MAGNETIC CHARACTERIZATION OF SEDIMENTS FROM LAKE FONCK CHICO, ARGENTINA

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ABSTRACT

In this work, we present the results of magnetic mineralogy, concentration and grain size in a sedimentary core collected from Lake Fonck Chico (41°18′36″ S 71°47′13″ W). Cyclic variations of magnetic mineralogy, as well as, in the amount of iron oxides are observed. Magnetic grain size also shows a cyclic behaviour and a decreasing grain size trend for the first 50 cm. Low S ratio values indicates the presence of high coercivity minerals that suggests the contribution of iron sulphurs and/or antiferromagnetic minerals in some periods. Magnetic susceptibility shows sectors with very low values indicating less clastic material and according to the lithology, higher percentage of organic matter. Changes in the remanence ratio suggest hydrologic variations, particularly, in four sectors, which would indicate a fall in the lake level. Frequency factor F suggests the presence of superparamagnetic grains, in general, associated to *in situ* processes.

Keywords: rock magnetism, Patagonia

RESUMEN

En este trabajo se muestran los resultados de mineralogía, concentración y tamaño de grano magnético en un testigo sedimentario del Lake Fonck Chico (41°18′36″ S, 71°47′13″ O). Se observan variaciones cíclicas tanto de la mineralogía magnética como de la cantidad de óxidos de hierro presentes. El tamaño de grano también presenta un comportamiento cíclico y una tendencia grano decreciente para los primeros 50 cm. La presencia de minerales con altas coercitividades sugiere la presencia de sulfuros de hierro y/o minerales antiferromagnéticos en algunos períodos se observada a través de bajos valores de S ratio. La susceptibilidad magnética muestra sectores con valores muy bajos respecto del resto lo que indicaría menor presencia de material clástico y de acuerdo a lo observado durante el muestreo, mayor porcentaje de materia orgánica. Los cambios en el cociente de remanencias sugieren variaciones hidrológicas, en particular hay cuatro sectores que indicarían un descenso del nivel del lago. El factor de frecuencia F sugiere la posible presencia de de granos superparamagnéticos, en general, asociados a procesos *in situ*.

Palabras Clave: magnetismo de rocas, Patagonia

1. Introduction

Lake sediments are excellent sources to obtain climatic and environmental variations information because they provide a continuous and high-resolution record during the deposition and consolidation time of the sediments. Particularly, different magnetic measurements and parameters are widely used as an approach to infer paleoenvironmental changes (Thompson and Oldfield, 1986; Ortega Guerrero *et al*., 2000; Vázquez Castro, 2012). The magnetic data and interparametric ratios could reflect changes in original source of the material, in the composition of the detrital mineral, in the balance of alloctonous / autochthonous component, in the hydrology of the lake, etc. The objective of this work is to determine the magnetic mineralogy,

magnetic grain size and concentration of magnetic minerals to infer the environmental conditions in which they were formed and transported until reach the lake.

2. Site description

In the southern area of the Nahuel Huapi National Park, there are the Fonck, Fonck Chico, Hess and Moscos Lakes along the course of the Rio Manso (Rogora *et al*., 2008). Fonck Chico Lake (41°18′36″ S, 71°47′13″ W) is an almost square lake of around 800 m side at 770 m a.s.l. (Figure 1). The lake is directly fed by the Tronador mountain ice cap and a subantarctic forest surrounds it. It is a lake with low strain anthropic influence (Libkind *et al*., 2003) and their waters show a low solute content (Rogora *et al*., 2008).

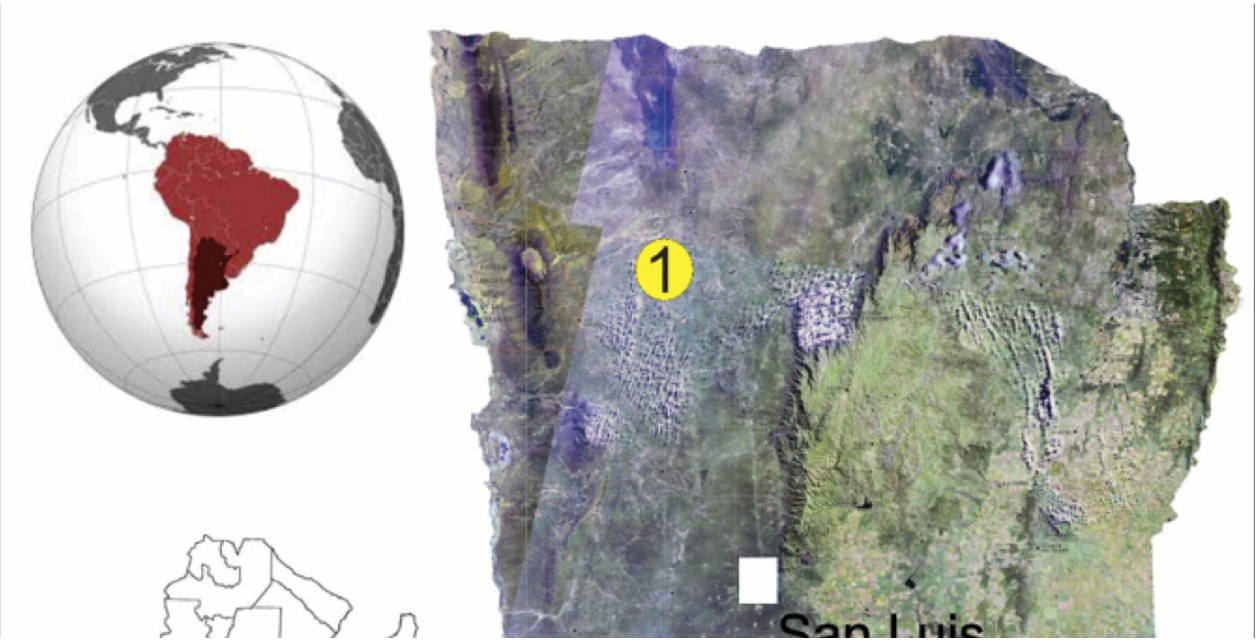

Figure 1. Location of Lake Fonck, Lake Fonck Chico and coring site.

3. Methodology

The composite profile was constructed by correlating the lithology of four cores collected from the same hole from Fonck Chico Lake (Figure 1). A total of 66 samples were recovered continuously in cubic plastic boxes (8cc). The followed measurements were made in all samples:

- Magnetic susceptibility in low (k_{lf} 470 Hz) and high (k_{hf} 4700 Hz) frequency with a magnetic susceptibilimeter Bartington MS2B. The frequency factor (F factor) was calculated as (k_{lf}-k_{hf}/k_{lf}) * 100
- Anhysteretic remanent magnetization (ARM) was applied with a continuous field of 90 μT and an alternating field (AF) with a maximum peak of 100 mT with an AF demagnetizer Molspin and measured with an Agico JR6.
- Isothermal remanent magnetization (IRM) was applied with a pulse magnetizer IM 10-30 ASC Scientific at room temperature in increasing steps until 1.2 T, reaching saturation (SIRM). Then a reverse field until 300 mT was applied. The coercivity (B_{CR}, the reverse field were the SIRM is cancelled) and the Sratio (IRM-300mT/SIRM) were calculated.
- The interparametric ratio ARM/SIRM was calculated.

4. Results

B_{CR} shows an almost cyclic behaviour with a variable period between 23 and 34 cm (Figure 2). The amplitude of the signal seems to decrease to the top. According to Peters and Dekkers (2003), this magnetic results could be attributed to at least four different minerals; magnetite, Ti-magnetite, greigite and/or hematite. Only two samples at 27 and 20 cm show very low S ratio values, indicating the presence of high coercivity minerals like hematite, although in low concentration. The rest of the core shows values of S ratio around 0.9, suggesting lower coercivity minerals.

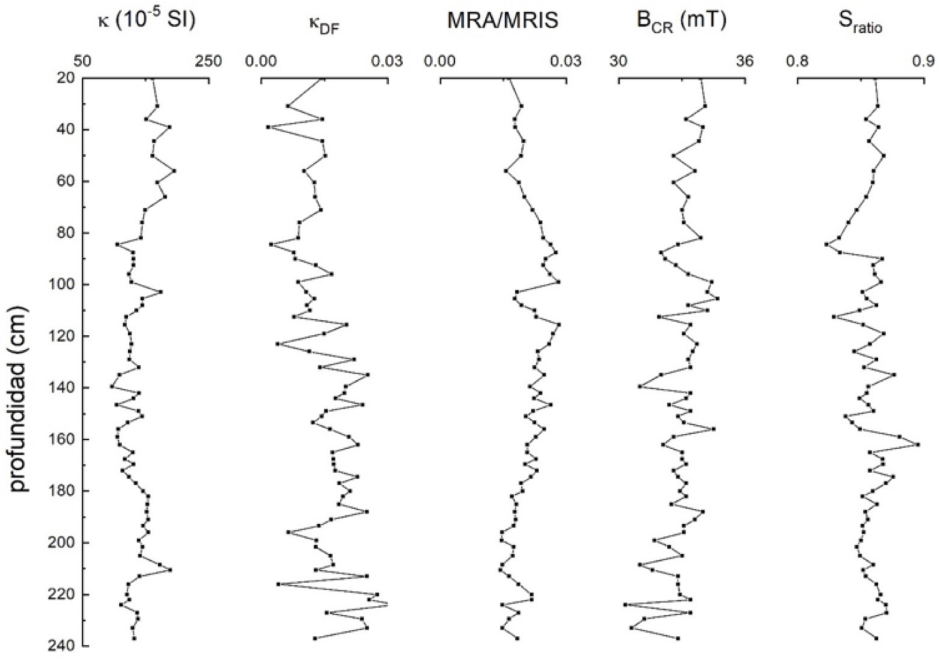

Figura 2. Remanence coercivity and Sratio as mineralogy indicators. The colored rectangles indicate the regions associated with the magnetic mineralogy suggested.

k_{lf} measures the magnetic minerals present in a sample, in a wide range of magnetic grain sizes. ARM responds to single domain (SD) ferromagnetic minerals. The concentration of magnetic minerals inferred from k_{lf} indicates three sectors with high values, between 76-81 cm and 41-46 cm and at 15 cm (Figure 3). Like B_{CR}, it seems to present a cyclic behavior with a period of 43 cm at the beginning of the record, followed by two consecutive periods of 33 cm. ARM shows a roughly similar trend than k_{lf} for almost all the core, suggesting the samples are mainly constituted by ferromagnetic minerals in the SD range. Between 10 and 17 cm ARM has low values compared to klf, which could be due to the presence of pseudo-single (PSD) or multi domain (MD) grains.

To infer magnetic grain size, two interparametric ratios were calculated, F factor and ARM/SIRM. The F factor shows values higher than 4% (Figure 4), suggesting a possible presence of superparamagnetic grains (SP) in several parts of the core, in around 50% of the samples. Most of the record has high values of ARM/SIRM suggesting a dominant smaller grain size, and according to the ARM and k_{lf} observations, probably in the SD range. Four sectors show general coarser grain size; 107-122 cm, 76-88 cm, 41-53 cm and 15-22 cm. The last sector also has high k_{lf} and ARM values. Additionally, ARM/SIRM also presents a cyclic trend with periods of 28 to 38 cm.

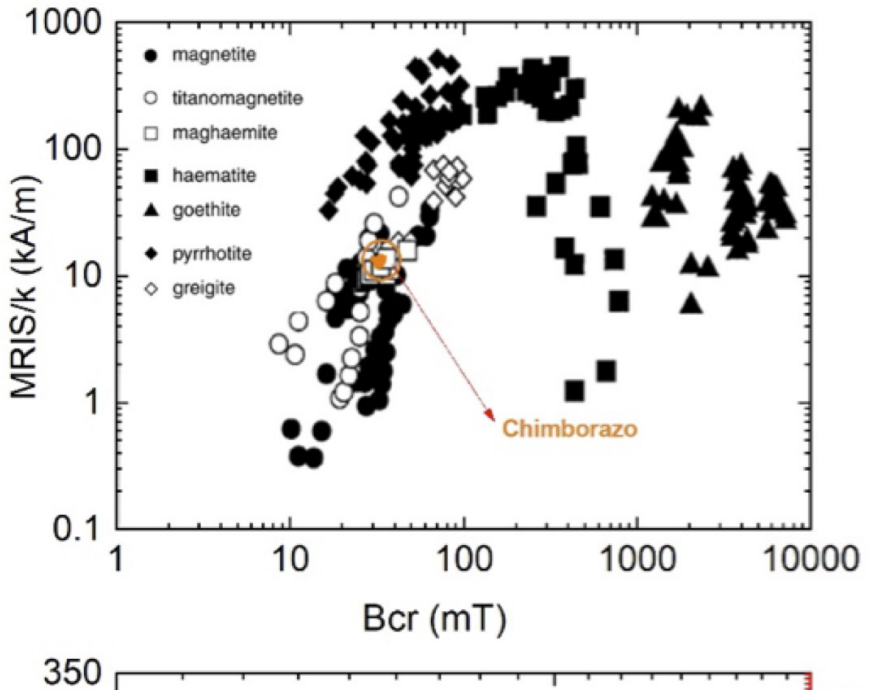

Figura 3. Magnetic susceptibility and anhisteretic remanence magnetization as concentration of magnetic minerals indicators.

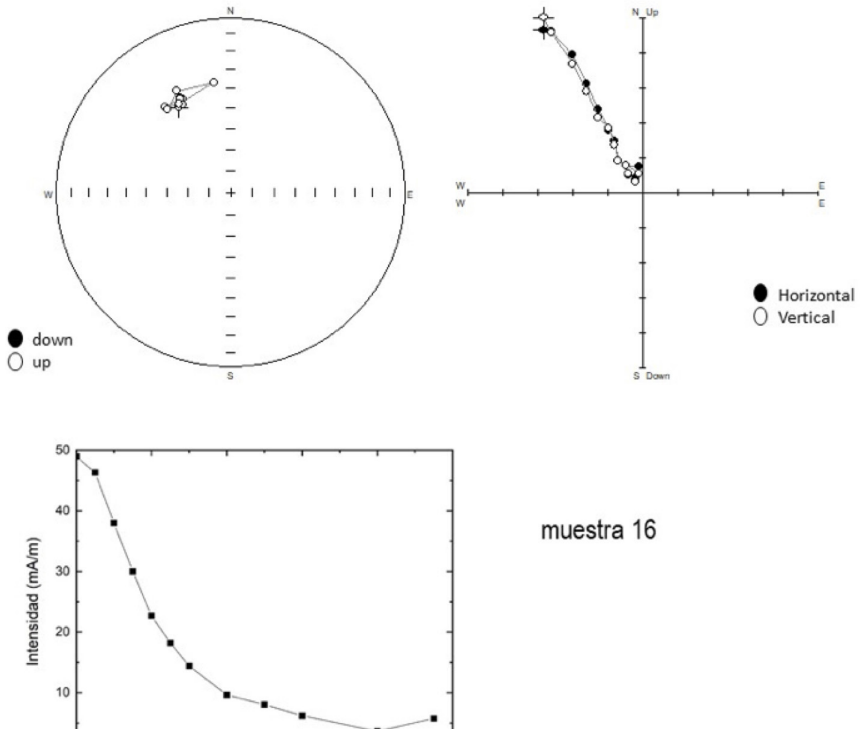

Figura 4. Frecuency factor and remanences ratio as magnetic grain size indicators.

5. Discussion and conclusions

Characteristic cyclic variations in magnetic mineralogy and in the amount of iron oxides/sulphurs are observed. Magnetic grain size also shows a cyclic behaviour but superimposed in an increasing grain size trend from 160 to 80 cm. In the first 50 cm, a notorious decreasing grain size is observed. A low S ratio value indicates the presence of high coercivity minerals that suggests the presence of iron sulphurs and/or antiferromagnetic minerals in some periods. At around 50, 80 and 120 cm, the highs in B_{CR} agree with lows in magnetic susceptibility. It would indicate less clastic material and according to the lithology, more percentage of organic matter. As consequence, the presence of greigite is expected assuming a possible eutrophication of the lake. At 20 and 27 cm, the situation is similar but S ratio suggests high amount of high coercivity minerals like hematite, but more studies are needed to identify the magnetic mineralogy more accurately. Changes in the remanence ratio suggest hydrologic variations. In particular, four sectors with low ARM/SIRM would suggest a fall in the lake level (Irurzun *et al*., 2014). F factor suggests the presence of SP grains, in general associated to eolian process, indicating periods of high wind influence or could be associated with *in situ* processes. Considering that Tronador glacier drains into the lake, the cyclic fluctuations observed in all parameters can be associated with glacier fluctuations, but more studies are needed to elucidate this assumption.

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