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VIII. WATER CONTENT OF SURFACE SEDIMENTS IN THE SOUTH OF THE NOVA-CANTON TROUGH, CENTRAL EQUATORIAL PACIFIC (GH82-4 AREA): RELEVANCE TO ACQUISITION OF DEPOSITIONAL REMANENT MAGNETIZATION

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Introduction

Water content was measured on deep-sea surface sediments in the south of Nova-Canton Trough, central equatorial Pacific. The water content has been measured in previous R/V Hakurei-maru cruises from geotechnical point of view for manganese nodule mining (e.g. Tsurusaki and Saito, 1982). Here I measured to understand better the acquisition process of the depositional remanent magnetization (DRM). For this purpose it is important to describe vertical change in water content of surface sediments with compaction.

This report presents the result of water content measurement. Further discussion of the relation between the water content and the remanent magnetization is presented in Yamazaki (1987).

Sample and measurement

Water depth of these sites ranges from 5200 to 5800 m (Table VIII-1). Lithology of the surface sediments is dominantly siliceous clay or siliceous ooze because the study area is within the organic high-productivity zone along the equator and the sample locations are below the Carbonate Compensation Depth which is about 5000 m here at present (Berger and Winterer, 1974). At the sites shallower than 5500 m, however, calcareous components have not yet dissolved completely. Description of core lithology is given in Nishimura and Ikehara (chapter VI, this volume) in this cruise report. Sedimentation rate in the study area determined by magnetostratigraphy is less than 10 m/m.y. (Yamazaki, chapter VII of this volume).

A GSJ type double-spade box-corer was used for obtaining undisturbed surface sediments (Kinoshita *et al.*, 1981). A subcore was taken from each box-core immediately after recovery. Air-tight plastic tubes of 11 cm diameter and 50 cm length were inserted into a box core while sucking by a vacuum pump to avoid contraction of the sediments during penetration. This subcore was split into halves, and samples of 2 cm thick were taken for measurement. Each sample was sealed up firmly for shore-based measurement. Water content was calculated from the weight of a sample before and

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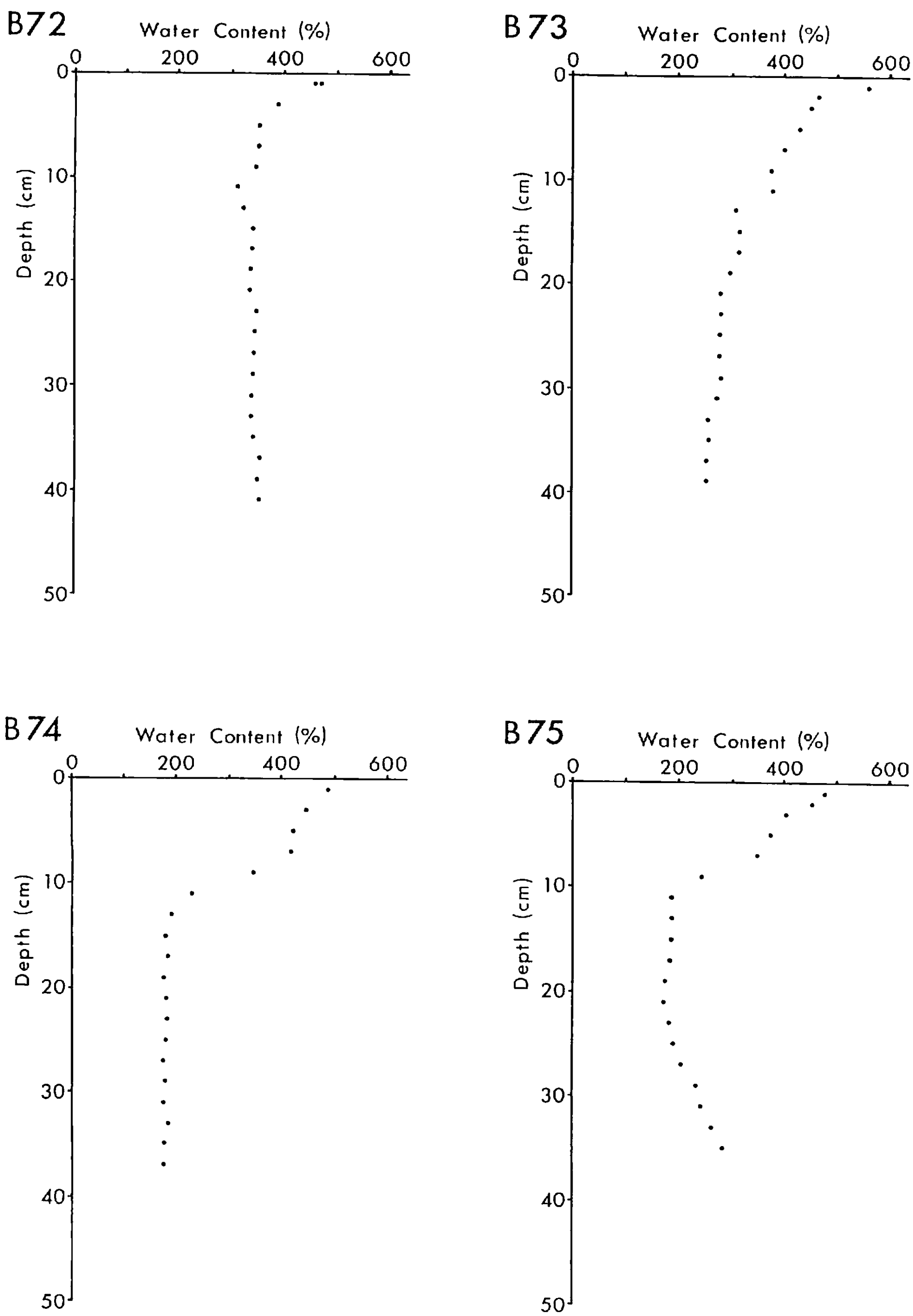

Fig. VIII-1 Variation of water content with depth.

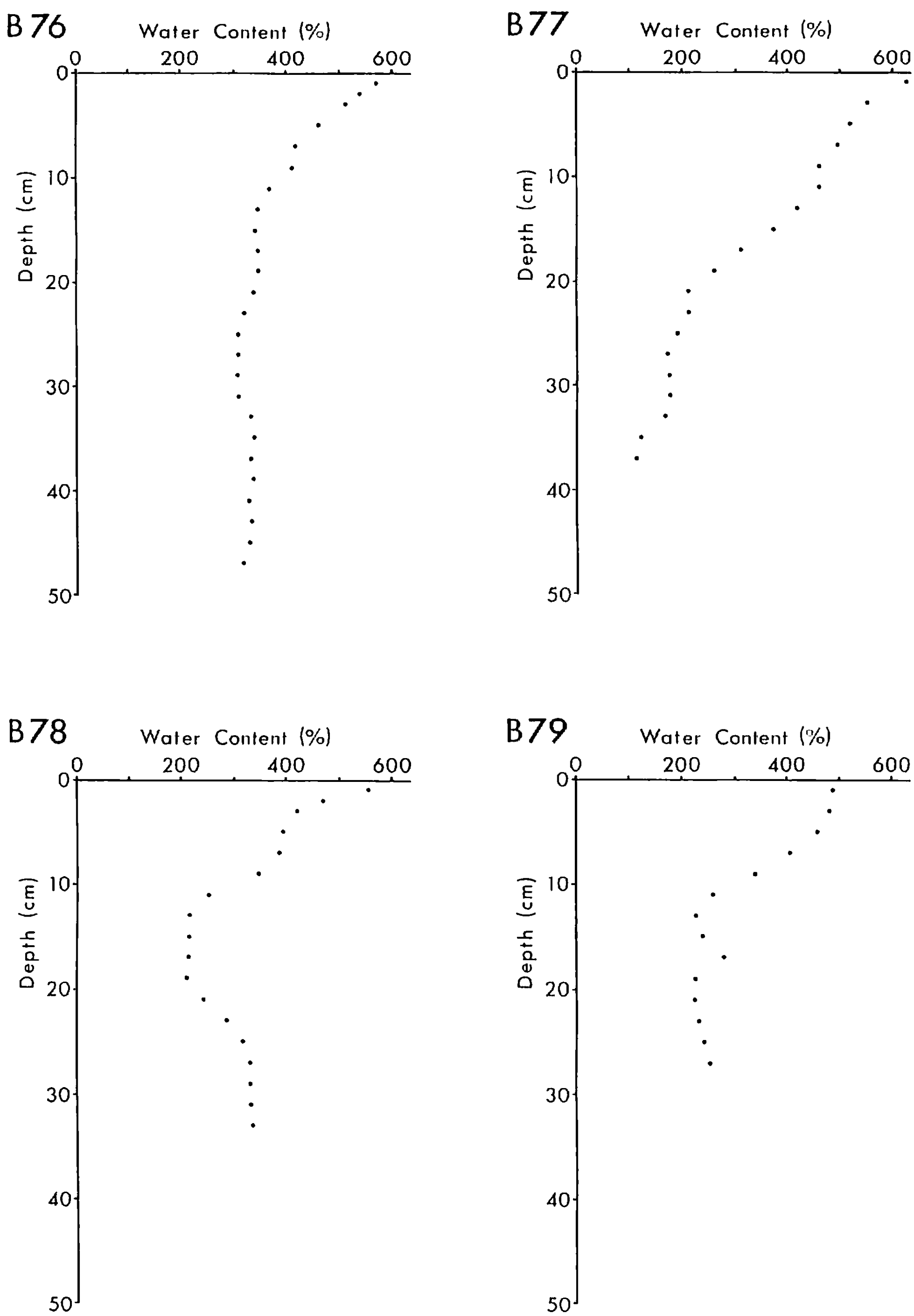

Fig. VIII-1 (continued)

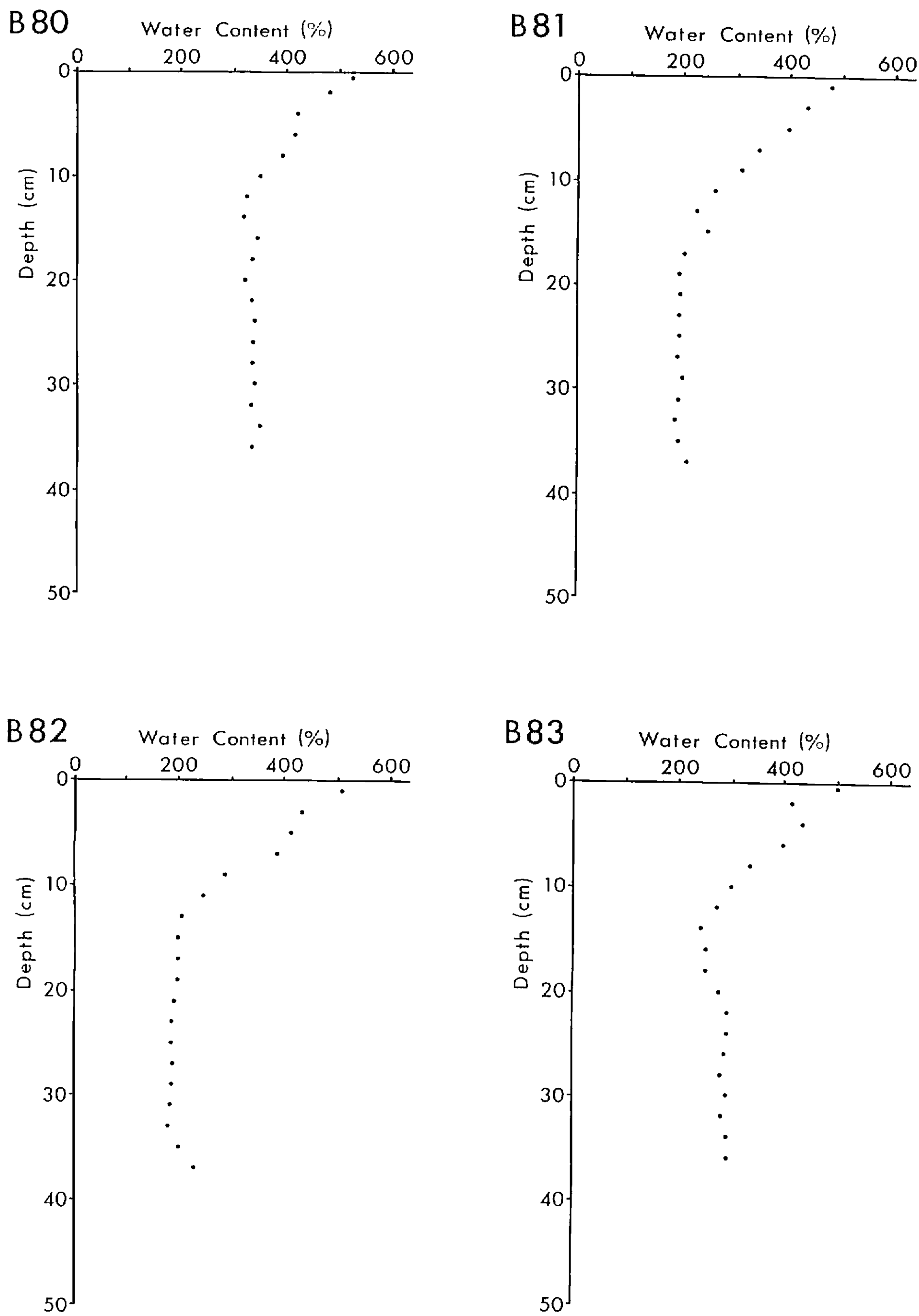

Fig. VIII-1 (continued)

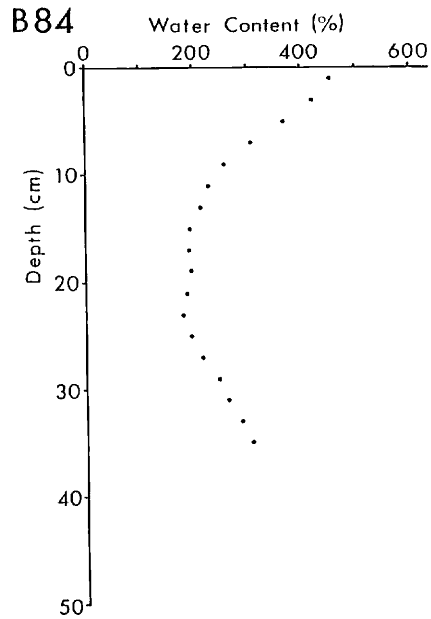

Fig. VIII-1 (continued)

Table VIII-1 Position and water depth of samples.

Sample	Latitude	Longitude	Depth(m)
B72	1°59.34'S	167°42.89'W	5693
B73	2°28.22'S	168°20.09'W	5387
B74	0°49.62'S	166°14.73'W	5300
B75	1°05.86'S	166°29.37'W	5167
B76	1°29.60'S	167°18.53'W	5765
B77	1°08.26'S	166°44.45'W	5367
B78	1°18.51'S	166°47.80'W	5225
B79	0°55.96'S	166°15.77'W	5405
B80	0°53.25'S	166°12.59'W	5514
B81	1°00.31'S	166°14.22'W	5359
B82	0°50.89'S	166°04.81'W	5302
B83	0°58.10'S	166°23.20'W	5359
B84	1°04.22'S	166°19.78'W	5305

after drying for 24 hours at 110°C. Water content was calculated here as 100 × (Mw-Md)/Md (%), where Mw is wet weight and Md is dry weight after heating at 110°C for 24 hours.

Results

Variations of water content with depth are shown in Figure VIII-1. For cores B72 and B76, very surface sediments of probably several centimeter thick may be lost due to overpenetration of the box-corer.

The most important result is that a steep decrease of water content of the surface sediments occurs within only about 10 cm from sediment-water interface. Changes of water content observed at deeper than 10 cm were associated with lithologic changes.

Secondly, the relation between lithology and water content is mentioned. Cores B72, B76 and B80 consist of siliceous clay and completely devoid of calcareous microfossils. Water content of these cores settles down to 320 to 330% below 10 cm. Cores B73, B74, B75, B79, B81, B82 and B83 have various amount of calcareous components except for upper several centimeters. Water content below 10 cm of these cores ranges from 150 to 250%. Calcareous sediments have low water content. For example, Tsurusaki and Saito (1982) reported a value of 100% for calcareous nanno ooze. The wide range of water content of these cores would reflect the ratio of calcareous fraction. Core B77 shows a gradual lithologic change downward from siliceous clay to calcareous ooze, which is accompanied by a gradual decrease of water content. A lithologic change from calcareous clay to siliceous clay occurs at the deeper part of cores B78 and B84, which results in the downward increase of water content.

Discussion: depth lag of DRM acquisition

It has been established that a post-depositional process plays a substantial role in acquisition of DRM (Irving and Major, 1964; Løvlie, 1974). Remanent magnetization is gradually fixed within a finite thickness of subsurface sediments (lock-in zone, Niitsuma, 1977). Thus a time (depth) lag exists between deposition and fixation of remanence. Compaction experiments in a controlled magnetic field (Hamano, 1980; Otofuji and Sasajima, 1981) revealed that the DRM is acquired together with a density increase of sediments by compaction.

The fact that the decrease of water content (increase of density) of deep-sea sediments occurs mainly within 10 cm from the surface implies that the DRM is acquired within this zone if the result of the laboratory experiments can be applied directly to natural deep-sea sediments. This agrees with the estimation of Hyodo (1984) using a linear system model. He concluded that the "half fixing depth" (the depth at which a half of magnetic moments is locked) is 10 cm or less in general from the pattern of a drop of remanent intensity at a geomagnetic polarity reversal recorded in deep-sea sediments. Niitsuma (1977) and Okada and Niitsuma (1990), however, postulated that the depth lag of DRM acquisition is about 40 cm based on the gap between the magnetostratigraphy and the oxygen isotope stratigraphy or tephrochronology recorded in marine silts exposed on the Boso peninsula. Their sedimentation rate is extremely high (about 4 m per 1000 years) which is three orders in magnitude higher than in the GH82-4 area. This discrepancy in the depth lag suggests that the width and/or depth of the zone of density increase would depend on sedimentation rate. Further studies of the physical properties of sediments having various lithologies and sedimentation rates are needed.

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References

Berger, W. H. and Winterer, E. L. (1974) Plate stratigraphy and the fluctuating carbonate line. *Intern. Assoc. Sedimentologists Spec. Pub.*, vol. 1, p. 11-48.

Irving, E. and Major, A. (1964) Post-depositional detrital remanent magnetization in a synthetic sediment. *Sedimentology*, vol. 3, p. 135-143.

Hamano, Y. (1980) An experiment on the post-depositional remanent magnetization in artificial and natural sediments. *Earth Planet. Sci. Lett.*, vol. 51, p. 221-232.

Hyodo, M. (1984) Possibility of reconstruction of the past geomagnetic field from homogeneous sediments. *J. Geomag. Geoelecter.*, vol. 36, p. 45-62.

Kinoshita, Y., Handa, K., Tsurusaki, K., Nakao, S. and Moritani, T. (1981) Notes on test of new sampling instruments in the GH78-1 cruises. *Geol. Surv. Japan Cruise Rept.*, no. 17, p. 251-257.

Løvlie, R. (1974) Post-depositional remanent magnetization in a re-deposited deep-sea sediment. *Earth Planet. Sci. Lett.*, vol. 21, p. 315-320.

Niitsuma, N. (1977) Zone-magnetization model and depth lag of NRM in deep-sea sediments. *Rock Mag. Paleogeophys.*, vol. 4, p. 65-71.

Okada, M. and Niitsuma, N. (1989) Detailed paleomagnetic records during the Brunhes-Matuyama geomagnetic reversal, and a direct determination of depth lag for magnetization in marine sediments. *Phys. Earth Planet. Inter.*, vol. 56, p. 133-150.

Otofuji, Y. and Sasajima, S. (1981) A magnetization process of sediments: laboratory experiments on post-depositional remanent magnetization. *Geophys. J. R. astr. Soc.*, vol. 66, p. 241-259.

Tsurusaki, K. and Saito, T. (1982) Geotechnical properties of deep-sea sediments, Wake to Tahiti. *Geol. Surv. Japan Cruise Rept.*, no. 19, p. 124-137.

Yamazaki, T. (1987) Fixation of remanent magnetization with compaction in deep-sea environment. *J. Geomag. Geoelecter.*, vol. 39, p. 307-312.