31. PALEOMAGNETISM OF THE IGNEOUS COMPLEX, SITE 462[1]

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ABSTRACT

Magnetization of the igneous extrusive-intrusive sequence at Site 462, nearly 500 meters thick, is entirely of normal polarity. Two groups of inclinations exist in Hole 462A: $-51.8 \pm 7.2°$ for the upper intrusive sequence and $-38.1 \pm 6.6°$ for the lower extrusives. Much of the coarse-grained material, notably the lower 130 meters (Hole 462A), has been remagnetized in the coring process. The large differences between the inclinations in these igneous units and those of the overlying Upper Cretaceous sedimentary strata suggest secular variations of the magnetic field. The very different inclinations of the intrusive rocks relative to the extrusive basalts imply that at least two igneous events occurred, separated by at least a short time.

INTRODUCTION

For both Hole 462 and Hole 462A, the entire suite of igneous rocks represented was sampled for paleomagnetic study. In material from Hole 462, 47 meters of basaltic rock and interbedded sediments was sampled at intervals of about one sample every recovered section of core (roughly one sample every 1.5 m). When unusual features were encountered, or when lithologies changed, sampling was denser at those points. Chilled margins were sampled whenever possible. All recovered intercalated sedimentary layers were sampled. Likewise, the 504 meters of igneous material from Hole 462A was sampled in this manner.

The igneous material is divisible into two parts, geologically, petrologically, and, as will be shown, magnetically. The upper 122 meters is primarily massive diabase sills intercalated in volcaniclastic siltstone (Site Summary, this volume). The igneous-rock units in this part of Hole 462A have similar magnetic properties and directions. Below these, the next 42 meters consists of several thin sills separated by sedimentary strata, both of which have scattered magnetic directions (Cores 36–43 from Hole 462A). The second major division within the igneous sequence begins with Core 462A-44 and continues for approximately 184 meters downhole. This interval appears to be a composite of extrusive basalts and massive diabase sills (Site Summary, this volume). The units within the two major divisions have similar magnetic directions which are different from those of the upper series of sills and sediment. The 42-meter interval between these two major divisions bears magnetic marks of both. The lowest 156 meters is almost entirely massive diabase sills from which very little magnetic information could be obtained.

The petrologic characteristics, stratigraphic relationships, and magnetic evidence, therefore, appear to suggest at least two episodes of igneous activity. The first apparently was an extrusive/intrusive emplacement near the sediment/water interface. At a later time, intrusion into overlying sediments must have formed the upper 122 meters of sills. The paleomagnetism will be discussed from the standpoint of two igneous events.

The site is presently situated at 7.2°N, 165°E. In the Jurassic and Cretaceous, the site was in the Southern Hemisphere (Lancelot and Larson, 1975; Larson and Chase, 1972). A tentative age for the igneous events can be assumed because of the evidence suggesting extrusion and intrusion near the sediment/water interface for the lower portion of these basalts. The sediments that were involved are Lower Cretaceous (Premoli-Silva et al., this volume). Thus, at least a portion of the basalt (the first igneous event) appears to be Lower Cretaceous. The exact location of this site in Early Cretaceous time is not well known. According to Larson (personal communication, 1979; Larson and Chase, 1972; Lancelot and Larson, 1975), the site may have been between 20 and 30°S at this time. Upper Cretaceous sedimentary strata at this site (Steiner, this volume), however, give inclinations implying the site was at 7°S in Campanian–Santonian time.

NATURAL REMANENT MAGNETIZATION (NRM)

Except for one sediment sample, all samples of basalt and intercalated sediments exhibit negative NRM inclinations (Tables 1 and 2). Since this site was located in the Southern Hemisphere, these negative inclinations indicate normal polarity. For Hole 462, the NRM value of the inclination was between $-40°$ and $-50°$. Hole 462A samples, however, gave values of between $-50°$ and $-85°$. In general, the coarser the grain size of the basalts, the steeper the NRM inclinations. The thickest sills show $-70°$ to $-85°$ inclinations. The sequence below Core 462-64 (576.5 m sub-bottom) is composed almost entirely of coarse-grained diabase. Except for a few fine-grained units, this sequence (Hole 462A) (212 m) has almost entirely very steep negative inclinations (Table 2). Susceptibilities are also generally higher than in the upper portions of the hole.

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Table 1. Paleomagnetic data, Hole 462.

Core-Sec., Sample Location in cm	Depth Sub-bottom (m)	Intensity × 10^{-3}emu/cm^3	NRM Incl. (°)	MDF (Oe)	Stable Incl. (°)	Susceptibility × 10^{-3}emu	
59-2, 42	551.42	0.002	−7.8		−18.0	(Sediment)	
60-1, 101	559.51	5.0	−49.7	105	−43.9	0.063	Magnetic Unit 1
60-2, 33	560.33	3.8	−38.2	115	−36.1	0.555	
60-3, 41	561.91	3.2	−46.7	140	−42.9	0.750	
60-4, 5	563.05	7.9	−34.4	160	−34.2	0.780	
61-1, 117	568.67	9.8	−44.2	70?	−36.0?	0.910	
61-2, 49	569.49	5.2	−40.2	55	−34.8?	1.120	
62-1, 132	577.82	34.4	−44.2	175	−42.9	0.820	Magnetic Unit 2
63-1, 89	580.39	6.0	−46.4	50	−44.0	0.865	
63-2, 71	581.71	7.1	−32.2	55	−39.9	0.985	
63-3, 40	583.00	19.5	−43.0	65	−43.7	0.795	
64-1, 76	586.26	3.3	−45.6	320	−46.7	0.450	Sediment
64-4, 80	592.30	6.7	−50.2	40	−53.4	1.665	Magnetic Unit 3
65-1, 34	594.84	8.8	−54.3	55	−50.8	1.470	
65-2, 22	596.22	9.2	−48.2	80	−48.3	1.115	
66-1, 103	600.03	8.7	−50.0	75	−50.9	1.485	
66-2, 56	601.06	4.4	−53.2	55	−44.9	1.560	
66-4, 59	604.09	7.6	−51.3	115	−48.5	1.115	
66-5, 23	605.00	11.2	−48.4	200	−45.3	0.970	
66-6, 39	605.90	18.3	−47.1	235	−46.9	1.205	
67-1, 22	606.22	9.4	−46.8	130	−48.9	1.305	
67-1, 46	606.46	8.3	−37.5	130	−47.5	1.855	
67-2, 38	607.98	11.7	−47.6	—	—	1.915	
67-2, 103	608.53	6.4	−47.0	115	−49.1	3.210	
68-1, 126	610.26	4.1	−51.2	—	—	1.170	
68-2, 114	611.64	7.9	−47.8	80	−48.1	1.470	
68-3, 64	612.64	13.4	−47.2	80	−46.3	1.500	
69-1, 59	614.59	48.5	−46.4	115	−44.6	5.200	
69-2, 75	616.25	9.6	−44.2	80	−41.8?	2.580	

The correlations of steeper inclinations with increasing grain size suggests that a steep negative overprint has been imparted to these samples. Since the site has a present inclination of +14° and has probably moved northward from only as far as 30°S, a drilling overprint is the simplest way to explain observed positive correlation of the steepness with grain size and susceptibility. It was shown in 1976 (Petersen, 1978) that the drill string produced a field of about 5 Oe in the vicinity of the core. Since then, however, the practice of magnafluxing has been introduced and may result in larger field strengths in the drill string, and which are not related to the field at the site.

NRM intensities in Hole 462 samples generally ranged between 3 and 12 × 10^{-3} G. Intensities in samples from the comparable portion of Hole 462A are much lower, generally between 0.3 and 3 × 10^{-3} G. Below this portion, however, the intensity of remanence jumps abruptly, to values of about 7 × 10^{-3} G. The abrupt increase occurs within a very thick sill, Petrographic Unit 12, as will be discussed. The intensities of samples from the rest of the hole remain higher than those from the top portion of the hole (Fig. 1). Portions of the lower part of Hole 462, have quite high intensities, often between 1 to 2 × 10^{-2} G.

The increased intensity in samples from the lower part of Hole 462A is roughly compatible with a decrease in whole-rock titanium content as determined by X-ray fluorescence aboard ship (Batiza et al., this volume). If the whole-rock titanium values are reflected in the titanium contents of the titanomagnetites within the rocks, a difference in intensity would be expected. Adding titanium to the lattice of titanomagnetite results in a lowering of the saturation and remanent magnetizations. Thus far, Curie-point studies in progress appear to indicate that a variation in titanium content of the magnetic mineral may exist (Steiner, this volume) and may be a partial cause of the observed differences in remanent intensity.

DEMAGNETIZATION PROCEDURE

Most samples from the upper 365 meters of the igneous sequence were treated with alternating-field (AF) demagnetization, using a Schonstedt single-axis AF demagnetizer. The instrument was tested for anhysteretic remanence (ARM) and found to be free of problems below 500 Oe. Above that field strength, ARM was observed, probably a direct consequence of the badly dented shielding cans. Very few of the igneous samples required more than 500 Oe demagnetization, however, and generally required much less.

The igneous samples fall into two groups according to their responses to demagnetization. Most of the fine-grained basalts have stable inclinations near their NRM inclinations, and retain 30% to 70% of their NRM intensities when a stable direction is reached. Median destructive fields (MDFs) are usually between 80 and 120 Oe. The coarser grained basalts, and some of the visually fine-grained ones, require destruction of 80% to 90% of their NRM intensity before yielding an apparently stable direction. Their MDFs range from 20 to 60 Oe. "Stable" here means that on two consecutive demagnetization steps the direction does not change. These steps are at least 50 Oe apart. Fine-grained samples showed this stability over as much as 200 to 300 Oe; coarse-grained samples were limited to a stability range of 50 Oe. Often some coarser grained samples do not stop moving in a linear direction before losing their entire remanence and becoming erratic.

Before proceeding with a description of the demagnetized directions, it is necessary to discuss the magnetometer used, since it had a substantial effect on the coarser grained samples and limited the number of samples which could be used in this study. Almost all the measurements were done with the shipboard Digico spinner magnetometer. The Digico utilizes a narrow set of three mu-metal cans to shield the measurement region from the earth's field. Large magnetic flux densities at the edges of such cans are a by-product of their shielding capability. The cans are oriented vertically and are very narrow in diameter (7.6 cm ID, 10.2 cm OD). This configuration makes it impossible to insert samples into the magnetometer without entering the region of high flux density that rings the "mouth" of the instru-

Table 2. Paleomagnetic data, Hole 462A.

Core-Sec., Sample Location in cm	Depth Sub-bottom (m)	NRM Intensity × 10^{-3}emu/cm^3	NRM Incl. (°)	MDF (Oe)	Stable Incl. (°)		Susceptibility × 10^{-3}emu	
14-2, 36	564.86	0.3	−61.1	55	−38.4		0.860	
15-1, 25	566.75	0.7	−72.4	35	−28.8		1.030	1[a]
15-1, 110	567.60	1.1	−47.3	55	−27.1?		1.630	
16-1, 29	572.29	1.1	−67.5	35	−20.3		1.245	
16-2, 12	573.62	1.3	−62.6	40	−27.2	Magnetic Unit A	0.980	
17-1, 41	574.41	1.2	−35.2	50	−20.3		0.830	2
17-1, 129	575.29	2.4	−24.0	55	−18.4		0.890	
17-2, 89	576.39	1.1	−34.0	45	−24.4		0.930	
18-1, 85	576.85	1.9	−35.3	<50	−24.7		0.820	
18-1, 122	577.22	2.1	−37.9	60	−31.6		1.120	
18-2, 57	578.07	0.7	−51.9	35	−33.0		1.490	3
19-1, 18	578.18	0.8	−46.3	60	−29.6		1.790	
19-1, 104	579.04	0.5	−63.2	27	−43.2	Magnetic Unit B	1.255	
19-2, 73	580.23	0.5	−48.9	50	−34.2		1.005	
19-2, 93	580.43	0.7	−41.4	50	−43.8		0.650	
20-1, 28	581.28	2.2	−53.0	55	−45.8		0.995	4
20-1, 59	581.59	2.3	−43.6	60	−40.3		0.900	
20-2, 71	583.21	1.9	−76.3	40	−64.9		0.990	
20-2, 137	583.87	2.8	−54.1	45	−49.7		0.925	5
21-1, 76	586.76	1.0	−73.1	20	−64.2		1.330	
21-1, 108	587.08	12.5	−56.2	50	−52.6		0.955	6
21-1, 135	587.35	2.5	−52.6	25	−49.3		0.530	7
22-1, 47	588.47	3.1	−33.8	>100	−32.9		0.660	9
22-1, 120	589.20	4.2	−56.3	50	−52.2		0.890	
22-2, 36	589.86	0.2	−48.4	210	−47.7		0.431	Sediment
22-2, 119	590.69	1.0	−41.5	35	−22.6		0.890	
22-2, 129	590.79	0.8	−38.0	—	—		0.885	
22-2, 144	590.94	1.6	−56.1	45	−44.0		1.231	
22-3, 50	591.50	1.6	−50.8	40	−46.2		1.310	
22-3, 134	592.34	1.9	−49.1	—	—		1.160	10
22-4, 33	592.83	2.2	−44.0	35	−43.5		1.146	
22-4, 69	593.19	1.3	−58.2	—	—		1.160	
22-5, 33	594.33	2.5	−52.5	?	−42.4		1.141	
22-5, 118	595.18	0.8	−65.1	—	—		1.100	
23-1, 22	597.22	0.7	−60.6	45	−58.7		0.690	
23-1, 42	597.42	1.2	−56.2	30	−41.5?		1.230	
23-1, 71	597.71	0.9	−64.7	30	−51.0		1.505	11
23-1, 94	597.94	1.0	−59.9	35	−46.2?		1.195	
23-2, 21	598.71	2.2	−66.1	35	−51.9		1.390	
23-2, 130	599.80	0.6	−57.0	50	?		1.260	
		(0.6)	(−24.8)				(1.325)	
23-3, 63	600.63	0.5	−73.8	40	−46.9	Magnetic Unit C	0.960	
23-4, 38	601.88	0.6	−62.0	20	−59.0		0.965	
23-4, 55	602.05	0.5	−81.7	20	−61.2		1.155	
24-1, 87	606.87	0.9	−65.2	25	−53.9?		1.250	
24-2, 96	608.46	1.2	−62.6	35	−52.7		1.365	
24-3, 47	609.47	0.4	−68.6	15	−61.9		0.710	
24-3, 118	610.18	3.2	−57.7	45	−51.3		0.890	
25-1, 128	616.28	1.4	−55.0	50	−49.3		1.335	
B1-1, 37	624.37	1.2	−71.1	25	−43.0?		1.485	
27-1, 91	626.91	1.3	−61.9	40	−50.2		1.510	
27-2, 112	628.62	·1.2	−56.3	55	−47.0		1.635	
27-3, 38	629.38	0.7	−62.7	60	−50.0?		1.485	12
28-1, 84	630.84	0.7	−58.8	30	−20.8		1.630	
28-2, 85	632.35	2.4	−60.5	30	−51.7		1.560	
28-3, 90	633.90	0.8	−64.9	30	−31.7?		1.350	
28-4, 95	635.45	1.5	−68.8	60	−56.5		1.360	
29-1, 1	636.01	8.9	−63.0	80	−55.7		1.085	
29-3, 91	639.91	9.0	−59.4	70	−54.0		1.220	
29-5, 49	642.49	7.4	−66.2	75	−53.6		1.220	
29-6, 86	644.36	8.2	−68.6	70	−57.9		1.270	
30-1, 39	645.39	7.3	−67.0	55	−38.3		1.850	
30-2, 23	646.73	7.9	—	45	−65.1		1.120	
30-3, 11	648.11	7.2	−73.8	—	—		1.050	
30-4, 32	649.82	6.4	−72.2	50	−28.0?		1.180	
30-5, 74	651.74	6.0	−70.4	—	—		1.285	
30-6, 17	652.67	5.0	−78.6	70	−50.0		1.250	
31-1, 45	654.45	3.9	−65.3	90	−46.0		1.250	
32-1, 34	655.84	10.7	−56.3	80	−52.6		2.120	
32-1, 123	656.73	4.8	−53.8	325	−54.4		0.446	
32-2, 29	657.29	4.8	−53.2	300	−52.8		0.725	Sediment
32-2, 95	657.95	4.7	−50.5	325	−51.3		0.575	
B2-1, 86	?	7.3	−59.5	40	−48.8?		1.265	13
38-1, 93	691.30	20.5	−51.1	30	−50.3		1.360	
38-2, 58	691.80	8.6	−66.5	85	−42.0		0.915	14
39-1, 4	692.04	9.0	−52.4	50	−38.8		1.080	15
39-1, 120	693.20	12.4	−55.2	50	−37.0		1.010	16
39-2, 26	693.76	5.8	−72.0	—	—		1.065	

Table 2. (Continued).

Core-Sec., Sample Location in cm	Depth Sub-bottom (m)	NRM Intensity × 10^{-3}emu/cm^3	NRM Incl. (°)	MDF (Oe)	Stable Incl. (°)		Susceptibility × 10^{-3}emu	
39-3, 57	695.57	8.3	−60.2	35	−36.3		1.080	16
39-3, 136	696.36	10.0	−53.9	50	−40.0		1.080	
39-4, 106	697.56	10.3	−38.2	65	−26.5		0.990	18
39-5, 44	698.44	16.7	−57.1	55	−48.2		0.960	
40-1, 60	702.60	13.7	−62.8	70	−56.1		0.880	19
40-1, 101	703.01	1.4	−31.3	315	−31.8		0.410	Sediment (tilted)
41-1, 115	712.15	5.9	−67.2	45	−58.6?		1.280	
41-3, 120	715.20	6.3	−70.7		—		1.265	
41-4, 103	716.53	5.1	−73.2	40	−67.2		1.220	
41-5, 68	717.68	5.8	−77.4	30	−48.4?		1.380	21
41-6, 42	718.72	5.7	−57.4	30	−36.1		1.420?	
41-6, 99	719.29	4.6	−61.6		—		0.910	
41-7, 94	719.64	4.4	−51.3	60	−32.2		1.100	
41-8, 38	719.78	3.6	−48.4	335	−49.3		0.430	
42-1, 18	720.18	0.3	−33.8	245	−36.9		0.260	
42-1, 69	720.69	0.7	−45.8	275	−46.8		0.380	
42-2, 65	722.15	0.4	−48.5	235	−53.7	$\overline{X}$ = −48.8	0.270	
43-1, 40	723.40	0.5	−42.4	220	−55.5	±5.6	0.355	Sediment
43-1, 125	724.25	0.4	−43.3	185	−47.2	N = 9	0.355	
43-2, 43	724.93	0.6	−47.0	245	−53.0		0.450	
43-2, 129	725.79	0.4	−40.7	225	−51.1		0.450	
43-3, 65	726.65	0.3	−45.1	215	−45.5		0.370	
44-1, 52	729.52	7.4	−49.9	105	−43.0		1.080	
44-2, 74	731.24	7.8	−54.5	110	−46.6		1.030	
45-1, 107	734.07	4.8	−46.8	80	−34.3		0.845	
45-2, 115	735.65	5.4	−42.8	95	−33.2	$\overline{X}$ = −38.6	1.100	
46-1, 33	738.33	4.6	−68.8	35	−33.2?	±9.9	1.270	22
46-2, 69	740.19	6.8	−60.3	55	−27.0	N = 7	1.230	
46-4, 29	742.79	6.3	−68.8	50	−55.0		1.380	
46-5, 123	745.23	5.0	−38.5	120	−31.1		0.960	
47-1, 140	748.40	6.5	−39.0	85	−31.0		0.935	
47-2, 124	749.74	7.4	−44.2	85	−29.5		0.935	
48-1, 25	756.25	7.1	−51.5	175	−42.0	$\overline{X}$ = −32.7	0.565	
48-3, 90	759.90	6.7	−46.0	—	—	±4.9	0.625	23
48-3, 108	760.08	6.1	−40.8	100	−28.3		0.955	
48-4, 65	761.15	8.5	−44.7	85	−32.7	N = 6	0.795	
49-1, 61	765.61	9.6	−44.2	95	−32.8		0.900	
49-2, 114	767.64	7.2	−50.4	55	(+11.9)?		1.370	
50-1, 38	768.38	3.5	−60.4	50	(+12.2)?		1.655	
50-2, 98	770.48	2.9	−55.7	40	(+8.6)?		1.630	
50-4, 122	773.72	4.9	−59.2	—	(+10.0)?		1.580	
50-6, 88	776.38	3.9	−69.4	—	(+20.3)?		1.730	
51-1, 24	778.74	3.5	−79.1	35	(+20.5)?		1.785	24
51-1, 81	779.31	2.9	−69.3				1.785	
51-2, 126	780.76	3.7	−71.6	55	−58.1?		1.605	
51-3, 134	782.84	3.7	−59.4	50	(> +9.8)?		1.260	
51-4, 2	783.02	4.3	−77.9	40	(+19.9)?		1.295	
52-1, 128	788.78	10.3	−85.1	35	−58.4		1.380	25
52-2, 106	790.06	4.4	−68.7	35	(+9.9)?		1.295	
53-1, 3	792.03	4.4	−44.7	275	−43.2		0.335	
53-1, 88	792.88	6.9	−37.3	80	−30.7		1.020	
53-2, 139	794.89	13.3	−55.7	80	−26.8		1.005	
54-1, 32	797.82	3.9	−44.9	240	−25.4?		0.440	
54-2, 23	799.23	7.3	−48.9	80	−35.5?	$\overline{X}$ = −35.5	0.980	
55-1, 50	801.50	6.6	−51.2	120	−42.8	±5.8	0.800	
55-1, 144	802.44	7.2	−39.9	110	−33.2	N = 9	0.910	26
55-2, 83	803.35	6.8	−48.0	105	−38.2		0.800	
56-1, 57	807.07	12.0	−54.6	60	−32.7		0.930	
56-2, 52	808.52	18.0	−50.0	110	−40.2		0.875	
57-1, 13	815.63	8.5	−42.1	100	−31.3		0.885	
58-1, 13	824.63	5.6	−68.9	—	—		1.300	
58-2, 15	826.15	4.0	−53.8	85	−38.9		0.770	
58-3, 30	827.80	3.7	−61.0	—	—		1.270	
58-4, 5	829.05	4.7	−57.5	—	—		1.270	27
59-1, 68	834.18	9.2	−56.5	—	?		1.355	
59-2, 36	835.36	3.4	−72.4	—	?		1.365	
59-3, 99	837.49	4.8	−67.0	—	?		1.365	28
59-4, 45	838.45	4.8	−57.6	—	—		1.365	
59-5, 20	839.70	14.2	−55.2	110	−37.2	$\overline{X}$ = −38.5	0.880	
59-5, 97	840.47	10.8	−44.4	95	−36.9	±3.2	1.010	
59-6, 11	841.11	6.4	−52.0	70	−37.0	N = 5	1.060	29
59-6, 104	842.04	8.0	−46.7	130	−44.2		0.890	
60-1, 17	842.67	6.0	−48.9	110	−37.0		1.080	
60-2, 47	844.47	4.9	−62.5	75	−42.3		1.165	
60-3, 95	846.45	5.5	−57.5	85	−45.4		1.050	
61-1, 71	852.21	6.3	−57.0	140	−43.1		0.960	
61-2, 67	854.17	7.3	−52.9	—	—		1.410	
61-3, 3	854.53	7.2	−44.3	140	−35.6	$\overline{X}$ = −44.0	1.050	

Table 2. (Continued).

Core-Sec., Sample Location in cm	Depth Sub-bottom (m)	NRM Intensity × 10^{-3}emu/cm^3	NRM Incl. (°)	MDF (Oe)	Stable Incl. (°)		Susceptibility × 10^{-3}emu	
61-3, 122	855.72	6.5	−57.3	—	—	±5.8	1.350	30
61-4, 119	857.19	6.0	−75.0	75	−47.8	N = 8	1.190	
61-5, 144	858.94	5.1	−53.7	—	—		1.220	
62-1, 94	861.44	9.9	−62.2	—	—		1.220	
62-2, 100	863.00	8.0	−53.0	90	−36.4		1.100	
62-3, 81	864.31	7.0	−65.3	120	−50.3		1.065	
63-1, 123	865.73	8.5	−52.8	55	−20.2?		1.165	
63-2, 66	866.66	5.9	−58.7	60	−51.0		1.270	
64-1, 33	869.83	7.3	−67.3	—	—		1.390	
64-2, 45	870.45	6.1	−70.3	—	—		1.350	31
64-4, 45	874.45	7.1	−52.7	70	−40.0		1.300	
64-5, 30	875.80	6.5	−55.7	60	−46.0?		1.260	
65-1, 4	876.54	19.4	−74.6	—	—		1.490	
65-2, 122	879.22	34.1	−72.7	40	?		1.430	
65-3, 46	879.96	28.8	−69.4	—	—		1.430	
66-1, 40	883.40	22.2	−77.2	—	—		1.440	
66-2, 68	885.08	23.0	−73.3	—	—		1.390	
66-3, 57	886.57	22.4	−75.6	—	—		1.540	
66-4, 93	888.43	23.3	−80.9	—	—		1.490	
66-5, 64	889.64	17.6	−75.1	—	—		1.580	32
66-6, 75	891.25	19.9	−78.0	—	—		1.470	
67-1, 34	892.34	17.3	−76.1	—	—		1.560	
67-2, 64	894.14	13.0	−80.0	40	< −70.3		1.800	
67-3, 36	895.36	18.6	−81.8	—	—		1.620	
67-4, 87	897.37	17.3	−73.7	—	—		1.720	
67-5, 88	898.88	17.1	−76.8	—	—		1.670	
67-6, 61	900.11	22.4	−71.9	—	—		1.750	
68-1, 43	901.43	25.9	−75.7	45	?		1.930	
68-2, 76	903.26	23.0	−79.8	—	—		1.720	
68-2, 126	903.76	10.8	−72.6	45	< −40.0		1.540	
68-3, 26	904.26	14.7	−85.6	70	−48.2		1.660	
68-4, 13	905.63	17.5	−77.0	—	—		1.320	33
68-5, 28	907.28	27.1	−68.9	—	—		1.320	
68-6, 18	908.68	6.7	−74.4	90	−38.6		1.140	
69-1, 4	910.04	14.6	−53.3	105	−38.6		0.910	
69-2, 45	911.95	14.1	−54.2	125	−42.9		0.840	
69-2, 89	912.39	7.1	−52.3	110	−39.0	$\overline{X}$ = −38.4	0.810	
70-1, 87	919.87	16.4	−62.3	50	−37.0	±2.3	0.872	
70-2, 144	920.94	12.0	−71.3	40	−35.6	N = 7	1.098	34
70-3, 145	922.45	27.4	−55.4	50	−37.1		1.003	
71-1, 69	928.69	5.0	−53.2	95	−24.2?		0.884	
72-1, 85	931.85	21.8	−68.5	—	—		1.383	
73-1, 103	938.03	21.7	−81.1	—	—		1.433	
73-3, 47	940.47	26.7	−64.6	—	—		1.241	
74-1, 8	946.08	22.8	−73.1	—	—		1.400	
74-3, 37	949.37	17.5	−71.1	—	—		1.590	
74-5, 86	952.86	15.1	−71.9	—	—		1.590	35
75-1, 94	953.95	12.7	−77.4	—	—		1.688	
75-2, 123	955.73	8.5	−76.3	35	−57.5?		1.497	
75-2, 140	955.90	11.7	−75.3	40	?		1.538	
75-3, 88	956.88	11.3	−85.5	—	—		1.357	
75-4, 30	957.80	11.0	−80.3	—	—		1.442	
75-5, 100	?	13.2	−77.5	—	—		1.470	
76-1, 63	958.63	14.1	−68.9	—	—		1.195	
77-1, 61	967.61	28.5	−67.0	45	?		1.118	36
77-1, 110	968.10	20.1	−84.8	—	—		1.147	
77-2, 72	969.22	25.2	−72.5	—	—		1.203	
77-3, 10	970.10	19.0	−77.7	—	—		1.100	
78-1, 100	977.00	17.4	−69.6	—	—		1.011	37
78-2, 44	977.94	30.8	−87.0	—	?		1.045	
78-2, 115	978.65	21.1	−74.1	—	—		1.218	
78-3, 45	979.45	12.0	−75.7	—	—		1.080	38
79-1, 102	986.02	5.6	−69.3	—	—		0.765	
79-2, 131	987.81	13.0	−59.7	—	—		0.960	
79-3, 79	988.79	16.9	−70.9	—	—		1.416	39
79-4, 97	990.47	22.8	−67.9	—	—		1.182	
79-5, 76	991.76	17.0	−78.3	—	—		1.243	
79-5, 143	992.43	13.1	−79.9	—	—		1.122	
79-6, 8	992.58	12.5	+42.0	230	+33.2		0.350	
80-1, 6	994.06	0.317	−49.2	150	−40.9		0.192	
80-1, 25	994.25	0.665	−37.0	200	?		0.313	
80-1, 64	994.64	0.612	−84.4	135	?		0.141	Sediments
80-2, 6	995.56	0.447	−76.4	—	—		0.176	
80-2, 101	996.51	0.438	−61.6	150	?		0.148	
80-2, 125	996.75	20.8	−67.2	—	—		1.145	
80-3, 92	997.52	18.2	−76.4	50	−54.0		1.328	
80-4, 34	998.00	53.1	−78.1	80	?		1.100	
81-1, 41	998.41	23.0	−77.2	—	—		1.366	40
81-2, 16	999.66	22.8	−74.1	—	—		1.324	
81-3, 52	1001.52	20.6	−77.2	—	—		1.004	

Table 2. (Continued).

Core-Sec., Sample Location in cm	Depth Sub-bottom (m)	NRM Intensity $\times 10^{-3}$emu/cm^3	NRM Incl. (°)	MDF (Oe)	Stable Incl. (°)	Susceptibility $\times 10^{-3}$emu	
84-1, 39	1005.89	13.2	−76.5		—	1.306	
84-2, 50	1007.50	12.8	−74.5	—	—	1.571	
84-3, 10	1008.60	11.1	−78.6	—	—	1.510	41
84-3, 58	1009.08	13.1	−76.7	—	—	1.400	
84-4, 12	1010.12	8.2	−80.4	—	—	0.980	
84-4, 24	1010.24	13.8	−81.5	—	—	1.427	
84-5, 59	1012.09	14.4	−77.7	—	—	1.291	
84-6, 70	1013.70	12.3	−74.4	—	—	1.254	
85-1, 112	1015.62	14.2	−88.6	—	—	1.624	42
85-2, 27	1016.27	12.2	−72.2	—	—	1.590	
85-2, 57	1016.57	13.1	−76.3	—	—	1.450	
85-3, 49	1017.99	12.5	−77.5	—	—	1.683	
85-4, 44	1019.44	16.2	−85.9	35	?	1.720	
87-1, 64	1026.64	23.4	−77.5	—	—	1.160	
87-2, 104	1028.54	16.7	−78.1	—	—	1.460	
88-1, 97	1033.47	14.5	−82.1	—	—	1.296	
88-2, 57	1034.57	10.9	−80.4	—	—	1.296	
88-2, 84	1034.84	8.6	−81.9	—	—	1.250	43
88-3, 26	1035.76	16.5	−74.1	—	—	1.254	
89-1, 89	1037.39	16.4	−84.3	—	—	1.508	
89-2, 11	1038.11	13.1	−81.0	—	—	1.487	
89-2, 111	1039.11	17.4	−53.7	—	—	0.956	
89-2, 122	1039.22	19.3	−55.8	130	−51.4	0.676	
89-2, 132	1039.32	28.8	−53.7	80	−50.2	1.066	
90-1, 30	1041.80	27.0	−52.3	—	—	0.942	
90-1, 75	1042.25	5.4	−66.2	—	—	0.780	
90-2, 57	1043.57	12.6	−69.7	—	—	1.256	44
90-3, 131	1045.77	13.2	−61.5	—	—	1.286	
90-4, 125	1047.35	8.1	−63.2	45	−47.3	1.355	
90-5, 7	1047.57	5.7	−62.2	50	−52.1?	1.123	

[a] The last column indicates the petrological unit numbers, as described in Site Summary (this volume).

ment. Because of the design. the manner of inserting the samples into the magnetometer normally results in passing samples right across the edges of these cans. No matter how the insertion is done, it is not possible to remain more than 2½ cm away from the innermost, and 5 cm from the outermost, can edge. The measured field at these (vertical) can edges is between 1 and 2 G. Repeated insertion of a sample after each demagnetization step is normally done in a very consistent manner, such that the sample is exposed to the same part of the field of the cans each time.

Many of the Leg 61 igneous rocks were affected by this situation. Many could be progressively magnetized by the magnetometer as their demagnetization in alternating fields proceeded. NRM measurements generally were not affected, but samples became susceptible after demagnetization had begun. The coarser grained samples and those with high susceptibility were the most susceptible to this influence. But even some visually fine-grained, low-susceptibility rocks began to be biased once they were below 50% of their NRM intensities.

The effect of the magnetometer is manifested as either a quite noticeable or a very subtle change, away from the progressive movement to the characteristic direction and toward a direction representing the field of the can. The effect on these entirely negative inclinations was to progressively shallow them; this is the same effect that demagnetization has on these samples. The configuration of the magnetometer-can field relative to the sample's magnetization as one inserted it would result in a shallowing of the samples inclinations when magnetization is being imparted by the can. The magnetometer's influence would appear at different times within the demagnetization of each sample, and often is so subtle as to be difficult to separate from the normal demagnetization response. More often, however, a distinct change in the progression of directions occurs, and this usually allowed this bias to be weeded out of the data.

The severity of this problem is illustrated by samples from several massive diabase sills between 767 and 904 meters sub-bottom (Hole 462A). It was these samples that led to understanding the more subtle influences the magnetometer had had on many of the samples from higher in the core. Essentially, it was observed that one could repeatedly obtain different directions, depending upon the manner in which one inserted the sample into the magnetometer. Different values were obtained, depending on whether one inserted the sample across the left, right, front, or back of the magnetometer cans.

The procedure used to demonstrate this effect was to insert a demagnetized sample in the normal position and measure it. Immediately, the sample was redemagnetized in the same or slightly stronger alternating field and placed into the magnetometer in a completely inverted position. Once inside the shielding cans, it was turned (with difficulty) into the correct sequence of measurement positions. Repeatedly carrying out this procedure at the same AF level gives different directions, which are repeatable for each insertion mode. Table 3 shows typical examples.

The effect of moving the samples through the laboratory field (measured at $< 25{,}000\ \gamma$) was also tested. Samples were moved from the AF demagnetizer to the magnetometer in the usual and in an inverted mode, and inserted, in both normal and inverted positions, into the magnetometer. No difference in direction resulted from the mode of travel through the laboratory field, but the difference related to the position in which the sample entered the magnetometer remained.

The problem seems to be entirely related to the magnetometer, and not related to the AF demagnetizer. The sense of insertion into the AF demagnetizer was alternated for each demagnetization treatment. Since treatment steps varied for each sample and some were done more than once at the same step, it is unlikely that, for samples listed in Table 3, the same mode of insertion into the AF unit corresponded to the same mode of insertion into the magnetometer. More compelling, however, is the fact that all coarse-grained high-susceptibility samples whose demagnetization treatment involved only normal insertion into the magnetometer showed continuous decrease in inclination during demagnetization, regardless of the mode of insertion into the AF demagnetizer. The only correlation of all the observations with one another is through the mode of insertion into the magnetometer. Even though the small value of magnetometer field involved (1-2 Oe) makes this interpretation awkward, it seem the most likely interpretation at present.

The final directions of petrologic units 24 and 25 (Table 3) demonstrate the extreme of the magnetometer's effect on some samples. These two units are two sills of massive diabase with relatively very high measured susceptibilities. Until demagnetized to 1 to 3 % of their NRM intensity (J_0), these samples (except for two) show no stable magnetization. After demagnetization to these low levels of J_0, samples moved to directions such that all samples had the same declination and acquired various values of *positive* inclination. NRM declinations had not been the same. All samples had been placed into the magnetometer in the same orientation. Because of these considerations and the fact that this occurred only after the samples were demagnetized to 1 to 3% of their intensities, it seemed clear that this was an extreme example of the "magnetometer remanence." Experiments with some of these samples confirmed the ability of the magnetometer shield to magnetize these, just as described for the others.

The safeguards against the magnetometer's bias were two: (1) biasing of the sampling and interpretation toward the fine-grained rocks, most of which do not demonstrate a tendency to be influenced by the magnetometer field; (2) performing "normal" and "inverted" demagnetization and measurements occasionally throughout the treatment of each sample. Also, in this study, any slight change in linearity in a demagnetization path was studied as a possible clue that magnetometer magnetization had become significant. Because this effect was not recognized until many samples had been processed, there is some uncertainty in some of the final inclinations. Many of these are indicated with a question mark in Table 2. The intercalated sediments (with their high MDFs) were generally not affected. In addition, most of the basaltic samples from Hole 462 were not affected. Except for a few, most had MDFs above 60 Oe.

STABLE INCLINATIONS, HOLE 462

Samples from Hole 462 generally exhibit very stable inclinations. Very little change occurs during demagnetization. Figure 2 illustrates both the NRM and demagnetized inclinations, and the associated MDFs. Figure 3 shows typical responses to AF demagnetization.

The basalts of this hole have three distinct groupings of stable inclinations (Fig. 2). The upper samples group around a mean of 39.3°, standard deviation = 4.8° (N=4). The second group, below an 8-meter recovery gap, have a mean of $-42.9° \pm 1.9°$. Finally , the lower 13 samples are grouped around $-48.2° \pm 2.6°$. These groupings are designated Magnetic Units 1 through 3 in Figure 2 and Table 1, and correspond to separate petrologic units (Site Summary, this volume). Although the number of samples is small, the similarity of inclinations suggests that Petrologic Units 1 through 6 (Magnetic Unit 1) may be contemporaneous, and that Petrologic Units 7 through 10 (Magnetic Unit 2) may be contemporaneous. The third magnetic unit has the same boundaries as the last petrologic unit, Unit 11.

The only other magnetic feature which changes noticeably within Hole 462 is susceptibility: a distinct increase occurs at the boundary between the second and third magnetic units (Fig. 2). Susceptibility is appreciably higher in the lower unit, and may be related to the larger grain size. The bottom of this unit is enriched in magnetite, both within the basalt and as veins running through the basalt (Batiza, et al., this volume). Samples of this rock do not show any higher intensity or susceptibility; but a sample of a magnetite vein (exhibiting octahedrons of magnetite) does show high susceptibility and intensity. Nevertheless, direction is the same as the rest of the magnetic unit.

STABLE INCLINATIONS, HOLE 462A

In contrast to Hole 462, Hole 462A had generally higher NRM inclinations and lower MDFs. Figure 1 shows the NRM intensity, the NRM and demagnetized inclination, the MDF, and the susceptibility for each sample. Figure 4A illustrates the typical low coercivity of remanence in the upper sills (interpreted as the second igneous event). Figure 4B shows the increase in coercivity associated with the extrusive–intrusive complex below 730 meters sub-bottom (interpreted as the first event).

In the upper sills, three magnetic groups (A, B, C) can be described. Petrologic Units 1, 2, and the uppermost portion of 3 (Fig. 1) have a mean inclination of $-23.9 \pm 3.8°$ (N = 8). The rest of Unit 3 and most of Unit 4 exhibit a trend of stable inclinations intermediate between those of Petrologic Units 1 and 2 and those of Unit 5 and below. No mean was calculated, because of this strong trend (see Fig. 3). The rest of this upper sill complex, Petrologic Units 5 through 12, show inclinations which group around a mean of $-51.8 \pm 7.2°$ (N = 35). The means quoted do not include samples which did not achieve a stable direction or those whose stable direction was questionable (see Table 2). Sediments immediately beneath the third magnetic group have a mean inclination (N = 3) of $-52.8 \pm 1.6°$, nearly identical to that of the basalts above them. Two sedimentary intervals, only one of which could be sampled, occur within Magnetic Unit C. The sample taken also gave a similar inclination, $-47.7°$. The sample was obtained about ½ meter away from the basalt above, and most likely has been baked.

In the lower part of the third magnetic interval, a marked increase in NRM intensity occurs, accompanied by noticeably higher MDFs (Table 2). No change in inclination occurs at this point, and no explanation can be advanced at this time. The higher intensities are, however, characteristic of the entire rest of the core. Rock magnetic studies in progress may illuminate this situation.

Below Petrologic Unit 12, large intervals of volcaniclastic sediment occur, intruded by thin sills. The amount of material available for sampling was limited. The stable inclinations of the igneous samples obtained were scattered. They do not appear to be a distinct magnetic group, but a mean was calculated for convenience of description: $-42.5 \pm 11.2°$ (N = 12).

A large amount of the lower of the sedimentary intervals (between Petrologic Units 21 and 22) was recovered and could be sampled for paleomagnetism. The samples obtained were unique in that their inclination values *increased* upon demagnetization; they were the only samples in this entire study to exhibit this behavior. Their average stable inclination is $-48.8 \pm 5.6°$ (N = 9). The average NRM inclination was $-43.9 \pm 4.6°$. This change from shallower to steeper inclinations may be related to an overprint of the present-day low inclination onto a steeper inclination. It may also be related to a partial remagnetization by the overlying or underlying igneous rocks, although it is difficult to understand why these sediments would have had an original magnetization so similar to that of the massive sills (second igneous event). It is easier to envision that they had a small viscous remanence in the present field. They have MDFs lower than most of the other intercalated sediments sampled. Further, their behavior is similar to that of the undisturbed sediments above the igneous intrusion (see Steiner, this volume).

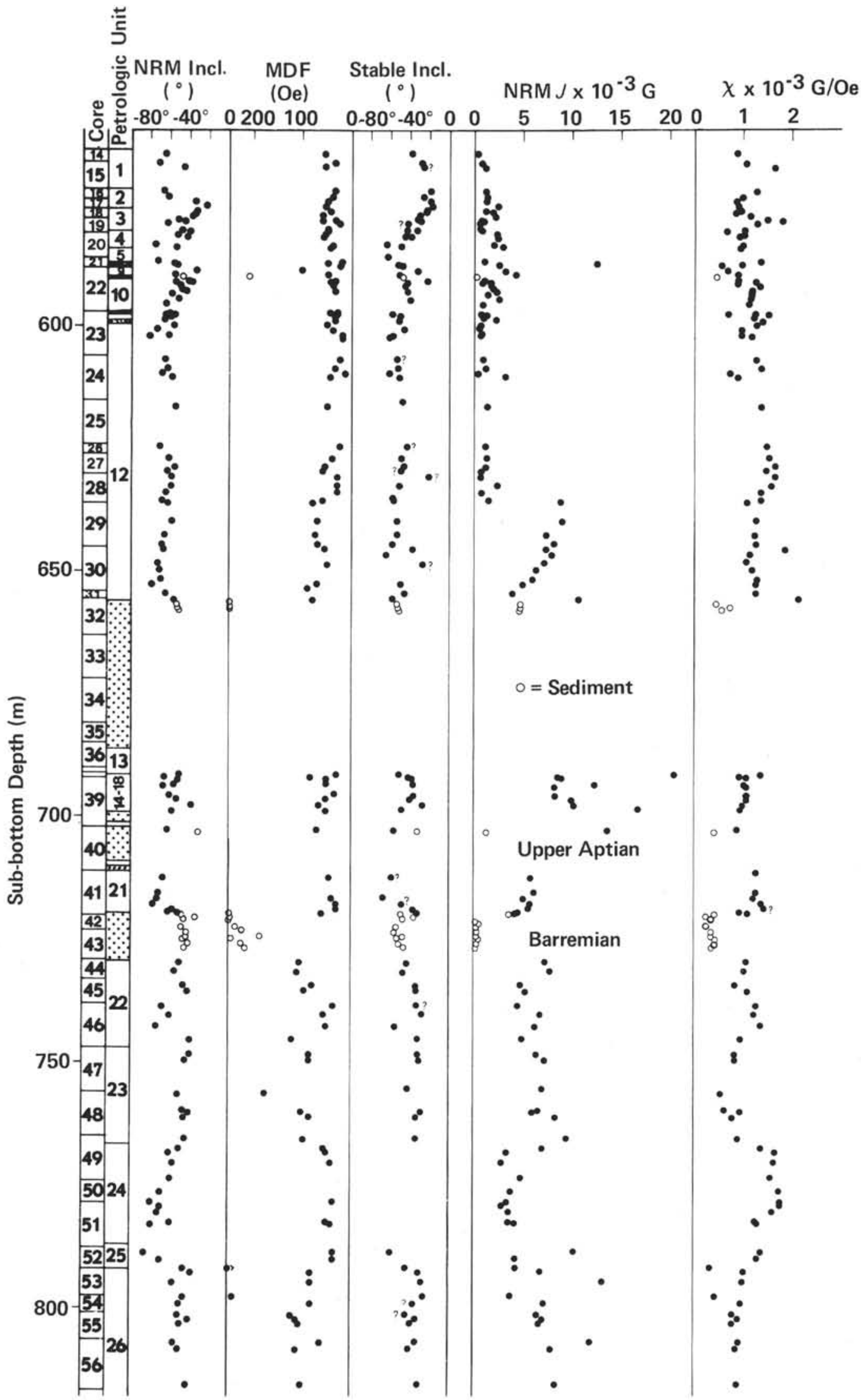

Figure 1. NRM and stable inclination, MDF, NRM intensity, and susceptibility, Hole 462A.

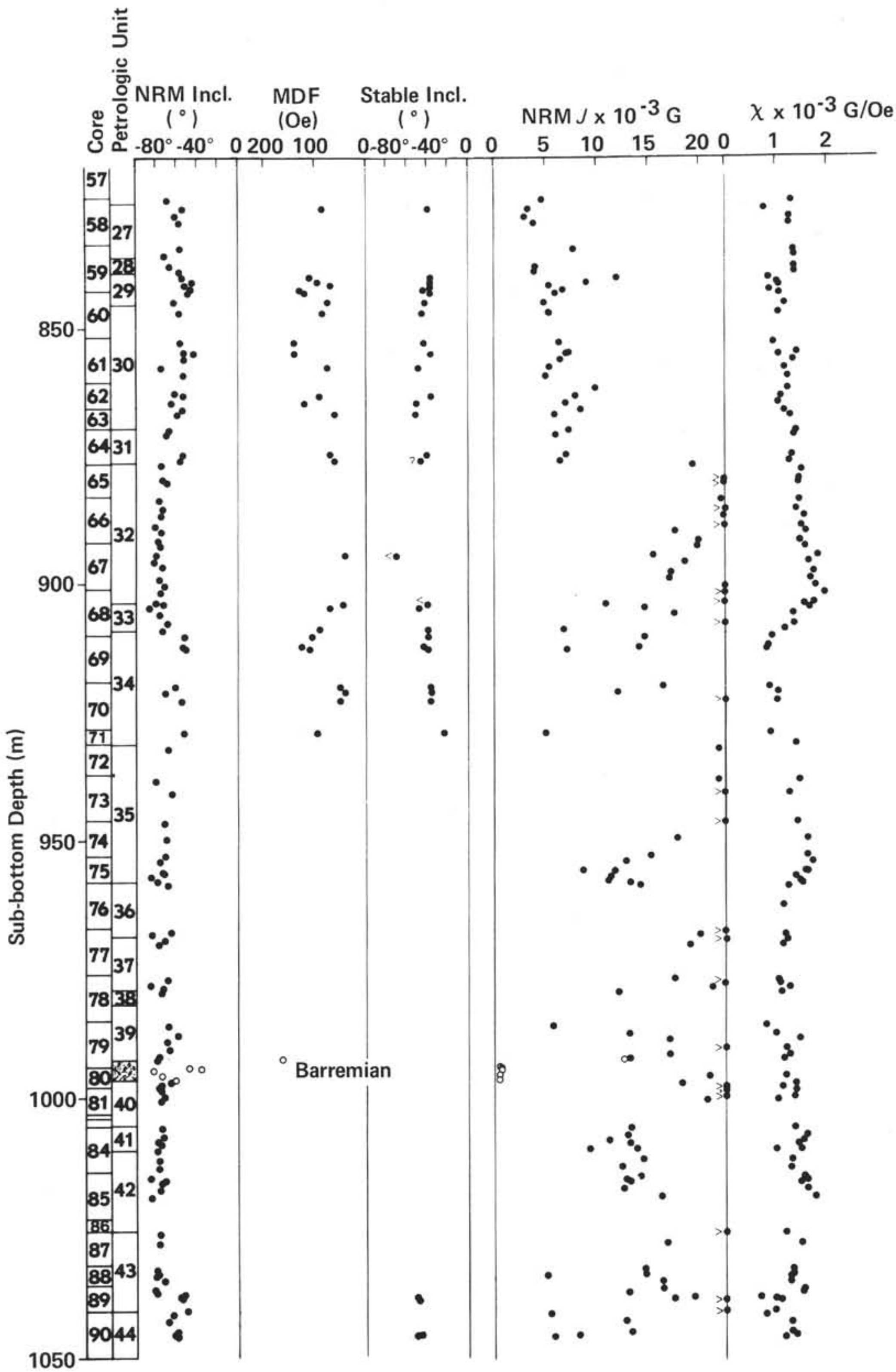

Figure 1. (Continued).

Table 3. Effect of magnetometer-can field on demagnetization response.

		Typical Examples				
			Normal Position		Inverted Position	
Measurement Sequence	Sample Treatment	% of NRM	Decl. (°)	Incl. (°)	Decl. (°)	Incl. (°)
1	NRM	100	220.0	−56.5	—	—
2	50 Oe	42	220.7	−49.8	—	—
3	50	—	—	—	223.0	−52.0
4	75	23	220.6	−45.8		
5	75	—	—	—	226.0	−48.8
6	100	14	222.4	−39.7		
7	100	—	—	—	231.3	−46.3
8	100	—	222.2	−39.6		
9	100	—	—	—	232.2	−46.4
1	NRM	100	146.0	−67.0		
2	50 Oe	30	162.9	−60.8		
3	50	—	—	—	157.5	−67.6
4	75	12	168.9	−49.5		
5	75	—	—	—	154.2	−66.0
6	100	8	171.0	−43.6		
7	100	—	—	—	150.1	−74.9
1	NRM	100	120.0	−72.0	—	—
2	100 Oe	12	128.9	−54.4	—	—
3	200	3	178.1	−3.3	—	—
4	250	2	—	—	58.8	−50.7
5	250	3	171.2	−4.1	—	—

Final Directions of Units 24 and 25[b]

Unit	Decl. (°)	Incl. (°)
24	179.3	+11.9
	170.0	+12.2
	169.2	+8.6
	170.5	+10.0
	158.5	+20.3
	182.6	+20.5
	327.4	−58.1[a]
	189.9	+9.8
	182.1	+19.9
25	23.1	−58.4[a]
	190.1	+9.9

[a] Did not exhibit same behavior as the rest.
[b] All samples from separate core pieces.

Inclinations below this lower sedimentary interval are clearly shallower than those of the sills to this point. All the petrologic units designated as extrusive (flows) give inclinations near −38°. The means of each of these units are given in Table 2. The mean inclination of these individual means is −38.0 ± 3.8° (N = 6); giving unit weight to the samples, the mean becomes −38.1 ± 6.6 (N = 42). The inclination of these units is clearly shallower than the inclinations of the sills above the large sedimentary interval (above 656 m sub-bottom).

The seven massive diabase sills interspersed with the flow units (24, 25, 27, 28, 31, 32, 33) generally did not have stable directions upon demagnetization (see Table 2). Units 24 and 25 have already been mentioned as examples of extreme instability and vulnerability to the shipboard magnetometer. Because of the general lack of success with pilot samples from the other massive units, and the vulnerability of Units 24 and 25, most of the coarse-grained samples were not demagnetized. This is true for the rest of the coarse-grained material recovered in this hole. *None* of the samples attempted below Unit 34 showed stable directions on demagnetization, except for one fine-grained, low-susceptibility interval at the base of the hole (Cores 89 and 90, Table 2). A few samples were demagnetized ashore (at the USGS laboratory in Menlo Park), but also proved to be highly susceptible to stray laboratory fields and/or the earth's field. No stable directions were obtained for those samples, either. In the cores below Unit 34, the very steep NRM inclinations, often extremely high NRM intensities, consistency of declinations, relatively high susceptibility—as well as the lack of useful response to demagentization—all suggest that these rocks have been remagnetized, probably in the drilling process. These characteristics also suggest a lack of sufficiently fine grained remanence carriers such that a stable remanence probably cannot be retained.

The fine-grained samples (Cores 89 and 90) at the base of this highly remagnetized sequence show NRM directions comparable to those of stable units from the top of the hole. They also demagnetize to stable directions and with inclinations of about −51°. This inclination value suggests a genetic affinity with the sill sequence near the top of the basaltic pile. These samples suggest that part of the material related to igneous

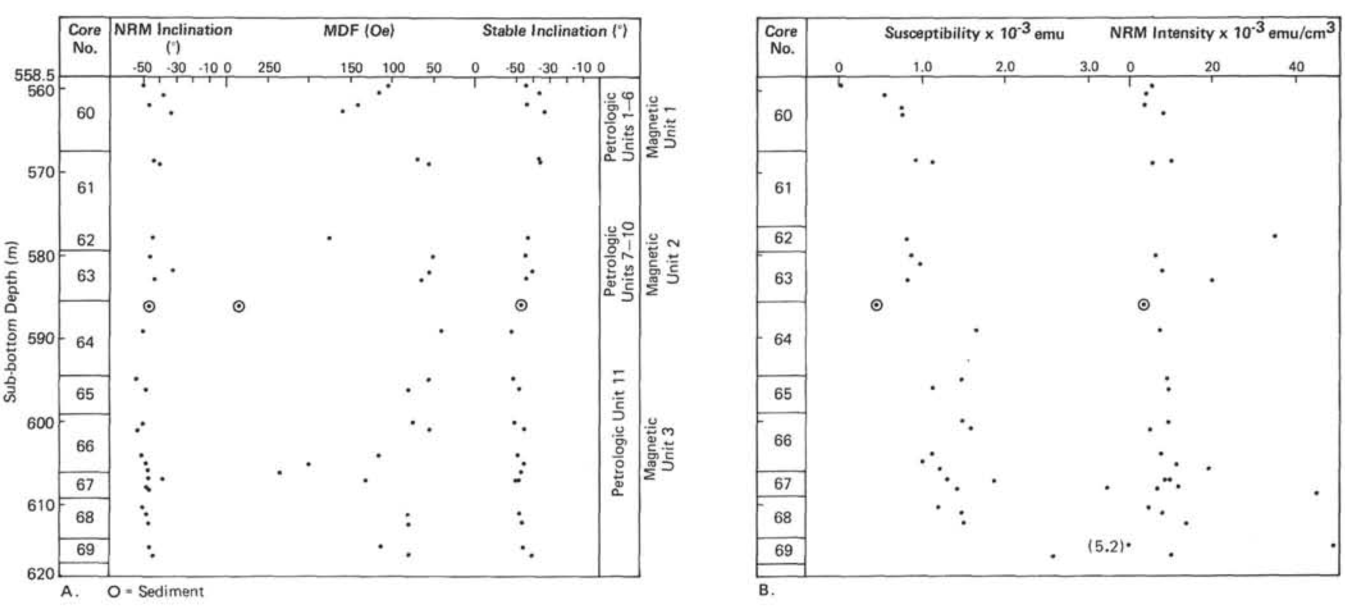

Figure 2. A. NRM and stable inclinations, Hole 462. MDF, susceptibility, and NRM intensity are also plotted (B).

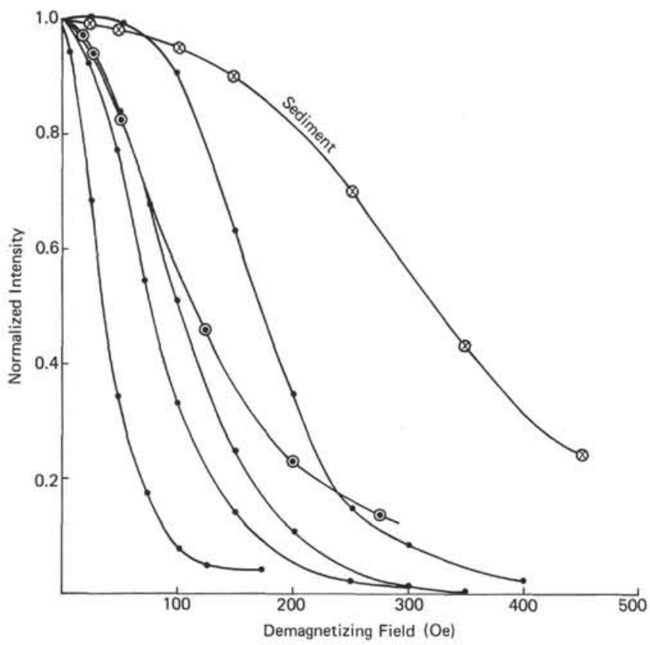

Figure 3. Normalized intensity response of typical samples from Hole 462 to AF demagnetization. One sediment sample is also shown.

episode 2 may have been intruded beneath and/or into igneous episode 1 units.

One last sedimentary interval was cored before termination of the hole (993 m sub-bottom). Of the six samples taken (Table 2), the top one had reversed polarity and the rest were normal, although the lower three had steep inclinations. The grain size of the sediment is clearly coarser in these lower four samples than in the higher sediments. This, with their lack of a stable direction, suggests that they may have been remagnetized by the drilling process. The reversed sample exhibits a stable inclination (+33°) which in nearly antipodal to the one below it (−41°). At first, this would appear to be a record of a geomagnetic field reversal. This would be consistent with the sediments having been laid down during the Hauterivian, a time of frequent reversals. The reversed sample, however, has magnetic properties unlike those of the rest of the sediments in that interval, particularly the sediments immediately below it. The NRM intensity is abnormally high, higher than any sediment sample recovered at this site. Its MDF is higher than that of the sample below it and those of two of the three other demagnetized samples in this interval. (This is similar to the situation in the other thick sedimentary interval sampled, between Units 21 and 22; see Table 2). The most suspicious aspect of this sample, however, is its color. The interval it was taken from is red, suggesting baking, and is only 10 cm away from the basalt contact. The adjacent basalts are all remagnetized in the steep negative drilling remanence direction, so their direction is not known. Still, given the proximity of this sample to the sill above it, it is unlikely that it could have retained its remanence through the heating event associated with the igneous episode. These

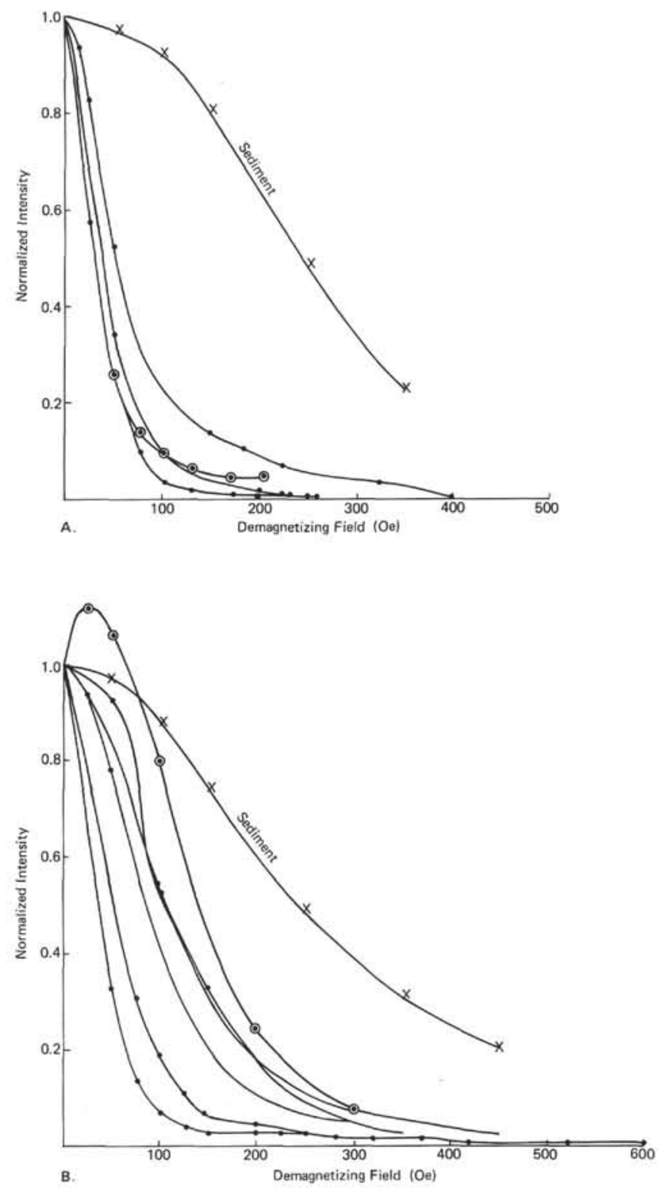

Figure 4. Normalized intensity response of typical samples from Hole 462A to AF demagnetization. A. Intrusives and sediment above 656 meters sub-bottom. B. Extrusives, intrusives, and sediment below 730 meters sub-bottom.

considerations leave the significance of this reversed sample ambiguous, but suggest self-reversal or thermal remagnetization.

CORRELATION OF HOLES 462 AND 462A

The upper basalts of Hole 462A resemble those of Hole 462 in some ways, although for the most part they are quite different. The magnetization of the comparable basalts from Hole 462A is much less stable than that of Hole 462 basalts. A considerable amount of soft component was removed during AF demagnetization of the upper part of Hole 462A. None of the the magnetic evidence suggest that the various alteration have changed the magnetization of the affected rocks.

CONCLUSIONS

Most of the intrusive/extrusive rocks at Site 462 have relatively soft to very soft magnetization. A steep uphole (negative) remanence (probably drilling remanence) is overprinted on the magnetizations. All igneous Hole 462A samples, whereas there was little to none in samples from Hole 462. In both holes, the uppermost inclinations are shallower than in the underlying units, but the stable inclinations of Petrologic Units 1 through 11 of Hole 462A do not correlate well with Units 1 through 10 of Hole 462. The recovery was very poor in the upper portion of the igneous sequence at Hole 462, and could be the reason that better correlation is lacking. The difference in stability of the magnetization suggests, however, that other explanations may also be possible.

The stable inclinations of the large sill comprising Unit 12 in Hole 462A are fairly similar to those of the thick lower unit, Unit 11, of Hole 462. The inclinations at Hole 462A are slightly higher and much more scattered, but both of these differences could easily reflect the overprinting (drilling remanence) in Hole 462A. The marked susceptibility increase in Hole 462, between Magnetic Units 2 and 3, is not as clearly apparent in Hole 462A, but there is an increase at that same depth (see 591 m sub-bottom in Fig. 1), and susceptibility continues to be generally higher downhole from that point. Thus, both susceptibility and stable inclination suggest a correlation of Holes 462 and 462A in their largest petrographic unit. This thick unit constitutes 58% of the overlap in the two sections. It is, moreover, entirely reasonable that the thinner sills comprising the higher units are not contiguous across the 500 meters separating the two holes.

ALTERATION

The basalts of the upper petrographic units in both Hole 462 and Hole 462A are visibly altered. The alteration was apparently multistaged (Batiza et al., this volume), and occurred both as late-stage magmatic and as later low-temperature (150°C) alteration. The alteration is of particular interest because of the reducing environment it reflects, and because magnetite is actually associated with the late-stage magmatic portion. Such alteration could have remagnetized these rocks. The magnetite occurs in the groundmass and as several veins of octahedral crystals in the lower part of Hole 462. It has a Curie point, in the vein material, of 560°C. Samples of the vein and of basalts containing dispersed secondary magnetite show, however, the same directions as samples from higher and lower in the igneous sequence. Only the vein itself exhibits any increase of susceptibility or NRM intensity. Numerous samples of the later chlorite, pyrite, and clay veins show diminished intensities but inclinations identical to those of nearby large non-veined areas. This continuity of directions occurs within all three different magnetic intervals within rocks for which stable inclinations were obtained are normally magnetized, as are all but one sample of the intercalated sedimentary rocks. In two large intervals, the inclinations are −51° and −38°, respectively. The lower portion of the core, approximately 130 meters thick, beginning at 931 meters sub-bottom (or 6117 m subsurface), appears to have been completely remagnetized, probably in the coring process. Figure 5 gives a schematic summary of the magnetization in the igneous sequence.

The magnetic data are most easily explained by two igneous events, just as the extrusive–intrusive geologic relationships suggest. The expected paleolatitude of this site is too poorly constrained to allow firm conclusions. Sediments suggest a near-equatorial latitude in Late Cretaceous time. Sediments from the nearby Ontong–Java Plateau also suggest a near-equatorial paleolatitude during the Late Cretaceous and a rapid increase

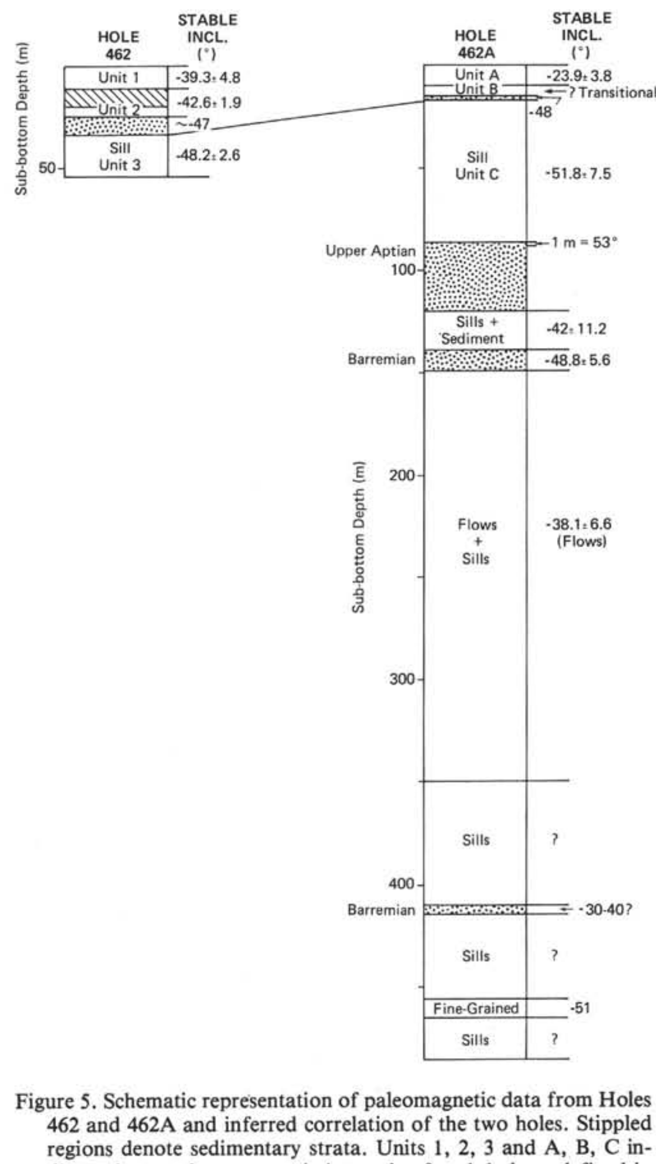

Figure 5. Schematic representation of paleomagnetic data from Holes 462 and 462A and inferred correlation of the two holes. Stippled regions denote sedimentary strata. Units 1, 2, 3 and A, B, C indicate the top three magnetic intervals of each hole as defined in the text. No correlation is implied except for the third interval. Numbers on the right of each column indicate the mean or approximate mean for each interval. (Lithology is intrusive sills when not noted.)

in paleolatitude through Cretaceous time (Hammond et al., 1975). Assuming no relative motion, Aptian basalt on the plateau indicates a paleolatitude for this site in Aptian time of 24.5°S, and Aptian sediments indicate very roughly 17.5°S (see fig. 3 of Hammond et al., 1975).

The inclinations recorded by the extrusives of Site 462 ($-38 \pm 6.6°$) give a paleolatitude of 21.3°S (ranging between 17.0 and 26.2°S). This value is similar to those suggested by the Ontong-Java Plateau samples. The inclination of the intrusives above the extrusives yields an apparent paleolatitude of 31.7°S. It cannot be argued that secular variation has been averaged out by either the extrusives or the intrusives; it probably has not. Both values of inclination ($-51°$, $-38°$) are within the range of secular variation expected for latitudes between 20° and 30°.

Although secular variation may not be averaged out in the extrusive inclination mean, it is interesting that the difference in inclination between the Site 462 Campanian sediments (Steiner, this volume) and the Barremian? extrusives is similar to that which would be predicted by the difference between the Ontong-Java Plateau Maestrichtian sediments and Aptian basalts. One problem, however, is that the Santonian through Cenomanian sediments of Site 462 do not verify this rapid change in paleolatitude suggested by the the Ontong-Java Plateau data, but suggest a near-constant paleolatitude between Campanian and Cenomanian.

In summary, the multiple uncertainties involved in trying to extract paleolatitude from the igneous rock inclinations do not allow quotation of paleolatitude on the basis of those data. Thus, the main magnetic information derivative from the igneous rocks is that two periods of igneous activity occurred and were separated by enough time to record two directions of secular variation. The magnitude of the two inclinations, however, does favor extrusion and intrusion in Early Cretaceous time. The magnitude of secular variation even at the equator makes it unlikely that the intrusions having 50° inclinations could have been emplaced in the Tertiary, when the plate was probably near the equator.

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REFERENCES

Hammond, S. R., Kroenke, L. W., and Theyer, F., 1975. Northward motion of the Ontong-Java Plateau between −110 and −30 m.y.: a paleomagnetic investigation of DSDP Site 289. *In* Larson, R. L., Moberly, R., et al., *Init. Repts. DSDP*, 32: Washington (U.S. Govt. Printing Office), 415–418.

Lancelot, Y., and Larson, R. L., 1975. Sedimentary and tectonic evolution of the northwestern Pacific. *In* Larson, R. L., Moberly, R., et al., *Init. Repts. DSDP*, 32: Washington (U.S. Govt. Printing Office), 925–939.

Larson, R. L., and Chase, C. G., 1972. Late Mesozoic evolution of the western Pacific Ocean. *Geol. Soc. Am. Bull.*, 83:3627–3644.

Petersen, N., 1978. *Glomar Challenger* drillings: The magnetic field produced by the drill and drill string. *In* Dmitriev, L., Heirtzler, J., et al., *Init. Repts. DSDP*, 46: Washington (U.S. Govt. Printing Office), 377–378.