9. Magnetostратigraphy of the Eocene-Oligocene Transition in Trans-Pecos Texas

DONALD R. PROTHERO

ABSTRACT
Previous studies of the Unstan, Duchesnay, and Chadronien rocks and their mammalian faunas of Trans-Pecos Texas are supplemented by more recent magnetostatigraphic research to provide a more up-to-date chronostatigraphic framework. In the Viqia area, reinter-
pretations of the work of Testarmata (1978) Testarmata and Gose, 1979, plus new magnetics, show that the Viqia Group (Colluna Chaps—Coapue Mountains tuffs) spans the interval from Cen C 19a (42 Ma) to C13n (33 Ma). The early Duchesnay Candesnay tuff occurs in C13n (42.5 Ma), the late Duchesnay Pravete tuff and early Chadronien Little Egypt tuff in C13n (37.3 Ma), and the mid-Chadronien Aircupt tuff in C16n (35.5 Ma). In the Agua Fria area, the Devil’s Grayed Formation spans the interval from C13n (42.5 Ma) to C13n (33 Ma), with a gap between C16n (35.5 Ma) and C16n (33 Ma) (whether between the Duchesnay faunas of the Skyline and Corra chaias). Revisions of Wallace’s (1992) magnetics interpretations place the mid-Pliocene Jester Lookout tuff in C15n (42.5 Ma), the early Unstan Whitehead Swarm tuff in early C12n (45.4 Ma), the late Unstan Seidner Sediment and Peril Beach tuff in C15e (142 Ma) and C16n (41 Ma), respectively. The mid-Chadronien Coffee Cup tuff occurs in C15n (42 Ma).

INTRODUCTION
The Trans-Pecos region of Texas is the only place in North America where the middle-late Eocene is recorded by superposed mammalian faunas datable by both radiometrices and magnetostatigraphy. There is no place in North America that contains interfingering marine/mammal sequences of this age, so this area is the key to unlocking the details of the Unstan-Duchesnay-Chadronien transition in land mammals.

The Trans-Pecos rocks (Fig. 1) contain a number of well-dated faunas of middle Eocene (Unstan and Duchesnay) and late Eocene (Chadronien) age (Wilson et al., 1968, Wilson 1978, 1980, 1984, 1986) with extensive radiometric dating (McDowell, 1979; Henry et al., 1986; Henry and McDowell, 1986; Henry et al., 1994). The first magnetostatigraphic work in the area was by Margaret Testarmata (1978, Testarmata and Gose, 1979). She sampled rocks in the Viqia area (Fig. 1) between the Buckshot Ignimbrite and the Mitchell Mesa Rhyolite, which included the Chambers and Capoer Mountain tuffs. However, Testarmata did not sample the late Unstan sections of Colluna Tuff, or many of the fossil localities of Duchesnay and Chadronien age in the area. Her sites were spaced about 1.5 m apart stratigraphically, but only a single sample was taken at each site, so no site statistics were calculated. Rock magnetic analyses (Testarmata, 1978, pp. 15-18) showed that the remanence was carried by fine-grained magnetite partially oxidized to hematite. Thermal demagnetization at 400-500°C gave the best results in her study.

Testarmata and Gose (1979, Fig. 7) summarized their magnetic stratigraphy, which was extremely noisy, with many single-site normal “zones.” Most of these “zones” are probably due to unremoved overprinting, which is hard to detect when only one sample per site is analyzed. It is possible, however, that some of these short polarity events might represent true “tiny wiggles” of the magnetic polarity time scale, which have been recently documented in the early Oligocene (Hard et al., 1993). This “tiny wiggle” interpretation might be more likely in the cases of short polarity zones 2-3 t
times in thickness. However, since the short zones cannot be correlated over distance, and do not seem to match any version of the magnetic polarity time scale, they are ignored in my correlations.

Once the shortest polarity events are discounted, Testarmata and Gose (1979) found a relatively long zone of reversed polarity ranging from just below the Brackas Rhyolite to above the Ford andesite, which they correlated with Chron C12r (Fig. 2). They based these corre-
lations on the K-Ar dates then known from the volcanic units, and using the magnetic time scale of Lajonis et al. (1977). At that time, Chron C12r was thought to range from 35-35 Ma, and the K-Ar dates on the Brackas Rhyolite were 36.5 and 36.8 Ma. Unfortunately, a key
interval just below the Mitchell Mound Rhyolite did not produce a stable polarity signal, and thus was considered of indeterminate polarity.

As a result of magnetic correlations with Playasoff Ries, Wyoming, Prothero et al. (1982, 1983) interpreted T. M. H. and G. A. C. (1976, 1977) from groups (Fig. 2). Prothero et al. (1982, 1983) had found that they belonged to the Centre C22; in middle Claymore basin in Playasoff Ries between K-A dates of 32 and 36 Ma. Consequently, they thought that the Centre C22 is the K-A date that the Campanian-Maastrichtian interval in the type area of the Playasoff Ries. This was also a key element in the Clade's stratigraphic framework, because the lower K-A date on the Sticks Rhyolite and the L Transform (1980) is included inside it.

Another palaeomagnetic study in the region was undertaken by Wallace et al. (1982, 1992) who sampled the lower and middle members of the Devonian Gavilán Formation in the area of the Playasoff Ries (Fig. 2). They also studied the Playasoff Ries (1984). Although multiple samples were eventually collected per site, no site statistics were calculated. The authors also showed that the mean sample was not significantly different from the gavilán Formation in the Playasoff Ries (1984). The result was a K-A date of 23-25 Ma and 30-32 Ma, respectively. The mean sample was thought to be similar to the gavilán Formation in the Playasoff Ries (1984).


Figure 3. Vector demagnetization plots of thermal results on typical samples from Trans-Pecos Texas. All four samples are reversed, with a component of normal remanence reversed at temperatures of 200-400°C. From 500-600°C, most of the magnetization must be due to a high Curie point mineral such as magnetite. The results below 150°C represent the low temperature component, then show the reverse component. L is the NRM value. Each increment equals 10° C.

Figure 4. Magnetic stratigraphy of the Strampone Sandstone Member of the Devil's Canyon Formation, Agua Fria area, Texas (Severa et al., 1984, fig. 10). The Chaconian Red Hill fauna (CMo 6/1861) is found at the base, and the Miller Basin limestones occur at the top. Positive values on geopagnetic pole (VGP) indicate normal polarity; negative VGP indicates reversed polarity. Small circle, Class II area of Ogg and others (1977); Class III area of Ogg and others (1977). This area is traversed by the Red Fork river. The Class II area is to the west of the river, Class III area, in which two stations out of three showed a clear polarity preference. Stratigraphy from Wilson (1974, fig. 4).

Severa et al. (1984) noted that the polished sections of these rocks reversed under reflected light showed magnetite which was partially remagnetized as well, and this is in good agreement with our results. Once the experiment was reversed, thermal demagnetization at 450-500°C seemed to produce the most stable results, and these directions were used for further analysis. The directions showed good clustering around reversed and reversed poles, and produced a positive reversed vector since the mean for the normal sites (n = 24; D = -182.7°, I = 13.1°, φ = 13.9°) was negligible to the mean for the reverse sites (n = 26; D = 181.0°, I = 10.8°, φ = 13.1°). A number of important sections were sampled. One section spanned about 100 feet of the Strampone Sandstone Member, or upper member of the Devils Canyon Formation (Severa et al., 1984, fig. 10). This section supplemented the records of Wilson (1974), who studied the lower and middle members of this formation. As can be seen in Figure 4, the section was mostly of reversed polarity, with a normal polarity zone between 400 and 500 feet on the measured section, and another normal polarity zone from 650 feet to the Miller Basin limestones at the top.

A second long section opened over 500 feet of the Colona Tuff (Wilson, 1974, fig. 6), the primary locality for the early Chaconian Chordacean fauna. As shown in Figure 5, the feet 150 feet of this section were reversed, followed by normal rocks from 100 to 375 feet, and reversed rocks to the top. Fifty feet of the section in the Reeves Member (Wilson, 1974, fig. 10), the primary collecting locality of the early Chaconian Littt Egypt (coal frame), were entirely of normal polarity.
Figure 6. Temporal correlation of the magnetic stratigraphy of Tonsina (1979), Tonsinata and Guad (1979), Walker (1982), and this study with the new time scale of Buggisch et al. (1983). Circles and time of Redwood and Shalter (1982). Punctures of the corresponding markers have been shown. All data are R.A. (from Heny et al., 1986), unless indicated otherwise. Darker lines correspond to the middle Miocene to lower Pliocene interval. Abbreviations: BRS = Beringian; MR = Mid-Rupelian; SR = Secretanian; MB = Middle Miocene; MPFS = Magnetic polarity time scale. The middle Chacovian Redwood local fauna (Wilson, 1978, p. 22), spanning about 46 feet, was of normal polarity for the lower 60 feet, at the top of the section was reversed in polarity.

CORRELATIONS

Figure 6 shows a summary of the correlations of the sequence analyzed in this study. The sequence originally reported by Tonsina (1978), Tonsinata and Guad (1979) and Walker (1982, 1986). They can be divided into two main zones, the lower, the Vein area, north of Chacovian Mitchell Mirror Rhyolite (Heny et al., 1986). Heny et al. (1986) also divided it into four main zones: 1) Vein area, 2) North area, 3) Middle Miocene, and 4) Pliocene. The two methods are in good agreement and the age of this unit is well-estimated. Stevenson et al. (1986) reported K-A dates of 33.2 ± 1.1; 33.7 ± 0.7, on the upper part of the section (Fig. 6). The lower part of the section contains the Chacovian Red Hill local fauna, part of the Agua Fria area (Stevens et al., 1986). Given these constraints, the simplest interpretation is that the lower part of the
section probably contains with C114, the middle normal zone with C125, and the upper normal part of the section with C112 (Fig. 5).

Walton (1962, fgs. 15-16) reported magnetic anomalies for the lower and middle members of the Devils' Geyser Formation. These anomalies are represented on the lower and middle members of the Devils' Geyser Formation. Since the lower member is on the upper part of the section, the upper part of the section contains C114, the middle part with C125, and the lower part with C112 (Fig. 5). Since the lower member is on the upper part of the section, the upper part of the section contains C114, the middle part with C125, and the lower part with C112 (Fig. 5).

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