XI. PRELIMINARY RESULTS OF REMANENT MAGNETIZATION MEASUREMENT ON PISTON CORE SAMPLES

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Sediments of the deep sea floor have a post-depositional remanent magnetization (DRM), the direction of which is equal to that of the geomagnetic field when the fine-grained particles containing magnetic minerals were deposited. The magnetic field of the earth has reversed many times and the ages of such reversals are already known. Therefore, we can estimate the age of any cores from examination of the measurement of remanent magnetization of the sediments.

DRM originally obtained from a low latitude area is characterized by a small inclination. Only a direction change of declination (180°) is available for tracing the geomagnetic field of an ancient age, because inclinations disperse about 10° according to sampling error (OPDIKE, 1968). The piston cores for the present measurement were not oriented in a horizontal plain and only the distinction of upper and lower parts was known. Therefore a change of declination (180°) is only significant for interpretation.

Measurement

Longitudinally split cores were available for measurement. Sampling was done continuously by cubes of 2 cm. Measurements were made on every five pieces by means of the P. A. R. Model SM-1D spinner magnetometer. When a reversal was detected, all samples above and below were additionally measured. 50 Oe Ac demagnetization of sediment was carried out on some horizons of the cores, and it resulted a little change of values of original intensity, declination and inclination. Partial demagnetization was also carried out on some samples of St. 412A (P69), as an example, as sediments on the deep sea floor have a high viscous remanent magnetization (VRM) (OPDIKE, 1968). As a result, VRM was cleaned by 50–100 Oe Ac demagnetization and DRM itself was fairly stable (Fig. XI-1), showing that the samples at the reversal part of P69 seem to have much VRM of normal direction, and the remanent magnetization increases by weak AC demagnetization. This provides the possibility of estimating the magnetic field at any depth from the data of the change of declination (180°) with depth and the increase of intensity after AC demagnetization.

Results

The results obtained from the above measurements are shown in Figs. XI-2—6 for the respective cores. In the figures the results of 50 Oe AC demagnetization are shown by open circles and broken lines. The magnetic stratigraphy of the five cores are summarized in Fig. XI-7, and the depth of the top of the first reversal is shown in Table XI-1, together with location and water depth of the measured cores.

As apparent from Fig. XI-7, definite reversal parts with 0.6–0.8 m thickness are recognized on P67, P69, and P71, though their depths are somewhat different from each other.

The respective cores have a uniform composition consisting of clayey sediments, except P67 which has a phosphorite cobble zone at a depth of 2.5 m. If we assume that the pelagic clays have been continuously accumulated up to present with a uniform sedimentary rate, the top of the first reversal would represent the Brunhes-Matuyama boundary (690×10^3 years ago) and the second normal would correspond to the

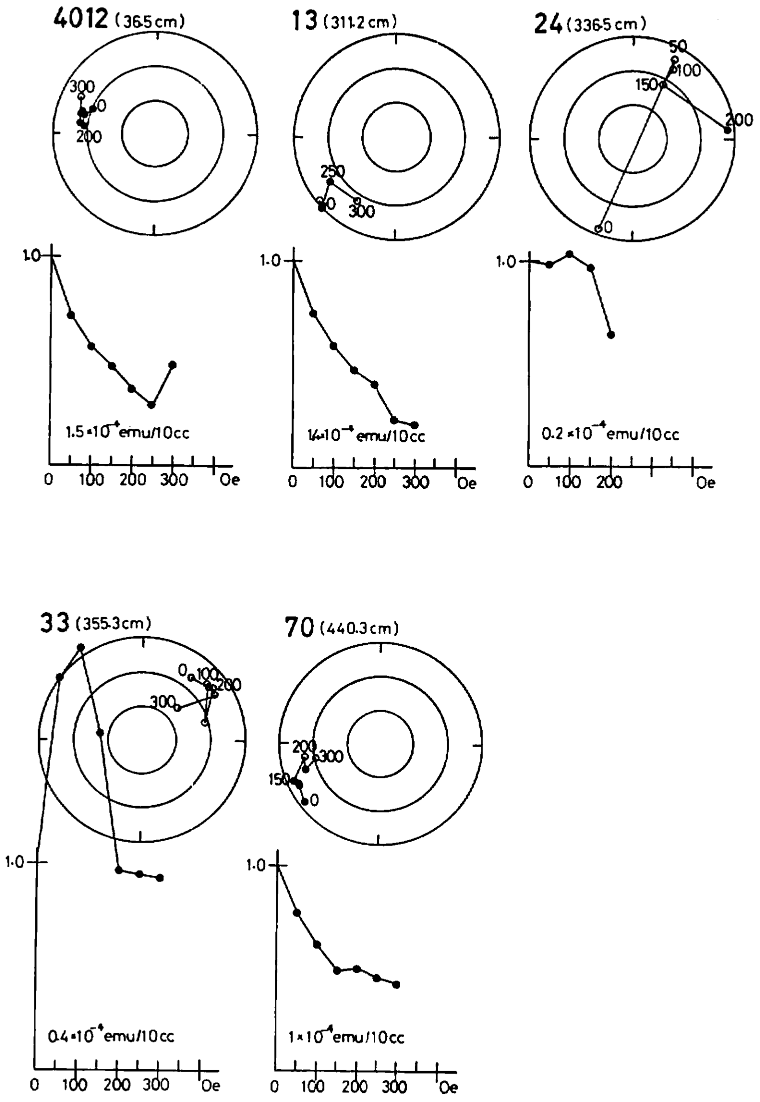

Fig. XI-1 Results of AC partial demagnetization on 412A (P69).
Figure number corresponds to the depth in the core; 4012; 36.5 cm, 13; 311.2 cm, 24; 336.5 cm, 33; 355.3 cm, 70; 440.3 cm.

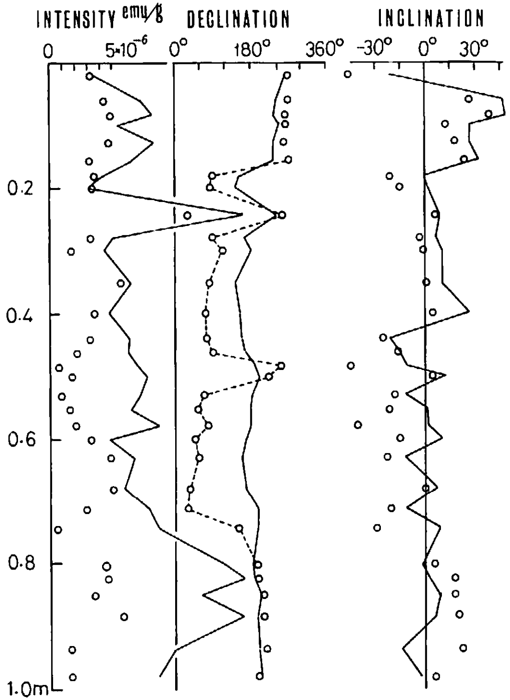

Fig. XI-2 408A (P73).
This core is short, but magnetic pattern is distinct. Solid lines are the results of first measurement, and open circles and broken lines are the results after 50 Oe AC demagnetization.

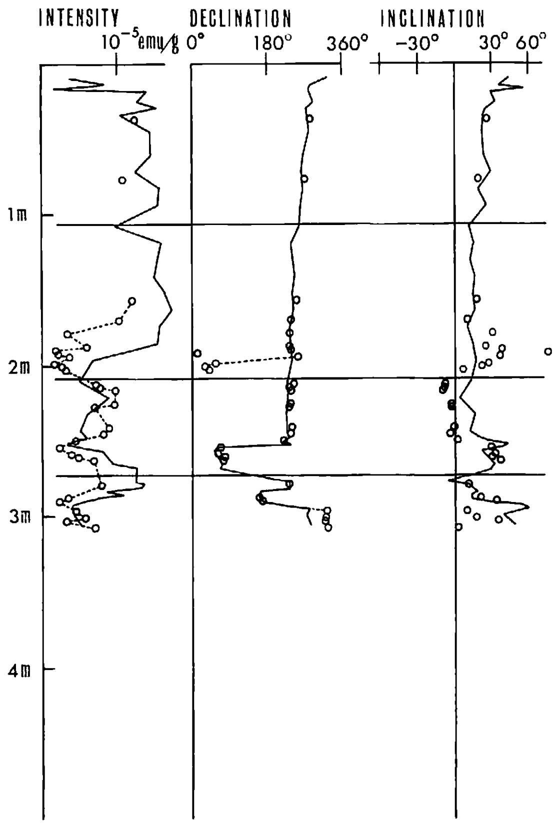

Fig. XI-3 410A (P71).
This core is disturbed at the bottom, but it may be said that the reversal parts are at the depth of 1.95 m to 2.63 m and 2.95 m to 3.1 m.

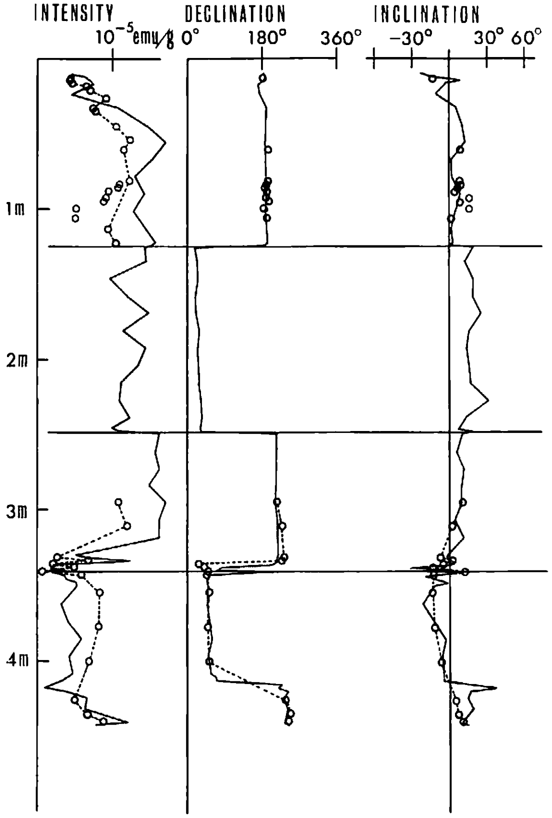

Fig. XI-4 412A (P69).
The horizon of 3.38 m shows the first reverse, and the normal appears again at 4.18 m. The solid circles show the results of measurements on dried samples. AC partial demagnetization was done about this core, and the results are shown in Fig. XI-1.

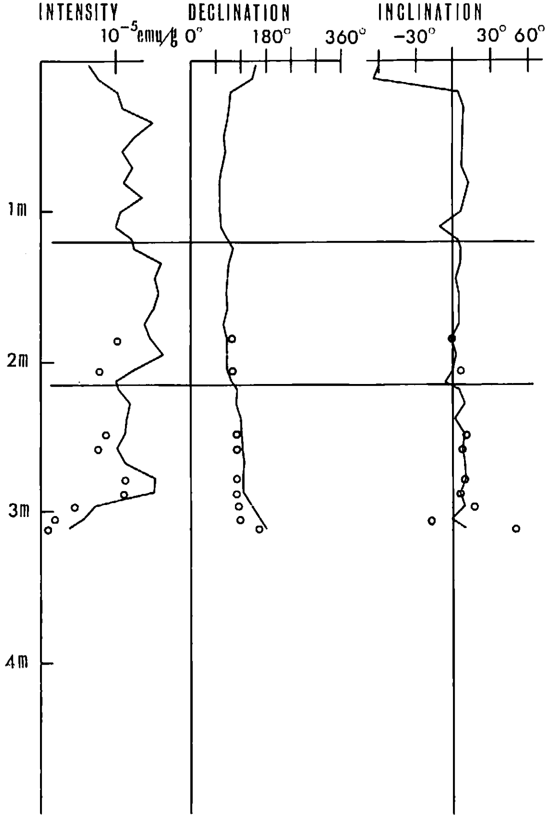

Fig. XI-5 413A (P68).
There is no reverse in this 3.18 m long core, but regarding to the intensity pattern, the bottom of this core seems to be near the first reverse.

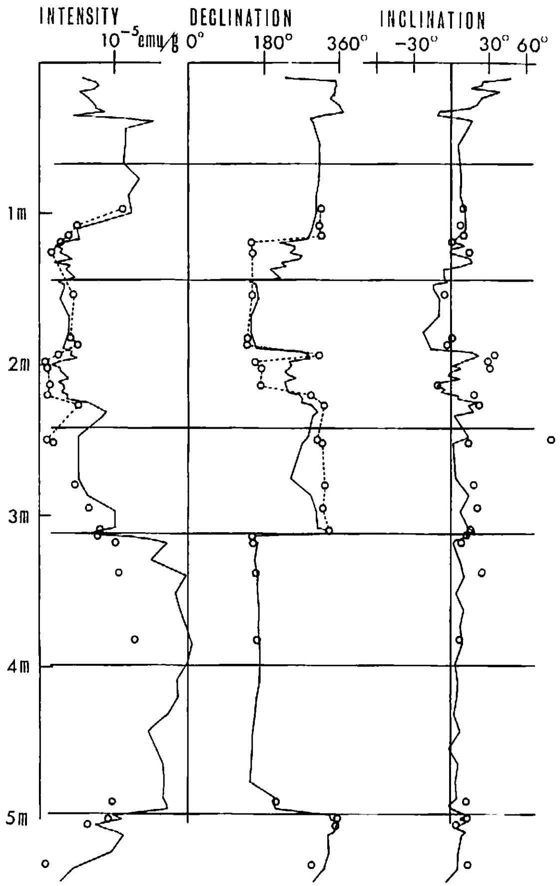

Fig. XI-6 414A-1 (P67).
After 50 Oe AC demagnetization the change of declination became clear. The horizon of 1.18 m shows the first reverse. At the depth of 2.5 m to 2.75 m there is a phosphorite cobbles zone.

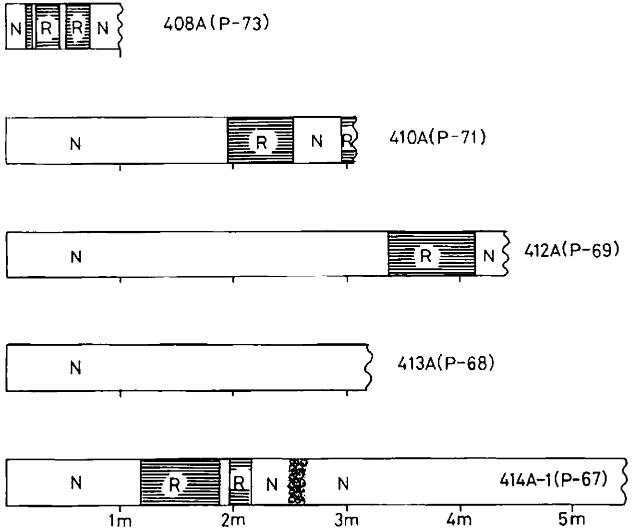

Fig. XI-7 Magnetic stratigraphy and correlation of 5 piston cores.

Table XI-1 Piston cores and depth of the first normal-reverse boundary.

Cores	Lat.	Lon.	Depth	First boundary
408A (P73)	9°58.7′ N	174°0.9′ W	5,820 m	0.19 m
410A (P71)	8°59.2′ N	173°1′ W	5,860 m	1.95 m
412A (P69)	6°59.2′ N	172°59′ W	5,920 m	3.35 m
413A (P68)	6°1.6′ N	172°59.3′ W	5,820 m	—
414A–1 (P67)	4°59.8′ N	172°58.3′ W	5,380 m	1.18 m

Jaramillo event. Under this assumption, it is probable that the normal magnetization in the lower part of P71 represents the Jaramillo event, as the thickness of the normal and reverse parts of the core are roughly proportional to their time intervals in Late Quaternary.

In the core P67. the following identification might be possible; the upper normal is correlated with the Brunhes. the middle normal with the Jaramillo or Olduvai. and the lower normal with the Gauss. However. under this assumption. the Matuyama reversal epoch is represented by relatively thin sequence. and the Gauss normal epoch is by anomalously thick sequence. accompanied by no reversal events expected within. This seems to make the identification difficult.

In the P73 core, if the reversal horizon of 0.18–0.72 m is assigned to the Matuyama. its thickness would be relatively too large in comparison with the rather thin Brunhes part.

As discussed above. chronological interpretation of magnetic stratigraphy in some of the cores seems to be reliable while in others it is unreliable.

Compositional analyses of the cores (M. ARITA; see Chap. X of this cruise report) seem to provide useful data for the interpretation of the magnetic stratigraphy (see Fig. X-8). According to ARITA's investigation, in the P67 core, fresh radiolaria occurs in the uppermost 60 cm, tending to decrease downwards, and stained radiolaria and shark's scale are found throughout the core, though the latter tends to be rather abundant in the horizon of the lower normal part. The fresh radiolaria is considered to be of Quaternary age, and the shark's scale is morphologically similar to those of Oligocene.

The P68 core, which is characterized only by the normal part, shows the occurrence of fresh radiolaria of longer stratigraphic range down to 220 cm.

In the P69 core, fresh radiolaria ranges from the top down to a level of 220 cm, and the distinct reversal part appears in the lower horizon, which is characterized by the occurrence of stained radiolaria and shark's scale of Oligocene type as in core P67. A similar situation is also found in core P71, although the Quaternary type fresh radiolaria is restricted to the top 25 cm or so.

In the short core of P73 which includes three reversal parts within a thickness of about 1 m, fresh radiolaria is notably confined to the uppermost normal part.

From above description, there seems to be a general relation between the position of the Quaternary type radiolaria and the stratigraphic range of the uppermost normally magnetized part, mostly being restricted to its upper-middle part, and also the lower horizons which include the reversal part are characterized by probable Tertiary forms. Moreover, it is likely that the uppermost normal-reverse boundary in the respective cores can be correlated with each other from the general relation outlined above, and it does not represent one of the Brunhes-Matuyama, but some age during Tertiary, if so, another problem is a disappearance of many magnetic epochs and events generally known during Tertiary-Quaternary. At any rate, the problems of exact identification of the normal and the reverse in the cores and the origin of the second problem remain to be solved by further detailed studies.

In conclusion, the present preliminary study on the remanent magnetization of cores cannot give any identification of the normal and the reverse parts by themselves. With the addition of micropaleontologic data, it is unlikely that the uppermost normal-reverse boundary which seems to be correlated throughout the cores represents the Quaternary Brunhes-Matuyama boundary. It rather appears to represent a certain horizon within the Tertiary, but this remains to be substantiated by further detailed investigations, together with the problem of the disappearance of the many expected magnetic epochs and events.

Appendix

Samples provided for the present measurements were in various drying stages, and it was felt that an experiment of the influence of drying on remanent magnetization was necessary. Seven samples from the P69 core were therefore dried in a geomagnetic field and measured under the following conditions.

Partial demagnetization was measured after 4 hours drying, 24 hours drying, and so on. In this experiment a change of weight of sample was used as the parameter of the stage of dryness. It would seem that the natural remanent magnetization decreased as the samples dried, but the direction did not change. The results are shown at a depth of 0.8–1.1 m in Fig. XI-4 by solid circles. After four weeks the weight of sample at a depth of 1.06 m decreased to 2.38 g from an initial weight of 9.0 g and the intensity decreased to about half of the initial one. However, the AC partial demagnetization curve was similar to that of the nondried sample. The decrease of intensity may have been caused by the twist of magnetic particles during drying and consequent shrinking. The stability against AC demagnetization became lower as the time of sample dryness increased, but the cause is not certain.

The present experiment shows that the magnetic direction measurement of samples that were entirely dried is reliable.

Acknowledgment

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Reference

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