Proceedings of the Eighth (1998) International Offshore and Polar Engineering Conference
Montréal, Canada, May 24-29, 1998

ISBN 1-880653-34-6 (Set); ISBN 1-880653-35-4 (Vol. 1)

The Scale and Nature of Water Column Variability in an Area Designated for Polymetallic Nodule Mining

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ABSTRACT

Within its pioneer area in the eastern part of the Clarion-Clipperton Fracture Zone, Interoceanmetal Joint Organization carried out a series of oceanographic surveys to study seasonal variability of the water column. The surveys were performed in autumn 1994, spring and 1995, and in spring 1997, as well as before and after Hurricane Barbara in July 1995. The scale of seasonal variability in the water column structure is evaluated. In the surface, upper intermediate, and near-bottom water masses the variability most important from the standpoint of the future mining is that related to the effects of the hurricane; the near-bottom and deep water masses are additionally affected by variability stemming from active volcanic, hydrothermal, and seismic processes.

KEY WORDS: Interoceanmetal, seasonal variability, water column structure, Benthic Impact Experiment, nodule mining

INTRODUCTION

During 1994 - 1997, Interoceanmetal Joint Organization (IOM) was carrying out research on basic oceanographic characteristics of its pioneer area in the Clarion-Clipperton ore field. The research concerned also the selection of a site for a benthic disturbance experiment (BIE) and the assessment of potential environmental consequences of polymetallic nodule mining (Kotlinski at al.,1996, Tkatchenko at al.,1996b). Within a 2.0 x 1.5 km BIE test site (central coordinates: 11004'N; 119 0 39'W), seasonal surveys of the water column characteristics were made and the near-bottom current regime was studied during cruises of RV Yuzhmorgeologiya (October 1994, March and July 1995) and RV Professor Logachev (April 1997). In July 1995, CTD casts were made to follow variations in water column physical and chemical characteristics before and after Hurricane Barbara (wind velocity in excess of 100 knots). This allowed us to compare the data obtained with the nature and scale of seasonal variability in major water column characteristics (temperature, salinity, dissolved oxygen content, and transparency). A "Neil Brown" and "Istok" CTDs were used in 1994 - 1995 and 1997, respectively; the latter lacked both an oxymeter and transmissometer. The data obtained should be considered within the site coordinates indicated above.

Most important for putting together a geotechnical characteristics of the area proposed for polymetallic nodule mining and for developing mining technologies producing minimal environmental damage, were the data on near-bottom current dynamics, supplied by Potok-2M current meters mounted on moorings kept on the bottom from 17 October 1994 until 24 July 1995 . A total of 7 moorings was deployed. Out of the four moorings kept 4 m above the bottom from 17 October 1994 until 4 July 1995, three were located at the center and on peripheries of the IOM BIE test site at 4400 and 4410 m, aligned 1 km apart in an array approximating the general orientation of the site (30o azimuth), in the axial part of the submeridional abyssal valley and close to its slopes. The fourth mooring was located 3 km north from the test site center in a small isometric basin, at the depth of 4440 m. The measurements were taken at 120 min intervals. Three more moorings with current meters recording at 15 min intervals were deployed on 6 July 1995 along the resedimentation zone of the experiment; those were retrieved on 24 July after termination of the experiment. RCM-8 current meters and transmissometers were mounted on two of those moorings.

As previously described, the oceanographic conditions of the IOM pioneer area are affected by interaction of a westward-flowing Northern Equatorial Current (NEC) and the North Equatorial Countercurrent (NECC) flowing to the east. The interactions between NEC and NECC are governed by the divergence zone which are particularly complex due to seasonal variations, anomalies and eddies occurring at local and regional scales (Kotlinski at al., 1996). Usually during spring and summer, the NECC may spread to 12 - 13^0 N, while its northern boundary in autumn and winter lies south of 10^0 N.

The water column structure and vertical distribution of its physical and chemical characteristics of the IOM pioneer area water masses have been presented earlier (Kotlinski at al., 1996, Tkatchenko at al.,1996a, Tkatchenko at al.,1997). In this paper we discuss the scale of seasonal variability both in the oceanographic characteristics of the upper water column and in the structure of the near-bottom current regime with respect to influences of complex by typhoons, hurricanes, local eddies and seismicity activation.

RESULTS AND DISCUSSIONS

Upper water column characteristic

Fig. 1 illustrates seasonal variability of the water column physical and chemical characteristics down to 200 m depth, i.e., within the surface water layer and the upper part of the intermediate layer within the major thermocline.

In autumn (October 1994), the surface layer thickness, quasi-homogenous thermally, was much lower than in spring and summer 1995 and showed the lowest salinity. The thermocline (Fig.1a) consisted of two