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ENVIRONMENTAL MAGNETISM OF A HOLOCENE EOLIAN SEDIMENTS AND PALEOSOLS SEQUENCE IN TIERRA DEL FUEGO (ARGENTINA)

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Abstract

This contribution includes preliminary environmental magnetism results of 80 samples collected along an eolian sedimentary sequence with 8 paleosols interbedded. According to the ^{14}C data the studied record represents the Holocene.

These results include vibrating sample magnetometer (VSM) measurements at room temperature, magnetic susceptibility at two frequency, and some measurements of susceptibility at high and low temperatures in selected samples.

The results discussed here, together with those of other climatic proxies, will define the climate variability occured in the southern extremity of the Americas. Based on our study we hope to contribute to the knowledge of the southern hemispheric atmospheric circulation variability along the recent geological times.

Resumen

Esta contribución incluye los resultados preliminares del estudio de magnetismo ambiental de 80 niveles muestreados en una secuencia de sedimentos eólicos limosos con 8 paleosuelos intercalados. De acuerdo a las dataciones ^{14}C disponibles la secuencia estudiada contiene registro geológico de todo el Holoceno.

Los resultados obtenidos incluyen parámetros magnéticos obtenidos en magnetómetro vibrante (VSM) a temperatura ambiente, susceptibilidad magnética a dos frecuencias, algunas determinaciones de coercitividad de la remanencia por campos inversos, y mediciones de susceptibilidad a altas y bajas temperaturas en especímenes seleccionados.

Los resultados aquí discutidos, sumados a los de otros proxies climáticos, definirán la variabilidad climática a estas latitudes de América durantre el lapso estudiado. Basados sobre estos estudios esperamos aportar al conocimiento del patrón de circulación atmosférica para el Holoceno.

Introduction

The studied sequence is located in the northern region of Isla de Tierra del Fuego, Argentina (53^0 42'48 .6"S, 68^0 18 '20.3"W, altitude of 71 m asl; Fig 1).

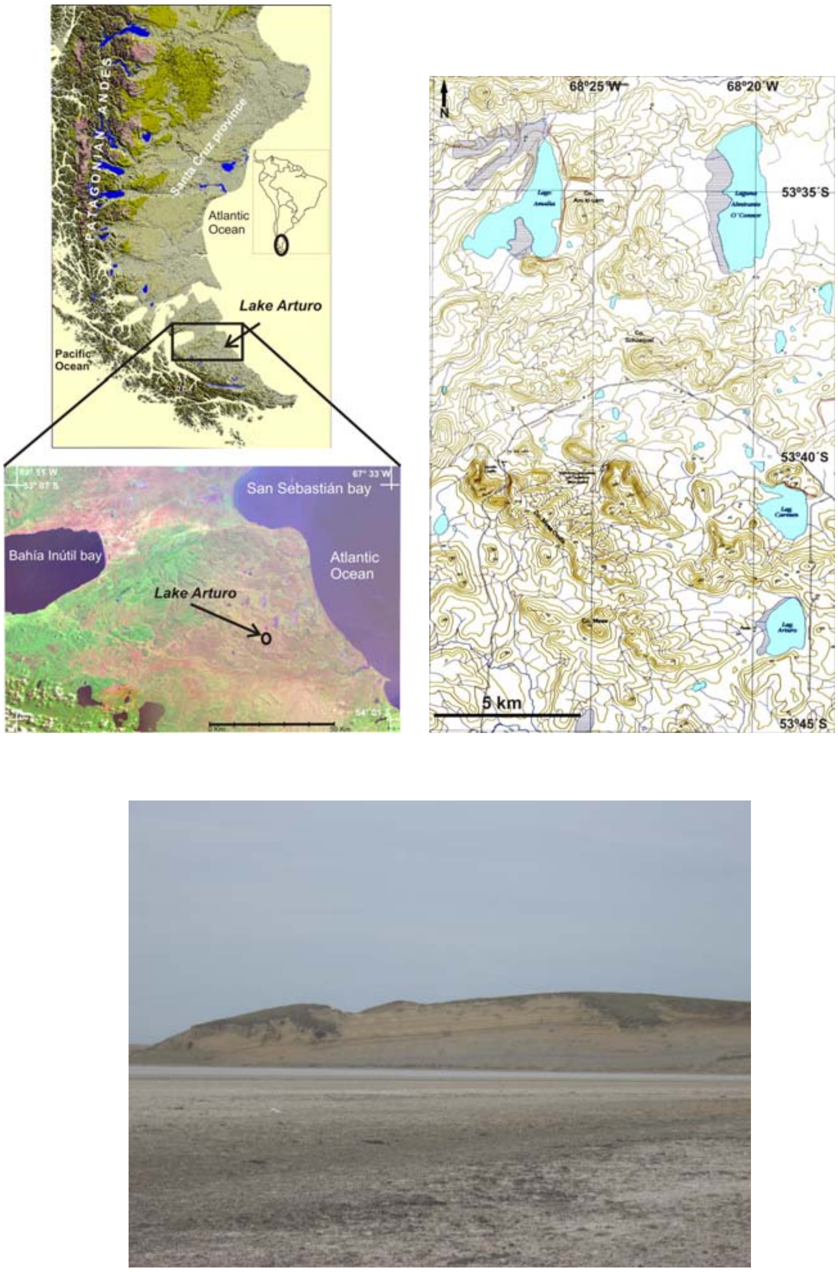

Figure 1. Location site, topograhy and panoramic view of the studied area.

It comprises a succession of 20 m of eolian silty-fine sand-clay sediments with 8 paleosols layers interbedded (Fig 2). Radiometric data indicate that the eolian deposition and the edaphic processes started during the Early-middle Holocene (botton ^{14}C data 9941 ybp) and it was continous up to late Holocene (top ^{14}C data 434 ybp) (Coronato et al, 2010)

The mean annual rainfall in the area is 383 mm and the mean annual temperature of 5.2^0 C. The sequence is located in a large area of low pressure under the effect of both the westerlies and the Polar Front. Wind frequency is daily, with and average rate of 25 km/h but frequent periods of higher speeds. The influence of Antarctic air produces short periods of colder and drier climate.

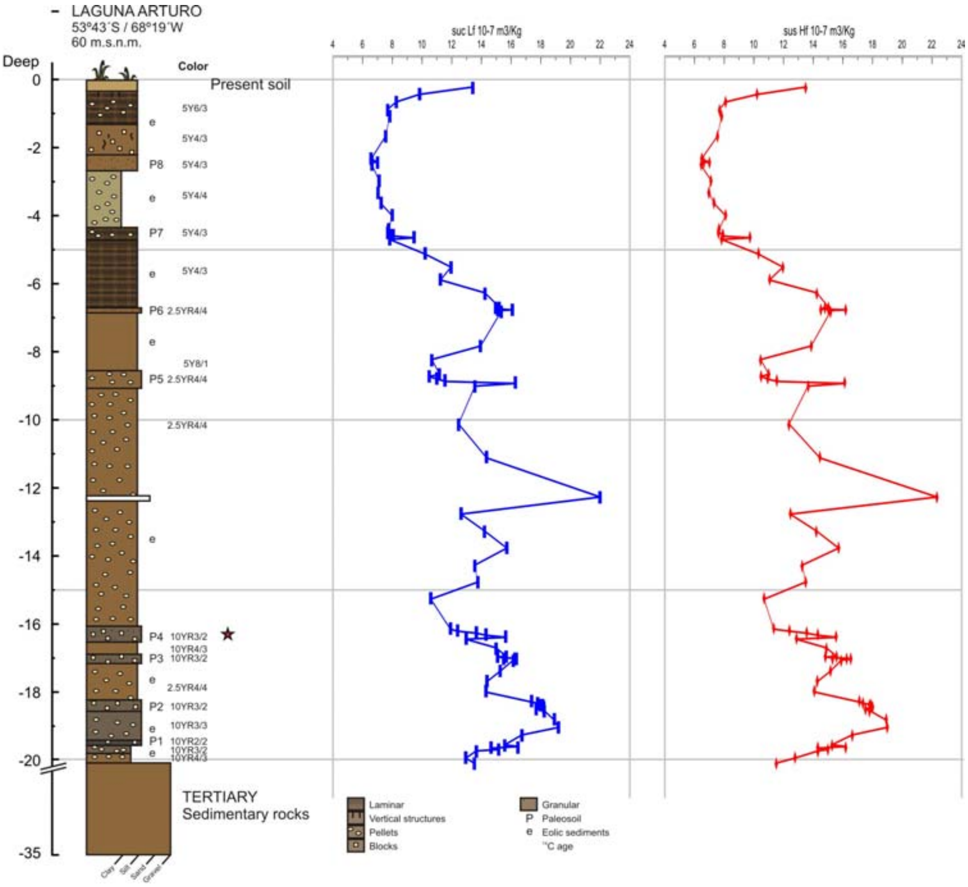

Fig 2. Stratigraphic profile . Magnetic susceptibility at two frequencies.

This contribution includes preliminary environmental magnetism results of 80 samples collected along an eolian sedimentary and paleosols interbedded. The aim of the study is to determine, on the basis of changes in magnetic mineralogy, the climate changes during the deposition and pedogenesis, taking into account the hypothesis proposed by Orgeira et al (2011a). These results will be also contrast in future contribution with the hypothesis presented by Boyle et al (2010).

Metodology

These results include VSM (Molspin) measurements at room temperature, suceptibility at 470 and 4700 Hz using a Bartington MS2, and some measurements of susceptibility at high and low temperatures (Agico Kappa bridge) in selected samples.

Results

Ferromagnetic mineral concentration recorded along the sequence (mass susceptibility between 17 and 7 E-7 m3/kg) is similar to the specific magnetic susceptibility of pampean loess sequences (Orgeira et al, 2011b). This fact allows us to compare the magnetic results from both areas to assess the impact of wind speed on the magnetic signal; apparently the magnetic susceptibility does not reflect differences in wind speed in both cited areas.

Figures 3 show hysteresis loops measured in eolic and paleosol samples. Magnetic mineralogy is driven along the profile by two components: a low coercitivity fraction, with Bc (coercitivity field) near 10 mT and a high field fraction
Table 1 shows magnetic parameters of the selected samples. High field susceptibility for both, eolic and paleosoil sediments, is practically the same value indicating that the contribution of the paramagnetic minerals is similar in both records. Values of X initial, Ms and Mrs and Bc for studied samples indicate that the ferromagnetic mineralogy is dominated by multidomain Ti poor titanomagnetite and /or maghemite.
Studies of variation of magnetic susceptibility with temperature from room temperature to 700ºC, in argon atmosphere were carried out. Results are shown in Fig 4. Irreversible curves due to mineral transformations were obtained in the studied samples. Some samples show a peak near 500ºC, it can be interpreted as a Hopkinson peak of Titanomagnetite with low Ti content. An step near 250ºC could be addressed to lepidocrocite transformation to ferrimagnetic minerals.

Character	Samples	Bc (mT)	Ms(Am2/kg)	Mrs(Am2/kg)	Xinit	Xpara
Eolic	*A1*	7.87	76.79	4.26	0.67	0.051
Eolic	*A7*	6.04	107.21	5.23	0.86	0.044
Eolic	*A17*	6.87	90.83	4.4	0.7	0.045
Eolic	*Average*	6.92	91.61	4.63	0.74	0.04
Paleosoil	*A4*	5.63	66.32	3.32	0.55	0.044
Paleosoil	*A63*	7	50.81	3	0.4	0.038
Paleosoil	*A70*	7.28	85.32	5.12	0.7	0.045
Paleosoil		6.64	67.48	3.81	0.55	0.04

Table 1: Magnetic parameters of selected samples

Variations in extensive parameters, such as, magnetic susceptibility, Ms and Mrs along the studied profile suggeste that the concentration of ferrimagnetic mineral differs from one paleosol to another. In other words, taking into account the hypothesis proposed by Orgeira et al (2011a) the obtained magnetic results suggest that the moisture in the different studied paleosols was different during their formation.
On the other hand, there is no evidences in the measurements of magnetic susceptibility at two frequences of generation of SP particles during pedogenic processes , althought anomalous ratios Xferimagnetic/Ms have been detected in present soil and in one paleosol.
Along the sequence different concentration of amorphous silica (phytoliths and / or volcanic glass) has been detected. Due to this fact a detailed analysis of these data must be done, in order to determine the potential impact of these in the magnetic signal.

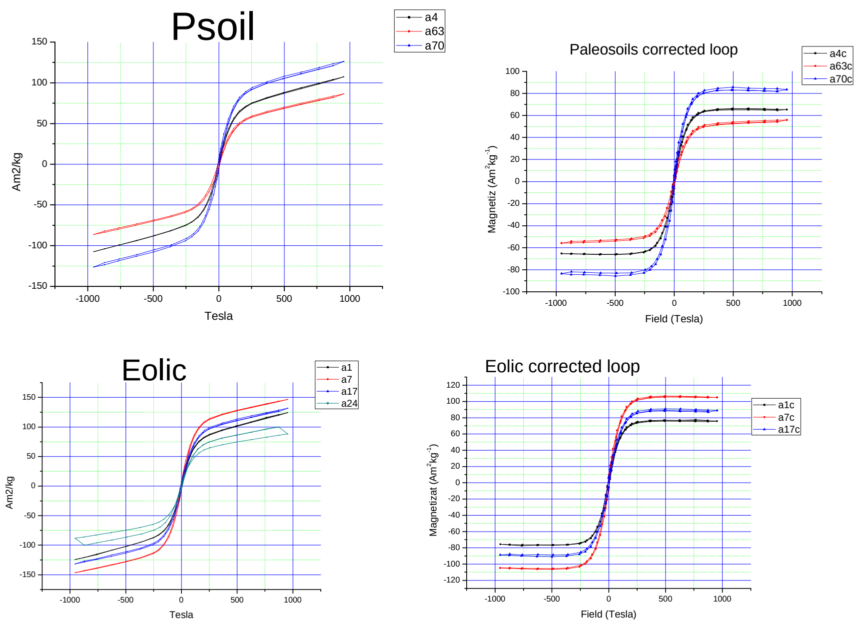

Figure 3. Hysteresis cycles of some samples

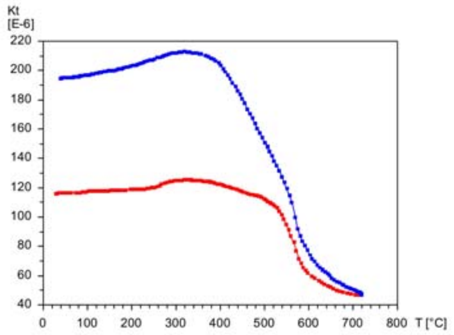

Figure 2: A4 sample

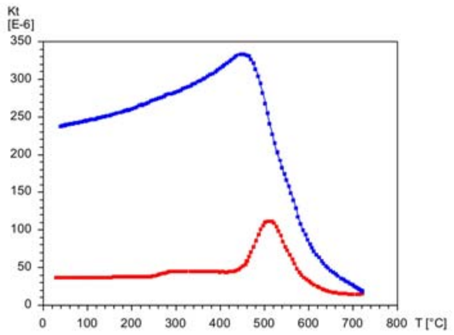

Figure 2: A48 Sample

Fig 4. Magnetic susceptibility changes with temperature.

Conclusion

The obtained magnetic results suggest that the moisture during the formation of the studied paleosols was variable for each one. It means the climatic changes during the Holocene have been different intensities.

The magnetic results, together with those of other climatic proxies, will define the climate variability occured in the southern extremity of the Americas, which will contribute to the knowledge of the southern hemispheric atmospheric circulation variability along the recent geological times.

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