11. A PRELIMINARY PALEOMAGNETIC STRATIGRAPHY FOR LOWER EOCENE SEDIMENTS AT SITE 366 (SIERRA LEONE RISE) AND MIOCENE AND OLIGOCENE SEDIMENTS AT SITE 368 (CAPE VERDE RISE), NORTHWEST AFRICAN CONTINENTAL MARGIN

Ernest A. Hailwood, Oceanography Department, University of Southhampton, U.K.

INTRODUCTION

In recent years magnetic polarity stratigraphy has emerged as an accurate tool for absolute correlation between rapidly and continuously deposited sedimentary sequences (e.g., Opdyke, 1972). Furthermore, under favorable circumstances, comparison of such polarity sequences with the established paleomagnetic reversal time scale can allow the assignment of absolute ages to the sedimentary sequence. Attempts have been made to apply this method of dating to DSDP cores with varying degrees of success (e.g., Ryan, 1973; Allis et al., 1974). In principle the technique is limited by the following factors:

1) Assuming an axial geocentric dipole geomagnetic field model, a magnetic polarity reversal should, theoretically, be represented by a change in declination of 180°, and a change in sign of inclination. Unfortunately, DSDP cores are not azimuthally oriented, and in any case the rotary technique used for coring is likely to lead to relative rotation of different parts of the sediment core, so that even relative azimuthal orientation is not necessarily preserved within a single core barrel. Consequently, measurements of magnetic declination are of very limited use in attempting to define the paleomagnetic stratigraphy.

2) Since magnetic inclination is a function of latitude, it is important that the site is situated at a sufficiently high latitude to allow accurate determinations of inclination to be made.

3) The precision of paleomagnetic determinations will generally depend on the intensity of remnant magnetization, which in turn is related to the sedimentary lithology. In general, clastic sediments are more strongly magnetized than biogenic pelagic deposits.

4) The validity of the magnetic stratigraphy depends on a clear demonstration that the magnetization is stable and of primary origin.

5) The existence of hiatuses in the sedimentary record will generally lead to ambiguities in correlation of the observed magnetostratigraphy with the established polarity time scale.

6) It is important that samples should be taken at sufficiently close intervals to allow the detection of all major magnetic epochs and events. A suitable sampling interval would be in the range of 10^4 to 10^5 yr.

An attempt has been made to determine a preliminary paleomagnetic stratigraphy for a portion of the continuously cored Eocene sediments at Site 366 (Sierra Leone Rise) and Miocene/Oligocene sediments at Site 368 (Cape Verde Rise). Particular problems inherent in this study are:

1) Site 366 is located at a relatively low magnetic latitude (5°41'N) and is unlikely to have undergone significant latitudinal movement during the Cenozoic. The corresponding low paleomagnetic inclination (approximately 11°) places severe limits on the reliability of polarity changes determined from magnetic inclination alone;

2) At both sites the sedimentary sequences are comprised predominantly, of pelagic oozes, with very weak intensities of magnetization.

MEASUREMENTS

All paleomagnetic determinations were performed on a Digico Spinner magnetometer (Molyneux, 1971), and, in most cases, triplicate measurements were made for each sample, in order to assess the reliability of the measured paleomagnetic directions. The precision is specified in terms of the Circular Standard Deviation (C.S.D. $= 81/\sqrt{k}$) of the triplicate measurements, where k is the Fisher precision parameter (Fisher, 1953).

Alternating field (AF) demagnetization was carried out by means of a "Highmoor" electronically controlled demagnetizer.

SITE 368

General Remarks

The sediments cored at this site are predominantly terrigenous, and the biostratigraphic record is very incomplete. This provided a stimulus for undertaking paleomagnetic measurements, in the hope of being able to place additional age constraints on certain parts of the sedimentary record. A preliminary set of 44 samples has been measured, principally to evaluate the suitability of these sediments for more detailed study. Where possible, these samples were taken in groups of three from the least-disturbed portions of continuously cored Miocene and Oligocene sediments. Three samples were taken from the Pleistocene and Pliocene sections, and eight samples from the middle and upper Eocene sections.

Results

NRM measurements reveal consistently high intensities of magnetization ($>1.5 \times 10^{-6}$ Gauss) down to a depth of about 200 meters, below which there is an abrupt drop in value by at least one order of magnitude (Table 1), correlating with the lithological change from nanno oozes and marls to nanno-bearing silty clays. Pilot AF demagnetization at 50 oe increments to 300 oe has been performed on each of the samples from above 200 meters depth, but attempts to demagnetize the weaker samples from below this depth were largely unsuccessful, due to problems in measuring the extremely low intensities of magnetization.

In general, treatment at 50 oe leads to changes in remanence direction of ca 10°, and further treatment at higher fields produces only small additional changes (Figure 1[A]). This behavior is consistent with the successful removal of a weak viscous component. In a few cases larger directional changes were observed, sometimes resulting in a switch of polarity of remanence after AF cleaning (e.g., Samples 368-5-6, 32-34 cm and 368-7-6, 135-137 cm). The stability of the single sample treated from below 200 meters depth (Figure 1[B]) is apparently lower than that of samples above this level, but this is considered to reflect the lower precision in measurement of its very weak remanence.

Remanence directions after AF demagnetization at the optimum field (chosen by visual inspection of Figure 1) are listed in Table 1. Below the 200 meter depth level treatment was restricted to 50 oe for all except three samples. Of these, 368-13-4, 92-94 cm was demagnetized to 200 oe, and 368-17-4, 33-35 cm and 368-19-3, 58-60 cm were too weak to demagnetize at all. The repeatability of measurements after AF cleaning is good (C.S.D. of triplicate measurements < 7°, commonly < 2°) above the 200-meter level, but variable, and sometimes poor below this depth (Table 1).

The remanence directions are plotted as a function of depth in Figure 2. The declination values for different samples from the same core barrel are linked, since the

TABLE 1
Results of Magnetic Measurements for Site 368

Sample (Interval in cm)	Depth in Hole (m)	NRM Dec.	NRM Inc.	NRM C.S.D.	NRM INT ±S.D. (μg)	Demag. Field	After Demag. Dec.	After Demag. Inc.	After Demag. C.S.D.	After Demag. INT ±S.D. (μg)
2-3, 8-10	12.09	165.2	+61.6	1.0	6.21 ±0.22	50(P)	160.6	+53.0	0.5	5.49 ±0.30
4-5, 84-86	91.85	220.9	+12.2	2.3	1.48 ±0.03	50(P)	213.1	+6.5	2.1	1.38 ±0.03
5-6, 32-34	130.83	202.5	+21.6	3.7	1.81 ±0.02	100(P)	177.8	-10.9	1.6[a]	1.99
6-4, 47-49	165.98	5.7	-7.3	2.5	4.19 ±0.44	50	19.6	+0.6	3.9	1.34 ±0.18
6-5, 104-106	168.05	326.9	11.2	3.0	2.37 ±0.08	50	254.7	+24.6	3.0	1.43 ±0.08
6-6, 44-46	168.95	359.8	4.3	0.4	14.40 ±0.38	50	1.8	+7.7	0.6	9.23 ±0.08
6-6, 90-92	169.41	48.1	-25.1	1.3	4.69 ±0.10	50(P)	47.7	-30.0	0.9	3.96 ±0.04
7-6, 135-137	179.36	283.0	+24.6	3.4	6.75 ±0.07	300(P)	292.2	-36.4	6.9	0.47 ±0.04
9-2, 101-103	192.02	25.6	-1.6	2.6	3.78 ±0.13	250(P)	24.6	-16.8	2.6[a]	2.09
9-3, 91-93	193.42	103.5	-38.3	3.0	4.66 ±0.01	50	139.3	-29.5	1.0	6.18 ±0.11
9-4, 51-53	194.52	2.5	-1.3	0.9	7.74 ±0.15	50	0.7	+0.9	0.7	3.88 ±0.18
9-5, 67-69	196.18	114.0	+36.8	1.5	5.45 ±0.15	150(P)	97.7	+27.6	1.5[a]	3.30
9-5, 70-72	196.21	328.4	-26.3	1.2	6.52 ±0.12	50	315.7	-32.9	0.6	4.21 ±0.39
10-1, 62-64	199.63	21.5	-0.8	1.0	7.87 ±0.21	50	44.1	2.5	1.1	4.06 ±0.11
10-2, 32-34	200.83	348.4	-2.9	0.4	17.69 ±0.58	50	335.7	0.0	1.1	10.25 ±0.12
10-2, 137-139	201.88	347.9	-15.2	1.0	26.96 ±0.70	50	314.2	-39.0	2.3	6.74 ±0.10
11-2, 19-21	210.20	196.2	+77.1	4.7	0.03 ±0.01	50(P)	163.4	+42.1	25.6	0.03 ±0.02
13-2, 51-53	229.52	147.4	+2.0	4.1	0.44 ±0.05	50(P)	60.6	-19.5	2.8	0.17 ±0.05
13-2, 86-88	229.87	13.5	-14.9	0.9	1.93 ±0.08	50	1.6	-17.3	11.4	0.39 ±0.15
13-4, 92-94	232.93	187.8	+12.4	1.2	0.92 ±0.02	100(P)	152.2	-24.2	8.9[a]	0.14
15-2, 87-89	248.88	73.4	13.6	0.8	68.62 ±0.20	50	77.4	+15.9	1.2	69.18 ±0.68
15-3, 19-21	249.70	5.0	-7.8	2.6	2.01 ±0.11	50	0.1	-15.5	5.8	0.33 ±0.01
15-4, 37-39	251.38	3.5	-0.7	1.0	3.48 ±0.40	50	10.7	-4.3	2.9	0.92 ±0.08
17-4, 33-35	270.34	316.5	+42.3	34.5	0.07 ±0.06	0[b]	316.5	+42.3	34.5	0.07 ±0.06
17-4, 130-132	271.31	23.1	-20.2	25.2	0.17 ±0.05	50	8.3	-36.3	4.7	0.09 ±0.01
17-5, 100-102	272.51	17.5	-15.0	22.3	0.27 ±0.04	50	38.2	-37.6	13.7	0.08 ±0.01
17-6, 48-50	273.49	3.9	-17.0	12.7	0.15 ±0.02	50	358.2	-45.8	10.1	0.14 ±0.02
18-4, 101-103	280.52	12.0	-24.3	11.9	0.10 ±0.04	50	43.4	-60.3	22.9	0.05 ±0.02
18-5, 110-112	282.11	24.2	-9.7	8.4	0.07 ±0.00	50	50.7	-27.5	7.9	0.08 ±0.02
18-6, 33-35	282.84	76.1	32.3	8.8	0.28 ±0.14	50	99.1	+35.6	4.4	0.27 ±0.02
19-1, 138-140	295.89	46.3	-41.3	10.0	0.07 ±0.01	50	3.2	-52.8	13.4	0.08 ±0.02
19-2, 62-64	286.63	37.3	-40.4	17.9	0.15 ±0.06	50	18.3	-33.2	7.2	0.17 ±0.01
19-3, 54-56	288.05	–	–	–	–	50	338.7	-62.9	24.5	0.16 ±0.08
19-3, 58-60	288.09	1.1	+20.4	8.7	0.02 ±0.01	0[b]	1.1	+20.4	8.7	0.02 ±0.01
20-1, 135-136	295.35	171.3	41.3	4.5	0.34 ±0.03	50	163.8	35.8	1.9	0.49 ±0.09
21-1, 96-98	313.97	345.8	-40.8	23.0	0.10 ±0.02	50	333.3	-21.9	17.2	0.07 ±0.02
21-2, 21-23	314.72	297.4	-23.1	66.1	0.10 ±0.04					
22-4, 130-132	328.31	21.2	-14.8	50.2	0.12 ±0.07					
22-5, 100-102	329.51	64.8	-74.2	81.0	0.06 ±0.05					
22-6, 48-50	330.49	65.4	-32.3	13.2	0.06 ±0.04	50	74.4	-18.7	31.1	0.08 ±0.02
22-6, 72-74	330.73	32.2	20.5	48.4	0.08 ±0.06					
25-1, 14-16	370.15	298.6	+54.4	77.2	0.08 ±0.02	50	359.5	+63.5	19.2	0.05 ±0.03
27-2, 75-77	387.26	226.3	+40.1	42.7	0.05 ±0.03	50	197.8	+15.7	39.5	0.02 ±0.01

NOTE: (P) indicates sample was incrementally demagnetized to 300 oe, and results are listed in Table 2.

[a]C.S.D. based on NRM or 50 oe measurement.

[b]Too weak for measurement after demagnetization, so NRM direction used.

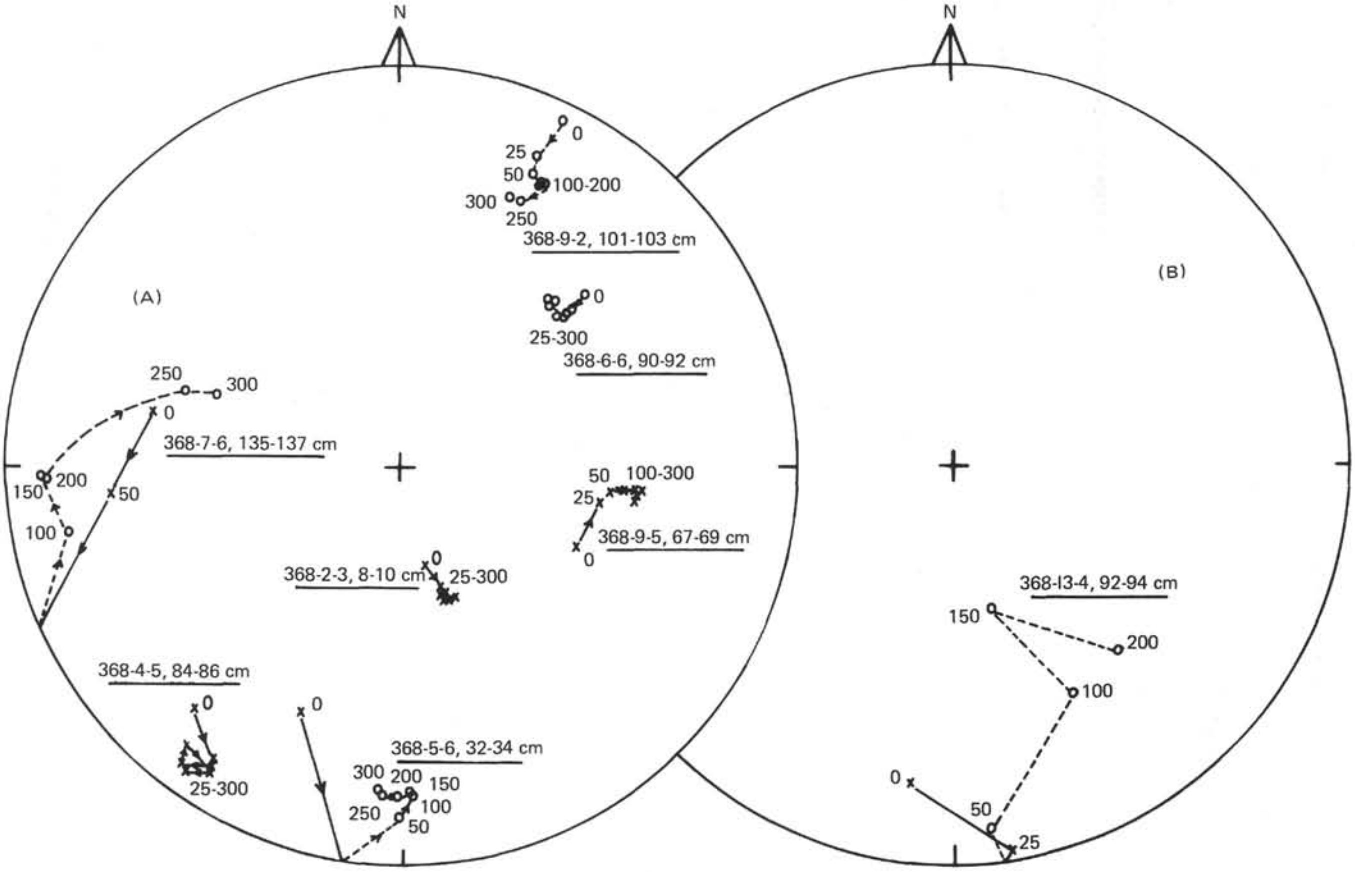

Figure 1. *Representative pilot AF demagnetization stability behavior for Site 368 (A) above and (B) below 200 meters sub-bottom. Plotted on polar sterographic projection, with arbitrary declination for each sample.*

relative azimuthal orientation within each barrel had been preserved. However, the possibility remains that apparent changes in declination may reflect relative rotation (i.e., "disking") of the sediment core during drilling, as discussed above.

The Miocene and Oligocene magnetic polarity sequence inferred from these measurements is plotted in the left-hand column of Figure 2(C), together with the position of nannofossil and foram zones. The magnetic polarity is assigned on the basis of the sign of the magnetic inclination (positive = Normal, negative = Reversed). In some instances changes in sign of inclination are corroborated by changes in declination of about 100° (e.g., at 169 m).

The magnetic reversal time scale of Ryan et al. (1974) is plotted in the right-hand column of Figure 2(C), and it is clear that the polarity determinations from Site 368 are too widely spaced to allow an unambiguous correlation with the "standard" time scale, on the basis of magnetic measurements alone. However, using the position of microfossil zones as an additional constraint, a highly provisional and speculative correlation is attempted by means of the broken lines. In view of the provisional nature of this correlation, no further discussion is presented here, but the general magnetic stability characteristics of these sediments suggest that a more detailed paleomagnetic study, based on a considerably closer sampling interval would probably yield a meaningful magnetostratigraphy (Table 2).

SITE 366

General Remarks

A very complete sequence of Cenozoic pelagic oozes was recovered from this site and the general absence of hiatuses and the co-occurrence of different microfossil groups contribute to making this a very suitable reference section for Cenozoic biostratigraphic zonation in tropical and subtropical latitudes.

Detailed paleomagnetic measurements have been carried out on part of the Eocene section, in which drilling disturbance is virtually absent, in an attempt to assign an absolute chronology to this biostratigraphic sequence.

The accumulation rate for these sediments is approximately 14 m/m.y., so that a sampling interval of 1 to 2 meters should correspond with a time interval of approximately 10^5 yr. A total of 178 samples was taken from the depth range 575 to 800 meters, giving an average sampling interval of 1.25 meters. This should be sufficient to allow the detection of most important magnetic events. Results from 44 samples in the depth range 575 to 645 meters are presented here, and work is in progress on the remaining samples, to be published elsewhere.

Results

Paleomagnetic measurements at Site 366 are summarized in Table 3. The intensities of NRM are very low, with 70% of the determinations lying in the

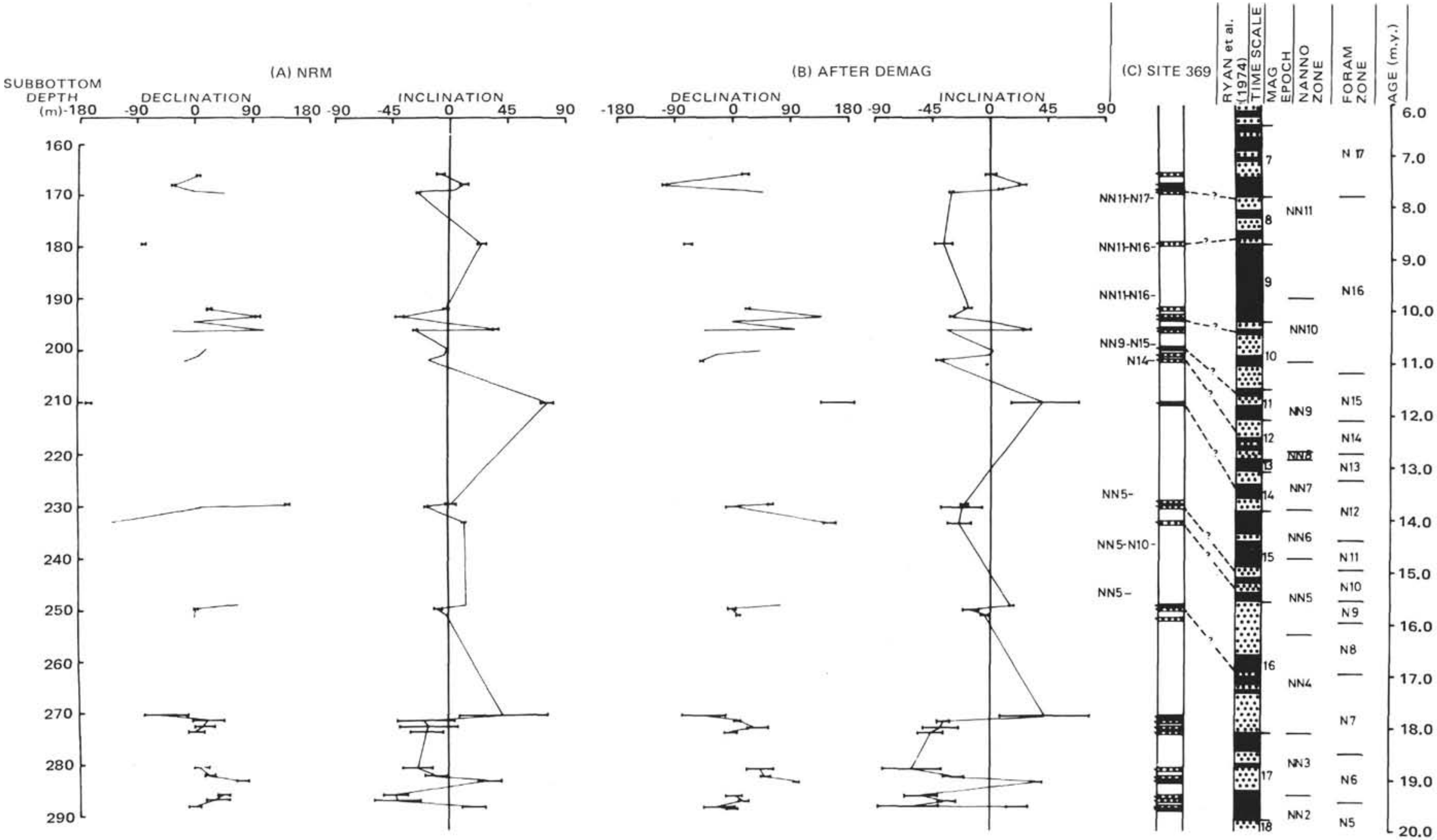

Figure 2. *Paleomagnetic measurements for Site 368. (A) NRM directions; (B) after demagnetization at 50 oe, (below 200 meters) or optimum field determined from pilot sample behavior (above 200 meters). Error bars represent the Circular Standard Deviation of triplicate measurements (see Tables 1 and 2); (C) summary of polarity determinations for Site 368 and highly tentative correlation with the Ryan et al. (1974) time scale, constrained by microfossil zones. Black shading represents Normal magnetization, and open circles, Reversed.*

TABLE 2
Pilot AF Demagnetization Results, Site 368

	368-2-3, 8-10 cm J_o = (6.21 ±0.22)μg				368-4-5, 84-86 cm J_o = (1.48 ±0.03)μg				368-5-6, 32-34 cm J_o = (1.81 ±0.02)μg				368-6-6, 90-92 cm J_o = (4.69 ±0.10)μg			
Demag. Field	De.	In.	C.S.D.	J/J_o	De.	In.	C.S.D.	J/J_o	De.	In.	C.S.D.	J/J_o	De.	In.	C.S.D.	J/J_o
0	165.2	+61.6	1.0	1.00	220.9	+12.2	2.3	1.00	202.5	+21.6	3.7	1.00	48.1	-25.1	1.3	1.00
25	161.5	+54.6		0.99	212.9	+6.9		0.95					47.9	-29.2		0.95
50	160.6	+53.0	0.5	0.88	213.1	+6.5	2.1	0.93	180.4	-7.7	1.6	1.24	47.7	-30.0	0.9	0.84
100	160.9	+53.0		0.76	212.8	+7.4		0.89	177.8	-10.9		1.10	46.8	-31.8		0.68
150	160.1	+52.1		0.66	217.0	+4.0		0.82	177.8	-10.9		0.87	48.1	-30.6		0.54
200	160.7	+52.4		0.63	217.9	+6.9		0.57	180.8	-11.3		0.63	44.2	-32.5		0.35
250	159.3	+51.4		0.55	216.3	+3.4		0.41	183.5	-11.0		0.51	43.7	-31.0		0.24
300	157.1	+50.5		0.48	212.9	+5.8		0.34	184.5	-11.7		0.41	42.3	-31.4		0.17
	368-7-6, 135-137 cm J_o = (6.75 ±0.07)μg				368-9-2, 101-103 cm J_o = (3.78 ±0.13)μg				368-9-5, 67-69 cm J_o = (5.45 ±0.15)μg				368-13-4, 92-94 cm J_o = (0.92 ±0.02)μg			
Demag. Field	De.	In.	C.S.D.	J/J_o	De.	In.	C.S.D.	J/J_o	De.	In.	C.S.D.	J/J_o	De.	In.	C.S.D.	J/J_o
0	283.0	+24.6	3.4	1.00	25.6	-1.6	2.6	1.00	114.0	+36.8	1.5	1.00	187.8	+12.4	1.2	1.00
25					24.7	-8.4		1.15	99.8	+34.8		0.90	170.7	+1.8		0.34
50	264.4	+16.4	1.1	0.60	25.1	-11.5		1.23	96.9	+32.7		0.83	174.4	-5.3		0.26
100	268.7	-4.9		0.60	27.1	-13.2		1.17	95.3	+30.9		0.68	152.2	-24.2		0.15
150	268.4	-5.2	2.3	0.20	28.2	-12.1		0.96	97.7	+27.6		0.60	167.5	-48.7	8.9	0.10
200	259.3	-8.1		0.15	27.0	-13.4		0.75	96.5	+27.7		0.51	137.7	-26.0		0.13
250	288.9	-29.7		0.10	24.6	-16.8		0.55	96.2	+26.8		0.42				
300	292.2	-36.4	6.9	0.07	23.0	-16.8		0.43	95.3	+30.7		0.32				

TABLE 3
Results of Magnetic Measurements for Site 366

		NRM				After Demag.			
Sample (Interval in cm)	Depth in Hole (m)	De.	In.	C.S.D.	INT ±S.D. (μg)	De.	In.	C.S.D.	INT ±S.D. (μg)
30-1, 135-137	604.86	38.7	-28.1	42.1	0.056 ±0.008	73.4	3.6	27.5	0.046 ±0.019
31-1, 82-84	613.83	146.0	-14.2	19.2	0.027 ±0.001	130.0	-19.7	16.7	0.023 ±0.007
31-2, 30-32	614.81	49.4	1.3		0.030	32.6	1.0	9.2	0.034 ±0.004
31-2, 133-135	615.84	42.9	-18.8	13.9	0.051 ±0.008	48.9	12.3	16.2	0.019 ±0.007
31-3, 91-93	616.92	60.2	-2.4	9.6	0.037 ±0.007	91.7	31.1	33.1	0.020 ±0.000
31-4, 48-50	617.99	115.9	-39.1		0.024	148.1	9.4	38.2	0.031 ±0.012
31-4, 146-148	618.97	46.6	-10.7		0.037	21.5	-8.2	9.5	0.037 ±0.019
32-1, 120-122	623.71	316.8	-17.5		0.012	281.8	1.4	51.2	0.015 ±0.006
32-2, 72-74	624.73	8.4	-6.3	23.0	0.026 ±0.005	3.8	21.9	15.8	0.023 ±0.018
32-3, 26-28	625.77	186.8	-17.8	62.1	0.023 ±0.009	191.2	50.2	23.7	0.018 ±0.006
32-3, 128-130	626.79	347.2	9.2	15.0	0.050 ±0.006	313.6	23.7	31.5	0.015 ±0.008
32-4, 80-82	627.81	169.0	-33.6		0.013	251.7	14.6	35.9	0.015 ±0.009
32-5, 32-34	628.3	85.4	14.5		0.032	111.0	18.0	14.9	0.024 ±0.003
32-5, 140-142	629.91	338.9	6.3	13.8	0.044 ±0.005	280.3	20.5	10.7	0.032 ±0.003
33-1, 108-110	633.09	111.5	-12.1		0.036	92.1	-1.7	26.1	0.024 ±0.001
33-2, 75-77	634.26	36.5	-4.1		0.016	388.6	16.1	46.0	0.009 ±0.004
33-3, 30-32	635.31	316.9	22.9	5.1	0.069 ±0.010	305.5	22.0	8.6	0.111 ±0.018
33-3, 127-129	636.27	44.4	-4.3		0.019	93.3	-4.4	22.0	0.015 ±0.003
33-4, 86-88	637.37	345.2	5.4		0.309	323.0	17.2	4.8	0.066 ±0.007
33-5, 38-40	638.39	6.8	-8.0	38.6	0.024 ±0.018	315.5	35.6	11.7	0.016 ±0.005
33-5, 142-144	639.43	98.8	-1.5		0.108	100.2	12.0	6.7	0.065 ±0.008
34-1, 106-108	642.57	359.8	26.1	21.3	0.047 ±0.012	346.3	52.7	39.5	0.034 ±0.015
34-2, 72-74	643.73								
34-3, 26-28	644.77	329.6	34.7	18.9	0.038 ±0.004	334.6	38.9	13.0	0.051 ±0.013
34-3, 132-134	645.83								
27-1, 2-4	575.03	10.9	-6.5	8.7	0.274 ±0.059	3.1	15.5	8.5	0.171 ±0.043
27-1, 104-106	576.05	352.6	17.5	22.8	0.019 ±0.015	348.7	25.9	29.8	0.032 ±0.009
27-2, 73-75	577.24	18.1	35.3	7.3	0.046 ±0.031	29.3	44.1	9.7	0.039 ±0.008
27-3, 30-32	578.31	105.0	-23.1	42.7	0.016 ±0.006	207.3	73.8	25.5	0.011 ±0.004
27-3, 130-132	579.31	112.5	-40.5	42.1	0.031 ±0.014	121.7	0.7	29.2	0.023 ±0.017
27-4, 84-86	580.35	354.8	-31.7	34.8	0.028 ±0.003	7.3	54.8	81.0	0.023 ±0.006
27-5, 35-37	581.36	13.2	16.4	38.6	0.026 ±0.017	114.0	29.4	41.5	0.031 ±0.009
27-5, 143-145	582.44	240.2	-13.4	16.0	0.098 ±0.024	223.7	-12.6	5.9	0.068 ±0.016
28-1, 122-124	585.73	112.3	17.3	17.2	0.218 ±0.068	126.4	21.6	3.6	0.169 ±0.015
28-2, 77-79	586.78	326.3	-22.4	2.0	0.133 ±0.016	330.1	-52.7	12.2	0.079 ±0.018
28-3, 30-32	587.81	98.1	28.4	7.1	0.266 ±0.044	100.8	30.0	1.8	0.142 ±0.011
28-3, 133-135	588.84	107.2	-61.2	7.2	0.120 ±0.034	76.0	-45.7	6.8	0.073 ±0.028
28-4, 86-88	589.87	321.5	-72.4	62.1	0.015 ±0.007	131.8	64.2	50.2	0.014 ±0.007
28-5, 42-44	590.93	18.9	56.2	15.8	0.060 ±0.019	37.2	77.2	3.1	0.048 ±0.019
28-5, 148-150	591.99	76.6	13.8	18.5	0.041 ±0.026	126.7	-13.1	39.1	0.021 ±0.002
29-1, 85-87	594.86	46.5	7.0	9.8	0.135 ±0.045	36.7	3.8	16.6	0.069 ±0.008
29-2, 33-35	595.84	168.6	-44.3	77.2	0.023 ±0.007	356.7	-21.4	90.0	0.016 ±0.010
29-2, 134-136	596.85	100.1	-35.1	17.6	0.082 ±0.022	108.4	-50.6	5.8	0.044 ±0.005
29-3, 91-93	597.92	59.4	23.9	42.7	0.255 ±0.324	26.8	-1.1	24.5	0.047 ±0.010
29-4, 42-44	599.11	35.1	19.3	2.8	0.482 ±0.059	43.3	20.9	7.3	0.522 ±0.147
29-4, 145-147	599.96	33.4	-47.0	4.8	0.154 ±0.044	33.7	-41.7	5.2	0.128 ±0.016

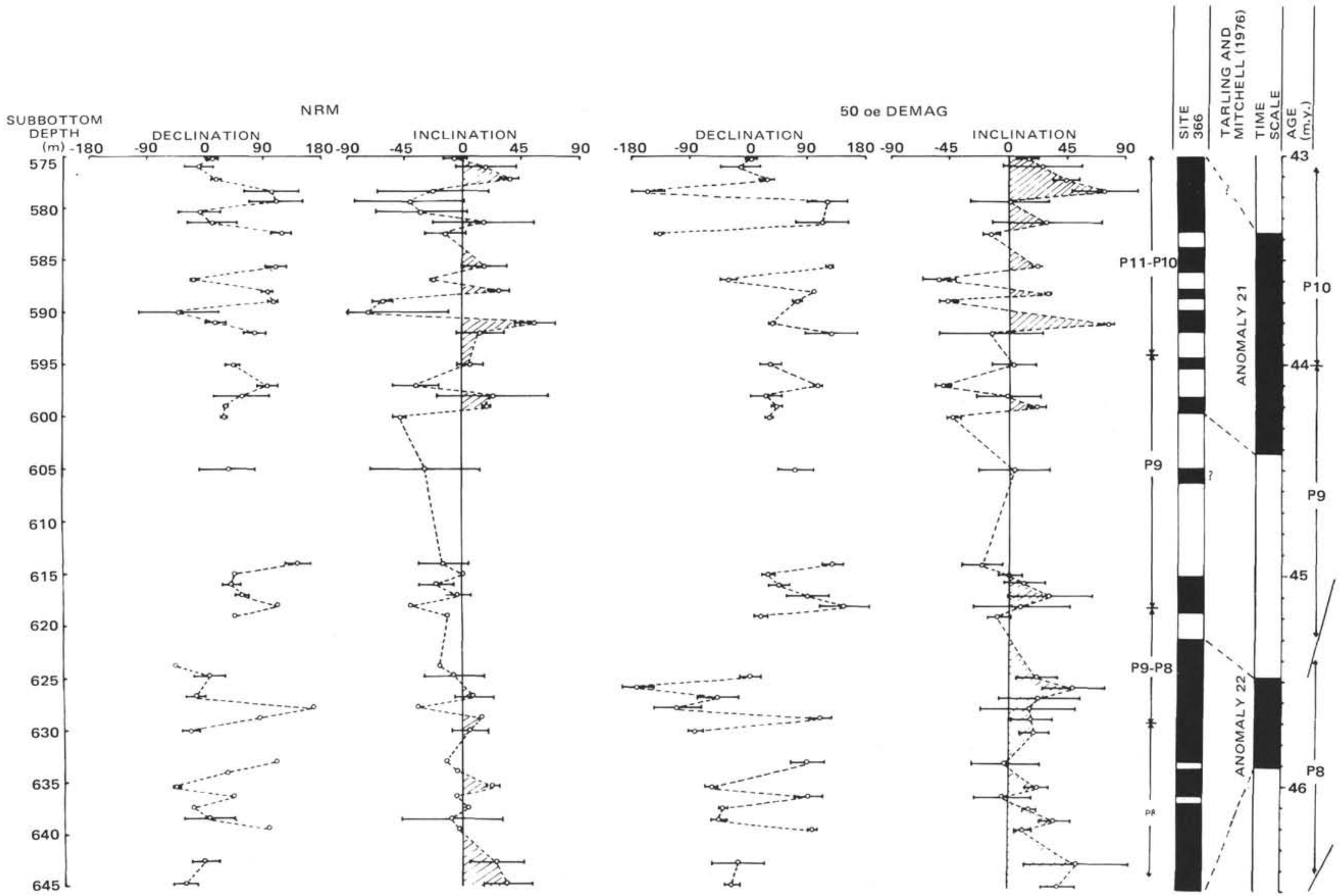

Figure 3. *Paleomagnetic measurements for Site 366. Symbols as in Figure 2, Normal polarity black, Reversed polarity, white.*

range 1 to 6×10^{-8} Gauss. In general, demagnetization at 50 oe reduced the intensity to a value close to the limit of measurement with the available magnetometer, and so demagnetization at higher fields was not attempted.

The directions of magnetization are plotted in Figure 3. The inclinations after magnetic cleaning at 50 oe are highly variable and generally low, with an overall mean value of $26 \pm 20°$. Interpretation of the results is hampered by a shortage of samples in the 600 to 612 meter depth range, but there is an apparent tendency for a concentration of Normal polarities near to the top and bottom of the plotted section, with a zone of mainly Reversed samples between. The inferred polarity sequence is plotted in Figure 3, and using the foram zones as an additional constraint, the upper and lower Normal zones are tentatively correlated with anomalies 21 and 22, respectively, on the Tarling and Mitchell (1976) polarity time scale. None of the inclination values used to define the restricted Normal zones centered on 605 and 616 meters are significantly different from zero, and so the presence of these zones must be regarded as questionable. Consequently, the top of anomaly 22 is taken to correspond with the top of the thick Normal sequence beginning at 621 meters.

CONCLUSION

The proposed correlation between the Site 366 polarity sequence and the Tarling and Mitchell (1976) time scale is shown in Figure 4 and implies a change in accumulation rate at some depth between 621 and 645 meters, from 23 m/m.y. to a minimum value of 52 m/m.y. below this depth.

Since the correlation and determination of accumulation rates are based on only four points, they must be regarded as highly provisional, and detailed measurements on the rest of the Eocene section, currently in progress, are likely to produce a more reliable absolute chronology for the biostratigraphic sequence.

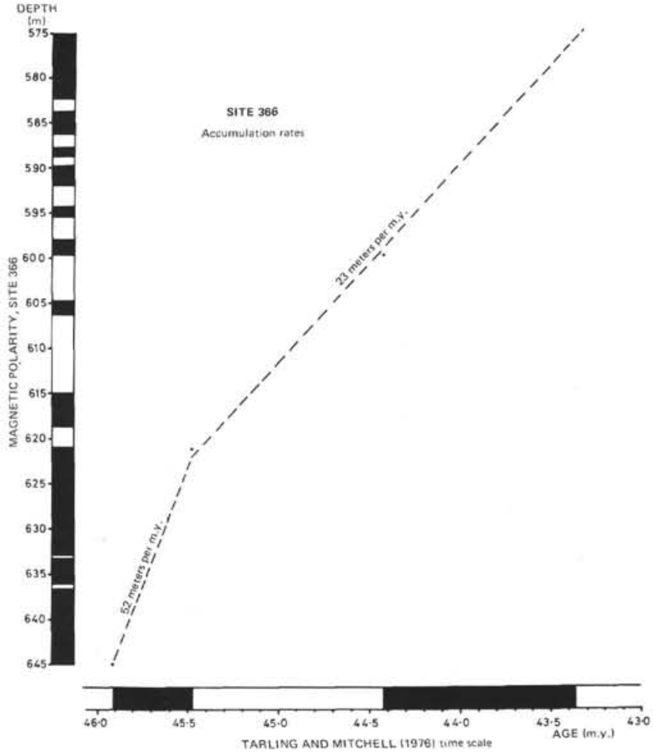

Figure 4. *Proposed correlation between the inferred polarity sequence at Site 366 and the Tarling and Mitchell (1976) time scale.*

ACKNOWLEDGMENTS

I would like to thank Mrs. Pat Copland for undertaking a substantial proportion of the remanence measurements, and Dr. Norman Hamilton for reviewing the manuscript.

REFERENCES

Allis, R.G., Barrett, P.J., and Christoffel, D.A., 1974. A paleomagnetic stratigraphy for Oligocene and early Miocene marine glacial sediments at Site 270, Ross Sea, Antarctica. *In* Hayes, D., Frakes, L.H., et al., Initial Reports of the Deep Sea Drilling Project, Volume 28: Washington (U.S. Government Printing Office), p.

Fisher, R.A., 1953. Dispersion on a sphere: Proc. Roy. Soc. Lond., Ser. A, v. 217, p. 295-305.

Molyneux, L., 1971. A complete results magnetometer for measuring the remanent magnetization of rocks. Geophys. J. Roy. Astron. Soc., v. 24, p. 429-433.

Opdyke, N.D., 1972. Paleomagnetism of deep sea cores: Rev. Geophys. Space Phys., v. 10, p. 213-249.

Ryan, W.B.F., 1973. Palaeomagnetic stratigraphy. *In* Ryan, W.B.F., Hsu, K.J., et al., Initial Reports of the Deep Sea Drilling Project, Volume 13: Washington (U.S. Government Printing Office), p.

Ryan, W.F.B., Cita, M.B., Dreyfus, R.M., Burckle, L.H., and Saito, T., 1974. A paleomagnetic assignment of Neogene stage boundaries and the development of isochronous datum planes between the Mediterranean, the Pacific and Indian Oceans in order to investigate the response of the world ocean to the Mediterranean "salinity crisis": Riv. Ital. Paleontol., v. 80, p. 631-688.

Tarling, D.H. and Mitchell, J.G., 1976. Revised Cenozoic polarity time scale: Geology, v. 4, p. 133-136.