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XII. REMANENT MAGNETIZATION OF PISTON CORES FROM THE WAKE-TAHITI TRANSECT IN THE CENTRAL PACIFIC

Masato Joshima

Introduction

Remanent magnetization of piston cores collected from the Wake-Tahiti Transect in Cruise GH80–1 was measured one month after the cruise. The samples for the measurement were continuously taken immediately after core recovering on board as cubic ones (2 × 2 × 2 cm) sealed with a polyvinyl case. These cases were packed every 100 together in larger cases and enclosed by cap and vinyl tape against drying before the measurement. Measured cores, about 130 m long in total, were twenty out of total twenty two of piston cores. Two cores (P166 and P158) were not provided for the measurement due to disturbance during the core sampling.

Preliminary measurement was firstly conducted at an interval of 8 cm from every core. When vertical change of magnetization was detected by the preliminary work, detailed measurement was conducted for the part of the vertical change.

In order to obtain detailed data for the top part of cores, the magnetization of selected four box cores (B6, B17, B24, and B30) was additionally measured.

Before the measurement a weak demagnetization was conducted on every sample with a tri-axial rotator and volt slider in almost same way as the previous measurements. (JOSHIMA, 1977; 1979; 1981). When a sample was rotating in the rotator, alternative magnetic field increased to 50 Oe (5 mT) and slowly decreased by a volt slider by man-handling.

A SCT CM-113 cryogenic rock magnetometer was used for the measurement of magnetization. The instrument has a capability of measuring 3 components of remanent magnetization of rock or sediment sample in one handling. Examination of anisotropic influence by sample's shape showed that the 2 cm cubic sediment samples in this study have no problem for the influence.

Results

The results of measurement on total 2,000 samples show that thirteen cores have a stable remanent magnetization with clear pattern of repeated normally or reversally magnetized part, and the remaining seven cores are not characterized by particular pattern due to the difficulty of determining the polarity of the measured samples.

Table XII-1 presents the measured cores and their data of present geomagnetic field at each site, which were calculated by the formula of IGRF, together with the results of measurements of inclination of top part of each core and 4 box cores. Figure XII-1 summarizes the results of measurement of the thirteen cores which have a stable remanent magnetization with a clear directional pattern, together with lithologic sequence of each core. The detailed results of the measurement are displayed in Fig. XII-2.

Table XII-1 Locations of measured cores and mean value of inclinations in their top 20 cm part, with the present geomagnetic property of each station.

Core (St. no.)		Lat.	Lon.	Depth (m)	IGRF[1)] Dec.	IGRF[1)] Inc.	Inc.[2)]
B6	(1601)	3°17.83′N	172°10.51′W	5350	10.5°	5.4°	3°
P159	(1603)	1°17.22′N	170°42.28′W	5479	10.4	1.8	4
P160	(1605)	0°57.91′S	169°01.69′W	5455	10.4	−2.3	−5
P161	(1607)	3°02.12′S	167°29.91′W	5698	10.4	−6.2	−7
P162	(1609)	5°11.60′S	165°51.90′W	4397	10.5	−10.2	—
P163	(1612)	8°01.08′S	163°48.40′W	4808	10.7	−15.5	—
P164	(1615)	11°36.55′S	161°05.41′W	3153	11.1	−22.0	−18
P165	(1618A)	14°28.86′S	158°52.66′W	5530	11.6	−26.9	24
B17	(1619)	13°34.29′S	157°05.16′W	5111	11.3	−24.8	−23
P167	(1622)	10°16.35′S	159°35.57′W	5235	10.7	−19.0	−12
P168	(1624)	8°08.05′S	161°12.37′W	3908	10.5	−15.1	13
P169	(1626)	5°47.32′S	162°55.92′W	4711	10.3	−10.7	6
P170	(1628)	3°30.50′S	164°09.94′W	4947	10.2	−6.2	−26
P171	(1630)	1°30.45′S	165°52.52′W	5537	10.2	−2.5	−12
B24	(1631)	0°58.61′S	166°20.89′W	5342	10.2	−1.5	−6
P172	(1632)	0°26.16′N	167°33.83′W	5255	10.2	1.1	3
P173	(1634)	2°32.13′N	169°06.07′W	5087	10.3	4.9	15
P174	(1635A)	3°16.31′N	169°40.25′W	5350	10.3	6.2	65
P175	(1636)	4°43.37′N	170°42.88′W	5747	10.4	8.8	10
P176	(1638)	6°48.65′N	172°15.46′W	5791	10.4	12.3	4
P177	(1640)	8°57.86′N	173°53.91′W	5915	10.5	15.8	37
P178	(1642)	11°06.38′N	175°30.07′W	5441	10.5	19.0	38
P179	(1644)	13°16.99′N	177°08.35′W	5027	10.5	22.1	39
B30	(1645)	14°06.61′N	177°47.28′W	5068	10.4	23.3	23

1) Declinations and inclinations of stations calculated by the formula of IGRF.
2) Mean value of inclinations in the top 20 cm of each core.

For identification of magnetic epoch, event, etc. in each core, the data of micropaleontology (TAKAYANAGI *et al.* and UJIIÉ and MISHIMA, this cruise report) were taken into consideration. Magnetostratigraphical age of cores was based on the marine magnetic time scale of NESS *et al.* (1980).

Northern to central Central Pacific Basin

Data of cores P159, P160, P172, P173, P174, P175, P177, and P178 from the northern to central parts of the Central Pacific Basin were obtained.

Core P160 (St. 1605) from the southern extremity of the central part of the basin shows the clearest magnetic pattern which is almost identical with the standard magnetic stratigraphy of the Quaternary to latest Pliocene (around 2.1 Ma) (see Fig. XII-4). The pattern implies a continuous sedimentation of siliceous mud during the ages in the site, whose sedimentation rate is calculated to be 3.82 mm/1000 years between the beginning of the Olduvai event (the lower limit of the lowest normal interval) and the present.

Core P159 (St. 1603) largely consisting of siliceous ooze is very different in magnetic pattern from the preceding core. The upper part shows no magnetic sign of the late to middle Quaternary, and identification of magnetic sequence throughout the core seems to be difficult. However, micropaleontologic data suggest that the core represents the

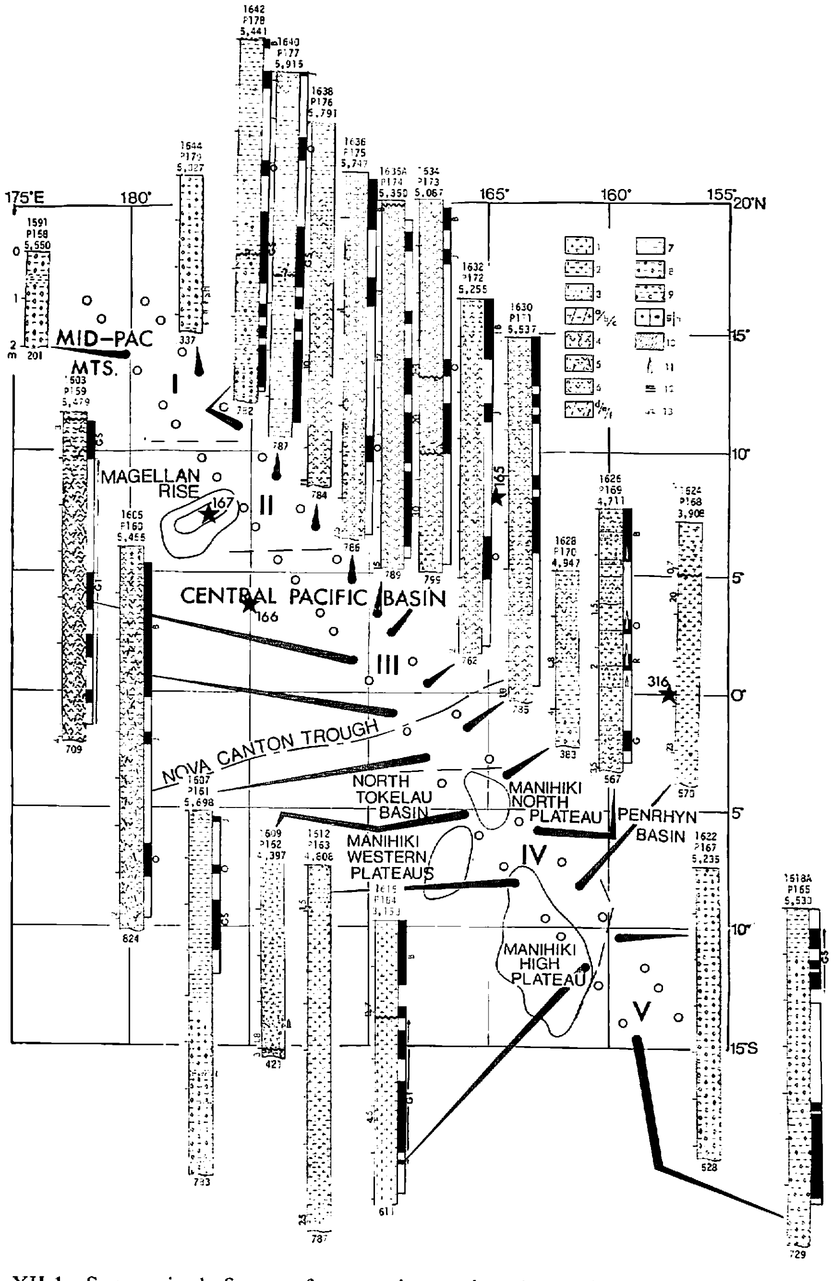
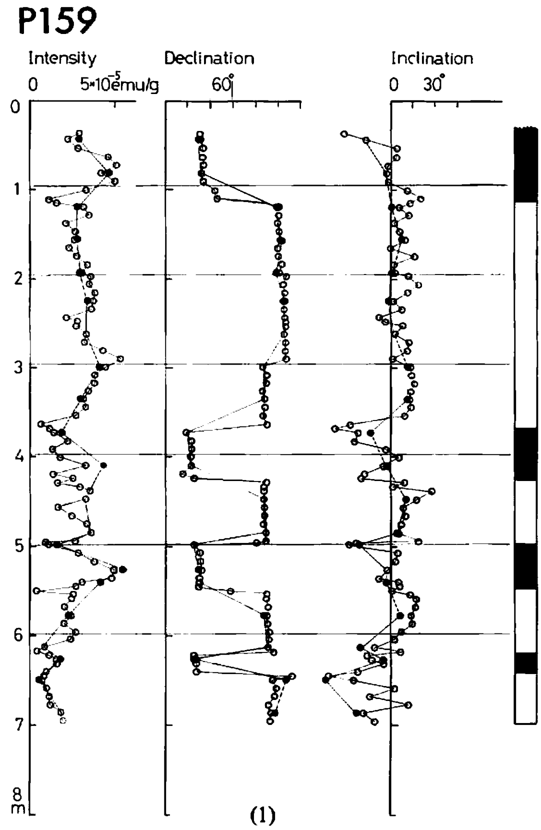
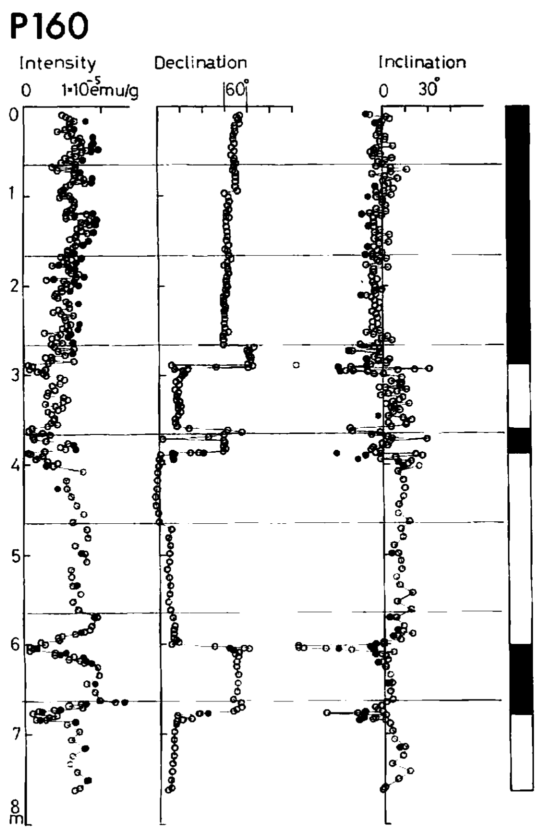


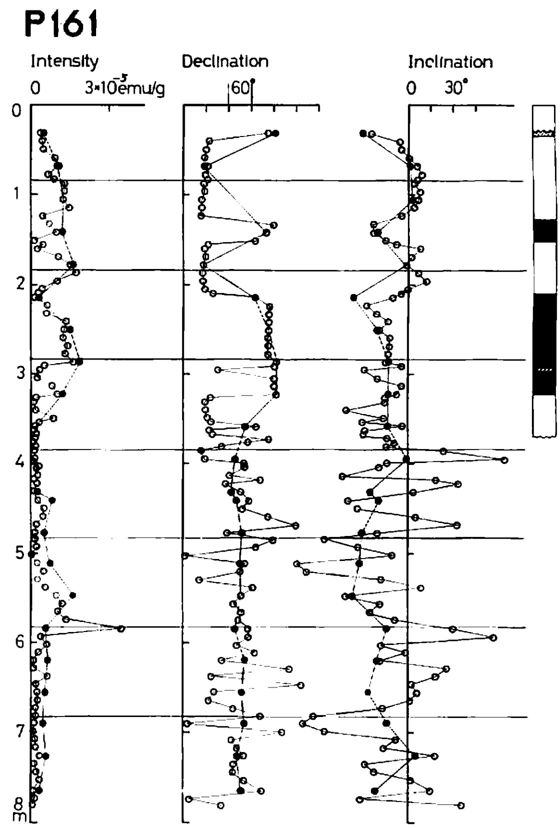
Fig. XII-1 Summarized figure of magnetic stratigraphy and lithology of sediment. Reproduced from Fig. V-4.

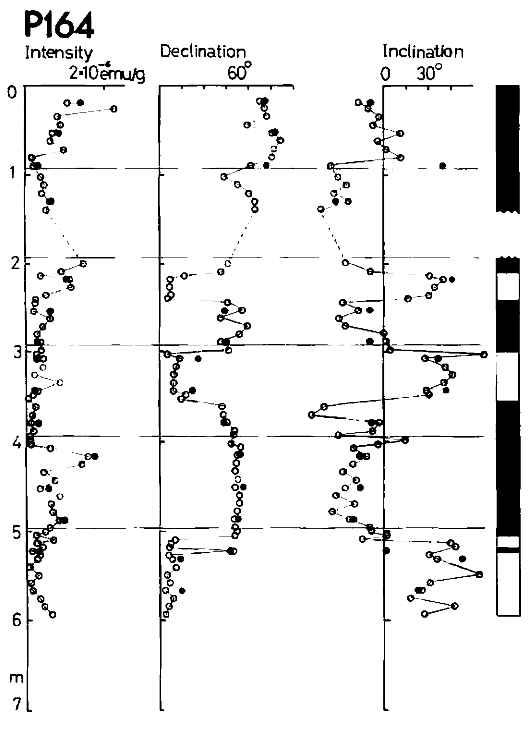
middle Pliocene *Spongaster pentas* zone (ca. 2.8 Ma to ca. 4.2 Ma). From both the general magnetic pattern and the micropaleontologic data, the lower normal intervals in the core possibly represents normal events within the Gilbert epoch, and the uppermost one does the lowest Gauss epoch. Sedimentation rate is calculated to be 4.82 mm/1000

Fig. XII-2 Detailed display of intensity, declination, and inclination of remanent magnetization of cores which are stable against alternative magnetic field demagnetization (1–13). Vertical axis shows depths in the core. Horizontal line shows the boundaries of sections of core cut on the ship. From left to right: calculated results of intensity, declination (relative), inclination and interpreted magnetized pattern; solid symbol shows normally magnetized part and open one does reversally magnetized part; obliquely hatched part is a possible normally magnetized interval.

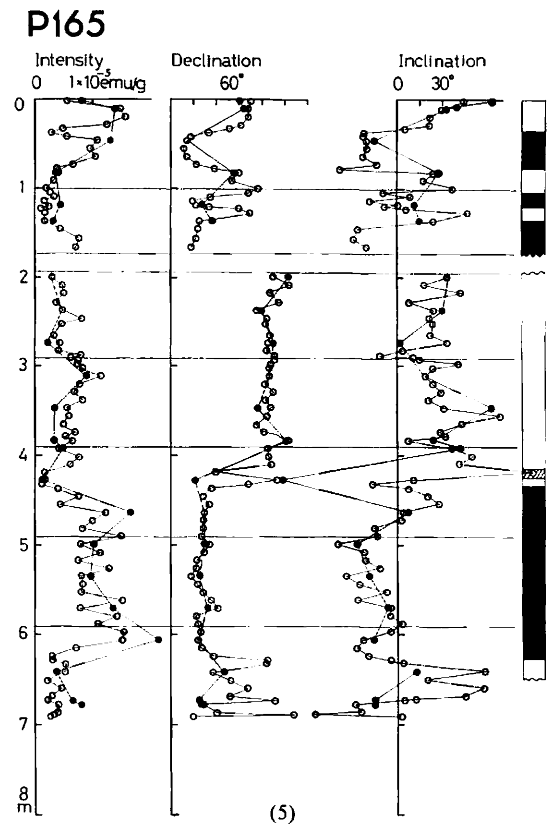




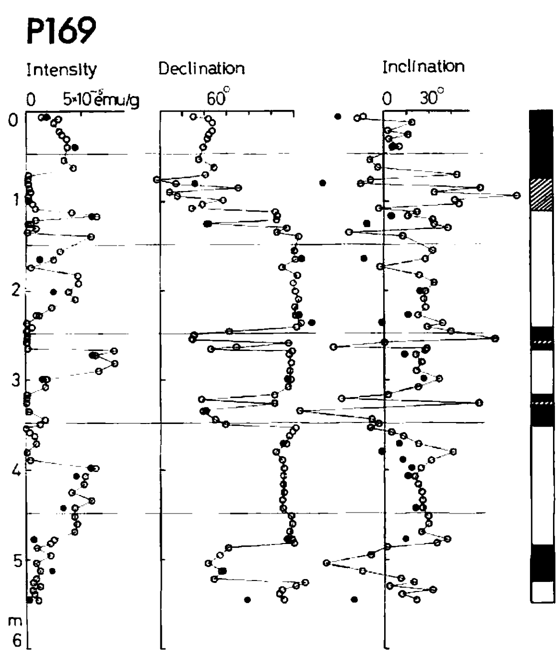



P164
Intensity
2×10^{-6} emu/g
Declination
60°
Inclination
0 30°
0
1
2
3
4
5
6
m
7

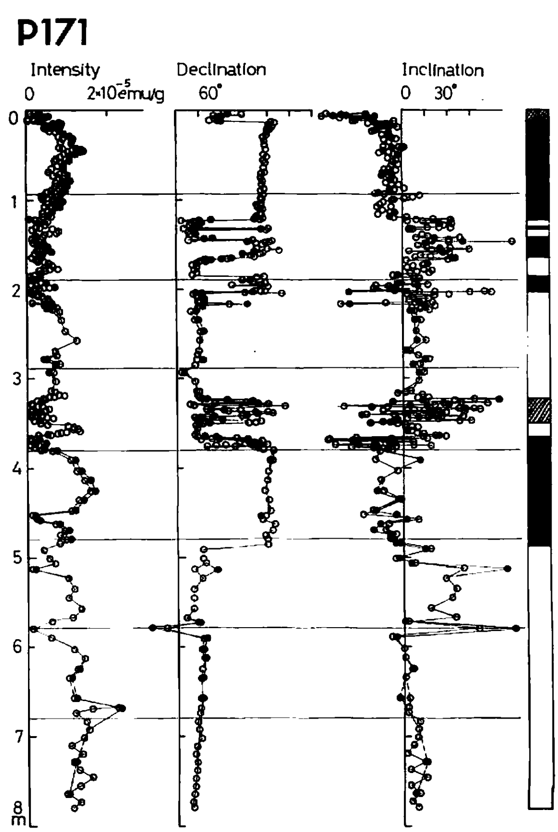
(4)


P165
Intensity
0 1×10^{-5} emu/g
Declination
60°
Inclination
0 30°
0
1
2
3
4
5
6
7
8
m

(5)

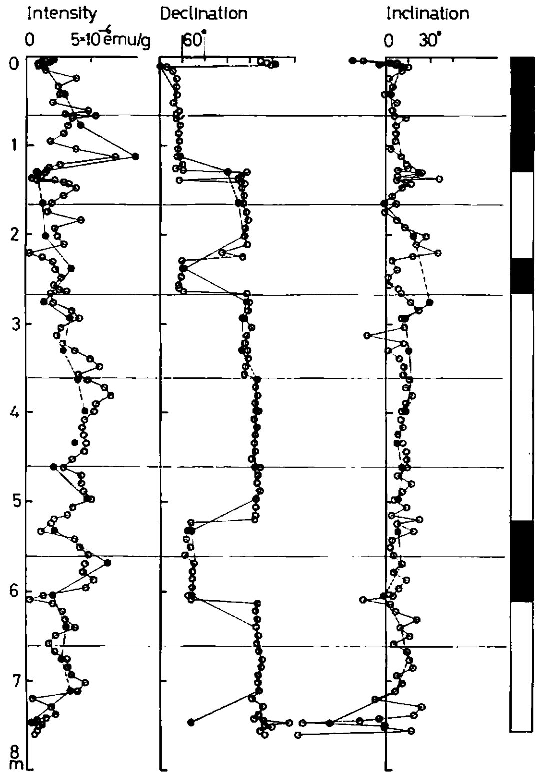

P169
Intensity
0 5×10^{-5} emu/g
Declination
60°
Inclination
0 30°
0
1
2
3
4
5
m
6

(6)


P171
Intensity
0 2×10^{-5} emu/g
Declination
60°
Inclination
0 30°
0
1
2
3
4
5
6
7
8
m

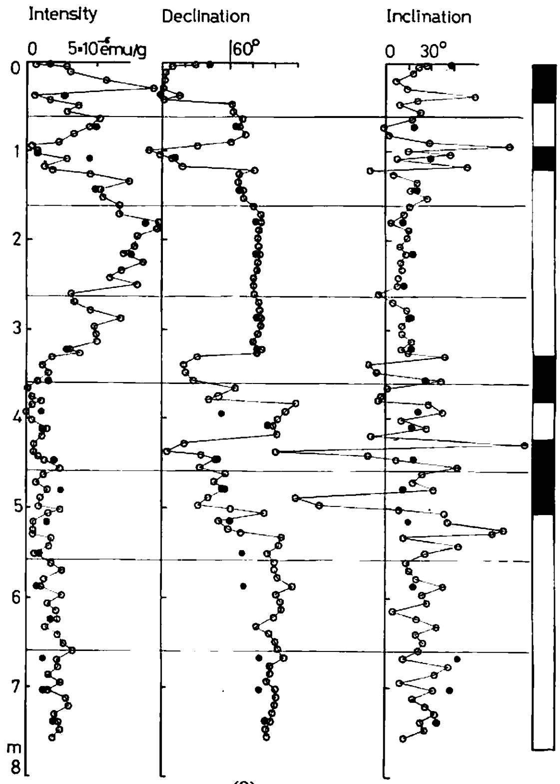
(7)

P172



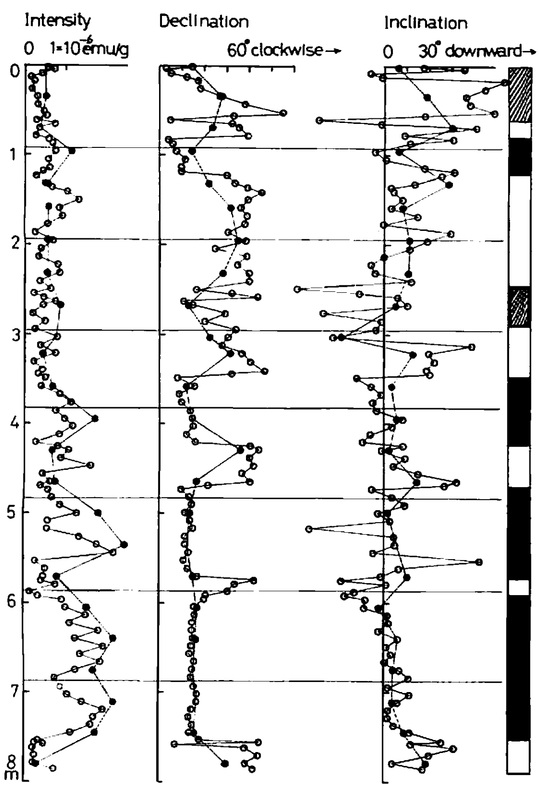
(8)

P173



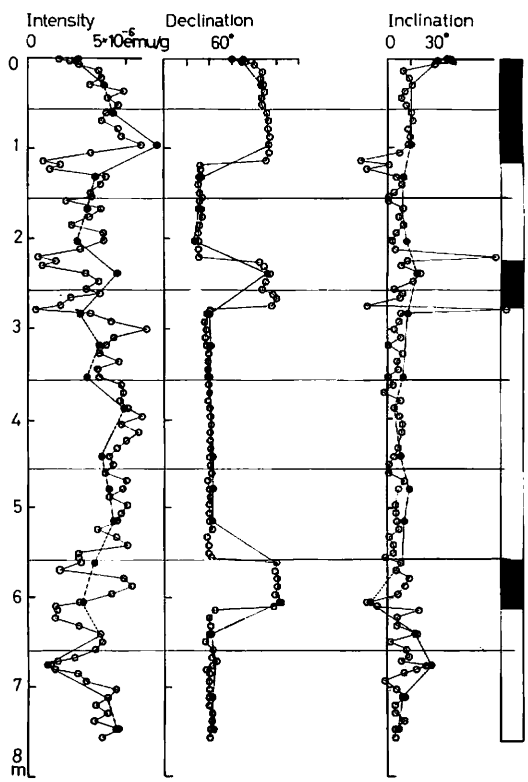
(9)

P174



(10)

P175



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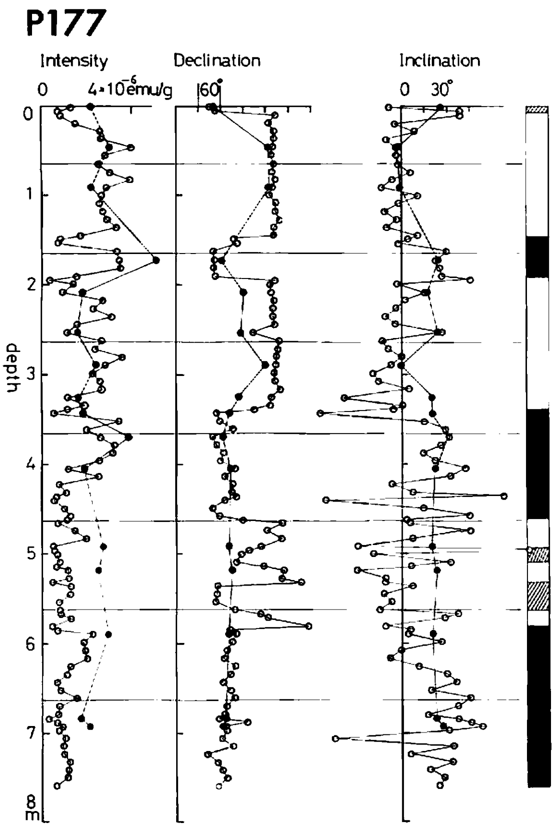

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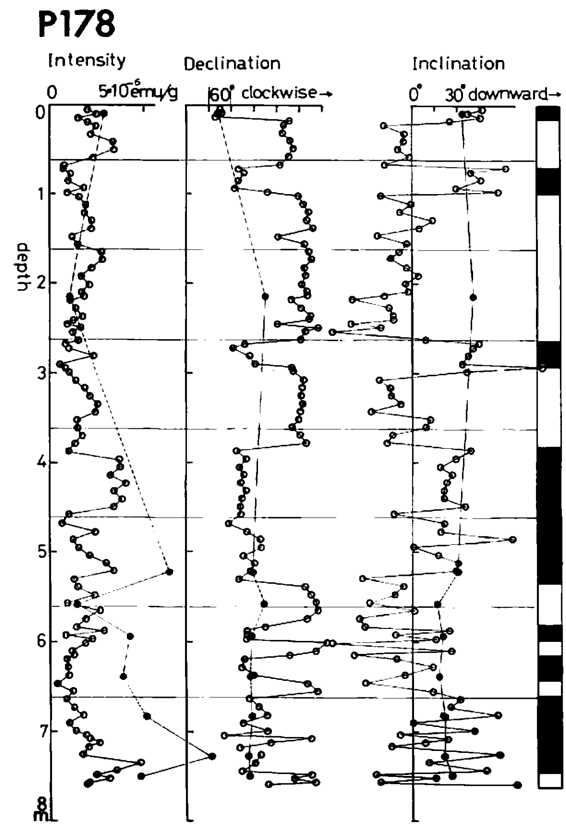


(13)

years between the end of Gilbert epoch (1.1 m) and the beginning of second normal event in the Gilbert epoch (6.4 m).

Core P172 (St. 1632) from the northeast of core P160, largely consisting of siliceous ooze, has a similar magnetic sequence to the latter, with the bottom dated about 2 Ma micropaleontologically as well. However, it has a shorter uppermost normal part than that assumed for the interval of the Brunhes epoch. There might be a sedimentation gap in the Brunhes epoch, sedimentation rate might have changed after the Brunhes-Matuyama boundary age, or there might be non-deposition/erosion at the present time. An artificial effect in the time of sampling seems to be almost insignificant.

Core P173 (St. 1634) shows a similar magnetic stratigraphy in the upper part to the preceding core. But the shortening of the interval of the Brunhes epock is more remarkably documented in P173. An artificial disturbance in the upper part can not be recognized, so the shortening may due to the effect of sedimentation history during the Brunhes epoch as well as in Core P172. The third normal part (from the top) may be identified with the Olduvai event, and this identification seems to be not inconsistent with micropaleontologic data. The micropaleontologic data suggest that an interval of ca.3.8 m–ca.5.5 m is the early Miocene sediment which is separated by hiatuses from the upper half having the three normally magnetized parts and the below lying reversally magnetized part. Thus it may be highly probable that a normally magnetized part, ca.4.3 m to ca.5.5 m, belongs to the polarity epoch 19.

Core P174 (St. 1635 A) north of P173 shows a magnetic pattern difficult to be identified. But it seems that the pattern is in good agreement with the standard one of magnetic stratigraphy between 12.7 and 15.0 Ma (middle Miocene), as shown in Fig. XII-4. The estimation is consistent with the conclusion of micropaleontologic analysis indicating that a larger part of the core is the middle to lower part of *Dorcadospyris alata* zone (ca.12 Ma to ca.16 Ma) and the pilot core is dated the latest Quaternary. We cannot recognize any artificial disturbance of the upper part of the core, so the findings may show that a great hiatus is present between the pilot core and the main core or within the uppermost part of the main core exclusively consisting of siliceous ooze.

Core P175 (St. 1636) is similar to P172 in magnetic pattern as a whole. But the third normally magnetized part (from the top) seems to be much shorter, and there is a possibility of slow sedimentation rate during the Olduvai event, because the age of bottom of the core is determined to the latest Pliocene (*Pterocanium prismatium* zone; ca.1.5 Ma to ca.2.8 Ma) by the micropaleontologic analysis.

Core P177 (St. 1640) northeast of the Magellan Rise consists almost of pelagic clay. Identification of magnetic sequence is very difficult. It is noticed that the magnetic intensity of lower half (below 4.2 m) is weaker than that of upper half, with much more fluctuated inclination. This possibly suggests the presence of discontinuity of sedimentation at a level of 4.2 m. Although the identification of magnetic sequence of the lower half is very difficult, that of the upper half seems to fit to the standard from the late Gauss epoch to the early Jaramillo event (Fig. XII-4), when we assume a continuous sedimentation during the ages.

Core P178 (St. 1644) from the northernmost of the Central Pacific Basin is characterized by similar magnetic sequence to P177 particularly in its lower half part. The nearly identical pattern (with two short normally magnetized parts sandwiched in between two long normal parts) strongly suggests that the lower half part is correlated with that of core P177. From the similar procedure as the case of P177, we can estimate that the upper part is correlated with the Gauss to the earliest Brunhes epoch (Fig. XII-4).

Nova-Canton Trough region

In the area between Nova-Canton Trough and Manihiki Plateau, the magnetic data were obtained for cores P161 and P171, which are difficult to identify the pattern with known part of standard magnetic stratigraphy.

Core P161 (St. 1607) from the south of the Nova-Canton Trough consists of pelagic clay and zeolitic mud (upper half part) and zeolitic mud (lower half part). The lower half part is characterized by quite unstable remanent magnetization, and a determination of normally or reversally magnetized part is very difficult. On the contrast, the upper half shows a clear magnetic pattern which seems to fit to the time from 1 Ma to 3.4 Ma. A sedimentation rate is calculated to be 1.18 mm/1000 year between the end of Olduvai event (Ca.1.2 m) and the beginning of Gauss normal epoch (Ca.3.2 m).

Core P171 (St. 1630) largely consisting of siliceous mud includes many normally magnetized part, longer or shorter. Despite that the core may range through the entire Quaternary from the evidence of microfossils, the determined magnetic sequence is not identifiable with the standard pattern of Quaternary magnetic stratigraphy in appearance. There are much silicoflagellata whose age range from ca.1.4 Ma to ca.0.6 Ma at 2.1 m (JOUSÉ, 1973). It is reliable that short normally magnetized part at 2.1 m is Jaramillo event. Then lower long normally magnetized part is identified as Olduvai event. The sedimentation rate seems to have changed from 5.7 mm/1000 year to 1.83 mm/1000 year during the interval of the end of Olduvai event and the beginning of Jaramillo event. The former value is calculated in the interval of Olduvai event, and the latter one is calculated between the end of Jaramillo event and present. But the upper short normally magnetized part at 1.6 m which corresponds to the brighter part in view of the half of core is not explained by standard magnetic stratigraphy. There might be a rotation of sediment by 180° during the sampling of piston corer, because the inclination of remanent magnetization in that part is positive but the inclination of normally magnetized part in this core is expected to be negative.

Manihiki Plateau region

Magnetic data of cores P164 and P169 are available in the Manihiki Plateau region.

Core P164 (St. 1615) consisting of calcareous ooze shows a clear pattern of remanent magnetization. Micropaleontologic data by TAKAYANAGI *et al.* and UJIIÉ and MISHIMA (both, this cruise report) show that the upper part (ca.0.7 Ma to the present) rests upon the middle to lower parts (around ca.4.5 Ma) with a hiatus. We can assign the uppermost normally magnetized part (0–2.1 m) as the Brunhes epoch and the remaining part (2.1 m to the bottom) as the Gilbert epoch. The normal part, 3.5 m to 5.1 m, may represent the Nunivak event. The accumulation rate in the Gilbert epoch is calculated to be 7.11 mm/1000 years.

Core P169 (St. 1626) from the Manihiki Northeastern Basin includes a repeated sequence of calcareous turbidites. Referring the micropaleontologic data, the uppermost normally magnetized part represents the Brunhes epoch and the lowermost one does the later half of Gauss epoch. Identification of the middle two normal parts is difficult, but is seems to be not unlikely that the second and third normal parts (from the top) are identified with the Olduvai and Reunion events from the micropaleontologic data, respectively. The magnetically much fluctuated interval of the core, around 1 m, possibly includes the Jaramillo event (Fig. XII-2).

Penrhyn Basin

Data of only P165 is available for magnetic stratigraphy. Unfortunately a part of the core was artificially destroyed in the time of sampling. The upper 1.8 m long part and the lower 5.5 m long part seems to be not destroyed, and a severe deformation occurs in-between. The upper part is characterized by a cycle of normally and reversally magnetized intervals, with the reversal uppermost part. We have no positive evidence for an identification at the present time, but it seems that the recurring pattern is very similar to the standard one from the early Matuyama to the Gauss. If it is the case, non-deposition/erosion must have occurred during the entire Quaternary. This may have been caused by intensified bottom current originated from the Antarctic. The identification of the magnetic sequence of the lower 5.5 m long is still open.

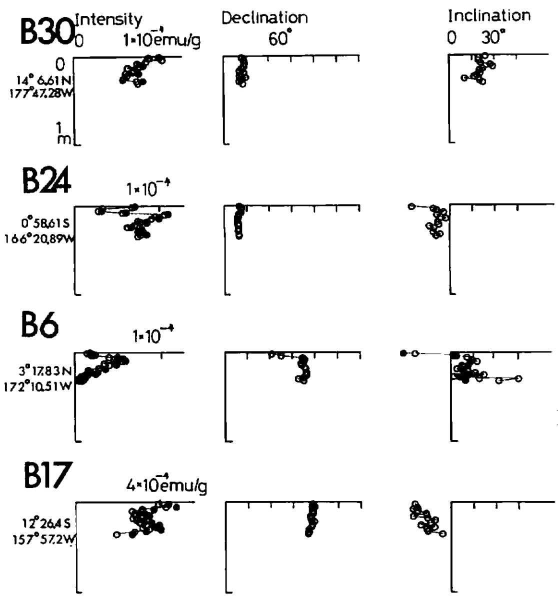


Fig. XII-3 Display of intensity, declination and inclination of remanent magnetization of four box cores measured for checking reliability of remanent magnetization of surface sediment. Their inclinations show nearly the same value of that of IGRF (see the right end column of Table XII-1).

Measurement of four box cores

The four box cores, B30, B24, B6, and B17 have no reversally magnetized part (Fig. XII-3): their declination changes by only 20 degrees, except for B6 (80 degrees at the top of B6) and inclinations show nearly the same value as the calculated IGRF, as shown in Table XII-1. Although the data don't show feature of reversal magnetization, magnetic intensity of B6 becomes weak at the bottom and there might be expected a reversal part just below the bottom, because the inversion of geomagnetic field causes weak magnetic intensity for sediment samples in general.

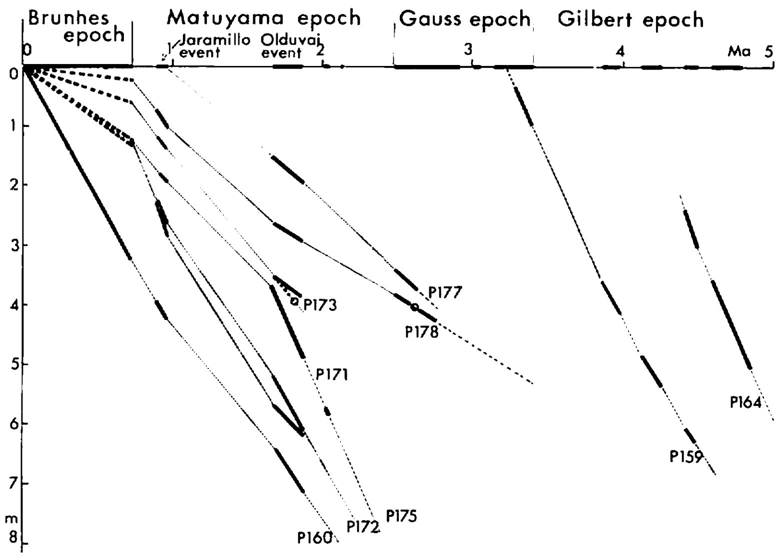
Summary and conclusion

Figure XII-4 summarizes the result of measurements in a style of sedimentation rate curve. There still remain may problems in identification of magnetic sequence, and it is necessary to conduct a further study to obtain additional data as for some sites. However, we may point to,some interesting respects for a sedimentary history of the Central Pacific from the available data of magnetic stratigraphy.

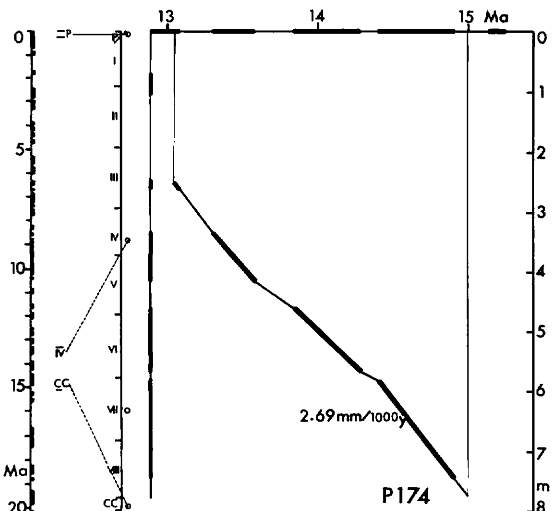
Almost steady continuous sedimentation during the Quaternary is only shown by core P161 in the central part of the Central Pacific Basin, and that during the late Pliocene through the Quaternary by core P169 in the Manihiki Northeastern Basin (although detailed feature of correlation is still open in part).

Other cores of which magnetic correlation was determined show a decreased sedimentation rate or sedimentary hiatuses possibly caused by non-deposition/erosion in various geologic ages.

Hiatuses in older ages are found especially in topographic high area. Core P174 in the central part of the Central Pacific Basin yields a large hiatus of the late Miocene to the nearly entire Quaternary, and this may have been caused by the strong influence of bottom current on an abyssal knoll. Core P173 from the nearby site, also located on the



(1)



(2)

Fig. XII-4 Sedimentation rate curves based on magnetic stratigraphy and micropaleontology. Heavy lines show normally magnetized parts.

topographic high, has remarkable hiatuses of the early Miocene and the middle Miocene to Pliocene, whereas the Quaternary history is represented by almost continuous sedimentation, although the Brunhes interval is some shortened. Shortened Brunhes interval is also found in some cores from the Central Pacific Basin (P172, P175, and P178). The lack of the sediments of post-Jaramillo event is encountered in cores P177 (northern Central Pacific Basin) and P161 (North Tokelau Basin). A larger part of the sediments of post-Gauss is missing in P159 (Central Pacific Basin) and P165 (Penrhyn Basin). The pre-Gauss hiatus is presumed in cores P177 and P178 (both in the northern Central Pacific Basin) and P165 (Penrhyn Basin), and the post-Gilbert, and pre-Brunhes hiatus is found in P164 (Manihiki Plateau).

The measurements revealed that continuous steady sedimentation has been very limited during the mid- to late Tertiary and the Quaternary even in the high productive area of the Central Pacific. Although further relevant studies are needed, the findings may contribute to better understanding of the paleoceanography of the Central Pacific during the ages.

References

JOSHIMA, M. (1977) Preliminary results of remanent magnetization measurement on piston core samples. *In* MIZUNO, A. and MORITANI, T. (*eds.*), *Geol. Surv. Japan Cruise Rept.*, no. 8, p. 118–124.

——— (1979) Preliminary results of remanent magnetization measurement on gravity core samples. *In* MORITANI T. (*ed.*), *Geol. Surv. Japan Cruise Rept.*, no. 12, p. 158–162.

——— (1981) Remanent magnetization of deep-sea sediments in the GH79–1 area. *In* MIZUNO, A. (*ed.*), *Geol. Surv. Japan Cruise Rept.*, no. 15, p. 223–228.

JOUSÉ, A. P. and MUKHINÁ, V. V. (1973) The *Mesocena Eliptica* EHR. zone in the Pleistocene sediments of the Pacific Ocean. *Oceanology*, vol. 13, no. 3, p. 386–394.

NESS, G., LEVI, S., and COUCH, R. (1980) Marine magnetic anomaly timescales for the Cenozoic and Late Cretaceous: a precis, critique, and synthesis. *Rev. Geophys. Space Phys.*, vol. 18, no. 4, p. 753–770.