38. MAGNETOSTRATIGRAPHY OF CRETACEOUS SEDIMENTS FROM DSDP SITE 386[1]

B. H. Keating and C. E. Helsley, Hawaii Institute of Geophysics, University of Hawaii, 2525 Correa Road, Honolulu, Hawaii

INTRODUCTION

The paleomagnetic reversal sequence for the Upper Cretaceous has been established through studies of DSDP cores, land sections, and sea-floor magnetic anomalies (see Keating et al., 1975); but the paleomagnetic stratigraphy of the Lower Cretaceous is not so well known. In an attempt to extend the polarity sequence into the Lower Cretaceous, we have taken approximately 2000 oriented samples from seven sites drilled in the Atlantic Ocean during Legs 40, 41, 43, and 44. A comparison of the reversal sequences from Sites 361, 363, 364, 386, 369, and 391C will be included in the Leg 44 report.

SAMPLING PROCEDURE

From DSDP Leg 43, Site 386, drilled in the northern Atlantic at 31°11′N, 64°14′W, 375 samples were collected. For the most part, 2.5-cm-diameter cylindrical samples were drilled from the sediment core using a diamond drill bit; these were cut to cylinders 2.5 cm in length. In the least lithified portions of the core, samples were collected using cylindrical plastic sample holders and in the fissile portions of the core, 1-cm cubes were cut from the core and measured in cubic plastic sample boxes. The procedure followed was to restrict sampling to core segments whose length was greater than the core diameter in order to eliminate inversions of core segments which might have taken place during drilling. An arrow marking the up direction was scribed along the center of the split core face. The core segment was then lifted from the core tray and a sample was drilled (or cut) at right angles to, and centered upon the orientation scribe.

The samples were flown to Dallas and refrigerated until measured on a ScT superconducting magnetometer, housed within a mu-metal room. The samples were refrigerated in order to minimize the chemical, physical, and magnetic changes that take place during desiccation and oxidation. After measurement of the natural remanent magnetization (NRM), a group of samples representative of the various lithologic units sampled in the cores was selected for pilot alternating field demagnetization studies using peak fields of 50, 100, 150, 200, and 300 Oersted. Selected portions of the original collection of samples were then demagnetized at alternating field values deemed appropriate on the basis of the pilot study, in this case 100 oe and 150 oe.

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SITE 386–STRATIGRAPHY

Hole 386 penetrated approximately 340 meters of Cretaceous sediments. Shipboard scientists divided the Cretaceous section into several lithologic units. The first sampled, Unit 5 (only Core 34 of this unit was sampled) consists of claystone. Unit 6 (Core 35-Core 41, Section 5; 630-725 m), consists of multicolored claystone, varying from red to gray red, and subsidiary marly limestones (greenish gray to gray-bluish white). Manganese nodules are found at the top of the unit.

The lower part of Unit 6 consists of zeolitic claystones that are dusky yellowish brown and interlayered with a few light greenish gray horizons 1 cm or less in thickness. Fe-Mn-oxides are present throughout Cores 35 to 40 and micronodules are present in some samples. The basal part of Unit 6 (Sub-unit 6C) consists of dark reddish brown claystone with occasional bands of dark greenish gray claystone, reflecting a pelagic environment.

Unit 7 (Core 41, Section 5-Core 65) consists of dark greenish gray claystones, marly chalk, and dark gray to black claystones (mudstones). The black claystones frequently are rich in organic matter. Radiolarian sand layers are scattered throughout the unit and pyrite, locally forming concretions, is present throughout the subunit.

Examination of nannofossils and radiolarians (see Site 386 Report) suggest that the sediments of Core 34 are upper Paleocene. Core 35 contains mid to upper Maestrichtian nannofossils.

Unit 7, in contrast to Unit 6, provides an exceptional record of well-preserved Albian and Cenomanian planktonic foraminifers and, since core recovery was relatively good, these cores can therefore be used to correlate a magnetostratigraphy with a well-documented biostratigraphic zonation. Core 44, Section 4-Core 49, Section 3 is assigned to the Cenomanian, Core 49, Section 4-Core 52 to the upper Albian-Cenomanian, and Core 53, Section 1-Core 57 to the upper Albian. Core 58, Section 1-Core 59, Section 1 is assigned to the middle Albian and Core 59, Section 2-Core 65, Section 1 to the lower Albian. (See Biostratigraphic summary in the Site 386 Report, this volume.)

Site 386 is located within the Cretaceous Quiet Zone, some distance from the youngest of the Keathley sequence anomalies. Thus, based upon the observation of sea floor magnetic anomaly sequences, the lower portion of Hole 386 should be characterized by an absence of magnetically reversed intervals. However, previous observations of the polarity of Lower Cretaceous cores by Keating and Helsley (1978a, b) suggest that additional reversed intervals may be present within Albian and Aptian material. Thus, we might expect to find several short intervals of reversed polarity near the base of the sampled interval.

STABILITY OF MAGNETIZATION

In order to test for magnetic stability, pilot samples from the core were subjected to progressive alternating field partial demagnetization studies. Samples chosen for the pilot study reflect the various lithologies found at this site (see Table 1). The shapes of the alternating field demagnetization curves vary widely (Figure 1a). For the most part, the curves are concave upward indicating that alternating field demagnetization through 50 oe has removed essentially all of the unstable secondary component in the samples. Two samples, 58-4, 44 cm and 35-4, 61 cm, show very high stability, as the intensity remains almost constant from 50 through 300 oe. The specimen displaying the highest coercivity is a black, fine-grained mudstone. In contrast, Sample 57-2, 114 cm, also a black mudstone but much richer in carbonate, displays a distinctively different demagnetization curve, the intensity at 300 oe being half that of the black mudstone with the lower carbonate content.

Sample 35-4, 61 cm, a green limestone, displays a large decrease (almost 50%) in intensity after demagnetization at only 50 oe. However, from 100 to 300 oe there is little change in intensity, again indicating that a stable component of magnetization is present. Samples 38-2, 14 cm and 38-6, 111 cm (red claystone) display large drops in intensity at low fields (50 oe). However, at higher fields the rate of change decreases sharply in contrast to previous studies of red claystones from the sea floor (Keating et al., 1975b). The demagnetization curve is very similar to those displayed by numerous chalk and limestone specimens. Thus, the magnetic mineral present within the white, carbonate-rich bands within both specimens apparently dominates the contribution made by the magnetic mineral contained within the red claystone layers. Sample 34-2, 101 cm is a green claystone which displays a progressive loss of intensity at each demagnetization step, indicating that

TABLE 1
Description of Samples Used in Pilot Demagnetization Study

Sample (Interval in cm)	Lithology
34-2, 101	Green claystone
35-4, 61	Light green limestone
38-2, 14	Alternating red claystone and white carbonate rich bands
38-6, 111	Alternating red claystone and white chalky bands
57-2, 114	Gray black mudstone
40-3, 132	Brown claystone
58-4, 44	Black mudstone

[a]Additional pilot samples were studied; however, for clarity only a limited number are illustrated here.

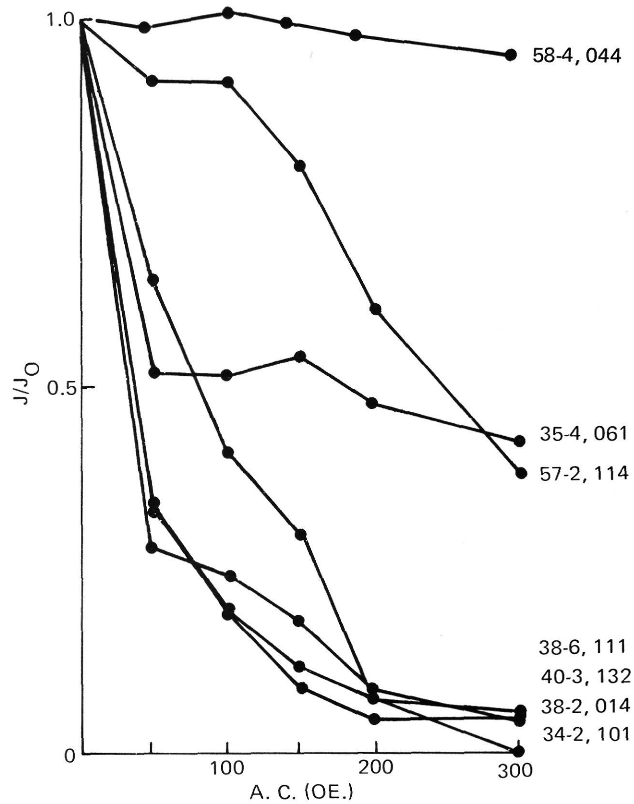

Figure 1a. *Normalized alternating field demagnetization curves for samples from Site 386. Sample identification indicates level in core from which sample was taken.*

a strong secondary magnetization has not been satisfactorily removed. Based upon these demagnetization curves, a 150 oe demagnetization step was selected for further demagnetization studies. By 100 oe, the unstable components of magnetization seen in most specimens have been removed, yet significant portions of the original magnetization still remain, and thus one is able to reliably identify the polarity of the specimen.

Figures 1b and 1c display changes in inclination and direction, respectively, after demagnetization. Samples 57-2, 114 cm (black) and 34-2, 101 cm (green) display high inclinations and show little movement on demagnetization. (Note that these samples have no absolute or relative orientation in regard to declination; thus, sample direction are meaningful only when comparing demagnetization steps for a single sample; the directions for multiple samples should be scattered around the stereonet.) Samples 38-2, 14 cm (red) and 58-4, 44 cm (black) also show little change in directions of magnetization during demagnetization experiments. Therefore, these four samples show directional stability despite the fact that the decay in intensities in a.c. fields below 50 oe suggests a considerable component of soft magnetization. Samples 38-2, 14 cm (red) and 58-4, 44 cm (black) display intermediate and low inclinations that show little change in inclination; however, they do display changes in declination.

The remaining samples, 38-6, 111 cm (red) and 35-4, 61 cm (greenish), show large changes in both decli-

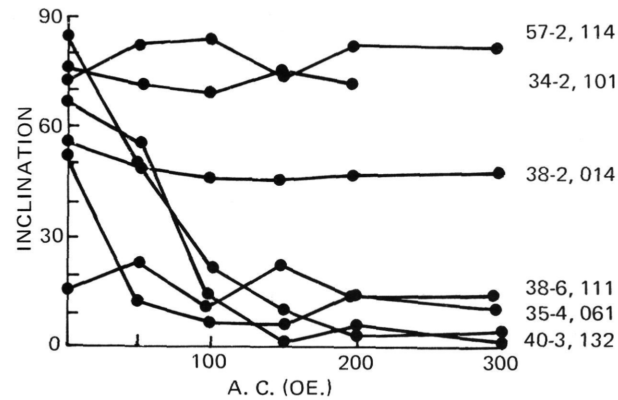

Figure 1b. *Change in inclination with demagnetization in a.c. fields up to 300 oe. Sample identifier indicates position in core.*

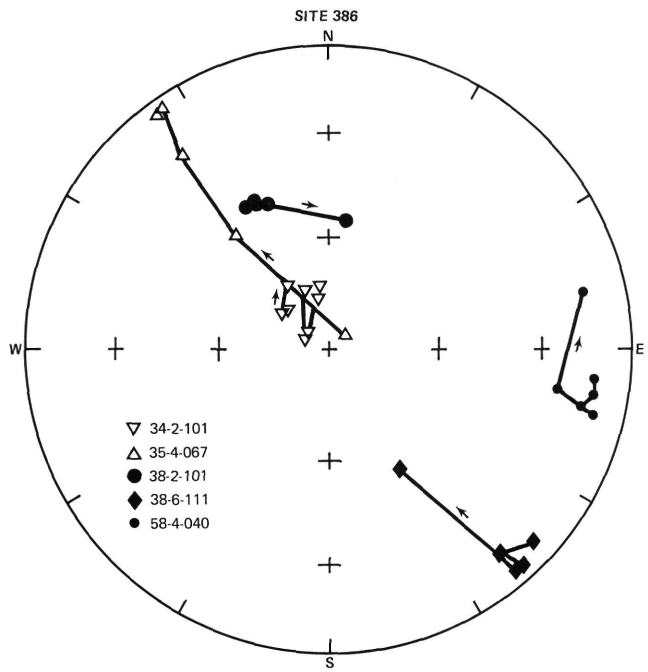

Figure 1c. *Stereonet (polar) projection of changes in direction of magnetization after demagnetization.*

nation and inclination. These changes when plotted on a stereonet show that the directions move from a direction indicative of normal magnetization (positive inclinations) to one of almost zero inclination. This could be the result of the removal of a normally magnetized secondary component from a reversely magnetized primary component. In this case, all samples displaying low inclinations after demagnetization have a primary component of magnetization that is reversely magnetized.

RESULTS

A stratigraphic plot of sample inclinations and intensity is shown in Figure 2. The mean NRM intensity was 2.04×10^{-5} emu. The mean intensity after demagnetization to 150 oe was 2.49×10^{-6} emu. In general, intensities range between 1×10^{-6} and 5×10^{-5} emu. However, clusters of samples having significantly higher intensities are evident throughout the section. These strongly magnetized samples occur in Cores 35, 38-40, 45, and 63-65. The first group is characterized by the presence of manganese micronodules, and the second is characterized by zeolitic claystones. The remaining clusters of samples having high intensity cannot be assigned a distinctive lithologic character which would allow differentiation from the samples having lower intensities. The mean inclination after demagnetization was 44.0° with a standard deviation of 12.1 (N = 307).

The stratigraphic plot of sample inclinations and intensities after demagnetization to 150 oe (Figure 2) shows an impressive clustering of results in all but the uppermost two cores. Several one-point reversals are present and may represent sample inversions resulting from handling. Reversed intervals represented by two or more consecutive samples occur in Cores 35, 52, 53, and 59. The reversed polarity intervals from Cores 35, 52, and 59 have been expanded by a factor of 10 and are shown in Figure 2. These intervals show a distinctive shift of inclination of approximately 90°. The reversed polarity in Core 35 was found in Maestrichtian sediments. This reversed interval is followed by an interval of normal polarity that is believed to correspond to the lower portion of the Cretaceous Quiet Interval (Helsley and Steiner, 1969). The reversed polarity intervals in Cores 52, 53, and 59 occur in lower Cenomanian to Albian-Aptian sediments. (Data from one of the samples of reversed polarity from Core 53 were accidently omitted from the plots of demagnetized data; because of this oversight, the directions from Core 53 were not expanded to a larger scale.)

SUMMARY

Two important observations have resulted from the paleomagnetic study of Site 386. The first is mixed polarity within the middle Maestrichtian and the Albian and Aptian stages. Mixed polarity within the Maestrichtian has been reported previously in a detailed study of the Maestrichtian (Keating et al., 1975). Thus, the results from Site 386 substantiate mixed polarity within the Maestrichtian. The observation of reversed polarity within the lower portion of the core is somewhat surprising considering that the site is located within the Cretaceous Quiet Zone some distance from the margin of the Keathley anomaly sequence. However, the results from the study of Cenomanian-Albian and Aptian sediments from Legs 40 and 41 (4 sites) also show reversed intervals (one to four) in this time interval. Thus, five sites from DSDP Legs 40, 41, and 43 offer convincing evidence that at least four brief intervals of reversed polarity postdate the M-sequence (see Larson and Hilde, 1975).

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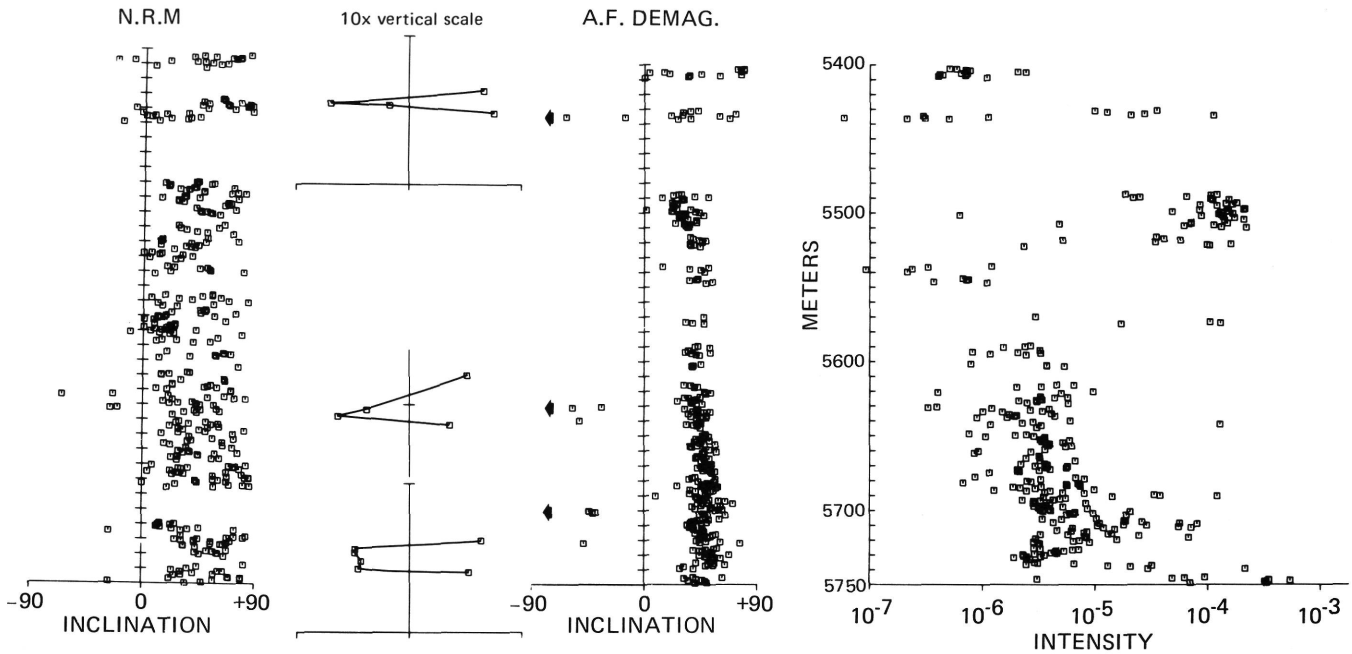

Figure 2. *Stratigraphic plot of sample inclinations and intensity for samples from Hole 386. Sample intensity is measured in emu. Intervals of mixed polarity are shown in expanded sections (vertical scale is expanded 10 times) in center inclination column. Outer inclination columns show NRM and demagnetized results. Each tick mark on the vertical scale represents 10 meters. Gaps between data points are due to poor recovery or gaps between adjacent cores. Depths on vertical scale are referenced to the drill rig floor.*

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