MAGNETIC POLARITY STRATIGRAPHY AND CORRELATION OF THE LEISEY SHELL PITS, TAMPA BAY, HILLSBOROUGH COUNTY, FLORIDA

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ABSTRACT

Oriented paleomagnetic samples were collected from plaster jackets containing fossils, *in situ* bivalves, and surrounding matrix from the Leisey Shell Pit. Analysis in the paleomagnetic laboratory indicates that the magnetization is probably carried in fine-grained magnetite. After both alternating field and thermal demagnetization, all of the five sites sampled are interpreted to be of reversed polarity for the local section at Leisey. In conjunction with the stage of evolution of the fossil mammals and interbedded Sr isotopic data, the Bermont Formation in the area of Leisey correlates to the late Matuyama Reversed Chron between about 1.66 and 1.4 Ma.

RESUMEN

Se colectaron muestras de orientación paleomeagnéticas desde moldes de yeso que contenían fósiles, bivalvos *in situ* y matriz circundante, provenientes de la Excavación de Conchuelas de Leisey. Análisis realizados en el laboratorio paleomeagnético señalan que probablemente la magnetización es transportada en magnetita de grano fino. Después de la desmagnetización con campos alternos y térmica, se considera que los cinco sitios muestreados en la sección local de Leisey tienen polaridad revertida. En conjunto con el estado evolutivo de los mamíferos fósiles y la formación de los isótopos de Sr en capas entrelaminadas, la Formación de Bermont en el área de Leisey se correlaciona con el Cron Revertido del Matuyana tardío, de cerca de 1.66 y 1.4 Ma.

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INTRODUCTION

The fossil record of Cenozoic mammals in Florida is excellent and unparalleled elsewhere in eastern North America. Despite this abundance, however, this sequence suffers from the lack of long continuous exposures, which are needed for paleomagnetic stratigraphy, and furthermore, there are no outcrops of potentially datable volcanic units. Thus, until recently, the age determinations of the rich Florida sequence were obtained from stage of evolution comparisons with dated faunas from the western United States. The results from the paleomagnetic and isotopic dating presented in this volume therefore represent a new direction in understanding the calibration of mammal evolution in this important region.

In this paper I present the results from the paleomagnetic sampling and laboratory analyses of samples collected from the Leisey Shell Pit. As will be explained below, this represents a novel approach because in contrast to conventional practice in which oriented sediments samples are collected, paleomagnetic samples were taken from sediment infillings (steinkerns) of oriented, *in situ* bivalves. The resulting polarity data are consistent with the other chronological results presented elsewhere in this volume and synthesized in the article by Morgan and Hulbert.

ACKNOWLEDGMENTS

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PALEOMAGNETIC SAMPLING AND LABORATORY PROCEDURES

The paleomagnetic study of the Bermont Formation at Leisey Shell Pit was initiated in 1987, and as such, there were no *in situ* exposures from the highly fossiliferous 1A locality, which had previously been excavated and was then destroyed during mining operations. Accordingly, paleomagnetic samples ("sites") were taken from oriented (top/bottom and some with azimuth) plaster jackets that were still available in the Vertebrate Paleontology collection at the FlaMNH. In the worst case scenario where only top/bottom data were available, the resulting polarity determinations could therefore be made from the vertical component (inclination) of the paleomagnetic vector (this procedure yields data similar to that of azimuthially unoriented deep-sea cores). In contrast, exposures from Leisey 3A were still available, and in addition to those taken from oriented plaster jackets,

Figure 1. *In situ* bivalves (*Mercenaria*) showing paleomagnetic sampling. After the flat surface is formed by scraping away part of the shell, the fossil is oriented with an azimuth. In the laboratory, these fossils are sawed open and the internal sediment cast (steinkern) is impregnated with a non-magnetic hardener. Thereafter, the sample is cut into a 2.5 cm oriented cube to be analyzed in the paleomagnetic laboratory. (Photograph from author.)

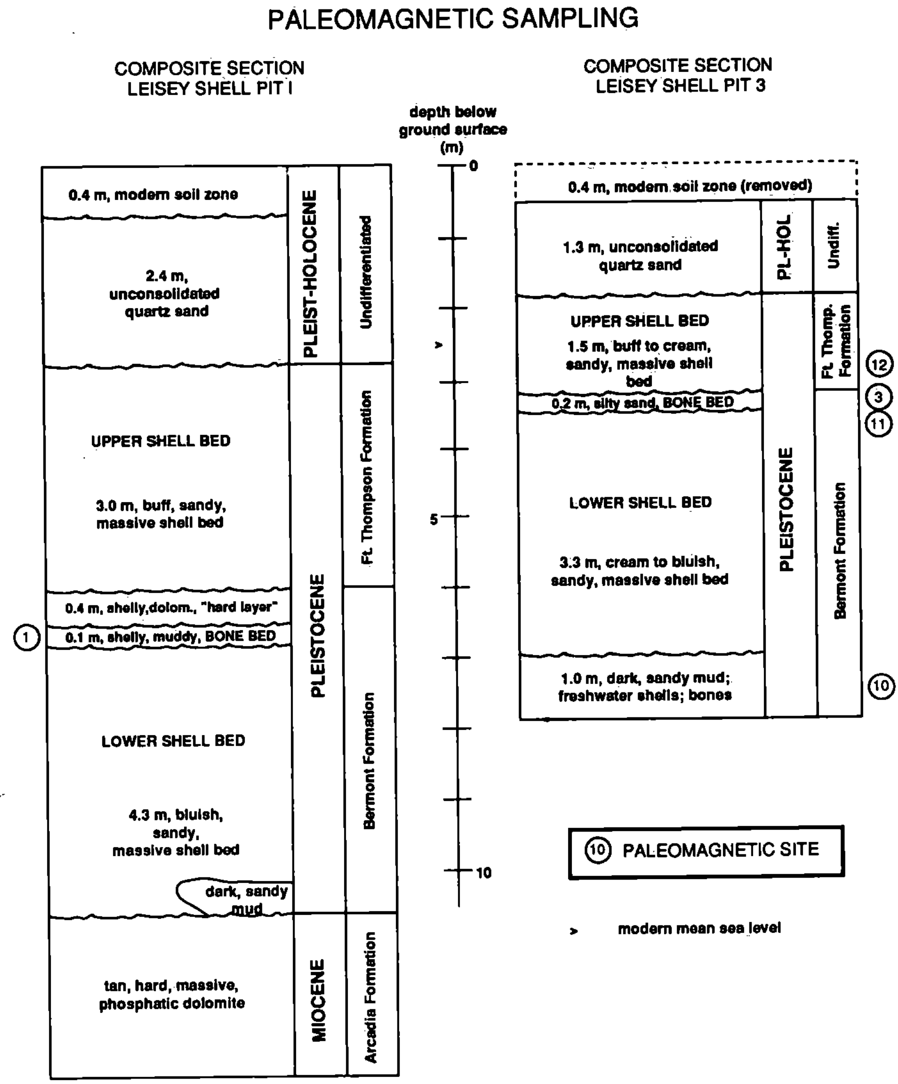

Figure 2. Stratigraphic sections showing Leisey 1A (where plaster jackets were collected prior to this study) and Leisey 3A, and position of paleomagnetic samples. The site numbers correspond to those listed in Table 1.

standard paleomagnetic samples of homogeneous fine-grained sediments were supplemented with oriented *in situ* bivalves (*Mercenaria*; from which hardened steinkerns were cut into paleomagnetic samples, see Fig. 1).

In total, three to five separately oriented paleomagnetic samples were taken from each of five horizons at Leisey, including the bone-bearing units (Fig 2.). In the laboratory these samples were prepared into standard 2.5 cm cubes. The poorly indurated nature of these sediments required that the samples be hardened. White glue or sodium silicate were used, both of which are non-magnetic (based on our measurements of test samples).

After preparation, samples were analyzed in the Paleomagnetics Laboratory at the University of Florida. In order to determine the dominant magnetic mineral, isothermal remanent acquisition experiments were carried out on selected samples (Fig. 3.). Magnetization was measured in a magnetically shielded room and measurements were made on a SCT cryogenic magnetometer. Demagnetization was done on Schonstedt alternating field (AF) and thermal demagnetizers. As is standard procedure, at least one sample from each locality was demagnetized in a stepwise regime in alternating fields of between 5 and 50 mT (milliTesla), some

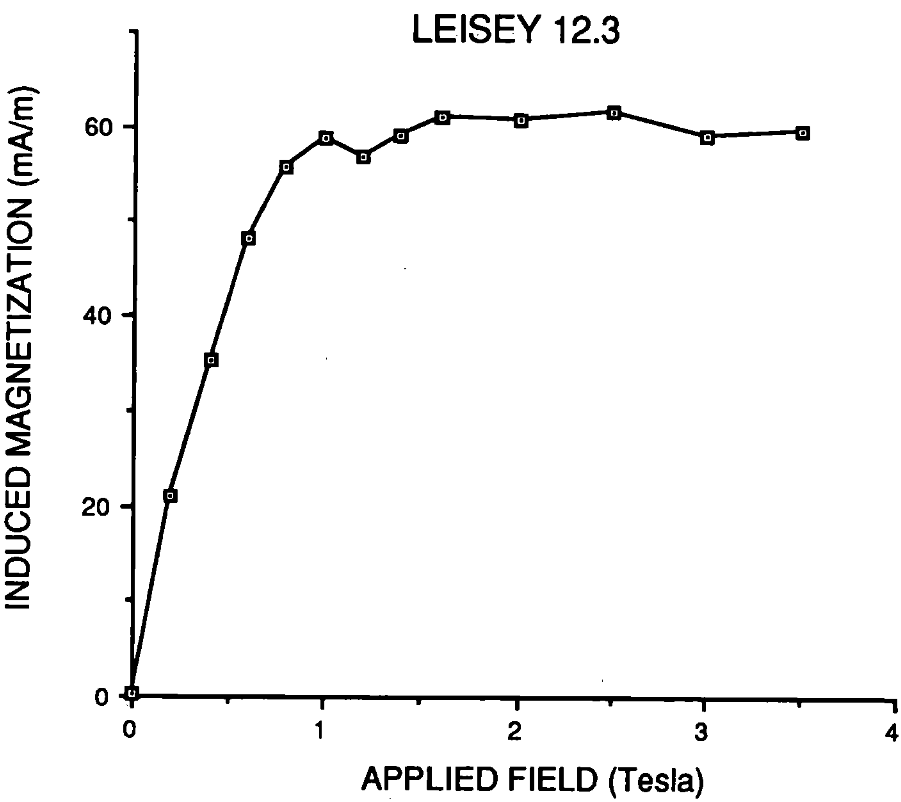

Figure 3. Isothermal remanence (IRM) experiment using representative example from Leisey (sample 12.3). In lower applied fields there is a progressive increase in magnetization until about 1 T. Thereafter, regardless of the increase in applied field, the induced magnetization remains the same, i.e. it is saturated. Behavior such as this is characteristic of low-coercivity minerals and probably represents fine-grained magnetite.

were demagnetized further up to 100 mT. A second sample from each site was also subject to a stepwise regime of thermal demagnetization, usually in 12 or more steps between 100° and 620° C (Fig. 4). The subsequent treatment of the other samples from each site was based on the results of the first and second samples.

PALEOMAGNETIC RESULTS

As exemplified in Figure 3, the results of the IRM acquisition experiments indicate that the dominant magnetic mineral in the Leisey samples saturates in relatively low fields of about 1 T or less. This kind of behavior is characteristic of low coercivity magnetic minerals and is probably carried in fine-grained magnetite. This observation is important to note, because, as such, the results from the AF demagnetization should be as valid as those of the thermal demagnetization. As it turned out, the polarity data are consistent from both of these laboratory techniques and suggest the lack of a high-coercivity component attributable to minerals such as hematite or geothite, which are oftentimes encountered in terrestrial sediments.

Intensities of magnetization lie within the general range that would be expected from fine-grained sedimentary magnetite. Prior to demagnetization, the mean NRM magnetization was 0.5 mA/m (N=17). After demagnetization, mean intensities ranged from 0.1 mA/m at 40 mT (N=9), to 0.14 mA/m at 500° (N=6), to 0.05 mA/m at 600° C (N=6). The large drop in intensity between 500° and 600° further suggests that magnetite is the dominant carrier of the paleomagnetic remanence.

The paleomagnetic data from the Leisey sites are summarized in Table 1. Values were taken from single steps at higher demagnetizations, thereby minimizing low-coercivity of low-blocking temperature components of the NRM. With the possible exception of 11.2, all samples are of negative inclination, and those with declinations lie within the southern hemisphere. As such, all of the paleomagnetic data indicate a reversed polarity for the Bermont Formation, and they yield a unit mean of dec. 157.24°, inc. -34.97° using the statistical method of Fisher (1953).

Comments on the Quality of the Paleomagnetic Data.– It is clear from the data presented in Table 1 that the quality of the paleomagnetic data is less than what would be hoped for. For samples 1 and 3, this could not be avoided because, as mentioned above, they were taken from sediment samples encased in plaster jackets. The data from the other samples (10-12) are also less than desirable, with only two samples per site giving results from which the polarity could be interpreted. In particular, the original data from these sites show considerable dispersion in declinations, and this possibly resulted from post-mortem rotation of the *Mercenaria* bivalves after acquisition of remanence. Despite these problems,

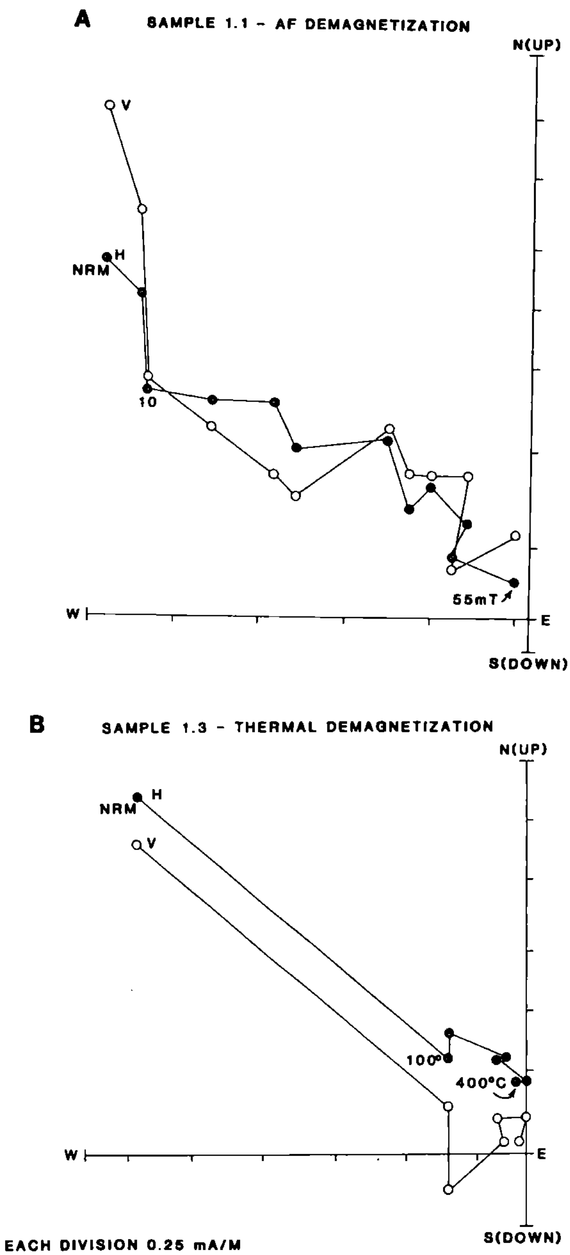

Figure 4. Plots of the behavior of the horizontal and vertical components of magnetization after alternating field (A) and thermal (B) demagnetization from Leisey. Although the declination is unoriented (see text) the vertical component indicates reversed polarity. The trend to the origin in higher demagnetization steps is interpreted to indicate removal of secondary components and isolation of the stable, "characteristic" component of magnetization that is used to interpret the polarity of the sediments at, or soon after, time of deposition.

Table 1. Paleomagnetic data from the Leisey Shell Pit used to interpret the site polarities. Also see Figure 2 for location of samples.

Site	Sample	Treatment	Declination	Inclination	Polarity
1	.1	55 mT	NA[1]	-33.8	Reversed
	.2	55 mT	NA	-32.2	Reversed
	.3	400° C	NA	-10.5	Reversed
	.4	50 mT	NA	-58.3	Reversed
	.5	70 mT	NA	-70.3	Reversed
	.6	250° C	NA	-3.3	Reversed
Leisey 3A					
3	.2	350° C	NA	-31.2	Reversed
	.4	350° C	NA	-32.2	Reversed
	.6	350° C	NA	-31.2	Reversed
(Other samples .1, .3, and .5 gave inconsistent results)					
10	.1	40 mT	115.6	-14.0	Reversed
	.2	590° C	102.2	-10.2	Reversed
11	.1	35 mT	185.4	-4.0	Reversed
	.2	550° C	270.5	32.3	?Normal
12.	.1	60 mT	224.9	-58.6	Reversed
	.2	500° C	200.4	-43.2	Reversed
10-12 Combined (except 11.2)			157.2	-34.97	Reversed
		(N=5, R=3.54, a_{95}=57.40°, k=2.73)			

[1] NA; not applicable because samples were taken from azimuthally unoriented sediments in plaster jackets.

however, the data indicate that reversed polarity predominates in the Leisey section.

In its most useful form, magnetic polarity stratigraphy is the technique of establishing the pattern of reversals in a local section and correlating it to the time scale. One might argue that, in situations such as those encountered at the Leisey Shell Pit and other recently analyzed late Cenozoic deposits that contain less than optimal sampling regimes and only single polarity patterns (e.g., Australia, Whitelaw 1991; Jones et al. 1991), paleomagnetism is of dubious geochronological value. On the contrary, magnetic polarity data, particularly if reversed (i.e, suggesting the lack of a present-day overprint) and if taken in conjunction with other, associated geochronological data, increase our ability to make valid correlations to the time scale.

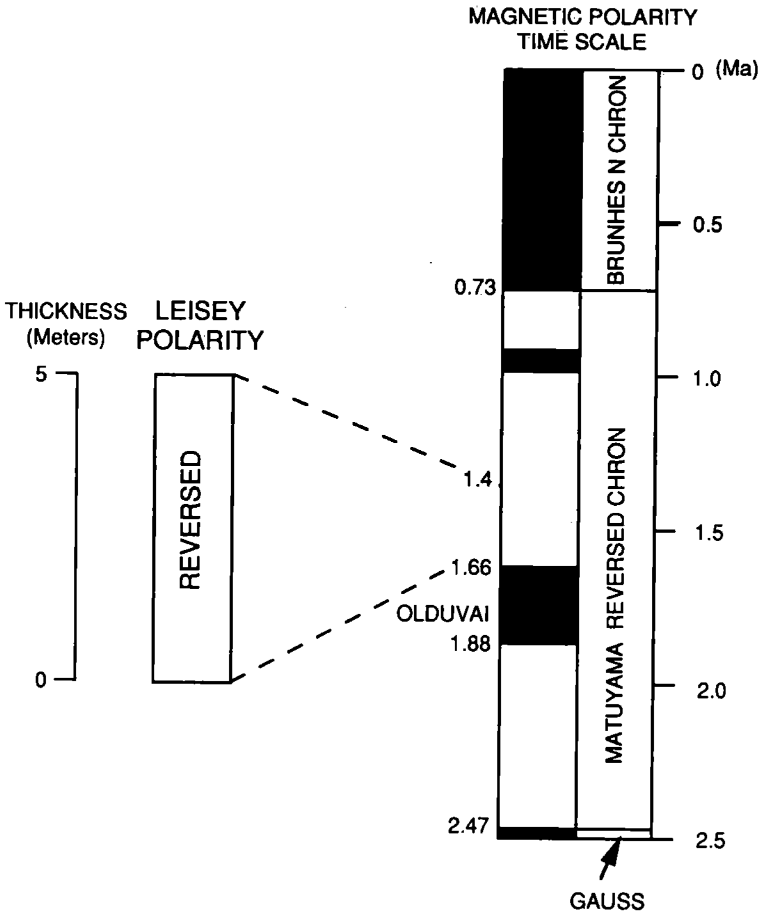

Figure 5. Correlation to the time scale (using Berggren et al. 1985). Given the reversed polarity represented at Leisey, as well as the other age constraints provided by the Irvingtonian age and Sr isotopic determinations (see text and other articles in this volume), the Bermont Formation and Leisey Shell Pit correlate to the late Matuyama Reversed Chron, and are therefore younger than 1.66 Ma (post Matuyama) and have an upper age limit (based on the Sr confidence limits) of about 1.4 Ma.

DISCUSSION: CORRELATION TO THE TIME SCALE

As also discussed in the summary article by Morgan and Hulbert (this volume), several lines of evidence are relevant to establishing the precise age of the Leisey Shell Pit and its contained fauna: (1) the mammalian fauna is of late early Irvingtonian North American Land Mammal age, which constrains the age to between 1.6 Ma to about 1.0 Ma (Lundelius 1987); (2) the Sr isotopic age determinations for the interbedded molluscs are about 1.75 $\pm$ 0.35 Ma (Jones, this volume); and (3) the entire section at Leisey is interpreted to be of reversed polarity. Given these constraints, the Bermont Formation and fossil mammals from the Leisey Shell Pit correlate best to the middle part of the Matuyama Reversed Chron above the Olduvai Normal Subchron (Fig. 5).

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