28. MAGNETIC REMANENCE ACQUISITION IN LEG 73 SEDIMENTS[1]

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ABSTRACT

The major magnetic mineral in the turbidites and slumped sediments recovered at Leg 73 drill sites was near to magnetite in composition and in the form of small multidomain particles. There was no variation in magnetic mineralogy with the lithology. The variations in the intensities and directions of the natural remanent magnetization could be explained in terms of postdepositional grain rotations within the wet sediment. In the sands realignment was partial, whereas in some of the slumps the entire remanent magnetization was reset. Fine-particle magnetite was also the main magnetic constituent of the red clays. A significant proportion of a higher-coercivity mineral was also present. The magnetic characteristics of the red clays are explained as a combination of concentration and grain rotation effects. The implications to the assessment of the reliability of paleomagnetic data are discussed. Note: Conversion factors are as follows: 1 Am^2/kg = 1 emu/g, and 80 A/m ≈ 1Oe.

INTRODUCTION

The paleomagnetic method is based on the assumption that each rock sample carries a record of the ambient geomagnetic field at the time of its formation, and that this record is preserved over geological time. To check the validity of these assumptions (and hence to ascertain the reliability of the observed paleomagnetic data), it is necessary to understand the mechanism of the recording process itself. For sedimentary rocks the primary remanent magnetization is acquired through the statistical alignment of detrital grains in the Earth's field. The remanent magnetization can subsequently be modified by chemical change or by physical disturbance of the grain alignment within the wet sediment (see Verosub, 1977). The magnetization resulting from this physical movement of the magnetic grains is termed postdepositional remanent magnetization (PDRM). The mechanism of PDRM has been established from controlled experiments on synthetic sediments (Tucker, 1980a and b). The factors controlling the PDRM in natural sediments are generally underdetermined, and a test of the PDRM theories is only possible under certain favorable circumstances. Some of the disturbed sequences from DSDP Leg 73 provided such an opportunity.

TURBIDITE SEQUENCES (HOLE 524)

The turbidite sequences in Hole 524 were deposited over a very short time interval during which the ambient field can be assumed to have remained constant. The primary remanence, therefore, was controlled solely by the magnetic state of the grains, their concentration, and the geometry of the fabric.

Mineralogy

The coarse layers consisted of sandstone, yellow to greenish gray, in general laminated, graded, and usually well consolidated. In some sequences (e.g., those in Core 17, Sections 2 and 3) the sand layer had a loose damp base. Interbedded with the turbidites were layers of fine-grained, gray, nannofossil marl or reddish brown claystone.

The magnetic mineralogy pertaining to each horizon cannot readily be determined optically and must be inferred from the magnetic properties themselves. Table 1 records the magnetic hysteresis and stability characteristics for Core 11, Section 3. The lithology is shown in Plate 1. The results for this core are typical of all turbidite sequences investigated. The stability of remanence can be quantified in terms of the coercive force (HC), coercivity of remanence (HCR), and median destructive field (MDF) of a saturation isothermal remanence. All three parameters are remarkably consistent throughout Core 11, Section 3, with, if anything, marginally higher values (higher stabilities) for the coarser samples. The values are typical of small-particle magnetite. The ratios HCR/HC and saturation remanence to saturation magnetization, MRS/MS, are indicative of the domain state. (Values of 1–2 and 0.5–0.87 respectively signify monodomain grains, and values of >5 and <0.1 are expected for large multidomain grains.) The ratios recorded here do not show any gross difference between the coarse and the fine fractions. The absolute values are indicative of small multidomain grains or a mixture of mono- and multidomain material.

Both the coarse- and the fine-grained samples gave sharp Curie temperatures (TC) of 580°C and low-temperature transitions at around −145°C (Fig. 1). These values compare well with those expected for magnetite.

Table 1. The magnetic hysteresis properties of a turbidite sequence (Hole 524).

Core-Section (interval in cm)	MS (10^{-3} Am^2/kg)	HC (10^4 A/m)	MDF (10^4 A/m)	HCR/HC	MRS/MS	Grain size
11-3, 61–63	31.03	1.08	1.40	2.31	0.26	Fine
11-3, 66–68	33.69	1.08	1.37	2.36	0.16	Medium
11-3, 71–73	21.69	1.09	1.56	2.39	0.15	Coarse
11-3, 76–78	24.27	1.08	1.66	2.37	0.17	Coarse
11-3, 81–83	38.47	1.06	1.31	2.22	0.18	Fine
11-3, 92–94	60.99	1.08	1.30	2.19	0.14	Fine

[1] Hsü, K. J., LaBrecque, J. L., et al., *Init. Repts. DSDP*, 73: Washington (U.S. Govt. Printing Office).

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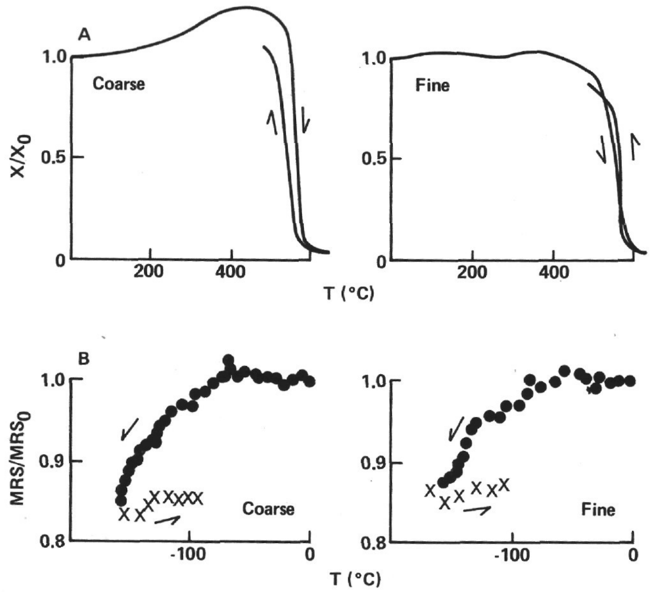

Figure 1. A. Temperature dependence of the initial susceptibility for coarse and fine samples from a turbidite sequence (Hole 524, Core 20). Zero subscript means room temperature. B. Low-temperature demagnetization of a saturation isothermal remanence for coarse and fine samples from a turbidite sequence (Hole 524, Core 24). Crosses = heating, dots = cooling. Zero subscript means room temperature. A sharp drop in remanence on cooling is associated with a change in the easy direction of magnetization. The temperature at which this transition occurs is indicative of mineral composition.

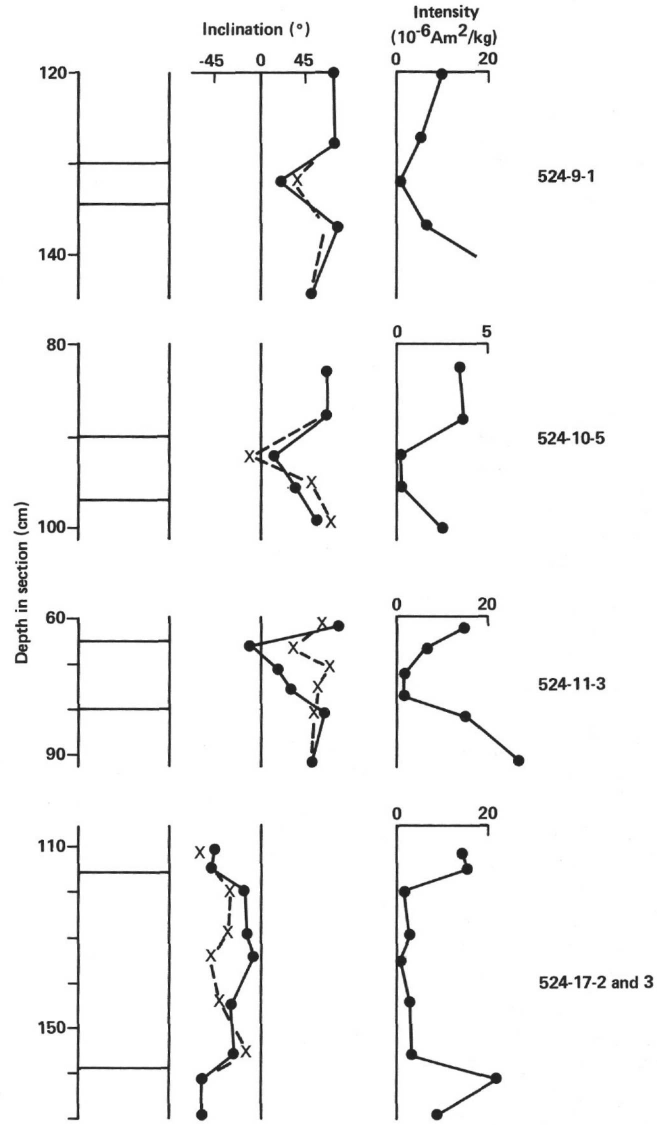

Figure 2. The variation of intensity and inclination through selected turbidite sequences (shown by blocks next to cm scale) in Hole 524. The solid lines refer to the NRM and the dotted after magnetic cleaning in 8×10^3 A/m peak alternating field.

Further, it should be noted that a transition would only be observed with multidomain "magnetite" or with nearly spherical unstrained monodomain grains.

I infer that (1) the majority of the magnetite is in the form of small multidomain grains and (2) the magnetic mineralogy is independent of the overall grain size.

The saturation magnetization (MS) shows a drop in intensity over the coarse fractions. In the light of the above argument, I interpret this solely as a concentration effect, the coarse samples having the lower percentage of magnetite.

Natural Remanent Magnetization

The variation in the intensity and inclination of the natural remanent magnetization (NRM) is shown in Figure 2 for both normally and reversely magnetized sequences. The remanent intensities of the coarse-grained samples were relatively low (0.3 to 5×10^{-6} Am^2/kg) compared with 10 to 60×10^{-6} Am^2/kg for the finer-grained samples. Relatively shallow inclinations were recorded for the sands. On alternating field (AF) demagnetization to peak fields of 8×10^3 A/m, stable directions were obtained. In general, the NRM inclinations were steeper than their demagnetized counterparts irrespective of the magnetic polarity (Fig. 2). The results of progressive AF demagnetization are shown in detail for Core 12, Section 4 in Figure 3. The main points are as follows. First, there is an initial steepening of inclination for peak fields up to 8×10^3 A/m (shown by a positive increase in the Z component). Second, stable directions (portrayed by demagnetization paths that are linear and directed toward the origin) were recorded for peak fields of 8 to 24×10^3 A/m. Third, above 24×10^3 A/m the remanence vectors were randomized. And fourth, the first and second effects were very much more pronounced for the coarser fractions.

Discussion

Consider how a sediment acquires its primary remanence. Initially magnetized detrital grains statistically align in the ambient field during deposition. At the sediment/water interface, the alignment may be disturbed through, for example, gravitational torques. The magnetic grains are then either trapped in environments where subsequent realignment is possible (e.g., small grains in large voids) or where free grain rotation is physically inhibited by the surrounding matrix. The "free" grains generally form only a small percentage of the total magnetic fraction (Tucker, 1980a). This size of

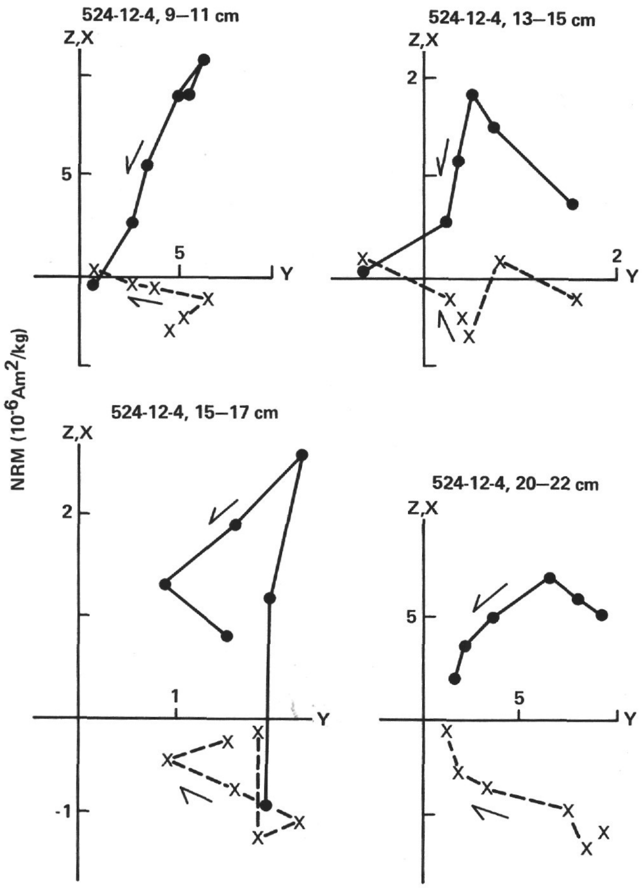

Figure 3. Zijderveld plots for stepwise AF demagnetization of the NRM. Circles refer to the YZ (vertical) and crosses to the YX (horizontal) component. The points correspond in sequence to 0, 4, 8, 16, 24, and 40 × 10^3 A/m peak field.

this percentage depends largely on the ratio of void size to grain size, and the proportion of free grains is higher for a coarse fabric (like the turbidite sands) than for a finer fabric. At a later date constraints on the movement of the free grains may be imposed through compaction, cement or gel formation, or simply by dewatering. The free grains are thus fixed in this later field direction. If the void sizes within a sample were uniform, it would be the smaller magnetic grains that were affected in this way. The smaller grains are generally those with the higher coercivities. This type of overprinting would result in a shift away from the primary direction toward a secondary remanence direction during the later stages of progressive AF demagnetization. This behavior is clearly shown by the turbidite sands. It implies that the higher-coercivity grains may have been blocked in a significant time later than the blocking of the stable component of magnetization.

The directional deviations at low demagnetizing fields are partly due to the gravitational flattening of the inclination (King, 1955) and partly the result of a more random effect. The removed vectors were not necessarily in the current (Brunhes) field direction. If the free grains within the sediment were not blocked in, they would, within a few tens of minutes, attain an alignment with the current (laboratory) field (Tucker, 1980a). Randomization by even the lowest alternating fields is sufficient to destroy this alignment. A significant change in remanence would, therefore, be seen during the initial stages of AF demagnetization.

For the finer fabrics, where the void sizes are smaller (the magnetite grain sizes, however, remaining comparable to the sands), the proportion of "free" grains is correspondingly small. The misalignment effects at both high and low coercivities are likewise small. At the other extreme is Sample 524-17-3, 10–12 cm, the loose wet texture of which would imply an abnormally high percentage of free grains; this sample did not give a stable magnetization direction on demagnetization.

SLUMPED SEQUENCES (HOLES 519 AND 520)

The slumped sequences in Holes 519 and 520 were emplaced during mass movement of sediment. The distortion and folding of the sediment can readily be seen (Plate 2). Inasmuch as slumping occurs over a short time period, the geomagnetic field for each sequence can be assumed to have remained constant.

Natural Remanent Magnetization

The stable NRM inclinations (for the slump sequence from Hole 519, Cores 4–8) are shown in Figure 4. The slump occurs in an interval of normal magnetization. Normal magnetizations also occur immediately before and after the slumped zone. We have assigned the normal polarity interval to the Jaramillo event (Tauxe et al., this vol.). Normal polarities are retained across each individual slump fold (Fig. 5). This is in contrast to Hole 520, Core 24, where the polarities follow the slump-fold directions. I tentatively conclude that for Hole 519, the magnetization was reset by independent grain movement during slumping, whereas at Hole 520 the magnetic grains remained fixed relative to the surrounding fabric (which distorted as a whole). The following study set out to test this hypothesis.

Mineralogy

The magnetic hysteresis parameters for selected samples from above, within, and below the slump zone are listed in Table 2. The coercive forces and median destructive fields do not differ markedly between zones; neither do the HCR/HC and MRS/MS ratios. There is, however, an indication of a slight shift in these values at the top of the slump. The saturation magnetization is marginally higher immediately above than within or just below the slump zone. There is, however, a good match between the magnetic properties of the slump and of the earlier sediments (presumably the source material for the slump). Curie temperatures of 570 to 580°C are recorded for every zone. I infer from the values listed in Table 2 that (1) the magnetic fraction comprises small multidomain grains near to magnetite in composition, (2) the slumping did not cause any gross alteration in magnetic mineralogy, and (3) the possibility that the normal polarity zone is the result of chemical overprinting can be discounted, because no marked change in mineralogy occurs across the slump.

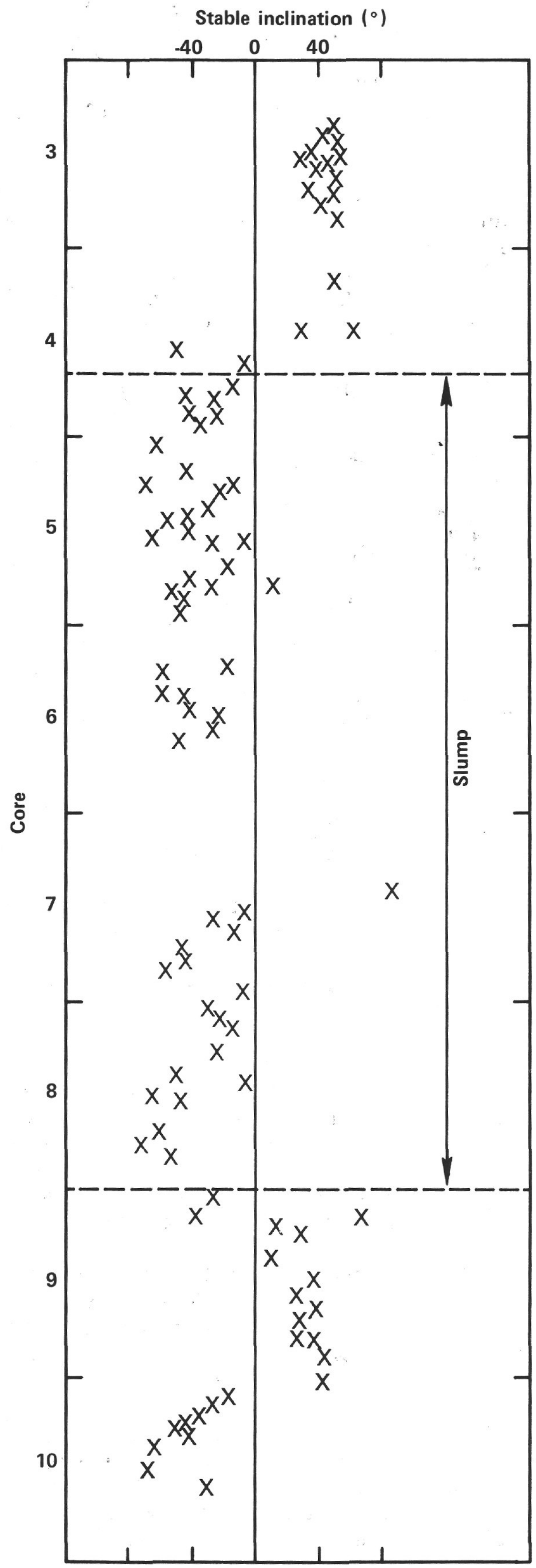

Figure 4. Stable NRM inclinations across a slump (Hole 519).

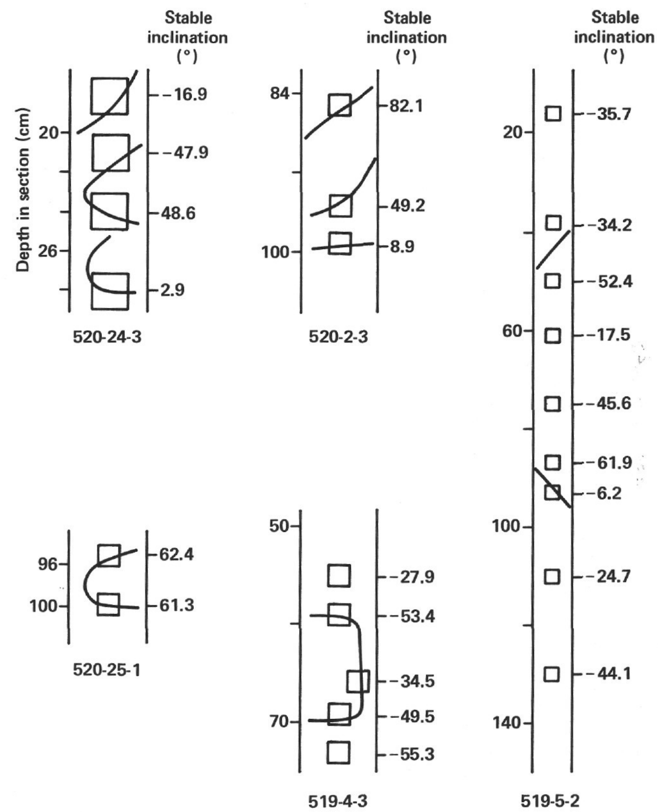

Figure 5. Stable inclination directions recorded through a series of slumps in Holes 519 and 520. Squares show the sample positions, heavy lines the slump-fold directions.

Viscous Remanent Magnetization

The values of viscous remanent magnetization (VRM) acquired in a field of 21 A/m (the present-day field at the drill site) over a period of 1000 hr. were measured. The results are listed in Table 3. Progressive AF demagnetization of the NRM showed that a stable direction was obtained at peak applied fields of 12×10^3 A/m. The laboratory-acquired VRM was also removed by that field. The VRM/stable NRM ratios show that no appreciable VRM could be induced in any sample (with the possible exception of Sample 519-10-1, 32–34 cm). Because the ability to acquire a VRM is very small and not significantly different in the slump than in the surrounding sediment, the possibility that the normal polarity zone is a viscous overprint (acquired in the Brunhes) is very small indeed.

Statistical Analysis

The NRM intensities of the slumped sediments are in general lower than those deposited normally (Tables 2 and 3). Normalization of the NRMs by the saturation isothermal remanence should correct for the different concentrations of magnetic material. After normalization, the NRMs of the slump remain lower. This indicates that the degree of magnetic grain alignment is not as great within the slump.

Statistical analysis of the magnetization directions before and after AF demagnetization (Table 4) reveals

Table 2. Magnetic hysteresis properties (Hole 519).

Core-Section (interval in cm)	MS (10^{-3} Am²/kg)	HC (10^4 A/m)	MDF (10^4 A/m)	HCR/HC	MRS/MS	NRM/MRS (10^{-3})
3-2, 63–65	6.95	1.43	—	2.68	0.19	—
3-2, 138–140	6.55	1.44	1.79	2.04	0.21	1.95
3-3[a]	12.13	1.55	—	2.18	0.28	—
4-3, 54–56[b]	2.07	1.53	1.79	1.65	0.30	1.07
5-2, 86–88[b]	1.35	1.51	1.79	1.66	0.35	0.85
6-2, 47–49[b]	1.69	1.61	1.70	1.48	0.28	1.25
7-2, 71–73[b]	2.04	1.43	1.91	1.69	0.20	1.15
8-1, 80–82[b]	2.71	1.41	2.03	1.72	0.23	1.57
8-2, 74–76[b]	5.13	1.16	—	—	—	—
10-1, 52–54	2.45	1.52	1.79	2.00	0.29	1.57
10-2[a]	1.95	1.52	—	1.67	0.27	—

[a] Label of cm interval was illegible.
[b] Slumped sediments.

Table 3. VRM acquired over 1000 hr. in a field of 21 A/m (Hole 519).

Core-Section (interval in cm)	VRM (10^{-6} Am²/kg)	Stable NRM (10^{-6} Am²/kg)	VRM/stable NRM (%)
2-2, 115–117	0.37	20.73	1.7
4-3, 33–35[a]	0.02	1.41	1.4
4-3, 99–101[a]	0.01	3.48	0.2
7-1, 120–122[a]	0.01	1.09	0.9
10-1, 32–34	0.60	3.12	19.0
10-1, 90–92	0.04	2.33	1.7

[a] Slumped sediments.

Table 4. Statistical analysis of magnetization directions before and after magnetic cleaning in an applied field of 8 × 10³ A/m (Hole 519).

Core	Precision parameter (K) NRM	Demagnetized
1	28.4	27.9
2	22.7	19.1
3	6.5	6.4
4	1.9	2.4
5[a]	10.8	4.8
6[a]	31.2	19.0
7[a]	8.6	7.5
8[a]	—	9.4
9	—	4.2
10	—	4.1
11	—	5.5
12	3.3	36.8
13	4.4	11.8

[a] Slumped sediments. For Cores 5 to 8 inclusive, the NRM value of K is 8.8; the demagnetized value is 4.2.

that (1) the scatter is often greater in the slumped zones (i.e., the precision parameters are smaller) and (2) in the slumps, the scatter always increases after demagnetization, whereas the scatter for the normally deposited sediments remains roughly constant or decreases with demagnetization.

Discussion

In the absence of external perturbations, only a few percent of the remanent magnetization are susceptible to realignment (Tucker, 1980b). To account for any gross remagnetization, additional mechanical disturbances of the sediment must have taken place. The forces involved during the slump itself serve to (1) reduce or remove the constraints on grain movement, allowing realignment in the ambient field and (2) partially or totally randomize the grains. On a local scale, bioturbation or the passage of gas or water can have a similar effect. Tucker (1980b) has shown experimentally and theoretically that the characteristic time over which the constraints are lowered after disturbance (1) increases with the magnitude of disturbance and (2) decreases with the increasing rigidity and cohesion of the matrix. Sediments of high water content and low clay content would thus be most susceptible to resetting.

Cores 5 to 8 of Hole 519 (where the magnetization was reset on slumping) had carbonate contents of 83 to 92%. For Core 20 of Hole 520 (magnetization not reset on slumping), the carbonate content was around 73%. The remaining 27% was comprised mainly of clay minerals.

The degree of realignment resulting from the slump (Hole 519) was not perfect, the NRM/MRS ratios and the directional scatter being larger than for the surrounding sediments. This would be the case if the characteristic time was less than the time needed for complete grain rotation or if mechanical torques acted on the grains in addition to the realignment torques (Tucker, 1980b).

Irving (1957) first proposed the mechanism of PDRM after noticing that certain slumped sandstone sequences were uniformly magnetized. He argued that grain rotation in water-filled voids was the primary cause of the remagnetization. I have shown that Irving's mechanism on its own is insufficient to account for complete remagnetization. It seems more likely that his sediments were reset during the slump itself. The slump or fold test that is used to differentiate between the primary magnetization and postdeformational (viscous or chemical) overprints must therefore be extended to take account of the possibility of magnetizations contemporaneous with the deformation.

RED CLAYS (HOLES 521, 522, AND 523)

The pelagic red clays typically seen in the Miocene sequences did not give reliable paleomagnetic results during routine shipboard measurement. The paleomagnetic record was very condensed, and there was considerable overprinting (see Tauxe et al., this vol.). The following study set out to ascertain the reasons for the latter behavior.

Natural Remanent Magnetization

The NRM intensities of the red clays were usually higher than those of the surrounding sediments (around 4 to 14 × 10^{-6} Am²/kg compared with 0.5 to 3 × 10^{-6} Am²/kg). With progressive AF demagnetization, the intensities of dark red samples rapidly dropped, typically losing 80% of the NRM intensity in peak fields of 12 × 10³ A/m (Fig. 6). After magnetic cleaning in such fields, tentative stable directions were deduced (Tauxe et al., this vol.). However, it was by no means certain that

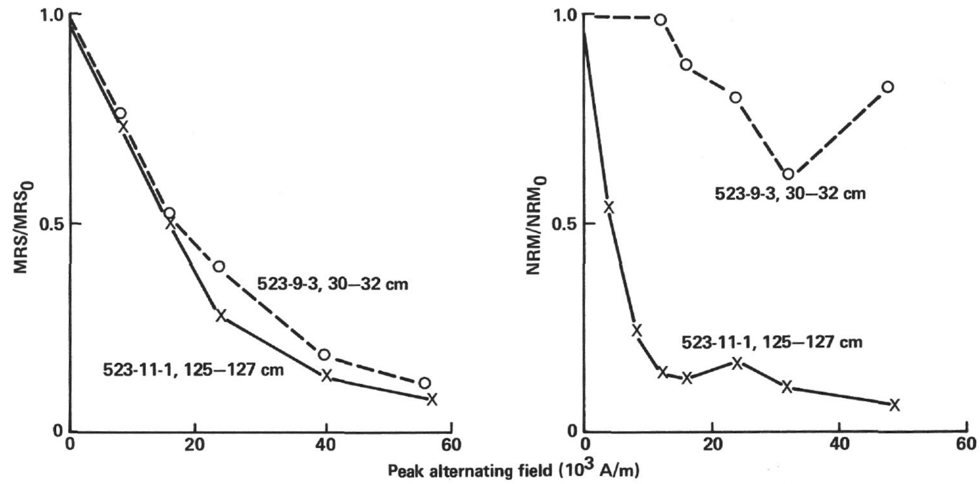

Figure 6. AF demagnetization of the NRM and of a saturation isothermal remanence for a red clay (523-11-1, 125–127 cm) and a nearby carbonate-rich sediment (523-9-3, 30–32 cm). The values are normalized to room temperature values.

this was a record of the primary magnetization. Certainly the high-intensity magnetically soft overprint was always of normal polarity irrespective of the polarity of the stable component and, as such, could be the result of viscous overprinting.

Viscous Remanent Magnetization

Samples from Holes 523 and 521 were demagnetized at applied fields up to 12×10^{-3} A/m and then stored in a laboratory field (intensity 21 A/m; the present-day field at the drill site) for a period of 24 hr. Figure 7 shows the change in remanence vector before and after storage and after subsequent redemagnetization. The results clearly indicate that the red clays picked up a large VRM component and that this component was completely removed on demagnetization in a 16×10^3 A/m peak field. The magnitude of the VRM was typically 5 times that of the "stable" component for the clays and less than 0.5 times the stable component in the less dissolved sediments.

Magnetic Stability

AF demagnetization of a saturation isothermal remanence is shown for both types of sediment in Figure 6. The results are typical of all closely paired sets from every hole investigated. Although the red clays are generally the softer magnetically, the difference in stability is never very great, certainly not as pronounced as for the NRM. The bulk hysteresis parameters HC and HCR do not vary systematically with clay content (Table 5) (see also Tucker and Tauxe, this vol.).

Identification of the Magnetic Carriers

The measured Curie temperatures (from initial susceptibility versus temperature curves) were approximately 575°C, giving a strong indication of magnetite for both the red clays and the carbonate-rich sediments. From these measurements there was no indication of another phase. The red pigment in the clays does, however, imply that substantial quantitites of hematite or goethite are present.

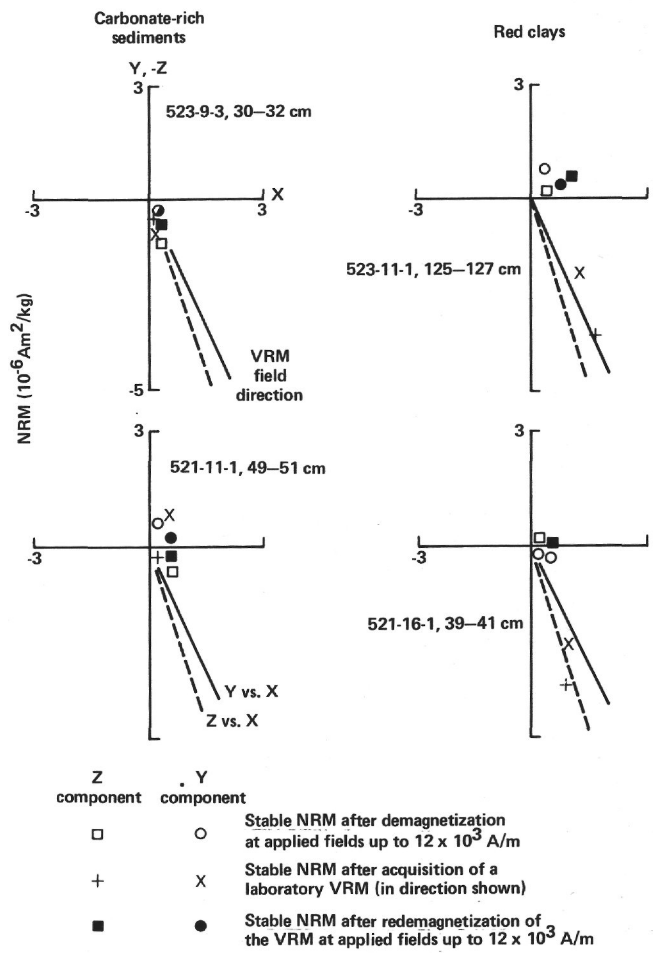

Figure 7. Vector plots of the remanent magnetization for red clays and nearby carbonate-rich sediments.

A possible remanence transition at −15°C was seen for Sample 523-10-2, 90–92 cm (Fig. 8). This could indicate the presence of hematite or titanomagnetite of composition around $Fe_{2.4}Ti_{0.6}O_4$ (TM60). Thermal demagnetization of the NRM (Sample 523-10-1, 121–124 cm)

Table 5. The magnetic hysteresis properties of the red clays (Hole 523).

Core-Section (interval in cm)	MS (10^{-3} Am^2/kg)	HC (10^4 A/m)	HCR (10^4 A/m)	NRM/ MRS (10^3)	MRS/ MS	Color
7-1, 114–116	1.67	1.43	2.86	1.58	0.26	White
7-3, 10–12	2.19	1.09	2.23	1.47	0.26	White
10-1, 120–122	23.25	1.02	2.40	1.06	0.20	Red
10-2, 90–92	49.30	1.67	2.46	1.20	0.15	Red
10-3, 50–52	73.63	1.01	1.98	0.56	0.11	Red
12-2, 23–25	11.00	1.07	2.12	1.51	0.27	Light brown

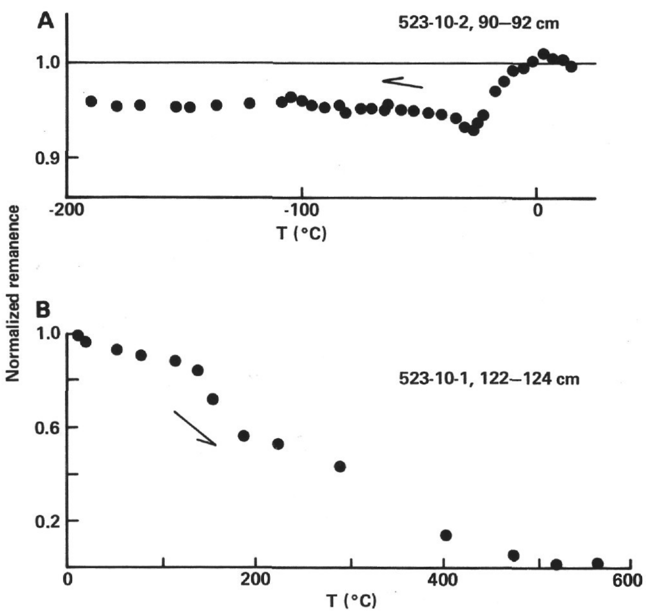

Figure 8. A. The effect of cooling on the saturation isothermal remanence for a red clay in Hole 523. B. Thermal demagnetization of the NRM.

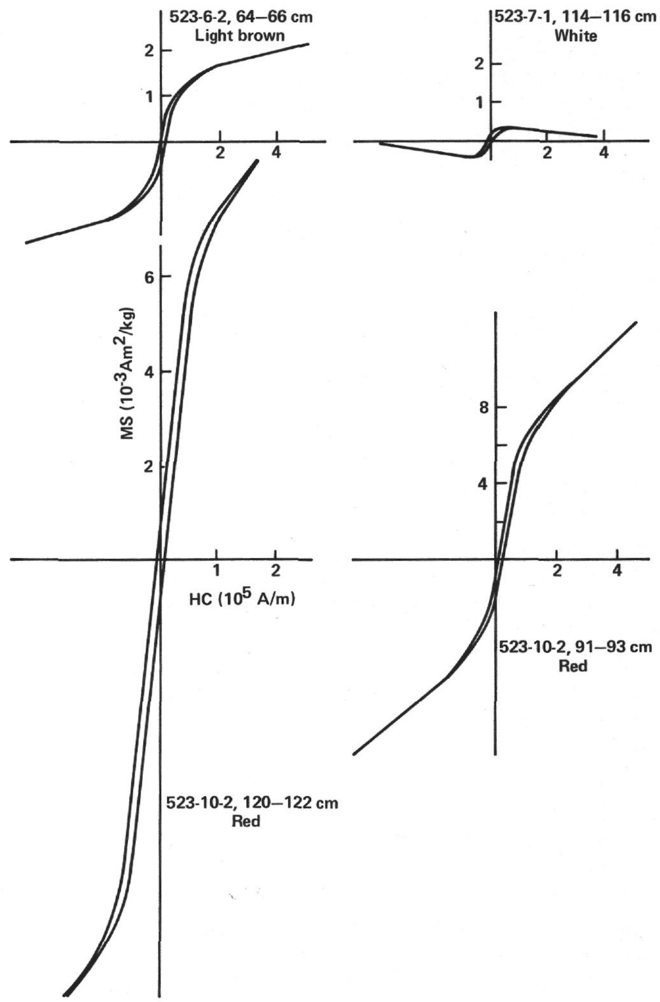

Figure 9. Magnetic hysteresis loops for red, white, and light brown sediments in Hole 523.

revealed a sharp drop in remanence at around 140°C (Fig. 8). This could be due to a breakdown of goethite or alternatively may represent the Curie point of TM60.

Perhaps the best indication of the presence of magnetic constituents comes from the hysteresis loops (Fig. 9). The greater vertical scale of the loops (i.e., MS) indicates a greater concentration of magnetic minerals in the red than the lighter sediments. The high-field slope of the loops (i.e., high-field susceptibility) is very large for the red clay. It decreases with a lightening of color (i.e., carbonate content) and becomes negative for the very weakly magnetized samples (see Tucker and Tauxe, this vol.). The large high-field susceptibility indicates a strongly paramagnetic or superparamagnetic phase to be present. It may include grains with short relaxation times capable of carrying a VRM. For the red clays, the loops do not close until $>2.5 \times 10^5$ A/m, compared with $<1.0 \times 10^5$ A/m for the carbonate-rich sediments. This delayed closure indicates a secondary high-coercivity phase capable of carrying a remanent magnetization. The coercivities for this phase are very much higher than those associated with any magnetite/titanomagnetite at room temperature. The coercive forces (width of loops) are of order 1×10^4 A/m for all samples. These values are typical of fine-particle "magnetite".

The NRM/MRS ratios are generally smaller in the clays than in the surrounding sediments (Table 5), indicating a lower degree of grain alignment. The MRS/MS ratios are likewise lower for the clays. This could imply either an effectively larger mean grain size or an increase in magnetic interaction between the grains.

Discussion

The bulk magnetic behavior of the clays can be accounted for by the presence of magnetite. There is also evidence of other magnetic minerals. A high-coercivity phase and a strong paramagnetic (or superparamagnetic) component are present. The results of some measurements could be interpreted as showing the presence of TM60. This is not implausible, as TM60 does form a major constituent of unaltered oceanic and continental basalts (i.e., a possible source of the detritus). However, TM60 cannot account for the observed high coercivities. The additional presence of hematite must still be invoked. Indeed a magnetite plus hematite (+ goethite?) mixture alone is sufficient to account for all observed magnetic properties.

Hematite may also be present in the carbonate-rich sediments, though in much smaller quantities. Because of the assumed greater dilution and the swamping of the high-field hysteresis properties by the diamagnetic carbonate, definite identification was not possible.

In the formation of the red clays by dissolution of the carbonate, the magnetic minerals would undergo concentration. An increase in concentration by a factor of about 20 would account for the observed values of MS. This is substantiated by the accumulation rates inferred from the magnetic stratigraphy (Tauxe et al., this vol.). Concentration alone can also account for the increase in the VRM component.

The NRM depends not only on the concentration of the magnetic carriers but also on their degree of alignment. If it is assumed that there was no chemical alteration in the magnetic fraction on dissolution, the inferred lower degree of alignment in the clays can be explained by the physical disturbance of the dissolution event itself. As the carbonate is removed, the fabric temporarily assumes a large void-size/magnetic-grain-size ratio. The magnetic grains are liberated and realign in the dissolution field. Large mechanical perturbations through the release of gas bubbles, dewatering, and compaction could effectively disturb this alignment and thus effectively reduce the stable component of remanence. During the dissolution event, the free magnetic grains may move through the residual fabric to form concentrated bands or grain clusters. Increased magnetic interactions could occur between such grains, leading to the observed decreases in MRS/MS and MDF and perhaps to giving rise to additional viscous effects. An alternative explanation would be the dissolution or chemical alteration of the finer magnetite grains (see also Tucker and Tauxe, this vol.). This would in effect increase the mean magnetite grain size and perhaps be a source, in addition to concentration effects, for the high-coercivity and viscous material.

SUMMARY AND CONCLUSIONS

The three types of sediment studied were those that did not yield reliable paleomagnetic data. I have shown that the reason for their behavior can be adequately explained in terms of postdepositional grain realignment (PDRM). The samples illustrate a progressive sequence of PDRM effects, as follows:

1) The undisturbed carbonate-rich sediments are the most stably magnetized. After the setting of the primary magnetization, little subsequent realignment occurred.

2) As the void size increased (turbidites), realignment effects became more pronounced, in the extreme completely destroying the primary remanence.

3) A temporary increase in effective void size arises as the result of mechanical disturbance, and total resetting of the primary remanence becomes possible (slumps).

4) The disturbance itself can serve to reduce the grain alignment (i.e., rotation by magnetic torques) through the additional mechanical forces and torques imposed (red clays).

The concentration of magnetic minerals of course leads to higher NRM values, with an associated greater precision in measurement. It should be kept in mind that the minerals that carry the unstable and viscous components would also be concentrated.

With careful AF demagnetization, stable paleomagnetic directions could be obtained from turbidite sands. Directional information can also be determined from slump sequences, provided that they pass the modified slump test. Dissolved sediments remain the most difficult to process, inasmuch as physical, viscous, and perhaps chemical overprints often swamp the stable magnetization.

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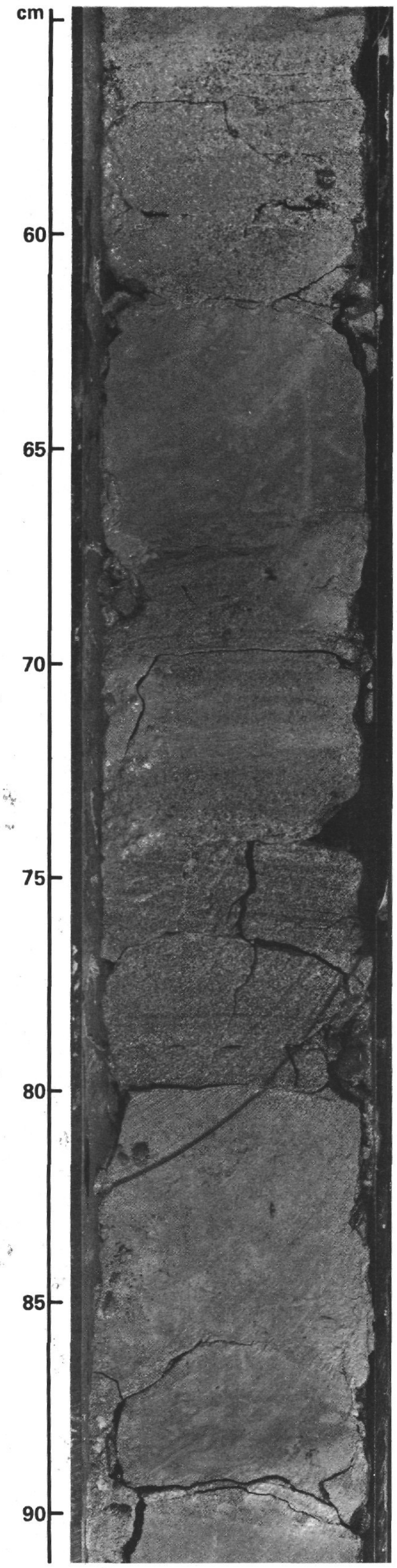

Plate 1. Lithology of a turbidite (Hole 524, Core 11, Section 3). The sampling intervals and magnetic hysteresis properties are listed in Table 1.

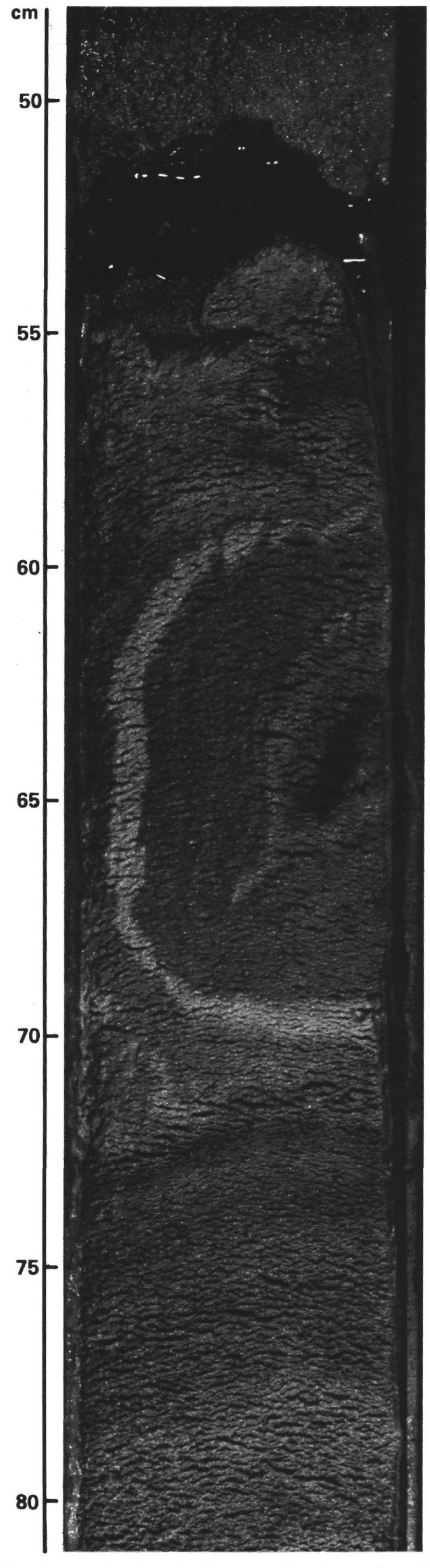

Plate 2. An example of slump folding (Hole 519, Core 4, Section 3). The sampling intervals and stable NRM inclinations are shown in Figure 5. (Fig. 5 shows the sampled and not the archive half of the split core, so the slumps are in mirror image.)