# A RECONNAISSANCE STUDY OF CENTRAL CORES FROM LAGUNA MELINCUÉ (PAMPEAN PLAINS, ARGENTINA)

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## ABSTRACT

We present the first magnetic, lithological and dating results on three center sites from Laguna Melincué to contribute to identifying paleoclimatic proxies and present preliminary paleomagnetic results for the site. Laguna Melincué has been previously studied from different approaches, mainly to understand hydrological and climatic variations, but more multidisciplinary studies are needed to understand its complex hydrological situation. From every site three cores were extracted and the longest one was selected to make $^{210}$Pb measurements. On the three cores, measurements of magnetic susceptibility and lithology description were made. The susceptibility logs indicate that in the sediments were recorded the variations of magnetic minerals concentration during the same period and a correlation between the dated core and the others could be done. The lithology description indicates granulometric variations that fluctuate between fine sands and clayed slit sectors. The presence of layers with high organic matter content was also identified. Variations in $^{210}$Pb were studied to date the sediments. This method provides very good dating results for the last century. In this case the first 36 cm recorded changes during the last 116 ± 4 years. It is interesting the study of this period since it makes possible a high resolution environmental analysis that possibly leads to some conclusion about the relationship between floods and agricultural exploitation in the area. Therefore, a comparison with a shore core previously studied is restricted to the period 1900–2016 AD.

**Keywords**: Lake sediments, magnetic susceptibility, lithology, $^{210}$Pb dating

## RESUMEN

Se presentan los primeros resultados magnéticos, litológicos y dataciones de tres sitios de muestreo del centro de la Laguna Melincué para contribuir en la identificación de los proxies paleoclimáticos y presentar resultados paleomagnéticos preliminares en la zona. La laguna Melincue ha sido previamente estudiada desde diferentes enfoques, principalmente para entender las variaciones hidrológicas y climáticas del lugar, pero son necesarios más estudios multidiciplinarios para entender su compleja situación hidrológica. De cada uno de estos sitos se extrajeron tres testigos sedimentarios y el de mayor longitud fue seleccionado para realizar mediciones de $^{210}$Pb. En los tres testigos (núcleos) se realizaron mediciones de susceptibilidad magnética y descripción litológica. Las curvas de susceptibilidad sugieren que en los sedimentos se registraron variaciones de concentración de minerales magnéticos durante el mismo período de tiempo y fue posible realizar una correlación entre el testigo datado y los demás. La descripción litológica macroscópica

muestra variaciones granulométricas que fluctúan entre arenas finas a sectores limo arcilloso. También se identificaron horizontes con alto contenido de materia orgánica. Las mediciones de $^{210}$Pb se utilizaron para datar los sedimentos. Este método provee muy buenas dataciones para el último siglo. En este caso se obtuvo una edad de 116 ± 4 años para los primeros 36 cm del testigo. Por lo tanto, solo se pudo realizar una comparación por susceptibilidad magnética con un testigo de costa estudiado previamente para el período 1900–2016 AD.

**Palabras clave**: Sedimentos lacustres, susceptibilidad magnética, litología, dataciones $^{210}$Pb.

## 1. Introduction and studied site description

Lake sediments are good sources of paleomagnetic and paleoclimatic variations because they provide a continuous record. The reason is that every change in the catchment area (rainfall and drought periods, temperature changes, difference of sedimentation rates, etc.), as well as, changes in the Earth magnetic field is reflected in the variations of directional and non-directional magnetic parameters. Particularly, magnetic susceptibility is the first magnetic measurement performed because it is fast and provides information about magnetic minerals concentrations and magnetic grain size. Moreover, it is a good litoestratigraphic correlation parameter between cores from the same lake. The main objective is to present the first magnetic, lithological and dating results obtained from the sediments cores selected

Laguna Melincué (33°41'27.8'' S, 61°31'36.5'' O) is a lake located in Santa Fe Province, Pampean Plains, Argentina. The actual catchment area is around 678 km$^2$. The basin is placed in a tectonically sunken block. The lake has a closed basin without important tributaries or effluents of permanent flow, and eliminated by evaporation. The mean annual precipitation is about 970 mm with the highest precipitation during austral autumn. The mean temperatures vary annually between 9.5°C and 24°C in winter and summer, respectively (Pasotti *et al.*, 1984).

## 2. Methodology

Nine 6-cm diameter cylindrical cores were collected from Laguna Melincué at a depth of approximately 4 m below the water level in October 2016 (Fig. 1) from three separate sites. From every site the longest core

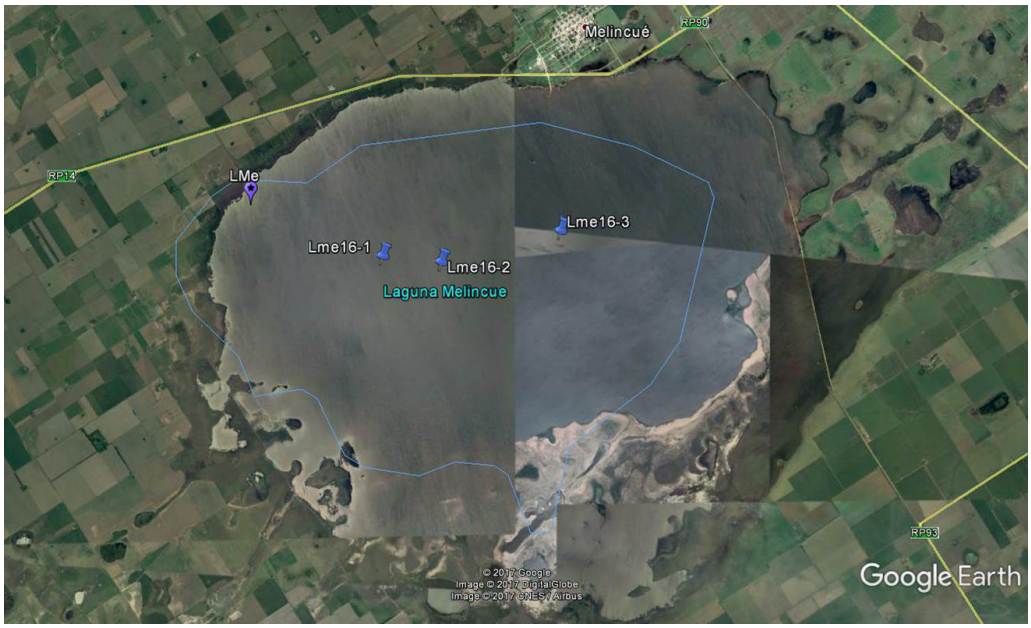


**Figure 1.** Aerial photo of Laguna Melincué (Google Earth), it shows the location of the coring sites used in this work (central cores) and a previously studied site (shore core).

was selected for this study. The selected cores are Lme16-1-3 from site 1, Lme16-2-1from site 2 and Lme16-3-2 from site 3. These cores were split into halves for lithological description and magnetic susceptibility (k) measurements (Fig. 2). After that, the cores were stored in a cool room at 4° C for future analysis. Lithology was described by visual changes in structure and color and k values were taken every 0.5cm with a Bartington MS2F, and every 1 and 2 cm with a Bartington MS2C to identify general details and general trends respectively. Core Lme16-2-1 (length 57.5 cm) was selected for $^{210}$Pb measurements in the Instituto de Ciencias del Mar y Limnología, México. Then the ages were transfer to the other cores by correlation using k logs (Fig. 3). k was also compared with the cores from Achaga *et al.* (2017) (Fig. 4) to verified the chronology obtained

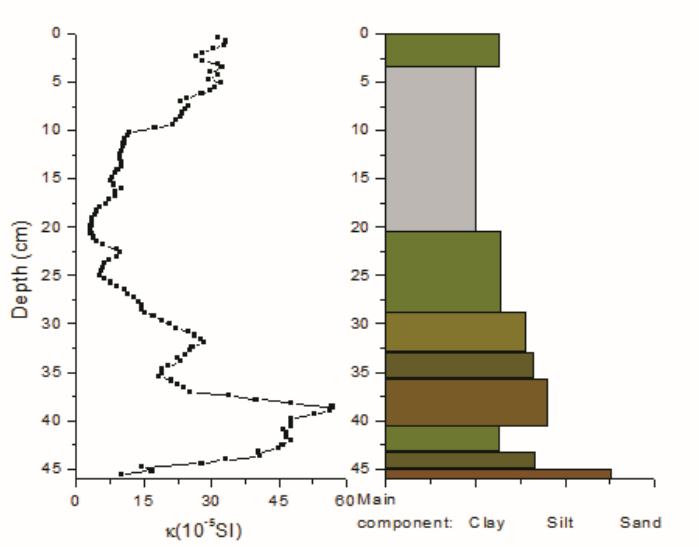


**Figure 2.** Magnetic susceptibility and lithological description of core Lme16-3-2.

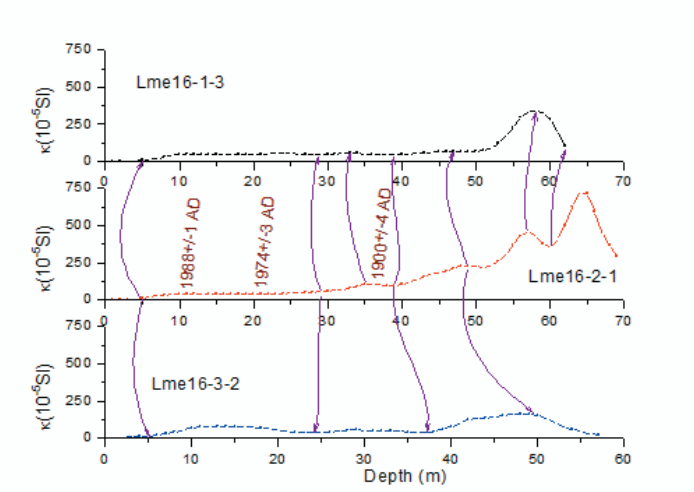


**Figure 3.** Correlation tie lines between the three sites: Lme16-1, Lme16-2, and Lme16-3. Three $^{210}$Pb dates are included.

## 3. Results

The Figure 2 shows the lithological description of core Lme16-3-2 along with downcore variations of k measured every 0.5 cm. Coarse grains are observed at the bottom of the record were some grains of sand are observed. From 45 to 43 cm and from 35.5 to 33 cm silty clay was found. From 43 to 40.5 cm, 29 to 20.5 cm and 3.5 to 0 cm clay with fine silt was observed. From 40.5 to 35.5, clayey silt was found. Clay was observed in the sector between 20.5–3.5 cm. Magnetic susceptibility varies from 10 x $10^{-5}$ to 160 x $10^{-5}$ SI and it seems to follow the changes in lithology. Lower values are present in sectors with small grain size

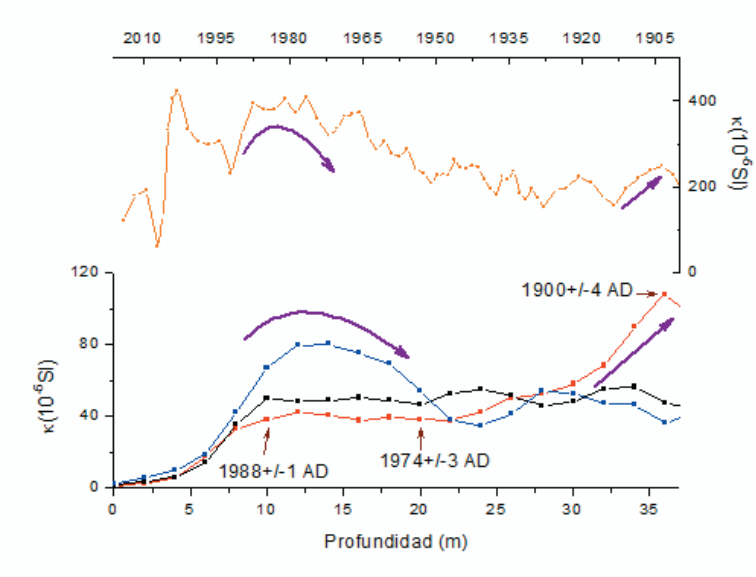


**Figure 4.** Comparison of the cores from this study and the core from Achaga *et al.* (2017). Lme16-1-3: black curve; Lme16-2-1: red curve; Lme16-3-2: blue curve.

sediments or between 44.5 and 46 cm where sand grains appear. High values are observed from 37.5 to 44 cm where higher content of silt was found.

Figure 3 shows the correlations tie lines between cores. Lme16-2-1 is the longest core and consequently record more changes in k. Lme16-3-2 core is the longest and only some general trends can be correlate. Lme16-1-3 has an intermediate length so it was possible to fine the first notorious maximum at 58 cm besides the same general trends. On core Lme16-2-1 some ages from $^{210}$Pb dating are shown. At 10.5 cm an age 1988 +/-1 AD was found, so a mean sedimentation rate of 3.7mm/yr is suggested. At 20.5 cm an age 1974+/-3 AD and a mean sedimentation rate of 4.8mm/yr was found. The oldest date, 1900+/-4 AD, was found at 36.5 cm suggesting a sedimentation rate of around 3.1mm/yr. The changes in the sedimentation rate can be due to different agricultural land uses and/or to climate changes (Irurzun *et al.*, 2014a).

In previous studies, a core from the shore was analyzed by Achaga *et al.* (2017). Because of the difference in the location of the cores, only some characteristics can be detected. Figure 4 shows a comparison restricted to the dated sediments. From 1900 to 1915 AD a linear trend is observed in both records. The main notorious behaviour was found between 1974 and 1988 AD where both records show the same rise and fall. In general, shore cores have large magnetic grain size than central cores (Irurzun *et al.*, 2014b). The k values depend on concentration of magnetic minerals and magnetic grain size (Turner, 1997) so the differences observed in Figure 4 from 1920 to 1970 can be attributed to one of those properties or both.

## 4. Conclusion

The studied cores show a similar behavior allowing a correlation between them. The magnetic susceptibility seems to follow the lithological changes suggesting the variations observed could be due to changes in grain size and/or changes in mineralogy. Three age derived from $^{210}$Pb dating indicate the first 36,5 cm recorded the fluctuations in the catchment area for the last 116 years. The sedimentation rate is not constant. Therefore, more rock magnetic and geochemical studies are needed to elucidate the main cause of these changes.

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