TERTIARY IGNIMBRITES FROM NORTHERN CHILE: ANOMALOUS MAGNETIZATION EXPLAINED BY SELF-REVERSAL AND TECTONIC ROTATION.

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RESUMEN

El estudio paleomagnetico de una serie de muestras de material de tipo ignimbritico procedente del norte de Chile muestra una remanencia anomala. La magnetizacion se explica a traves de la combinacion de un doble proceso de self-reversal y rotacion tectonica.

Key Words: Upper-Miocene ignimbrites Chile, self-reversal, fore-arc rotation,

INTRODUCCION

Upper Miocene ignimbrites of the San Bartolo Group were sampeled in the San Bartolo Dome area of Northern Chile. The area lies immediately north of the large Salar de Atacama basin. The stratigraphy of the area has been described by Hollingworth and Ruthland (1968), Flint (1985) and Jolley et al. (1990). The Oligo-Miocene Paciencia Group is overline unconformably by the Mio-Pliocene San Bartolo Group. This unit conteins seven ignimbrites rainging in age from 12.6 to 2.3 Ma. The Paciencia and San Bartolo groups were rotated clockwise by Neogene thrusting (Jolley et al., 1990 and Hartley et al., this conference). Paleomagnetic sampeling of all seven ignimbrites was undertaken using field drilling and hand sampling. Orientation was by sun compass and magnetic compass. Meassurements of the NRM was made usinng 2-axis cryogenic and spinner magnetometers. Thermal and AF demagnetization was done for specimens from each site. In addition a variety of rock magnetic measurements were made including studies of the susceptibility anisotropy.

PALEOMAGNETIC RESULTS

The intensity of the initial NRM ranged from 3541.8 to 50.4 A/m. Fig. 1a shows the distribution of the initial NRM directions and the present day field direction (PDFD) for the area. The most significant feature of these results is that the sign of inclination is opposite to that of the PDFD. After AF demagnetization of all the specimens at 50 mT no significant directional differences were observed. Within site scatter is very low, but between site scatter is much higher. Between 4 and 8 specimens from each site were subjected to thermal or AF demagnetization. During AF demagnetization there is a rapid loss of in NRM intensity; normalized decay curves are concave-up with median destructive field of 5 to 40 mT, typical of multidomain magnetite (Fig. 1b). The NRM is stable to AF demagnetization; stereographic proyections and orthogonal plots show esentially a single component of magnetization (a randomly oriented low-coercivity component is removed between 0 and 5 mT). Similar results are seen in thermal demagnetization (Fig. 2). Only minor loss of remanence occurs between room temperature and 300°C (Fig. 2a). Above 580°C there is virtually no remanence remaining, and the specimens are almost completely demagnetized. There are only minor directional changes observed during thermal demagnetization. For the most part specimens show a single normal component of magnetization with NE declination and shallow to moderate downward inclination or SW declination with shallow to moderate upward inclination. In the majority of cases the direction in the NE quadrant show a change in inclination to a more negative position between 500 and 650°C. Although this component is to weak to be precisely defined, it lies nearer to the PDFD and may be more representative of the Upper Miocene field direction. In rare cases both these components are present in the same specimen. It is interesting to note that in such cases the 400°C unblocking temperature is absent (Fig. 2a).

From the demagnetization results the carachteristic remanence of the Upper Miocene ignimbrites has been stablished. Three groups are recognized M_1, M_2, M_3 (Fig. 2c & 2d). The M_1 and M_2 remanences are caracterized by wide coercivity (0-100 mT) and blocking temperature (20-580°C) spectra. M_1 has mean D=24.86° I=16.56° a_{95}=6.61. M_2 has mean D=207.26°, I=-19.37° and a_{95}=17.33. M_3 is characterized by much higher coercivity and has a blocking temperature spectrum in the range 580-680°C. M_3 has mean D=16.52°, I= -15.03° and a_{95}=7.64. It should be noticed that remanences M_1 and M_2 are aproximatly antiparallel whereas remanence M_3

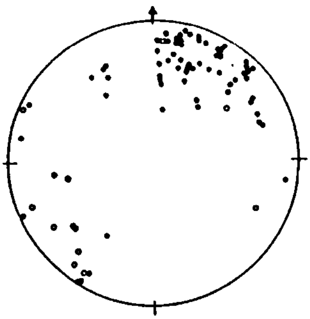

fig. 1a

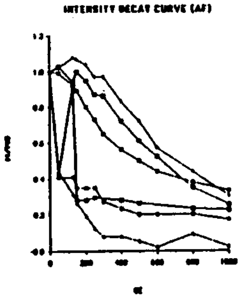

fig. 1b

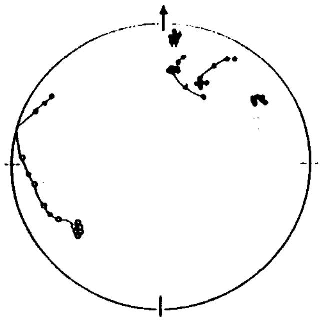

fig. 1c

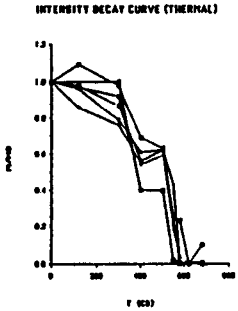

fig. 2a

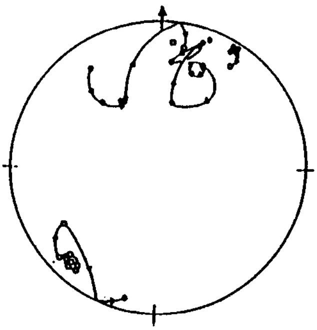

fig. 2b

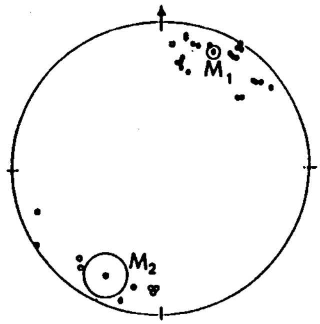

fig. 2c

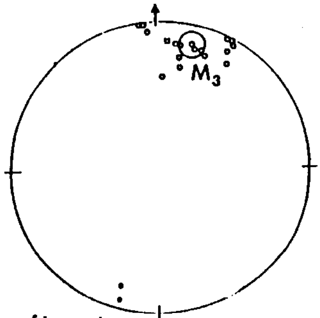

fig. 2d

Fig. 1a: NRM, stereographic plot.

Fig. 1b: Normalized Intensity Decay Curve for AF demagnetization.

Fig. 1c: Selected specimens from AF demagnetization.

Fig. 2a: Normalized Intensity Decay Curve for Thermal demagnetization.

Fig. 2b: Selected specimens from Thermal demagnetization.

Fig. 2c: Isolated Components at 500oC

Fig. 2d: Extracted Components abouve 600oC lies on the same axis but whith a shallow negative inclination.

DISCUSSION

The most significant feature of the results is that the characteristic remanence is anomalous. Northly directed vectors have downward inclination, whilst southerly directed vectors have upward inclination. Since the sampling sites lie 22°S the PDFD and predicted Upper Miocene field direction showed, have the opposite sign of inclination. For this reason we believe that the results are best explained in terms of self-reversal (Neel, 1959). This phenomenon is well known in dacitic and rhyo-dacitic volcanic rocks like those described here.

Self-reversal can occur as the result of the presence of two discrete magnetic constituents, having two different Curie points (Neel, 1959). During cooling magnetite passes through its Curie point an is magnetized. At the same time maghemite is produced as the result of lower temperature oxidation. At some point the maghemite starts to cristalize under the influence of the demagnetization field due to the magnetite. Under these circunstances the maghemite can be magnetized oposite to the external field.

However, even allowing for self-reversal, the axis of magnetization sould still coincide with predicted for the Upper Miocene field direcction of the area. Our prediction is that this could not be substantially different from the from the PDFD by 10° . Our results are thus consistent with tectonic rotation after self-reversal. In fact the spread of isolated components between the PDFD and their present position suggests that self-reversal may have been contemporaneous with tectonic rotation.

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