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EVIDENCE OF A POSSIBLE REVERSION OF THE GEOMAGNETIC FIELD REGISTERED DURING THE LATE HOLOCENE IN THE PROVINCE OF CHUBUT, ARGENTINA

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Abstract

Paleomagnetic studies were carried out on sediments sampled at an archaeological excavation sited on Angostura Blanca, Piedra Parada Valley, Province of Chubut (42°30'S, 69°42'W). The archaeological traces show the occupation of the site during the late holocene; this is confirmed by the C^{14} dating of samples obtained on the site (2140±50 years).

The usual laboratory techniques for paleomagnetic studies were applied to isolate the directions of the stable remanent magnetization (measurements of natural remanent magnetization, demagnetization by increasing temperatures, measurements of residual remanent magnetization after each step of demagnetization). Using the isolated directions, which represent the directions of the geomagnetic field during the deposition and consolidation of the sediments, the virtual geomagnetic poles were obtained.

The analysis of the results shows evidence of a possible record of a reversed polarity event on the studied sediments. This conclusion, if it is confirmed by other paleomagnetic data, would agree with the existence of the Etrussia excursion, recorded in Russia, on sediments of about 2700 years.

1. Introduction

Excursions and polarity events of the geomagnetic field (gf) are inferred from paleomagnetic studies in which short-term directional fluctuations of great amplitude are registered. These fluctuations are a chronostratigraphic tool for the dating and correlation of quaternary sediments. It is on this account that palaeomagnetic studies carried out on quaternary sedimentary deposits, in which excursions or events have been recorded, have increased in the last decade (Cheng Guo Liang, 1981; Mörner, 1979, 1981 and 1986; Lovlie and Sandness, 1987; Petrova and Pospelova, 1990; Liddicoat, 1992).

On the other hand, numerous investigations have demostrated the utility of sediments from caves and archaeological excavations for paleomagnetic studies (Creer and Kopper, 1974, 1976; Noel and St.Pierre, 1984).

In Argentina, and particularly in the Patagonian region, paleomagnetic studies on quaternary sediments, lacustrine (Creer et al, 1983) and glacial (Sylwan, 1989a, b, c), have been carried out since the eighties. Recent investigations made by the authors in archaeological excavations in the centre-north Patagonian region have revealed information, both from an archaeological and a paleomagnetic point of view, which consitutes the first archaeomagnetic studies carried out in the country (Nami and Sinito, 1992).

Continuing this line of investigation, this paper presents results obtained from the Rockhelter Angostura Blanca (Piedra Parada Valley, Chubut Province).

2. Sampling Site

This site is one of the many surveyed in the Piedra Parada investigation area, located in the northwest of Chubut Province along the mid-course of the homonymous river between 42°30' and 43°S parallels and meridians 70°30' and 69°30'W. Specifically, rockhelter Angostura Blanca (42°30'S, 69°30'W) is an archaeological site of moderate dimensions, located on the southern edge of the Chubut river valley, approximately 100m from the river bank (Fig.1).

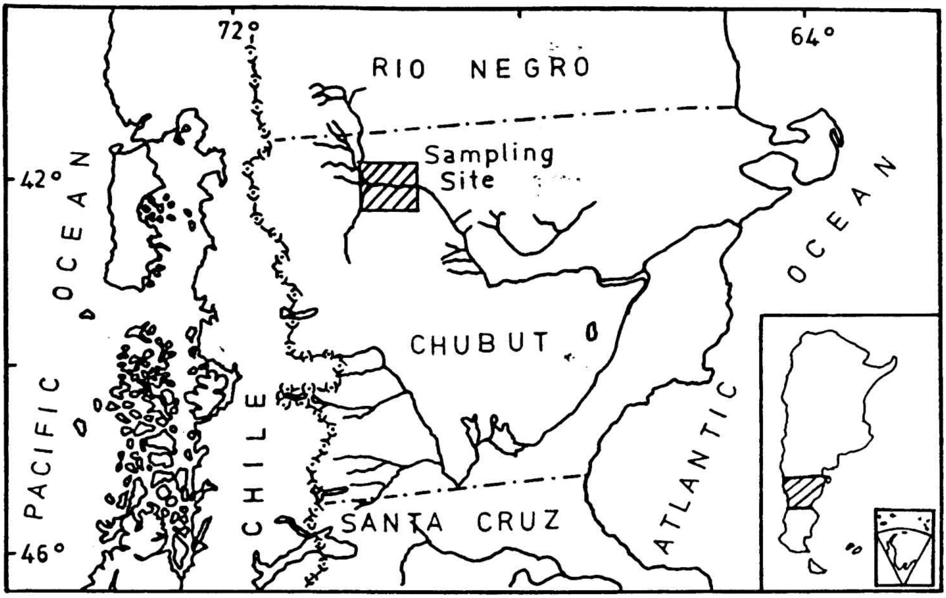

Fig. 1: Sketch showing the location of the study area

The sequence consists of a superficial horizon composed principally of cow and sheep dung (A), followed by another of compacted dung (B), both sterile archaeologically and magnetically. Underlying these are loessic sediments which present different colours according to the various remainders left by man. These sediments have traces of charcoal, a product of different combustion episodes, man-accumulated vegetable remains and different archaeological vestiges.

Many different investigations from an archaeological point of view have been carried out in this area (Aschero et al, 1983; Aschero, 1987; Bellelli, 1987, 1988; Bellelli et al, 1987; Perez de Micou, 1979-1982).

Angostura Blanca was submitted to a 1m sounding in 1990. Diverse remains left behind by hunter-gatherers socio-cultural systems that inhabited the region in the past were found (Onetto, pers. comm., 1991).

Vegetables, artifacts and lithic and faunistic ecofact accumulations were identified in this sounding. The section is shown in Fig.2. In level "B", small stem projectile points, engraved ceramics, stone flakes and debitages and others such as guanaco (Lama guanicoe) bones were found. In level "C" a perforated valve and lithic instruments were found; it also presents combustion structures (C'). Level "D" is composed of vegetable remains left by man and for this reason impossible to sample. In level "E" no remains were found and in "F" blades artifacts and an unfinished "bola de boleadora" were found. The section also preserves blocks fallen from the walls of the rockhelter.

For a relative age of part of this section, datings carried out in other sites in the area are available. Stem points and ceramics from Campo Moncada 2 (8km from Angostura Blanca) were dated using C^{14} method in 780±80 and 860±60 years bp, respectively. In Piedra Parada, another site close to Campo Moncada and Angostura Blanca, small and big stem points were dated in 1330±50 years bp (CSIC-495, Perez de Micou, 1979-192). A dating on material near sample No.7 of the present section (Fig.2) gave its age as 2140±50 years (the dating was carried out by BETA Analytic, University of Florida, with sample No.49254).

3. Sampling and measuring techniques

The samples were collected in hydrobronze tubes one inch in diameter and long. They were introduced continuously into the section except in the horizon with abundant vegetable remains. Due to the nature of the sediment and to the dry atmosphere which prevails in the rockhelter, it was necessary to wet the section so that the loose sediment would not separate while being sampled. The samples were later consolidated with a sodium silicate solution. The orientation of the samples (strike and dip) was determined with a Brunton compass. A total of eleven samples was obtained (Fig.2).

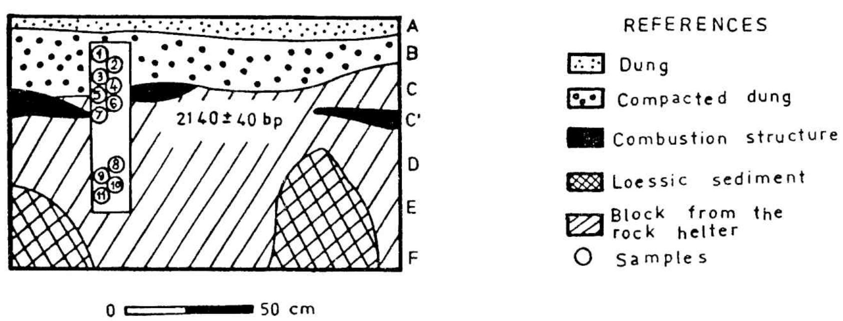

Fig. 2: Stratigraphic section showing the position of the samples

In the laboratory, the natural remanent magnetizations (nrm) of all samples were measured using a rotative type magnetometer. For the purpose of choosing the adequate demagnetization stages to isolate the stable remanent magnetization (srm) five samples were selected. These were submitted to a detailed thermal demagnetization (at temperatures of 100, 200, 250, 300, 350, 400 and 450^{0}C) and, after each warming stage, the residual remanent magnetization (rrm) was measured. The directions and relative intensities of the rrm were represented in stereographic projections and cartesian graphics respectively, and in Zijderveld diagrams (Fig.3).

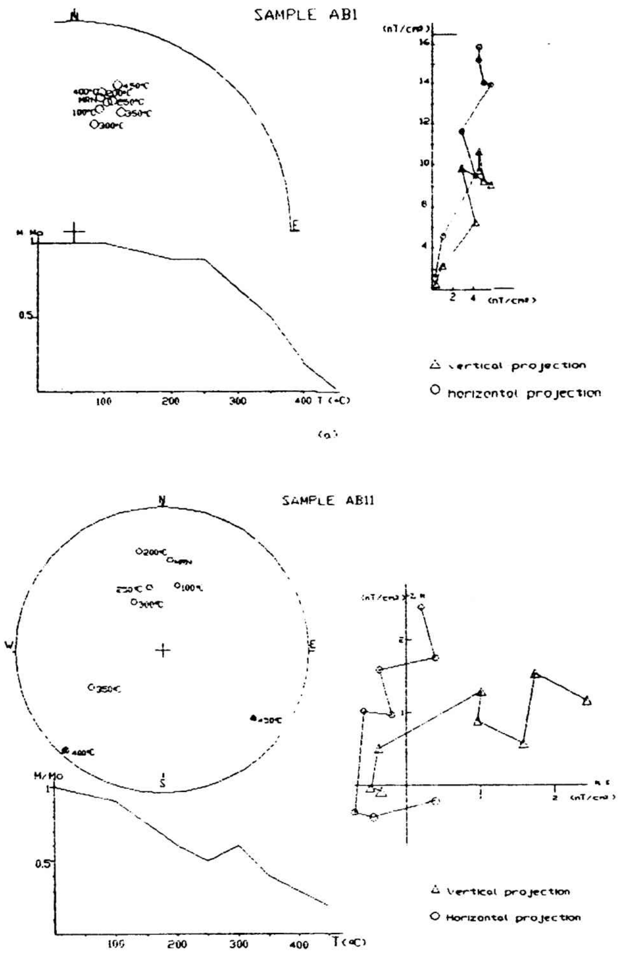

Fig. 3: Representation of the residual remanent magnetization after each demagnetization step; the directions and relative intensities are shown in stereographic and cartesian projections respectively, and in Zijdervel diagrams. a) sample AB1, b) sample AB11

A detailed demagnetization on the rest of the samples to which, when possible, new thermical stages of 500, 525 and 550°C were added, was decided after studying the results obtained.

4. Results

The results indicate that the samples present different magnetic behaviours. While some of them have an univectorial magnetization (Fig.3a), which is manifest in that there are no direction variations along the different demagnetization stages, others show superposition of at least two magnetic components (Fig.3b), since the rrm directions show a path.

Diverse methods of magnetic multicomponent analysis were applied such as identification of the plane defined by two magnetic components (trace of maximum circles) and calculating the direction of the magnetizations that are eliminated in each demagnetization stage (vectorial substraction).

The traces of maximum circles with the directions of the rrm of each demagnetiztion stage corresponding to all those samples with multivectorial behaviour are represented in Fig.4. It is to be noted that all the traced circles cut each other in two areas, which indicates two directions, practically antipodal. One of them is very near to the direction of the normal dipolar field while the other indicates the presence of a reverse component. On the other hand, the vectorial substraction showed that in these samples different proportions of the two components, one normal and another reverse, were alternatively being eliminated.

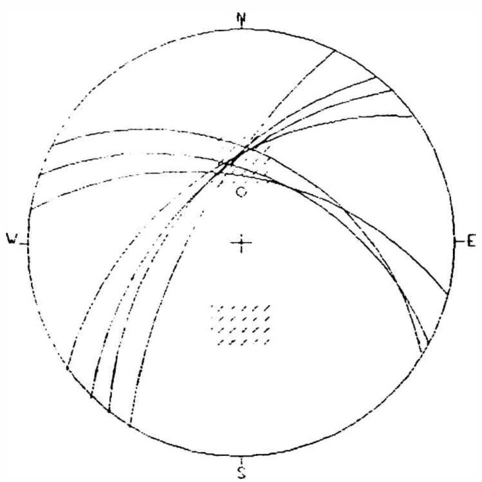

Fig. 4: Maximum circles corresponding to the directions of residual remanent magnetization of the multicomponent samples. The shaded areas represent the intersection of the circles..Dipole direction.

The combination of the two mentioned procedures allowed the definition of the srm of each of the samples, which represent the directions of the gf during the deposition and consolidation of the sediments studied (Fig.5, Table 1).

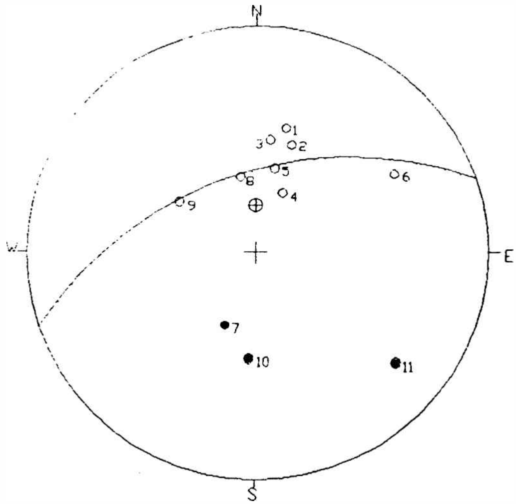

Fig. 5: Directions of the stable remanent magnetization. Dipolar direction

From the inclination (I) and declination (D) values of the defined srm, sections with those parameters vs. depth were constructed (Fig.6a and 6b).

The virtual geomagnetic poles (vgp) and the angular deviations of the vgp with respect to the magnetic pole were calculated (Table 1). Fig.6c represents the deviation profile vs. depth. This profile indicates that the samples from the upper section have a normal polarity while the others are reverse or oblique.

Sample	SRM		VGP		
Sample	Declination	Inclination	Longitude	Latitude	Angular Deviation
AB1	13.3°	-31.5°	318.1°E	62.1°N	10.5°
AB2	18.1°	-37.2°	330.7°E	63.5°N	9.1°
AB3	7.1°	-37.1°	307.6°E	67.4°N	7.5°
AB4	24.1°	-58.2°	16.9°E	71.5°N	15.9°
AB5	12.4°	-48.5°	331.4°E	73.6°N	2.5°
AB6	59.7°	-21.3°	7.1°E	29.6°N	48.3°
AB7	202.0°	52.1°	177.7°E	70.1°S	169.2°
AB8	348.8°	-52.4°	243.4°E	77.1°N	20.0°
AB9	303.6°	-46.3°	199.2°E	42.4°N	59.1°
AB10	183.4°	39.9°	119.1°E	70.0°S	171.6°
AB11	128.3°	14.6°	42.3°E	32.7°S	117.6°

Table 1. Directions of the stable remanent magnetizations, positions and angular deviation of the virtual geomagnetic poles

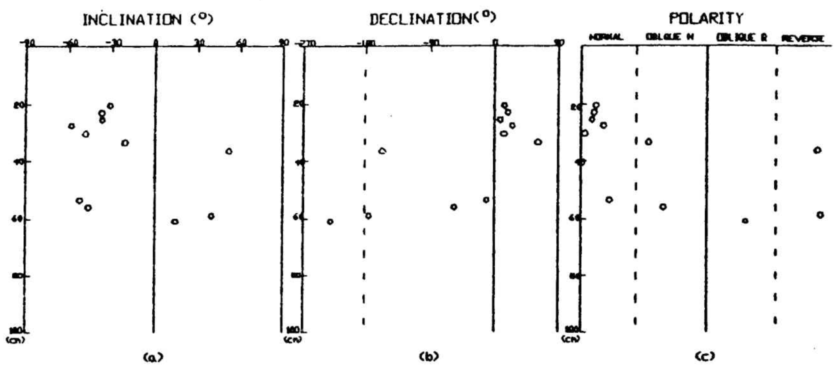

Fig. 6: Inclination (a), Declination (b) of the srm and angular deviation of the VGPs (c)

5. Conclusions

The sediments studied suggest the existence of a gf polarity reversion with a minimum age of approximately 2140 years. This reversion could be correlated with an excursion registered in sediments in Russia of approximately 2700 years, named Etrussia excursion (Petrova and Pospelova, 1990). To confirm this record it is necessary to increase the available number of paleomagnetic data.

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