PRELIMINARY RESULTS OF MAGNETIC PROPERTIES OF A LOESS-PALEOSOL SEQUENCE IN CORRALITO, CÓRDOBA, ARGENTINA

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Resumen

El objetivo de esta contribución es presentar el estudio preliminar de propiedades magnéticas en la secuencia de loess-paleosuelo en la cárcava cercana a la localidad de Corralito, Córdoba, Argentina; con la finalidad de aportar nueva información sobre los cambios climáticos acaecidos durante el Cuaternario Tardío en esta área. En esta contribución se presentan los datos preliminares de las propiedades magnéticas de la secuencia Corralito 1. El área está conformada por un suelo enterrado (edad 20 ka y 14 ka para el material parental) y tres paleosuelos intercalados con depósitos de loess cuya base data de *circa* 114 ka. Se realizaron mediciones de susceptibilidad a 470 Hz y 4700 Hz, coercitividad, coercitividad de remanencia, magnetización de saturación y magnetización remanente de saturación. Los resultados obtenidos permiten inferir un cambio de la señal magnética entre el primer paleosuelo y el último, los cuales corresponden al MIS 3 y al MIS 5 respectivamente.

Palabras Clave: Propiedades Magnéticas. Paleosuelos. Cuaternario.

Abstract:

The objective of this contribution is to study the magnetic properties of the loess-paleosol sequence in the Corralito gully, Córdoba, Argentina, in order to obtain new information about climatic change during Late Cenozoic in the area. In the present work, preliminary results of magnetic properties of Corralito 1 are presented. The area is formed by one buried soil (20 ka and 14ka for parent material) and three paleosols interbedded in loess sequences. According to the available luminescence data the bottom of the outcrops is *circa* 114 ka.The magnetic susceptibility measured at 470 Hz and 4700 Hz, coercivity, coercivity of remanence, saturation and saturation of remanence were obtained from samples collected in this profile.Results show a change in the magnetic signal between the first paleosol and the last one, which belong to MIS 3 and MIS 5, respectively.

Keywords: Magnetic Properties. Paleosols. Quaternary.

Introduction

The studies of environmental magnetism in the Chinese sequence were used as proxies of the climatic change during the Quaternary. (Maher and Thompson, 1995). The magnetic parameters are used to calibrate and quantify proxies in the climatic system.(Maher and Thompson,1999).
Many contributions (Maher and Thompson, op.cit.; Liu et. al. 1995; Han et. al 1996; Orgeira et. al. 2011; Boyle et. al., 2010) proposed different hypotheses in order to understand the relationship between the climatic system, pedogenic processes and magnetic properties. Actually, there are many studies of magnetic properties in the Chinese loess-paleosols sequences, but only a few of them were carried inside Argentina.
Climate affects directly some pedogenetic processes, such as the organic matter decomposition rate and the mineral weathering. These processes allow us to deduce the average of temperature and precipitation during soil formation by using climo-functions. (Catt. 1991).
The magnetic particles (minerals of Fe) are important because of their sensibility to changes caused by pedogenetic processes. (Orgeira *et al.* 2003 among others).

The aim of environmental magnetism studies is to analyze changes in the magnetic minerals, caused by changes in pH, or in redox which are closely related to the climatic fluctuations. (Orgeira, op.cit.).
Orgeira and Compagnucci (2010) suggest a climatic index, PWS (potential water storage) for the magnetic signal in loess-paleosols sequences. Soils and paleosols with positive PWS belong to a reductive environment and generate the depletion of detritic magnetic minerals, like the ones in SE of China and our Pampean plain.On the contrary, negative PWS, preserves ferrimagnetic minerals and under certain environmental conditions, new magnetic nanoparticles are formed on the soils. This process produces magnetic enhancement in soils of Europe, Asia and North Africa. According to the hypothesis of the mentioned contribution, Córdoba is in a climatic threshold

Geological Setting.

The studied site is situated in the Pampean plain where Cenozoic sediments are represented by loess mantles, and reworked loess with some volcaniclastic material.
The loess mantle is 1-10 m thick and forms a sequence of loess- paleosols, which is very important as geoindicator of paleoclimatic changes. Alternating periods of dryness and wetness were interpreted from this sequence (Sanabria *et al*. 2002).
Corralito gully is located about 90 km away from Córdoba city within the Tilted Platform, with less than 3% in slope.(Capitanelli. 1979). (Fig. 1).
This gully was formed after an intense rainfall, during the end of ’70 and as a consequence of a wrong land use. The gullies terminate as alluvial fans on the plain, harming the land and the agriculture. (Frechen et.al. 2003, Argüello et al. 2006). According to the luminescence studies carried out by Frechen et al.(2009) the age of the loess paleosol sequence corresponds to Late Pleistocene. Taking into account IRSL ages (115±21 ka to 92.1±14.7 ka, Frechen et al. 2009) obtained from the lowest loess sediment of the studied profile, the stratigraphic oldest paleosol, paleosol III (PIII) could be assigned to the Marine Isotope Stage 5 (MIS 5). This paleosol is covered by a loess deposit which indicates arid and cold climate conditions; IRSL age 66.1±9.4 ka suggests that this loess deposit could be correlated with the MIS 4. The pedocomplex integrated by paleosol II and I could be assigned to the MIS 3 (Fig. 3) The overlying loess deposits with luminiscense data of around 32.7 ka could be correlated with the MIS 2. Finally, the uppermost truncated buried soil is covered by deposits of an age between 18.9±2.4 ka and 13.8±2.1 ka; this luminescence data allow us to assign them to Lateglacial loess.
The samples were taken in the south wall of the gully because it is the most representative part of the whole profile; the sedimentological and pedological field description was previously performed by Sanabria *et al*. (1996).

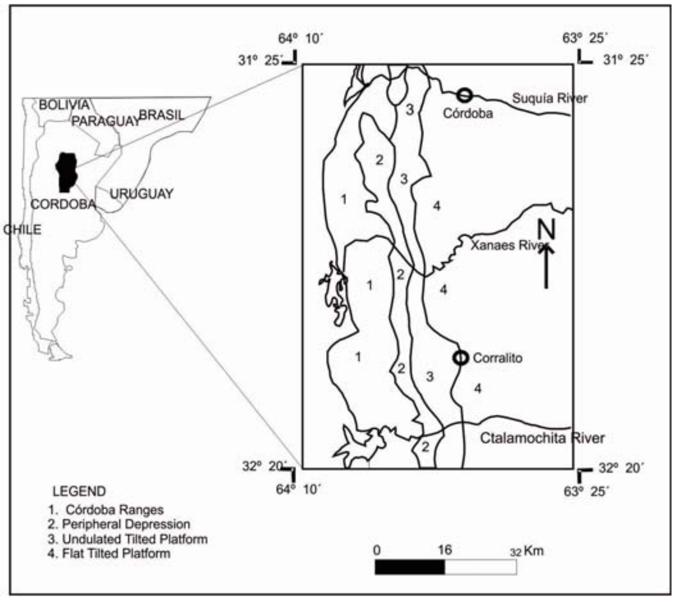

Figure 1. Location Map

Methodology

The samples were taken using an aluminium spade after cleaning the first 50 cm of profile in order to take out the weathered material. Vertical equidistance among samples was 10 cm. In the lab, samples were dried up and stored into plastic boxes. The susceptibility measurements were carried out with Bartington MS2 at two frequences: 470 Hz and 4700 Hz. The hysteresis cycles were obtained with a Vibrant Sample Magnetometer Molspin.

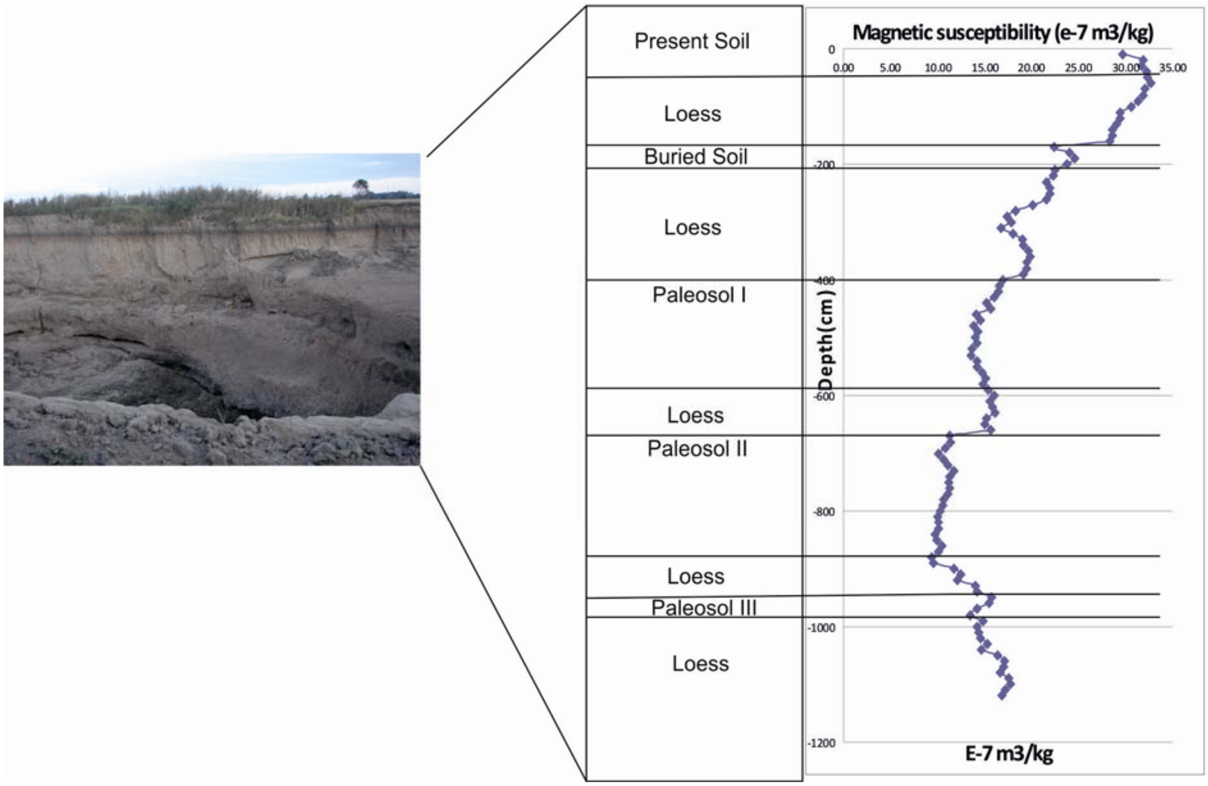

Figure 2. Loess-paleosols profile vs. magnetic susceptibility

Results

As a first approach, it can be observed a general increase of the magnetic susceptibility from- 6,5m to the top (Fig 2). It can be related with and increase of the concentration of the ferrimagnetic particles. Additionally, it could be related with a smooth decrease of the coercivity of the remanence (Fig 3). Both tendencies can be related with the magnetic particles content and with an increase in their grain size, which could be associated with a progressive increase of wind speed.

In paleosols some observations can be done. The variation of the magnetic susceptibility (Fig 2) shows smooth enhancements in PIII, in the buried soil and in the present soil; PI shows depletion of the ferrimagnetic minerals. PII maintains similar magnetic behaviour related with its parent material. Similar tendencies can be observed in Mrs; Ms does not show any particular tendency. These behaviours can be related with changes in concentration of ferrimagnetic minerals due to pedogenic processes.

Taking into account Orgeira *et.al*.(2011) hypothesis, the analogous magnetic behaviour of PIII, and buried soil with the present soil can represent similar climate condition for them all. PI, characterized by depletion of ferrimagnetic minerals, could have developed under climate conditions more humid than present time.

The magnetic properties (Fig 3), such as Hc and Hcr between 4-7 mT (Hc) and 35-37 mT (Hcr), indicate magnetite or titanomagnetite as the main ferromagnetic mineral present in the studied profile. Hcr/Hc vs. Mrs/Ms plot indicates pseudo-single domain meaning a grain size of 1-20μm for magnetite. (Dunlop.2002)

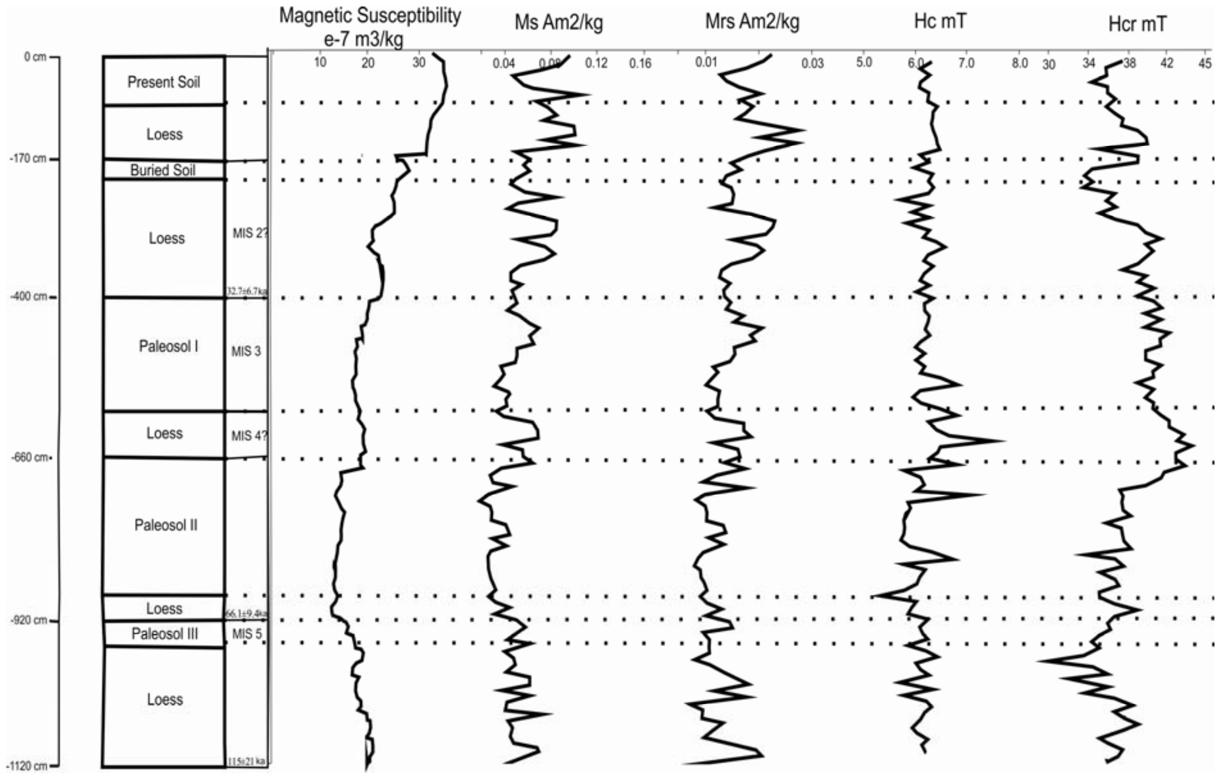

Figure 3. Magnetic properties: Ms (Am2kg), Mrs(Am2kg), Hc(mT) and Hcr(mT)

Conclusions

The magnetic properties indicate the presence of detrital ferrimagnetic minerals such as magnetite or titanomagnetite.
The tendencies in the extensive magnetic parameters can be related with the magnetic particles content and with an increase in their grain size, which could be associated with a progressive increase of wind speed.
Enhancement in the magnetic signal is detected in PIII (114 ka, MIS5), the buried soil and present soil, which could indicate similar climatic condition for both climatic periods. On the other hand depletion is observed in PI; it could be associated with a higher storage of water in the soil.

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