15. PALEOMAGNETISM OF IGNEOUS ROCK SAMPLES-DSDP LEG 45[1]

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INTRODUCTION

One goal of deep penetration of the oceanic igneous crust during Leg 45 was to try to answer some of the more pressing questions about the magnetic properties of rocks that make up the oceanic basin. Although dredging, sampling by submersible, and drilling during previous DSDP cruises have provided a wealth of information about the magnetic structure and the origin and evolution of the oceanic igneous crust, these earlier studies have produced more questions and anomalous results than satisfying answers. The Vine-Matthews (1963) hypothesis has withstood the test of time and provided an extremely valuable first-order model of the origin of linear marine magnetic anomalies. It was, in part, to try to test this hypothesis directly that deep penetration during DSDP Legs 34, 37, and 45 (and subsequent legs) was planned. Like the anomalous results of previous studies, the three polarity intervals found in Hole 395A and the non-dipole inclinations found in Holes 395 and 396 have raised questions about a simple model for the magnetic structure of the ocean crust and the source of marine magnetic anomalies.

Site 395 is situated in oceanic crust which has well-defined magnetic anomalies; the two holes at this site were drilled in crust about 7.2 million years old. Holes 395 and 395A were drilled on the west flank of the Mid-Atlantic Ridge in the normal polarity magnetic anomaly 4 (geophysical data are from the site surveys of G. M. Purdy, WHOI; D. Hussong, HIG; and data from R/V *Akademik Kurchatov* [USSR]; see Purdy et al., Regional geophysics of Sites 395 and 396 [this volume]). Seismic refraction data indicate that Layer 3 at this site is approximately 1 km below the sea floor. Hole 395 penetrated approximately 100 meters and Hole 395A penetrated 576 meters of oceanic igneous crust.

Site 396, with somewhat older crust (9 or 10 m.y.), is on the east flank of the Mid-Atlantic Ridge at the same latitude as Site 395, and is within normal polarity magnetic anomaly 5. Penetration of igneous crust for Hole 396 was approximately 100 meters. Layer 2A at Site 396 is approximately 400 meters thick and the top of Layer 3 is about 1.9 km below the sea floor.

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EXPERIMENTAL PROCEDURES

Sampling and measurement techniques were identical to those used on Legs 34 and 37 (Ade-Hall and Johnson, 1976; Hall and Ryall, 1977). Paleomagnetic directions and sample intensities were measured on shipboard using a Schonstedt DSM-1 spinner magnetometer. Alternating field demagnetization on shipboard was carried out using a Schonstedt single-axis demagnetizing unit. Additional magnetic measurements were made at the University of Colorado with a Schonstedt SSM-1 spinner mangetometer and a 2-axis tumbling AF demagnetizing unit.

During the magnetic studies of the samples from Leg 34, several secondary components of magnetization were identified in the coarse-grained massive flow material recovered from the Nazca plate. One of the major components of this secondary magnetization was a vertical (directed downward) soft component of remanence that was attributed to the drilling process (drilling remanent magnetization, Ade-Hall and Johnson, 1976). A non-magnetic Monel drilling collar was used during the Leg 37 deep basement penetration, and the drilling-induced magnetization in recovered samples was greatly reduced (Hall and Ryall, 1977). The Monel drilling collar was not used during Leg 45; all samples reported in this study were drilled with a standard steel drilling collar. Almost all samples in this study acquired a (sometimes very strong) downward directed, vertical component of "drilling remanence" that was, in most cases, not completely removed until after AF demagnetization to 75 or 100 oe. Analysis of the components of magnetization removed by each AF demagnetization step indicates that the component of drilling remanence was in all cases parallel to the vertical drill string. The intensity of the drilling remanence was greatest in the coarser grain samples and much less intense in the fine-grained oxidized, pillow basalt samples. In the very coarse grained serpentinized peridotite samples, the presence of the drilling remanence component made identification of any natural remanent magnetization impossible. In all other samples, the drilling remanence was removed at alternating fields sufficiently low that a stable magnetization direction could be clearly identified. During Leg 45, the presence and direction of this component was reliable enough to serve as a secondary orientation technique for a few samples that were overturned during the initial handling of the drill core. The origin of this drilling remanence has been attributed to either an IRM or a moderate-field VRM induced in the core during drilling (Ade-Hall and Johnson, 1976; Lowrie and Kent, 1976). Additional studies are underway to try to determine the origin of this magnetization.

RESULTS

Figure 1 shows the values of stable inclination for the AF-demagnetized samples, integrated over each 9.5-meter core where the averaging is justified by the lithology, magnetic inclination dispersion, and geochemistry. The value of inclination for an axial, centered dipole for the latitude of both sites is ±40°. Table 1 shows the stable inclination values averaged over each lithological unit. The inclinations for Hole 395 show a general trend toward shallower values with increasing depth, a trend not present in the same rock units of Hole 395A (the two holes were separated by less than 100 m). Rock magnetic studies of these units indicate that the shallowing of inclination with depth in Hole 395 is not a result of the addition of a post-formation CRM component, but may be a result of tectonic rotation of the units in Hole 395 (Johnson, Rock magnetic properties of igneous rock samples—Leg 45, this volume). Although it is difficult to imagine a tectonic process that would provide a gradual shallowing of inclination progressively throughout the same rock unit, the inclinations from the upper two basalt units of Hole 395 become very similar (but not identical) to the upper two basalt units of Hole 395A if they are increased by 15°.

Hole 395A shows three clear polarity intervals in the upper extrusive basalt units:

normal polarity	0 to 170 meters sub-basement (Units A_2, P_2, and P_3)
reversed polarity	170 to 480 meters sub-basement (Units P_4, P_5, and A_3)
normal polarity	480 to 525 meters sub-basement (Unit A_4 above the dolerite)

Below 525 meters sub-basement, a 22-meter-thick dolerite intrusion occurs (actually two separate dolerite intrusions, separated by a thin aphyric inclusion). The contact between the upper dolerite intrusion and the aphyric basalt lying directly over it was not recovered. The section of the aphyric Unit A_4 directly above the dolerite did not show any effects of remagnetization caused by heating associated with intrusion, but this may be a result of the incomplete recovery (Table 1). The dolerite units (Sections 61-1 to 62-1 and 62-1 to 64-2) were geochemically identical to the phyric extrusive basalt Unit P_4 (Sections 23-1 to 27-2; 170 m to 220 m sub-basement in Figure 1) (M. Rhodes, H. Bougault, personal communication). The average magnetic inclinations of the two units (P_4 average inclination = −33° ±4°; dolerite average inclination = −39° ±1°) are not identical, but are very similar. The magnetic data are not conclusive, but will be considered to be consistent with the idea that the dolerite intrusives are the same rock unit as the extrusive basalts of P_4. The aphyric basalt units both directly above and below the dolerite intrusion, as well as the small aphyric inclusion that separates the two dolerite units, are geochemically the same rock unit, A_4 (M. Rhodes, H. Bougault, personal communication). The magnetic inclinations of the samples taken from this aphyric Unit A_4 just below the dolerite intrusion are almost identical to that of the intrusion, and the scatter increases with increasing distance below the intrusion. It would appear that the dolerite intruded the normally magnetized Unit A_4 at a time when the magnetic field was reversed in polarity, and in doing so, partially remagnetized the sections of A_4 that were *below* the intrusion. There is no evidence that the sections of A_4 *above* the dolerites were at all remagnetized. At the same time that the dolerite units intruded, the small aphyric unit separating them was also remagnetized and the pillow basalt units of P_4 were also being extruded. It is likely that the dolerite units were, in fact, the feeder dikes to the extrusive pillows of P_4. The dolerite dikes may have served as an impermeable "cap" to the hot water that must have been present during intrusion. This would have allowed the elevated temperatures necessary for remagnetization to persist for a longer time and at a greater distance from the intrusion in the lower units of A_4 than in the permeable basalt pillows of A_4 directly above the intrusion.

Two breccia zones are present in Hole 395A: Sections 32-1 to 32-2 (260 m sub-basement in Figure 1) and Section 49-1 (420 m sub-basement). There is some scatter of the magnetization directions of samples from these breccia zones, but the directions in each zone are roughly coherent and the average values are very close to the axial dipole value of ±40°C (Figure 1). Rock magnetic studies show that some of the samples from these breccia zones (Core 32 in particular) have Curie temperatures above 400°C and show the characteristic ilmenite lamellae within oxidized titanomagnetites that indicate exposure to high-temperature oxidation (Johnson, Rock magnetic properties of igneous rock samples, this volume; Opaque mineralogy of the igneous rock samples, this volume). These breccia zones may have served as conduits for hot water, and may have been remagnetized by the resulting reheating. The breccia zone in Core 49 (420 m sub-basement) has the same polarity as the rocks above and below it, and could have been formed at the same time as the surrounding units. The breccia zone in Core 32 (260 m sub-basement) has, however, a magnetic polarity opposite that of the surrounding rocks, and was clearly remagnetized at a time after their formation (Figure 1).

One last point regarding Hole 395A: the distinction between Units P_3 and P_4 (Table 1) is made strictly on the basis of a reversal of the magnetic polarity. The geochemistry of the two units (both phyric basalts) is essentially identical (M. Rhodes, H. Bougault, personal communication). A reversal in magnetic polarity is generally considered to take approximately 2000 years. If there was truly a time period of the order of 2000 years between the formation of Units P_3 and P_4, and if

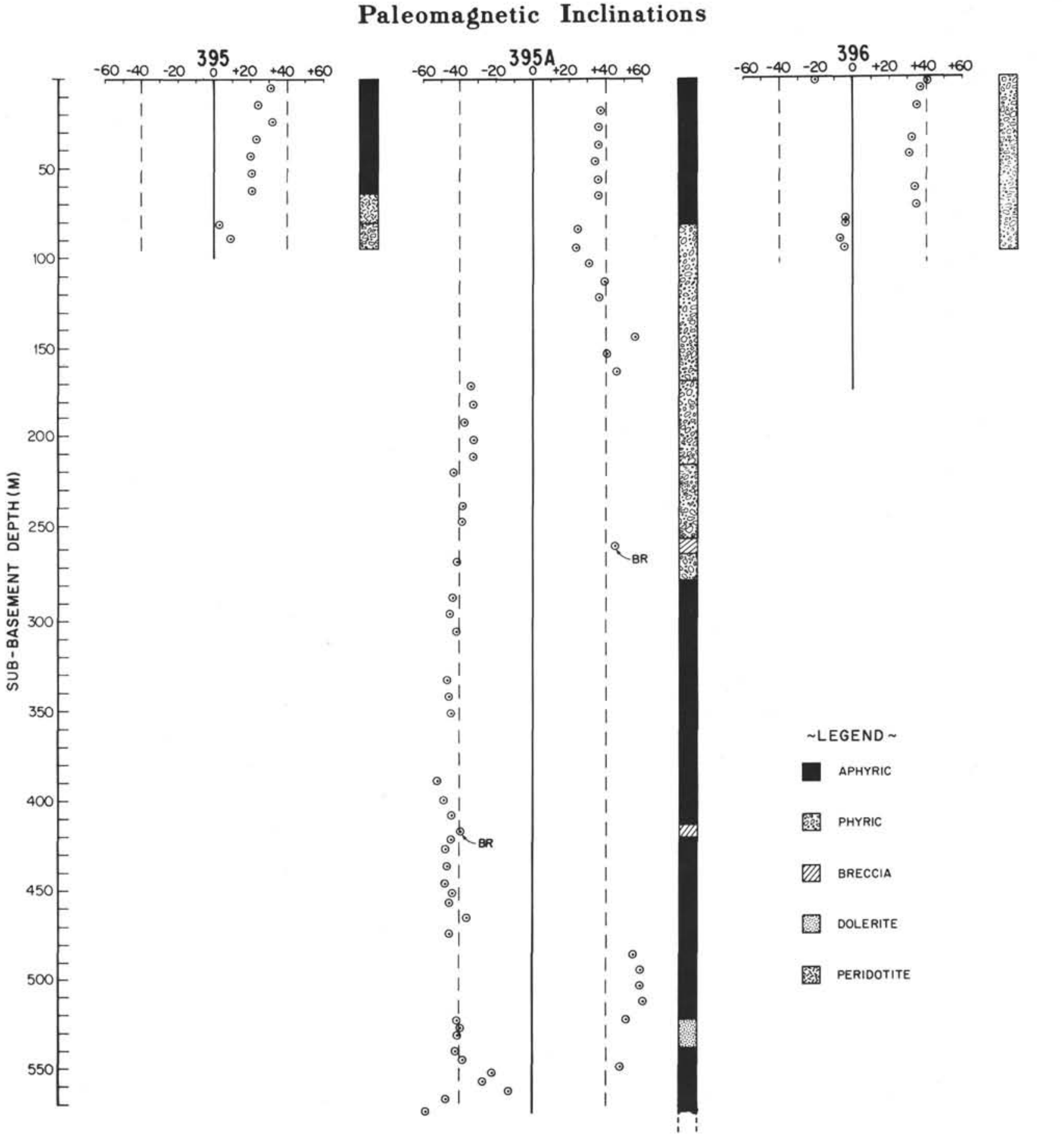

Figure 1. *Stable paleomagnetic inclinations for Holes 395, 395A, and 396. Inclination values were averaged over each 9.5-meter core section where the averaging was justified by inclination dispersion, lithology, and geochemistry. The centered axial dipole value of inclination for the latitude of both sites is ±40°. The two breccia zones which have coherent magnetic directions are labeled BR.*

further shore-based studies confirm their geochemical identity, then this will place strong constraints on models of magma chambers present during ocean crust formation.

The magnetic inclinations for Hole 396 are shown in Figure 1 and Table 1. The top unit, P_a, shows a shallow inclination of −20.8° ±1°. The bulk of the drill core (Sample 14,CC to Section 22-3, Unit P_b) has an average inclination of +34.5° ±3°. The bottom unit in the drill core (Sections 22-4 to 25-1, Unit P_c) again has shallow negative inclinations averaging −5.3° ±2°. Similarly to Units P_3 and P_4 in Hole 395A, the three defined lithological units in Hole 396 are geochemically virtually identical, and the division into sub-units

TABLE 1
Magnetic, Geochemical, and Lithological Stratigraphy for Holes 395, 395A, and 396, as Assembled Using Data From the Entire Shipboard Scientific Party

Unit Name	Upper and Lower Limits of Unit: Core-Section (Piece)	Lithology	Average Stable Magnetic Inclination (±1 S.D.)	Numbers of Samples	Criteria for Boundary
Hole 395					
A_2	11-1(2) to 17-1(6)	Aphyric basalt	+23.9° (±6°)	24	
					Lithology
Gabbro	17-1(7) one piece	Gabbro	–45 (talus?)	1	
					Lithology
Periodotite 1	18-1(2) to 18-2(2)	Harzburgite	no stable directions		
					Lithology
Periodotite 2	18-2(15) to 19-1(1)	Lherzolite	no stable directions		
					Lithology
A_2	19-1(2)	Aphyric basalt (contact)	+38°	1	
					Lithology
P_2	19-1(3) to 20-1(5) bottom of hole	Phyric basalt	+4.4° (±8°)	4	
Hole 395A					
A_2	5-1 to 13-1(3)	Aphyric basalt	+35.7° (±6°)	12	
					Lithology
P_2	13-1(4) to 16-1(2)	Phyric basalt	+28.5° (±8°)	14	
					Geochemistry
P_3	16-1(3) to 22-2(9)	Phyric basalt	+45.4° (±7°)	7	
					Magnetics (identical geochemistry)
P_4	23-1(5) to 27-2(11)	Phyric basalt	–33.0° (±4°)	13	
					Geochemistry
P_5	28-1(2) to 33-2(8)	Phyric basalt	–38.8° (±6°)	6	
					Lithology
A_3	33-2(9) to 56-3(141 cm)	Aphyric basalt	–44.0 (±4°)	31	
					Magnetics and geochemistry
A_4	57-1(7) to 61-1(1)	Aphyric basalt	+58.0 (±9°)	11	
					Lithology
P_4'	61-1(2) to 62-1(2)	Upper dolerite	–39.0° (±1°)	4	
					Lithology and chilled margin of P_4'
A_4	62-1(3) to 62-1(6)	Aphyric basalt inclusion	–39.0° (reheated by dolerite)	1	
					Lithology
P_4'	62-1(7) to 64-2(132 cm)	Lower dolerite	–38.6° (±2°)	7	
					Lithology and chilled margin of P_4'
A_4	64-2(132 cm) 67-2(cc) bottom of hole	Aphyric basalt	–44.4° (±17°) (reheated by dolerite)	14	
Hole 396					
P_a	14-6(4 to 7 cm) to 14-6(97 to 99 cm)	Phyric basalt	–20.8(±1°)	2	
					Magnetics (identical geochemistry)
P_b	14-cc(17 to 19 cm) to 22-3 (108 to 110 cm)	Phyric basalt	+34.5 (±3°)	19	
					Magnetics (identical geochemistry)
P_c	22-4(135 to 137 cm) to 25-1(145 to 150 cm) bottom of hole	Phyric basalt	–5.3° (±2°)	7	

is made on the basis of the magnetic inclinations. This additional evidence adds weight to the previous conclusion drawn in regard to Hole 395A: that virtually identical, (geochemically) highly differentiated basalts can be extruded in the same place with substantial time intervals (100 to 1000 years) between them.

A histogram of the stable inclination values for Hole 395A is shown in Figure 2. These inclination values show a reasonable distribution around the axial dipole value of ±40°. This type of distribution argues against the presence of post-formation tectonic tilting of the crust or the presence of rock units formed during a magnetic polarity transition. Figure 3 shows the same type of histogram of stable inclinations for the samples from Holes 395 and 396. The values for Hole 395 are grouped together, but the inclinations for Hole 396 are separated into the individual rock units. The inclinations for Hole 395 are distributed in a reasonable manner around an average value of +22°. If, as previously suggested, this deviation from the axial centered dipole inclination value is a result solely of tectonic rotation and the inclinations of Hole 395 were initially the same as the equivalent units in Hole 395A, the crust sampled in Hole 395 have had to undergo a minimum of 18° of rotation. If the rotation vector is not perpendicular to the vertical plane that contains the magnetic vector, then the amount of rotation required to change the inclination angle by 18° will be much larger. Though there is some evidence from Leg 37 of tectonic rotation of oceanic crust (Hall and Ryall, 1977; Ryall et al., 1977), further evidence will be

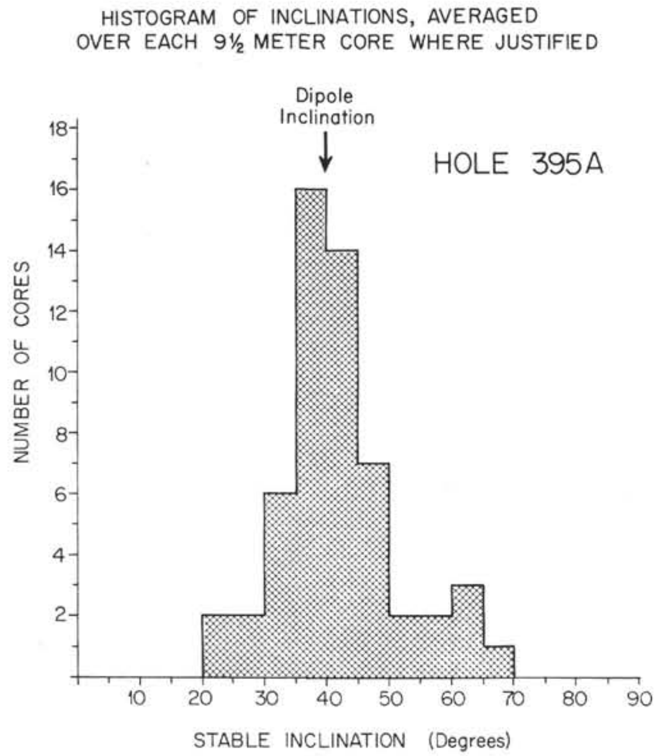

Figure 2. *Histogram of stable inclination values for Hole 395A averaged over each 9.5-meter core section, using the same criteria as Figure 1.*

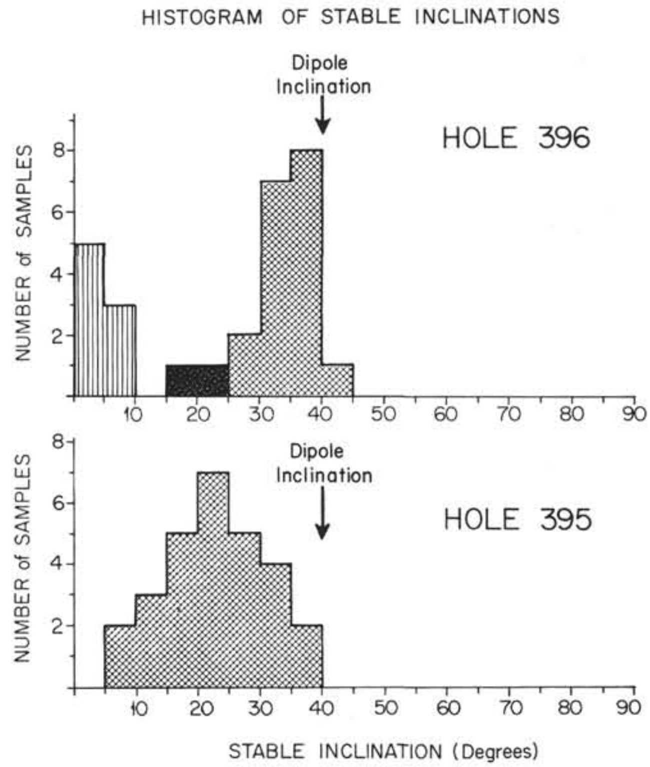

Figure 3. *Histograms of stable inclination values for the samples from Holes 395 and 396. Samples for Hole 395 are all grouped together, and samples from Hole 396 are differentiated according to the divisions in Table 1.*

needed to confirm this as the mechanism responsible for the shallow inclinations in Hole 395.

Hole 396 also shows inclinations shallower than the expected dipole value. However, the two units with the shallow inclinations (P_a and P_c) lie both above and below Unit P_b, which has an average value close to the dipole value (Table 1). The origin of these shallow inclinations, therefore, is unlikely to have been post-emplacement tectonic movement.

An alternative explanation for the values of inclination that deviate from the expected dipole value is that there are too few units within each drill core to average out the scatter caused by geomagnetic secular variation. The average angular dispersion of virtual geomagnetic poles resulting from secular variation, for the latitude of the drill sites, is about 14° (McElhinney and Merrill, 1975). This would give a range of possible inclinations (for 1 standard deviation), for the latitude of the drill sites, of between 18° and 56° for the dispersion caused by secular variation. Even though it is unlikely that the small number of rock units (actually time units) in Holes 395, 395A, and 396 would span a sufficient amount of time to average to the dipole inclination, Hole 395A values show unexpected close agreement with the dipole value. Inclinations from Holes 395 and 396 are also largely within the expected range for dispersion caused by secular variation.

The variation in magnetization intensity (NRM) with depth in each drill core is shown in Figure 4. Hole 395 shows essentially a random scatter of values and

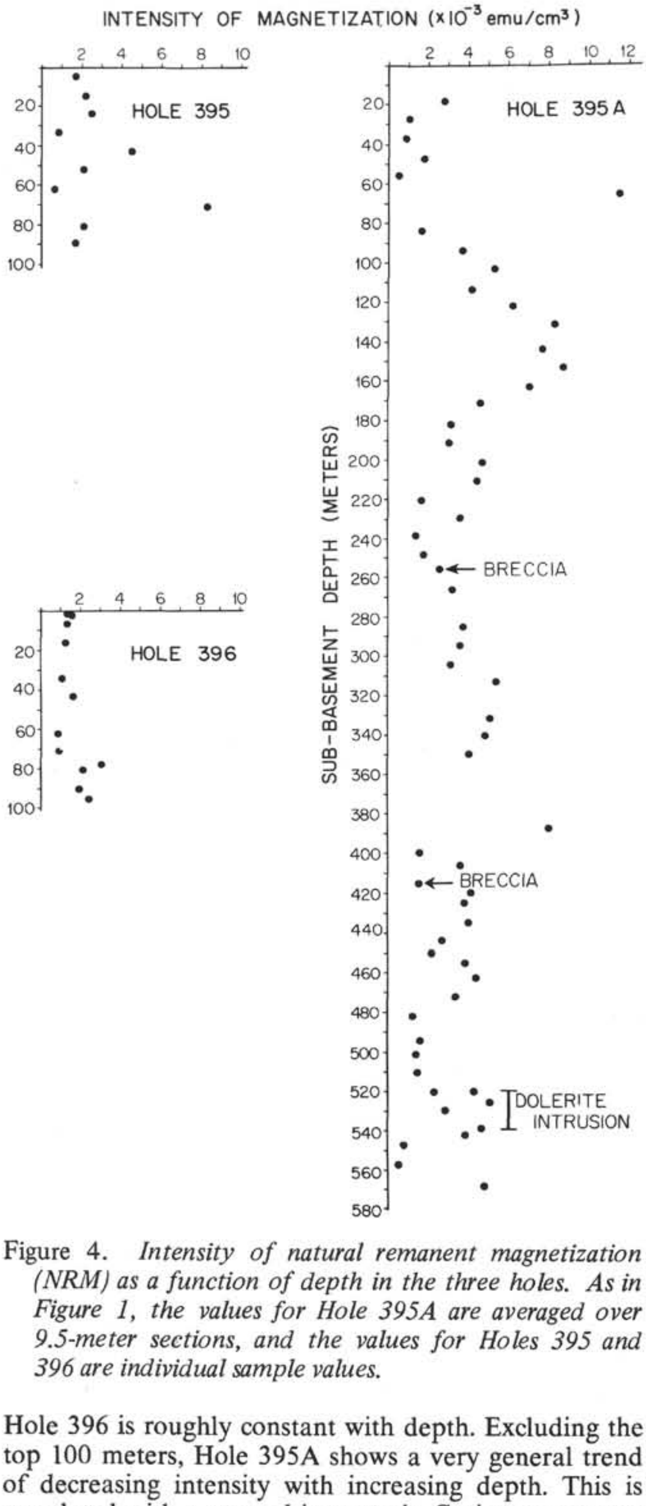

Figure 4. *Intensity of natural remanent magnetization (NRM) as a function of depth in the three holes. As in Figure 1, the values for Hole 395A are averaged over 9.5-meter sections, and the values for Holes 395 and 396 are individual sample values.*

Hole 396 is roughly constant with depth. Excluding the top 100 meters, Hole 395A shows a very general trend of decreasing intensity with increasing depth. This is correlated with a general increase in Curie temperature with decreasing depth in the same core (Table 2 in Johnson, Rock magnetic properties of igneous rock samples, this volume). The integrated magnetic intensity (assuming that the unrecovered material is the same as the recovered material) for the entire column of Hole 395A is $3.78 \pm 0.65 \times 10^{-3}$emu/cm^3. The integrated intensity for Hole 396 ($1.53 \pm 0.15 \times 10^{-3}$emu/cm^3) is less than half the value for Hole 395A. The integrated intensity for Hole 395A is very close to the average value of 4.0×10^{-3}emu/cm^3 determined for the basalt samples from Leg 37 (Hall and Ryall, 1977) and close to the value predicted for samples of this age from studies of the Mid-Atlantic Ridge at 37°N (Johnson and Atwater, 1977).

DISCUSSION

Polarity Reversals and Crustal Age

One of the striking features of Figure 1 and Table 1 is the presence, in the deep drill core from Hole 395A, of three distinct magnetic polarities. This excludes the reversals associated with the dolerite intrusions, the reheated (and remagnetized) zones below the dolerite, and the breccia zones. The Vine-Matthews (1963) hypothesis, as generally interpreted, requires prisms of oceanic crust to be uniformly magnetized in polarity, at least, if not uniform in direction. The observation of more than one magnetic polarity within a given vertical cross-section of crust requires a closer look at our current models of crustal formation.

The time required, on the average, to form the extrusive part of the oceanic crust can be estimated by assuming that all extrusive activity takes place within the inner valley of the ridge axis. Macdonald (1977) has shown, using deep tow data, that 90 per cent of the extrusive activity of the Mid-Atlantic Ridge at 37°N takes place on the floor of the inner valley. This is consistent with the results obtained from magnetic studies of the same area (Johnson and Atwater, 1977). If we assume (1) that all extrusive activity takes place on the inner valley floor, (2) that the spreading rate is roughly constant, and (3) that mass is conserved, then the time for formation of the extrusive part of the crust can be estimated by using the following relationship:

$$\text{time of formation of extrusive crust} = \frac{\text{width of valley floor}}{\text{spreading rate}}$$

If we assume a valley floor of between 3 and 8 km and spreading rates between 1 and 1.5 cm/year, then the time for formation of the extrusive section of the crust should be, very roughly, 300,000 to 500,000 years. If we further assume that the extrusive layer of the crust coincides with layer 2 and has a thickness of 1 km at site 395, then the time interval represented by the upper 500 meters of 395A might be of the order of 200,000 to 300,000 years. Numerous assumptions, some of which are probably unjustified, were made to arrive at this value, but the figure of 200,000 to 300,000 years for the *average* time of formation of the upper part of the igneous (extrusive) oceanic crust is probably a reasonable first-order estimate. It is important to note that this figure is slightly higher than the mean polarity interval for the Cenozoic of 200,000 years.

Given the above rough estimate for the time of formation of the rocks in the drill core from Hole 395A, we can now examine the probability of occurrence of several polarity units within a given vertical section. Figure 5 shows the crustal age of Site 395, as estimated from the position of the site within magnetic anomaly 4. Since the absolute age of the site depends critically on the age of the boundaries of anomaly 4, the age of the site is shown as determined by both the magnetic chronology of LaBreque et al. (1977) and Tarling and Mitchell (1976). The age of the basal sediments, as determined by the paleontology of the sediments, is also shown in Figure 5 (J. Natland, personal communication). It is comforting to note that, for this site at least, the sediments are somewhat younger than the basalt on which they lie. It seems clear from Figure 5 that if we allow a time of 100,000 to 500,000 years for formation of the extrusive part of the crust, it is not surprising to find one or two reversals within a 600-meter vertical drill core. This will certainly be true if the drill site is fairly close to the edge of a magnetic anomaly or near a short reversal that may have occurred within the time span of an anomaly. From the inclination data in Figure 1, it is clear that this crust formation is not smooth or continuous, but is made up of a series of short, episodic periods of volcanic activity followed by long periods of quiescence. This is in agreement with the results of Leg 34 (Johnson and Hall, 1976) and Leg 37 (Ryall et al., 1977).

The age of Site 396 with respect to the magnetic chronologies of LaBrecque et al. (1977) and Blakely (1974) is shown in Figure 6. The site is situated within positive anomaly 5, and it is interesting that the bulk of the Hole 396 core was also positively magnetized. A serious discrepancy between the age of the basal sediments of Hole 396 and the age as determined by the position within magnetic anomaly 5 is obvious from Figure 6. The age of the sediments as determined by paleontology is clearly greater than that determined by the magnetic anomaly (J. Natland, personal communication). Although tectonic activity can sometimes result in sediment transport from older to younger sites over moderate distances, resolution of this age discrepancy between crustal and sediment ages will require additional data.

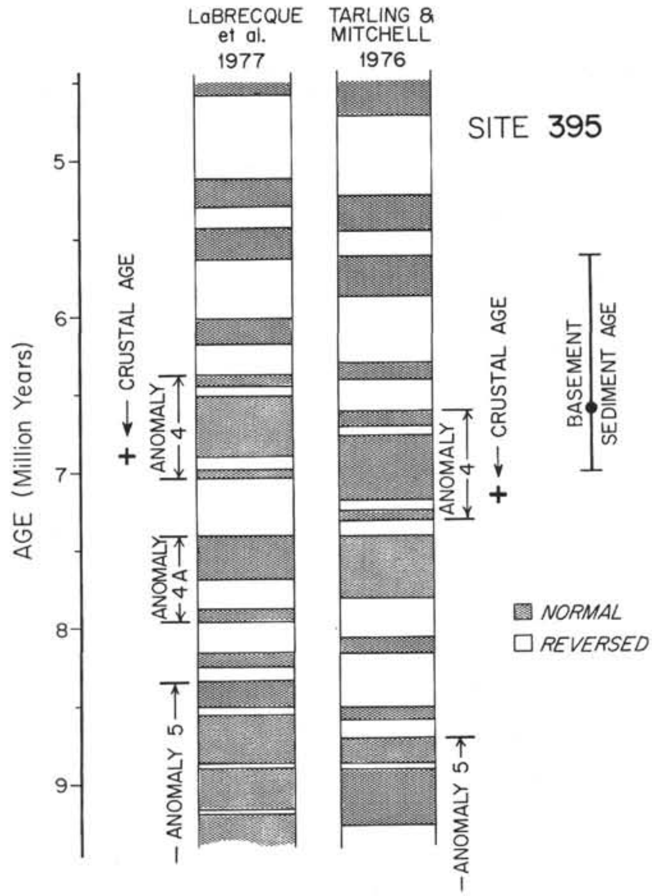

Figure 5. *Best estimates of the age of Site 395, along with the reversal chronology of LaBrecque et al. (1977) and Tarling and Mitchell (1976). The crustal age was determined from the position of the site with respect to magnetic anomaly 4. The best estimate of the age of the basement sediments is shown as a filled circle; the range of possible ages is shown as an error bar.*

Magnetic Source Layer

Before the site surveys related to the Leg 45 drilling, two surveys were run in the general area of the drilling sites and the magnetic anomalies were modeled assuming different magnetic intensities and thicknesses of the magnetic layer. Van Andel and Bowen (1968) calculated a magnetic profile, to fit their anomaly data, that assumed a magnetization of 2.5×10^{-3}emu/cm^3 and a thickness of the magnetic layer of 1.7 km (upper surface at 3.7 km depth and lower surface at 5.4 km depth). Lattimore et al. (1974) assumed a magnetization of 12×10^{-3}emu/cm^3 and a thickness of the magnetic source layer of 400 meters. Note that the solutions to these inversion models are not unique. For example, either the intensity of magnetization or the thickness of magnetic layer may be varied. The integrated magnetic intensities for the drill cores from Holes 395 and 396 should allow us to estimate the thickness of the magnetic layer. If the polarity differences in Hole 395A are ignored, then the average magnetic intensity of this hole would allow approximately 1 km of the type of material recovered in Hole 395A to account for the intensity of the overlying magnetic anomalies. This is in agreement with the roughly 1-km thickness of the magnetic layer that was determined for the very young crust in the FAMOUS area of the Mid-Atlantic Ridge at 37°N (Johnson and Atwater, 1977). As mentioned previously, however, the Hole 395A drill core contains at least three distinct magnetic polarity units. In fact, even though Site 395 is situated in a positive magnetic anomaly, the drill core from Hole 395A is only 33 per cent normally magnetized and 67 per cent *reversely* magnetized. The presence of one or more reversals within a vertical column of oceanic crust will clearly require a magnetic layer thicker than one that is uniformly magnetized. If the presence of anomalous directions and/or multiple polarities within a given vertical section of oceanic crust is widespread, then a substantial contribution to the magnetic anomalies will be required from the

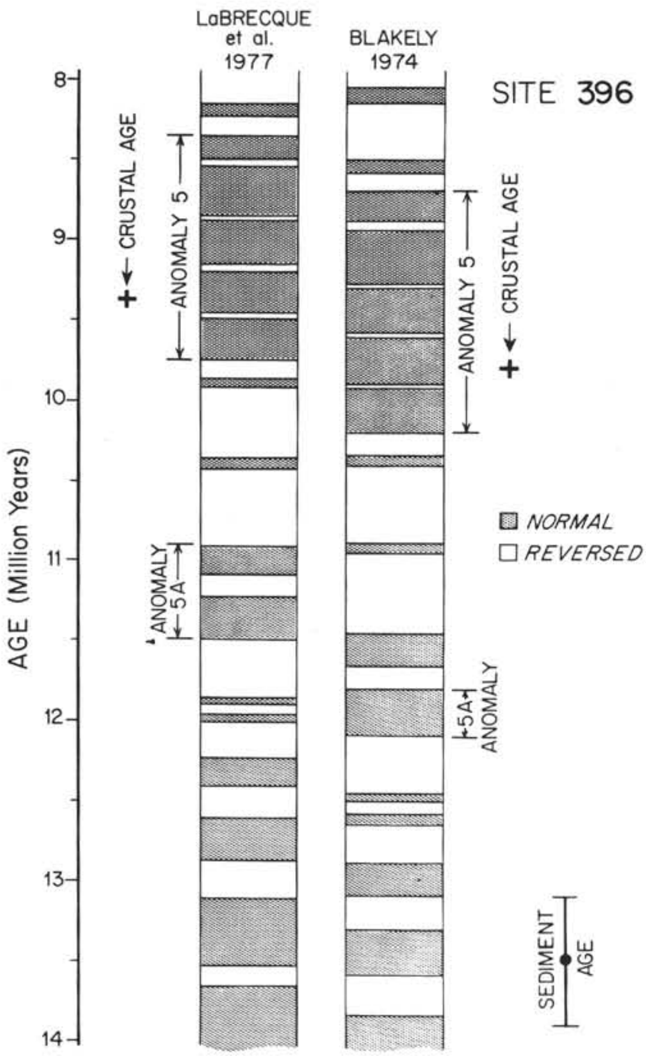

Figure 6. *Best estimates of the age of Site 396, along with the reversal chronology of LaBrecque et al. (1977) and Blakely (1974). As discussed in the text, the age of the basal sediments, as determined by paleontology, is considerably older than the crustal age determined by the position of the site within the magnetic anomaly.*

layers that lie below the upper 1 km of igneous crust. Evidence is accumulating that this is indeed the case for the slowly spreading Mid-Atlantic Ridge.

CONCLUSIONS

1. Samples recovered from 600-meter-deep Hole 395A showed three clear magnetic polarity intervals with average inclinations close to the ideal dipole value of ±40°.

2. A dolerite intrusion at 520 meters sub-basement was very probably the feeder dike for an extrusive pillow basalt unit higher in the drill core.

3. The intrusion of this dolerite dike heated and remagnetized the extrusive basalt units below it, but did not heat (at any great distance at least) the same basalt units above the dolerite. This is probably because the relatively impermeable dike acted as a "cap" and restricted circulation of the hot water associated with the intrusion to the units below it. The permeable units above the dolerite were probably cooled by the free circulation of seawater.

4. Two breccia zones within the drill core showed roughly coherent directions of magnetization (both for the clasts and matrix of the breccia) and some evidence of high-temperature oxidation. This reheating and remagnetization of the breccia zones may be a result of the passage of hot hydrothermal fluids during formation of the breccia zones.

5. The discovery, in both Hole 395A and Hole 396, of geochemically highly differentiated basalt units, with essentially identical geochemistry but different magnetic polarities, implies that a hiatus of at least 2000 years in volcanic activity can have little effect on the composition of the extruded basalts of a given cross-section of crust. This would seem to indicate either a single magma chamber that produced basalts whose composition varied in a cyclic manner, or several magma chambers contributing to the basalts in a given vertical cross-section—in which case these magma chambers would have evolved through identical geochemical stages.

6. The average magnetic intensity of the samples from Site 395, would, ignoring magnetic polarity, require a magnetic layer of the order of 1 km thick. The presence of several different polarity units within the drill core, argues, however, for a substantial contribution from the layers of igneous crust below the upper 1 km.

7. First-order estimates of the time required to form the extrusive igneous crust at the Mid-Atlantic Ridge have indicated that it may take as long as 300,000 to 500,000 years to generate the upper layers. If this crustal formation takes place during a time when the earth's magnetic field is reversing at roughly the same rate, then it will not be surprising to find one or more reversals within a single vertical cross-section of oceanic crust. This is consistent with the data from Hole 395A.

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