A PALEOMAGNETIC DATING STUDY OF RÍO VALDÉZ PALEOLAKE OUTCROUP (TIERRA DEL FUEGO, ARGENTINA)

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ABSTRACT

A sedimentary sequence from Río Valdéz outcrop (Tierra del Fuego Island, Southernmost Argentina) provides high-resolution and continuous paleoclimate and paleoenvironmental records in the Late Pleistocene. The ^{14}C dating method has inherent inaccuracies in dating these glaciolacustrine sediments as they contain a very low amount of organic matter and the period covered by them exceeds the age limit for the method. In order to overcome this drawback, the known changes of the Earth's magnetic field recorded in the sedimentary sequences were used to produce a more detailed and accurate timescale. The variations in the inclination and declination were compared to the paleosecular variations over the last 52,000 years recorded in the lake sediments from Laguna Potrok Aike. This correlation made it possible to construct a high-resolution time-scale for the sediments from Río Valdéz outcrop during the period 33,000 - 52,000 years B.P. This work further showed that the geomagnetic secular variations can serve as an effective tool to determine the sediments' age and correlate the stratigraphy for the different deposition environments in a wide region

Keywords: Paleosecular Variation, Patagonia, Magnetite

RESUMEN

La secuencia sedimentaria del afloramiento Río Valdéz (Isla de Tierra del Fuego, extremo Sur de Argentina) proporciona un registro continuo de variaciones paleoambientales y paleoclimáticos de alta resolución en el Pleistoceno Tardío. El método de datación por ^{14}C tiene problemas inherentes a la metodología para utilizarlo con estos sedimentos, como la cantidad muy baja de materia orgánica contenida en los mismos y el hecho que el período cubierto este cerca del límite de edad de utilidad del método. Con la finalidad de superar este inconveniente, se utilizaron las variaciones seculares del campo magnético terrestre registradas en las secuencias sedimentarias para construir la cronología de estos sedimentos. Variaciones en inclinación y declinación se compararon con variaciones paleoseculares de los últimos 52.000 años registrados en los sedimentos de la Laguna Potrok Aike. Esta correlación hizo posible construir una escala de tiempo de alta resolución para el período 33,000 – 52,000 años A.P. para la secuencia sedimentaria del afloramiento Río Valdéz.

Palabras Claves: Variaciones Seculares, Patagonia, Magnetita

1. Study Area

The Río Valdéz paleolake outcrop is located close to the mouth of Río Valdéz, on the south coast of Fagnano Lake (54° 35' S; 67°20' W). It develops at 62 m a.s.l. and 25 m above the lake shore (Fig. 1). It forms a 1.5 km^2 plain placed in between a morainic complex. The outcrop shows a 7 m depth of laminated silty-clay

Figure 1. Location of the Río Valdéz paleolake outcrop.

sediments with low content of laminated sands overlaid in erosive boundary by a 0.25 m of chaotic gravels in silty matrix. Based on geomorphological and sedimentological characteristics, the studied outcrop is interpreted as rhythmic glaciolacustrine deposits formed among basal moraines made by the Fagnano paleoglacier (Coronato et al., 2009), which occupied central Tierra del Fuego during the Late Pleistocene. Lateral moraines are located at the foot of the mountains, while basal moraines are beside the lake. The presence of dropstones allows us to interpret this deposit as an ice-contact lake. Two parallel sequences, a few meters apart from each other, were sampled using cubic plastic boxes (8 cc) during the 2012 Austral summer.

2. Methodology

The measurements of the natural remanent magnetisation (NRM) of all samples were carried out at the laboratory of Paleomagnetism and Environmental Magnetism in Tandil, (Buenos Aires, Argentina). Alternating Field (AF) demagnetisation and principal component analysis (Kirschvink, 1980) were applied to determine the characteristic stable inclinations and declinations of NRM. Stability of the magnetisation was analysed by alternating field (AF) demagnetisation. A group of rock magnetic measurements was performed in order to characterise the magnetic minerals contained within the sediments. For example, SIRM/k vs. B_{CR} [3] (saturation of the isothermal remanent magnetization/susceptibility vs. coercitivity of the remanence) is plotted to discriminate magnetic mineralogy.

3. Results

3.1 Rock Magnetic Results

Rock magnetic parameters were investigated to characterise the magnetic properties of the glaciolacustrine sediments deposited in the Late Pleistocene. The results indicate that low-coercivity minerals are the dominant magnetic carriers (Fig. 2). Progressive removal of SIRM by back-field demagnetisation indicates that B_{CR} varies between 25 and 55 mT, except for a group of samples for which the value of B_{CR} is higher. According to Peters and Dekkers (2003), these results agree with the characteristic average value of pure magnetite, between 8 and 60 mT. The B_{CR} values are a little higher than the characteristic value of pure

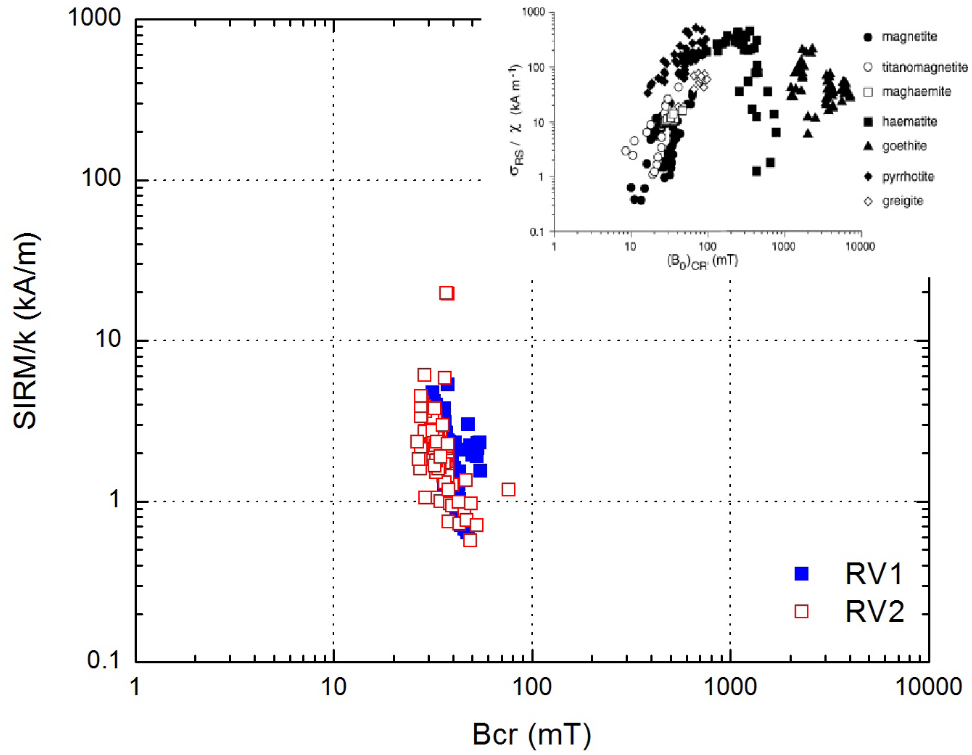

Figure 2. SIRM/k vs. B_{CR}. The upper right margin shows the location of different minerals found by Petters and Deckers (2003).

magnetite, which could be explained by the presence of oxidized titano-magnetite (Roberts and Turner, 1993) and/or anti-ferromagnetic minerals in low concentrations, or by the relative decrease in the grain size.

3.2 Paleomagnetic Curves

Typical examples of vector endpoint diagrams during progressive AF demagnetisation show a stable primary remanence pointing toward the origin after demagnetisation up to 100 mT (not shown). Paleomagnetic directions were calculated by fitting a linear regression line to minimise the maximum angular deviation (MAD). These values are generally smaller than 5°, providing evidence that the paleomagnetic directions are stable and well determined.

3.3 Age Control

There were obtained four accelerator mass spectrometer (AMS) radiocarbon dates by the AMS Laboratory of the University of Arizona, which were converted into calendar years using the calibration curves of Roberts and Turner (1993). The information about each sample is listed in Figure 3. Distinctive magnetic features of Río Valdez inclination record, close to the dated levels, were identified and correlated with similar features of the PSV curves from Laguna Potrok Aike (41°S, 71°30´W; Lisé-Pronovost et al., 2013); so four connecting points were defined. This correlation was consistent with the age scale determined for Laguna Potrok Aike. The four connecting points defined four zones; within each zone new tie points were determined (based on visual inspection of the curves, Fig. 3). The correlation was mainly based on inclination data, but declination data were used as an aid in dubious cases (not shown). The correlation procedure itself was relatively straightforward. On the basis of this correlation, a total of 25 tie points were defined.

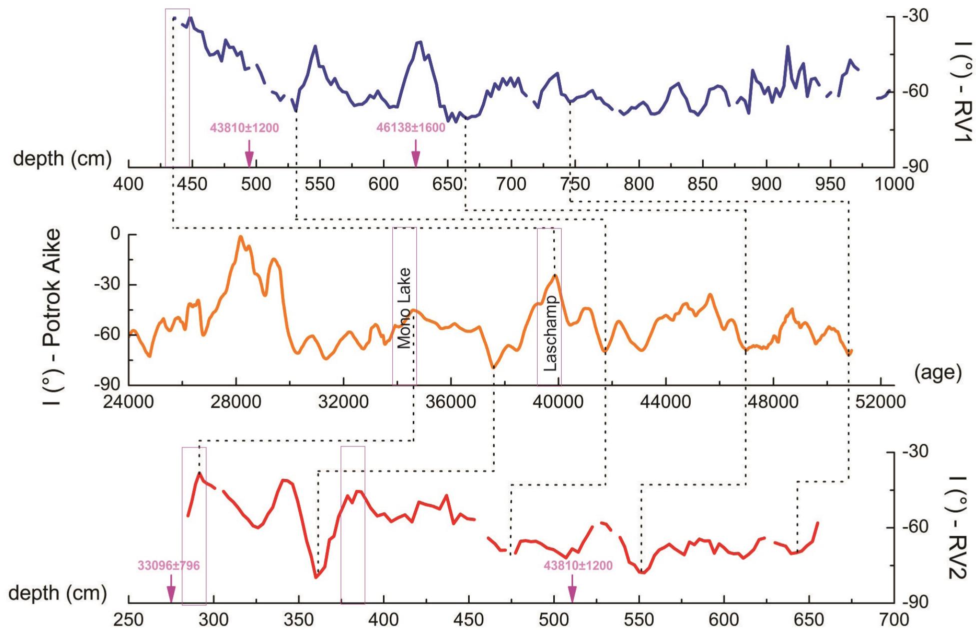

Figure 3. Inclination plots from both sequences of Río Valdéz (RV1 and RV2) and Laguna Potrok Aike.

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