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MAGNETOSTRATIGRAPHY IN THE TRANS-PECOS VOLCANIC FIELD: PRELIMINARY RESULTS FROM THE EOCENE-OLIGOCENE VIEJA GROUP

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INTRODUCTION

The Vieja Group, which accumulated on the western edge of the Trans-Pecos volcanic field, consists of 600 m of volcaniclastic sediments subdivided by several interbedded extrusive units (fig. 1). Radiometric dates (McDowell, 1978), diagnostic mammal fossils (Wilson and others, 1968; Wilson, 1978), and geologic setting suggest that the Vieja Group represents a continuous record of deposition from 40 to 30 m.y.b.p., thereby making it ideal for a magnetostratigraphic study of latest Eocene through early Oligocene.

Initial results of this study have been published in another guidebook (Testarmata and Gose, 1979). Since then, we have more than doubled the number of samples in order to fill in data gaps and to extend the section for a firmer correlation.

OBJECTIVES

Lithologic continuity is lacking in the Trans-Pecos volcanic field, and biostratigraphic and radiometric dating have been able to provide only a general correlation. Magnetostratigraphy applied in conjunction with these other techniques may prove a useful correlation tool. This study is intended to investigate this possibility by establishing the reversal stratigraphy of the Vieja Group, which can then serve as a reference section for the region.

A broader objective of this study is to correlate the reversal stratigraphy of the Vieja Group with the marine magnetic anomaly sequence. Such a correlation would test the consistency between marine and continental dating: K-Ar dates from the Vieja Group could be compared with ages assigned to the marine magnetic time scale; and Eocene-Oligocene boundaries, defined by mammal faunas in the Vieja Group and marine faunas in the oceans, could also be compared.

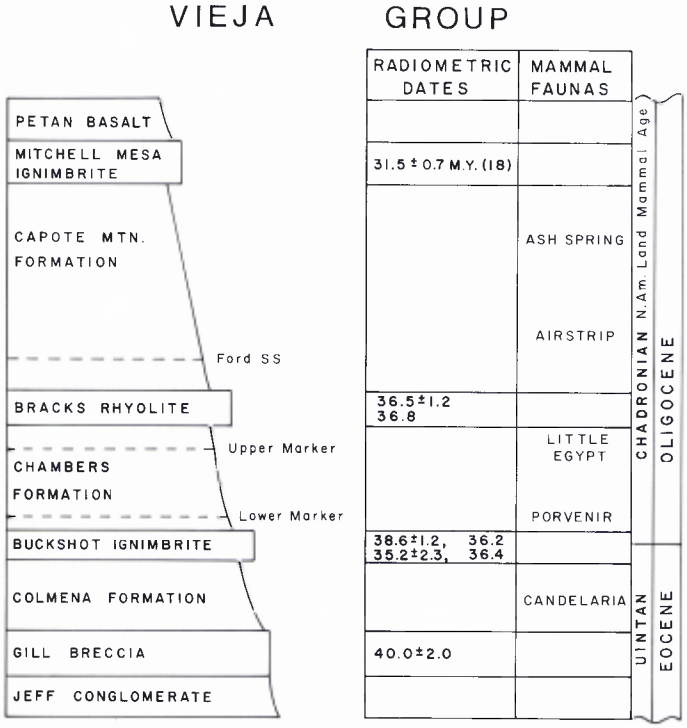

Figure 1. Stratigraphy, K-Ar dates, and mammal faunas of the Vieja Group. After Walton (1972). Age of Mitchell Mesa Ignimbrite is the average of 18 dates.

DATA COLLECTION

More than one thousand samples were collected from the Vieja Group in the Candelaria area (30°08'N, 104°41'W). By collecting different parts of the section at different sites and using contacts and marker beds to tie sections together, complete coverage from the lower part of the Colmena Formation to the Mitchell Mesa Ignimbrite was achieved. Oriented cores were collected with a portable, gasoline-powered drill. In sedimentary rocks, samples were collected in stratigraphic sequence at an average spacing of 1 m. Approximately 10 samples were collected from each extrusive unit with sampling distributed throughout the thickness of the unit.

Samples were measured with a cryogenic magnetometer and between measurements were stored in a magnetically shielded room in a field of a few hundred gammas. Standard techniques of alternating field and thermal demagnetization were used to remove unstable components of magnetization.

Most sedimentary samples displayed similar changes in direction during demagnetization. A strong viscous normal overprint dominating the natural remanent magnetization (NRM) was removed after demagnetization to 200°C. The stable directions revealed at 200°C were more clearly defined after heating to 400-500°C, and these data were used for determination of magnetic polarity. Heating of samples above 575°C, the Curie temperature of magnetite, usually resulted in a scatter of directions (fig. 2), indicating that magnetite is the carrier of the stable remanence. Measurements of magnetization versus temperature and examination of polished sections support the dominance of magnetite as the carrier of remanence. As magnetite is not an authigenic mineral, this implies that the sedimentary rocks carry a detrital remanent magnetization (DRM) acquired at the time of deposition.

Samples from extrusive rocks in most cases showed stable NRM directions which changed very little upon demagnetization. They display a thermal remanent magnetization (TRM) acquired at the time of extrusion.

INTERPRETATION

Magnetic polarities of most samples from the upper 400 m have been determined, and analysis of the lower portion is now under-

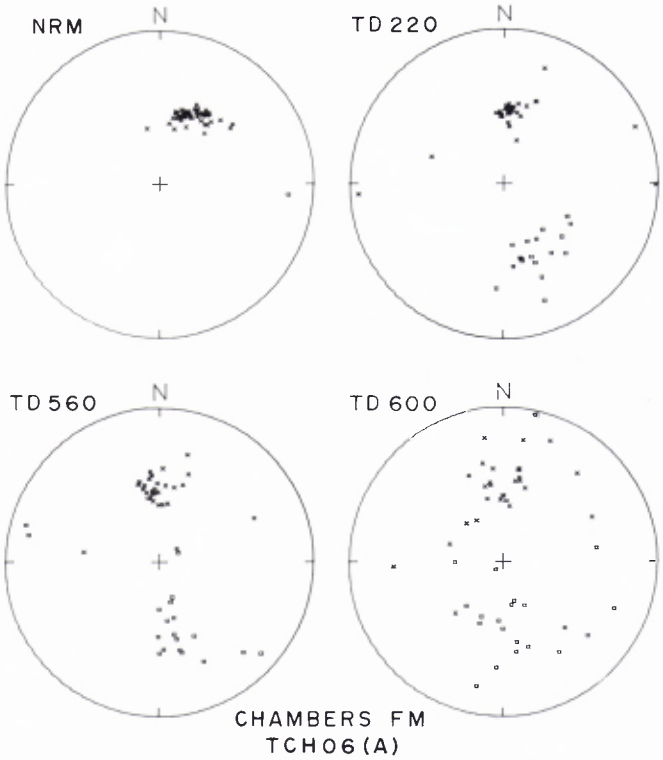

Figure 2. Equal-area stereographic projections of NRM directions and directions after demagnetization at 220°C, 560°C, and 600°C for part of the Chambers Formation. Open symbols are in upper hemisphere, crosses in lower hemisphere.

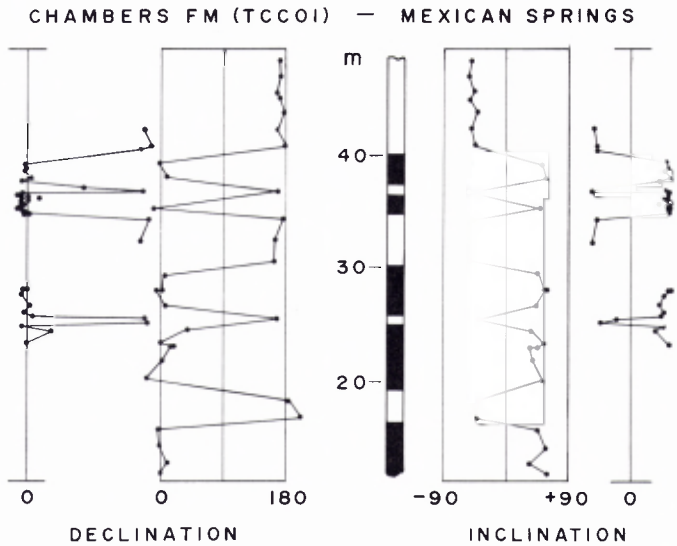

Figure 3. Paleomagnetic data and polarity interpretation for part of the Chambers Formation. Inner columns show initial data; outer columns, data after dense sampling of selected zones. Declination and inclination values are after demagnetization to 450 to 500°C. Black indicates normal polarity; white, reverse. Same convention applies to other figures.

way. When magnetic polarities are plotted in stratigraphic sequence, many thin polarity zones are evident. Because most of these zones were based upon only one or two samples, selected zones were resampled at a higher density in order to insure that the zones were real and not due to human error. In most cases, the existence of the thin zones was confirmed (for example, see fig. 3). High-density sampling showed that zones were as thin as 0.3 m, thus explaining why they had been represented by only one sample. It is likely that additional thin zones were not detected because the sample spacing was greater than their thickness. For regional or global correlation these zones are of little importance. The large-scale reversal pattern is of prime interest. However, the thin zones are significant in that they imply frequent reversals of the geomagnetic field in early Oligocene time.

Stratigraphic overlap between the sections made it possible to attempt local correlation. The problem is that the overlap is at an interval of predominantly reverse polarity with short normal intervals (fig. 4). Which normal zones correlate with each other is not easy to determine because all zones are of approximately equal thickness, and zones recognized in one section may have been missed in another if they were thinner than the sampling interval.

Prospects for regional correlation look promising. When thin zones are ignored, an overall reversal pattern, which should prove useful in regional correlation, emerges.

Because not all samples have been completely demagnetized, we can only propose a tentative correlation with the marine polarity time scale (fig. 5). For a unique correlation, a distinct reversal pattern is necessary. This is a major problem in the Tertiary because most polarity intervals are of similar duration. However, marine magnetic profiles display low amplitudes between anomalies 12 and 13, indicating a long period of reverse polarity from 33 to 35.5 m.y. The long predominantly reverse zone in the Vieja Group is tentatively identified as correlating to this time period. This correlation is constrained by radiometric dates and fossil ages, as well as the fact that 400 m of Vieja sediments should represent approximately 6 m.y., if 600 m were deposited in 10 m.y. If this correlation is assumed correct, a comparison can be made between marine and continental age dates. The radiometric dates correspond fairly well, as do the Eocene–Oligocene boundaries.

The most noticeable disparity in correlating the Vieja Group with the marine section is in the large number of short polarity intervals in the Vieja Group. Those of less than 40,000 years duration would be difficult to detect in marine anomaly patterns. However, longer polarity intervals may be represented by small-scale amplitude fluctuations in marine magnetic profiles. These fluctuations are often interpreted as intensity variations, but in light of the large number of thin polarity zones found in the Vieja Group, we suggest that they be reinterpreted as short polarity events. For example, LaBrecque and others (1977) indicate eight "short events or intensity fluctuations" in the long reverse period between anomalies 12 and 13 (fig. 5). Many of these correlate well with thin polarity zones in the Vieja Group, suggesting that they are indeed polarity events.

CONCLUSION

The large number of magnetic polarities encountered in this time interval is rather surprising. We are not aware of any other study with a similar multitude of short magnetic events, although their existence has been theoretically predicted (Cox, 1968). Because some of these events are represented by as little as 0.3 m of stratigraphic section, they are easily missed where sampling is at 1-m intervals, and we therefore cannot expect a one-to-one correlation between overlapping sections. When this is taken into account, the various sections compare reasonably well, and the magnetic correlation readily agrees with all geologic constraints.

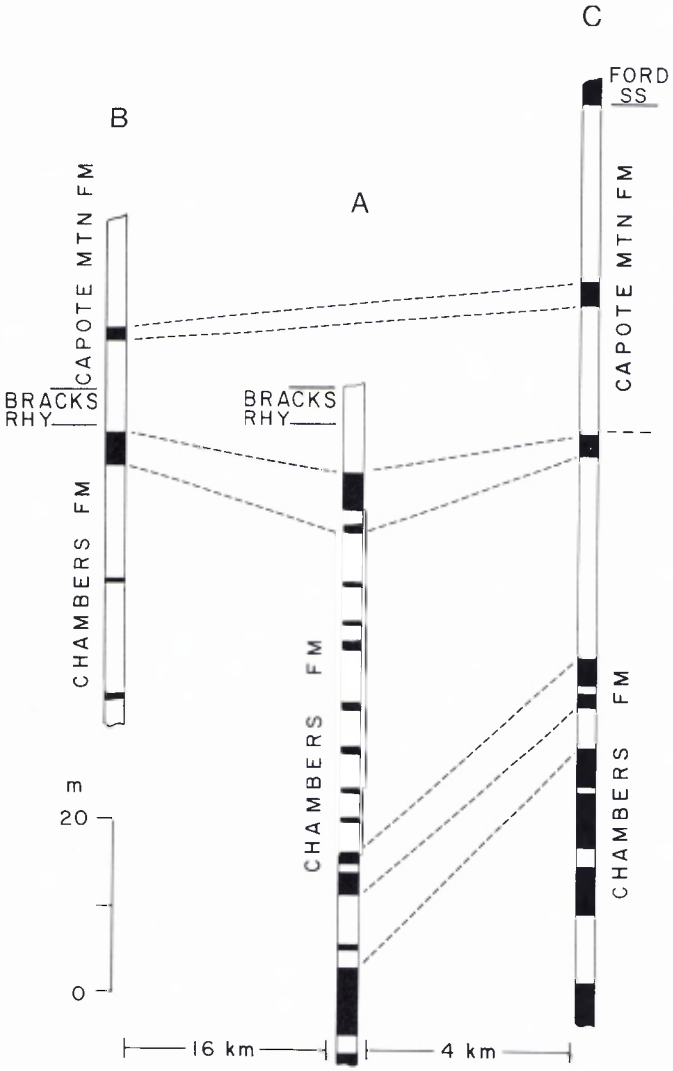

Figure 4. Magnetostratigraphic correlation of overlapping sections.

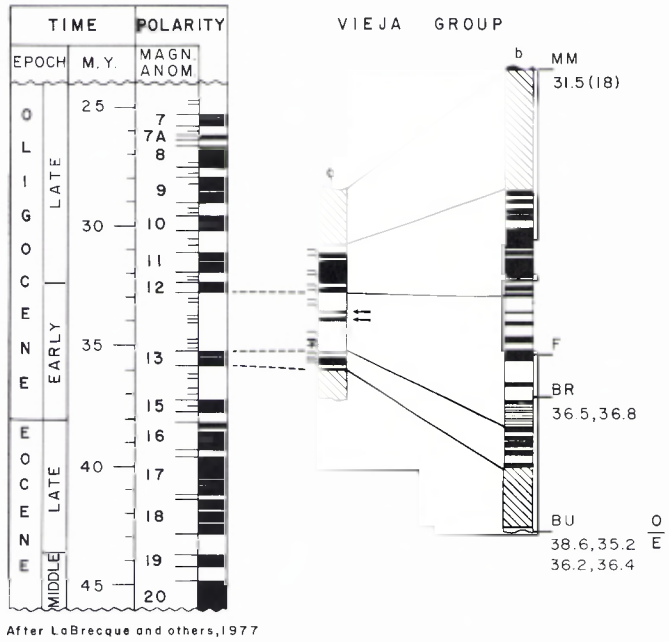

Figure 5. Correlation of Vieja reversal stratigraphy (columns a *and* b*) with the marine magnetic time scale (left column). Column* a *is a simplified version of column* b*, in which zones less than 3 m thick are represented by short lines to the left of the column. Hachured zones are of undetermined polarity. Positions and ages of Mitchell Mesa Ignimbrite (MM), Ford siltstone (F), Bracks Rhyolite (BR), and Buckshot Ignimbrite (BU) and position of Oligocene-Eocene boundary (O/E) are indicated in column* b.

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Tobosa plant, *Hilaria mutica*.