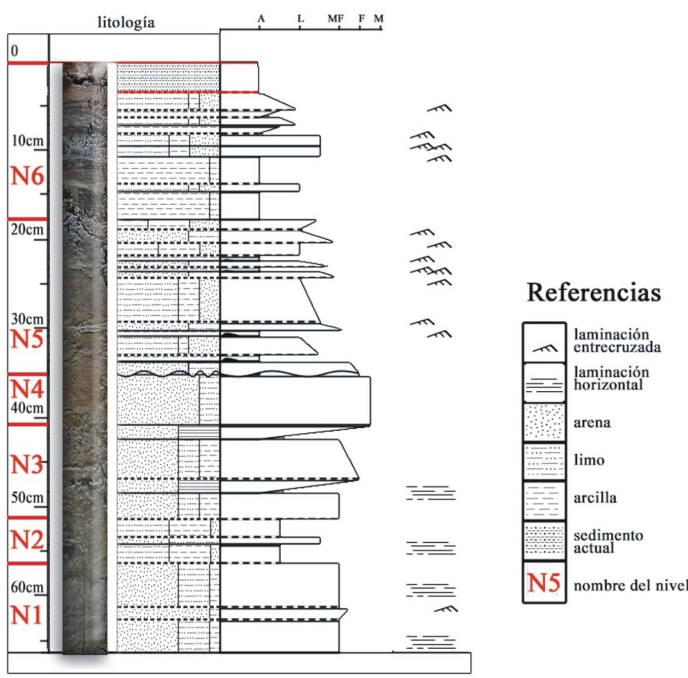



**Figure 1**. Log of lithology of TBBA2

**Dating**

The topmost 27 cm of core TBBA1 represents the last 110 years approximately ($^{210}Pb$ –based dating). A radiocarbon AMS dating performed at 76 cm indicates an age of ~ 650 AD for this level. The calculation of a model age integrating both ages was not possible due to the sedimentological hiatus observed at 30 cm. Further AMS dating will be performed in order to elucidate this question. Correlation between cores should be possible based on lithology, especially for the topmost 30 cm.

**Magnetic Parameters**

The TBBA2 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 25 samples were obtained. To procure a magnetic characterization of Escondido Lake sediments, a set of laboratory experiments were carried out on every sample of TBBA2.

The following measurements were carried out: intensity (NRM) and directions (D and I); magnetic susceptibility at low and high frequency (470 and 4700 Hz), anhysteretic remanent magnetization (ARM) was imparted with a peak alternating field, (AF) of 100 mT and a direct current (DC) biasing field of 0.05 mT, then demagnetized and measured in a minimum of 8 steps (0, 10, 20, 30, 40, 50, 60, 70 mT); isothermal remanent magnetization (IRM) in growing steps until 2T, reaching the saturation isothermal remanent magnetization (SIRM); back field, in growing steps until cancelling the magnetic remanence. The associated parameters were computed: F (relative variation of magnetic susceptibility with frequency), *S* ($IRM_{-300\ mT}$/SIRM), remanent coercive field ($B_{CR}$), SIRM/k (k is susceptibility at low frequency), ARM/k and ARM/SIRM. Alternating Field (AF) demagnetization and principal component analysis (Kirschvink, 1980) have been applied to determine the characteristic stable inclinations and declinations of the natural remanent magnetization (NRM). Stability of the magnetization was analyzed by alternating field (AF) demagnetization. Samples were demagnetized successively at peak fields of 5, 10, 15, 20, 25, 30, 35, 40, 50 and 60. The median destructive field of the natural remanent magnetization ($MDF_{NRM}$) was calculated in order to determine the required applied field to remove half of the initial remanence. It is a measure of the coercivity of the remanence carriers and hence depends on the magnetic mineralogy and grain size. When the magnetic mineralogy is uniform, the $MDF_{NRM}$ informs on the magnetic grain size of the magnetic recording assemblage.

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 demagnetizer 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.

**Results**

**Biological Proxies**

Three biological indicators were analyzed from core LBBA 1, chironomids, ostracods and fossil pigments for the topmost 30 cm. They allow inferring dry and saline conditions between 1900 and 1950, with allochthonous organic matter input. The second one, between 1950 and 1990, can be interpreted as a transitional phase with increased humidity and a moderately productive system. Within this period, the 1970's Climatic Transition can be recognized in the all the bioproxies analysed. The last period since 1990, biodiversity and productivity increased, indicating the establishment of a freshwater permanent pond and modern conditions.

## Magnetic Carriers Minerals

The NRM, specific susceptibility (k), SIRM and ARM logs show similar characteristics, with correspondence in peaks and troughs. Variations in the magnetic grain size can be typically monitored by analyzing ARM/SIRM and ARM/k records (Fig. 2). Both of them suggest the presence of coarse-grained magnetic particles and both they show a weak increasing trend from bottom to top. The differences between the records may be due to the presence in variable concentration along the sequence of paramagnetic minerals. These results suggest that the behavior of these parameters is determined mainly by the concentration of the magnetic minerals.

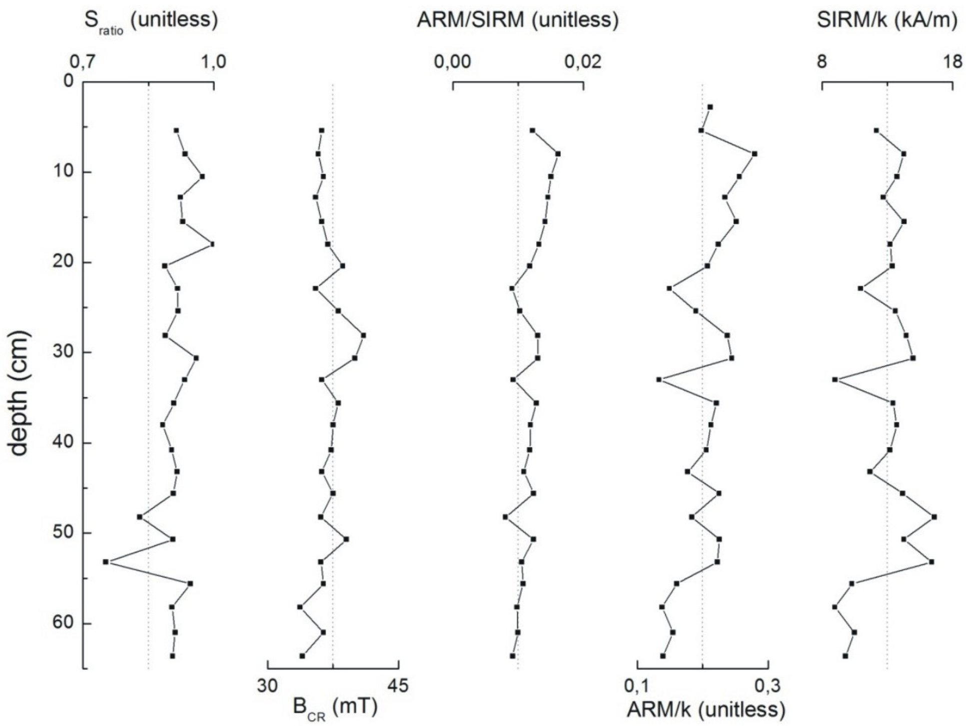
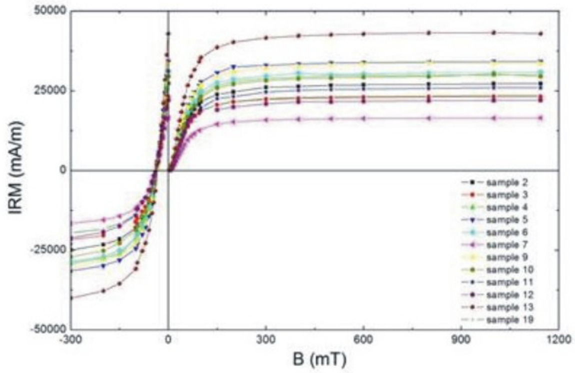


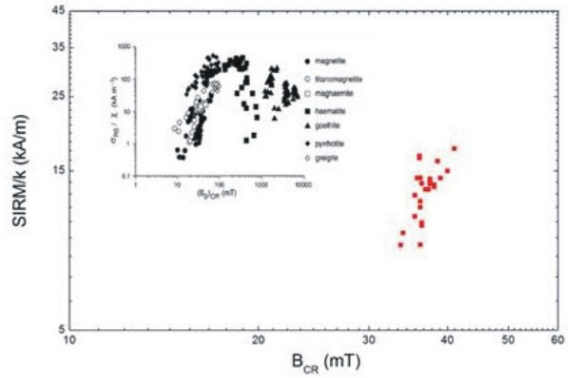

**Figure 2**. Down-core variation of selected rock magnetic properties from core TBBA2. Logs of $S_{ratio}$ (unitless), $B_{CR}$ (mT), ARM/SIRM (unitless), ARM/k ($10^2$ A/m) and SIRM/k (kA/m) vs. depth.

Magnetic susceptibility oscillates between $120\times10{-5}$ and $480 \times 10{-5}$ SI, values corresponding to ferromagnetic materials "sensu latu". Values of F are below 5%, so super-paramagnetic grains do not control the assemblages of magnetic grains (Bartington Instruments Ltd., 1994). The higher values of low frequency susceptibility ($270\times10^{-5} \sim 480\times10^{-5}$ SI) correspond to coarser grains (lower values of ARM/SIRM), on the other hand, lower values of low frequency susceptibility ($120\times10^{-5} \sim 200\times10^{-5}$ SI) correspond to material with high proportion of organic matter and fine grain size (higher values of ARM/SIRM) (Fig. 2).

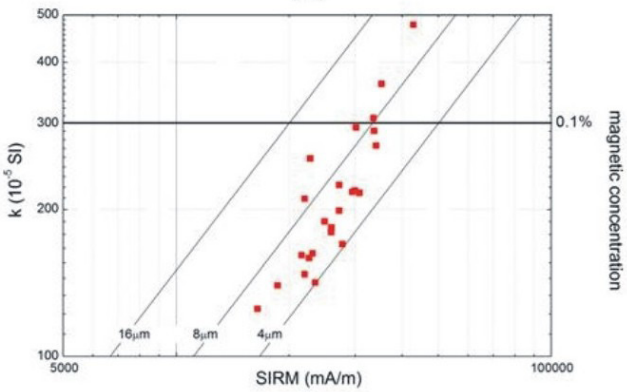
Stepwise acquisition of isothermal remanent magnetization (IRM) in fields of up to 1.2 T documents that 90% of SIRM were acquired in fields of 150-200 mT (Fig. 3.a) for most samples. Progressive removal of SIRM by stepwise increasing applying reversed fields indicates that the remanent coercive field of the SIRM ($B_{CR}$) varies approximately between 33 and 41 mT, suggesting that a low coercive magnetic mineral, such as magnetite might be predominant within the sediments (Fig. 2). The $S_{ratio}$ ($IRM_{-300mT}$/SIRM) varies between 0.88 and 1 (except two samples whose $S_{ratio}$ values are 0.83 and 0.75, respectively), with a mean value of 0.91± 0.05, indicating the predominance of low-coercivity minerals like magnetite, (titano-) magnetite (Fig. 2). SIRM/k vs. $B_{CR}$ (Petters and Dekkers, 2003) agrees with these results (Fig. 3.b). The SIRM vs. k plot (Fig. 3.c) implies that the magnetic concentration ranges from 0.08% to 0.11% magnetite by volume and the SIRM/k ratio is consistent with a magnetic grain size of 4 to 10 μm. The linearity of the SIRM vs. k ($R^2$=0.78) implies that the grain size does not change much within the sediments.




(a)




(b)




(c)

**Figure 3.a**. IRM acquisition curves of samples from core TBBA2; **3.b.** k *vs.* SIRM for all samples in order to estimate concentration and grain size according to Thompson and Oldfield (1986); **3.c.** SIRM/k vs. $B_{CR}$ for all samples in order to estimate magnetic mineralogy according to Petters and Dekkers (2003)

### Direction, Intensity and Stability of NRM

The AF demagnetization results of representative sample are illustrated in Figure 4. As a first estimation for grain size variations the median destructive field ($MDF_{NRM}$) was calculated. $MDF_{NRM}$ ranges from 4 to 15.3 mT (11.8±1.7 mT) and NRM intensities are almost completely demagnetized in fields of 50 mT. These results indicate that the magnetic signal is carried by coarse-grained magnetite or (titano) magnetita. The orthogonal demagnetization diagrams show that a viscous remanent magnetization is removed with a field of 5 mT. The characteristic remanent magnetization (ChRM) has been derived from principle component analysis (Kirschvink, 1980) of mostly four demagnetization steps. Since the core was not orientated relative to magnetic north, the declination values for each core are centered about average declination. NRM values range from 11.5 to 41.3 mA/m and inclination vary -34°±3°. These records represent the preliminary results of variation of declination and inclinations vs. depth, registered in sediments of Laguna La Barrancosa and further radiocarbon data will allow us to perform the depth-age model to obtain paleosecular variations.

### Acknowledgements

Laboratory tasks were supported by the Comisión Nacional de Investigaciones Científicas y Técnicas de la República Argentina (CONICET), Agencia Nacional de Promoción Científica y Tecnológica (ANPCyT), UBA and UNCPBA. We are much indebted to Pablo Zubeldía for assistance with measurements.

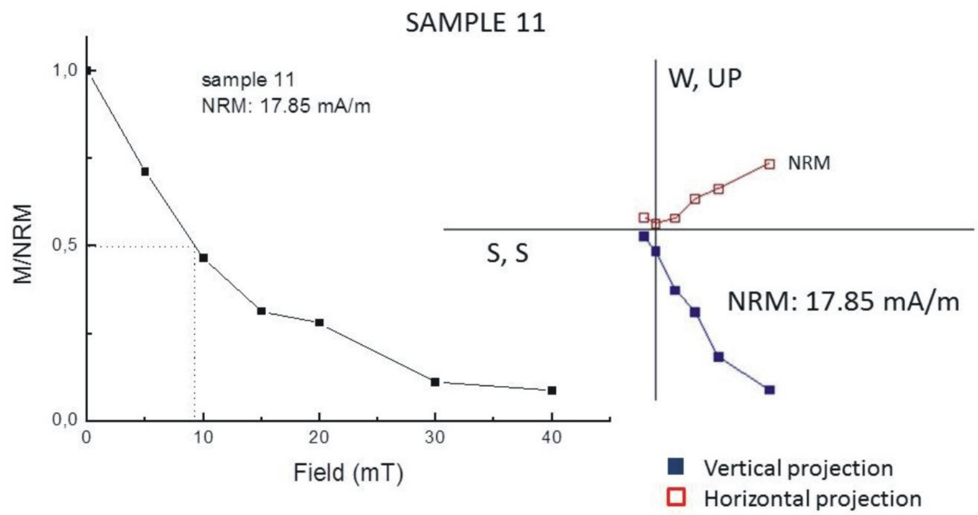



**Figure 4**. Typical AF demagnetization behavior for sample 11. Zijderveld diagram: closed and open symbols represent projections on the vertical and horizontal planes, respectively. Normalized intensity decay plot.

## References


Bartington Instruments Ltd., 1994, Environmental magnetic susceptibility-Using the Bartington MS2 system, operation manual, 54 p., Witney, U. K.

King, J. W., Banerjee, S. K., Marvin, J., 1983, A new rock magnetic approach to selecting sediments for geomagnetic paleointensity studies: Application to paleointensity for the last 4000 years, *J. Geophys. Res*., 88, 5911-5921

Kirschvink, J. L., 1980, The least squares line and plane and the analysis of paleomagnetic data, *Geophys. J. R. Astron. Soc*., 62, 699-718

Peters C. and Dekkers M.J., 2003, Selected room temperature magnetic parameters as a function of mineralogy, concentration and grain size, *Phys. Chem. Earth*, *28,* 659-667.

Thompson, R. and F. Oldfield, 1986, *Environmental Magnetism*, 225 p., Allen & Unwin Ltd.