XX. NODULE GROWTH RATES IN THE GH79-1 AREA

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Introduction

Manganese nodules, collected on Cruise GH79-1 from 10 stations in the Central Pacific Basin by the R/V Hakurei-Maru, were analyzed for total alpha activity. All sampling stations are located in an area centered at approximately 167°40'W, 10°N (Fig. XX-1).

The aims of these analyses are (1) to ascertain nodule growth rates and (2) the relation of growth rate to nodule composition and sediment lithology, and (3) to determine metal accumulation rates within pelagic sediments, i.e. the oceanic budget of metals in the sediment of the Central Pacific Basin. These last calculations require additional data (nodule composition and nodule abundance at the sediment surface), which are presented in other chapters of this report.

Technique

The total alpha activity of nodules was measured by the method described by ANDERSON (1978). Nodules were halved and the flat surface was polished and placed on a sheet of cellulose nitrate (KODAK CA180-15). The film was exposed to the nodule for 60 days, then etched with 10% NaOH for 14 hours at a temperature of 18°C. Alpha tracks were then counted using an optical microscope, at 500X magnification, at each 0.1 mm interval from the nodule surface to a depth of approximately 3 mm.

The profiles of alpha activity (Fig. XX-2) recorded by the cellulose nitrate can be used to calculate nodule growth rates after making several assumptions. Within the outer few tenths of a millimeter most of the activity comes from the decay of ^{230}Th and its daughter products. Contributions from other radionuclides, which have a relatively long half-life, can be subtracted out by measuring the activity at a depth within the nodule where the ^{230}Th activity is negligible, at a depth of a few millimeters into the nodule where the profiles are flat. This background level was reached at 0.8 to 2.0 mm into the nodules. The necessary correction was usually less than 10% of the total activity for the outer fraction of a millimeter. This correction can be reduced by a factor of 2 by merely counting the nodules for 8 months rather than 2 months. Correction for alpha activity of ^{231}Pa is made by an iterative calculation (ANDERSON, 1978) assuming an initial ^{230}Th/^{231}Pa ratio of 5. Nodules are assumed to be a closed system for ^{230}Th and its daughters. Agreement of growth rates measured by this technique (McDOUGALL, 1979) with several other different radiometric techniques (KU, 1977) supports these assumptions.

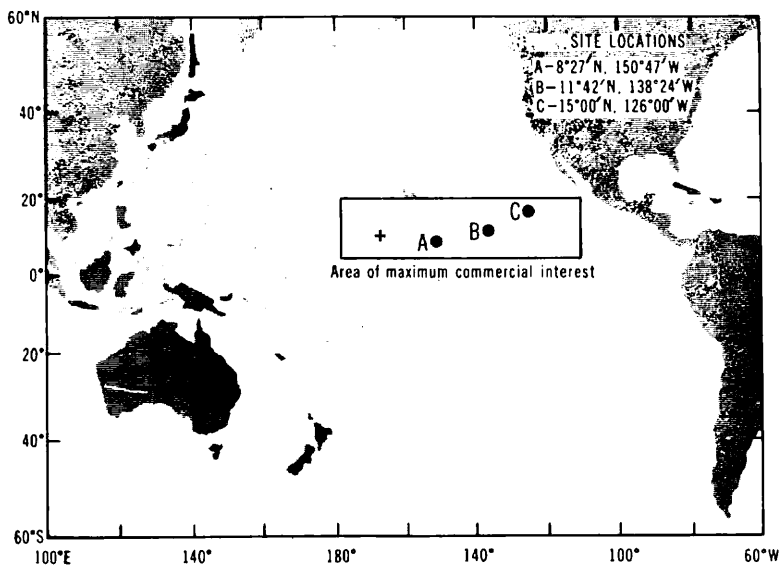*U.S. Geological Survey, Menlo Park, U.S.A.

Fig. XX-1 Location of the area surveyed in this study (+) and of the three DOMES sites. Location of the DOMES sites are given in the upper right corner. The area examined in this study is located at approximately 10°N, 167°40'W.
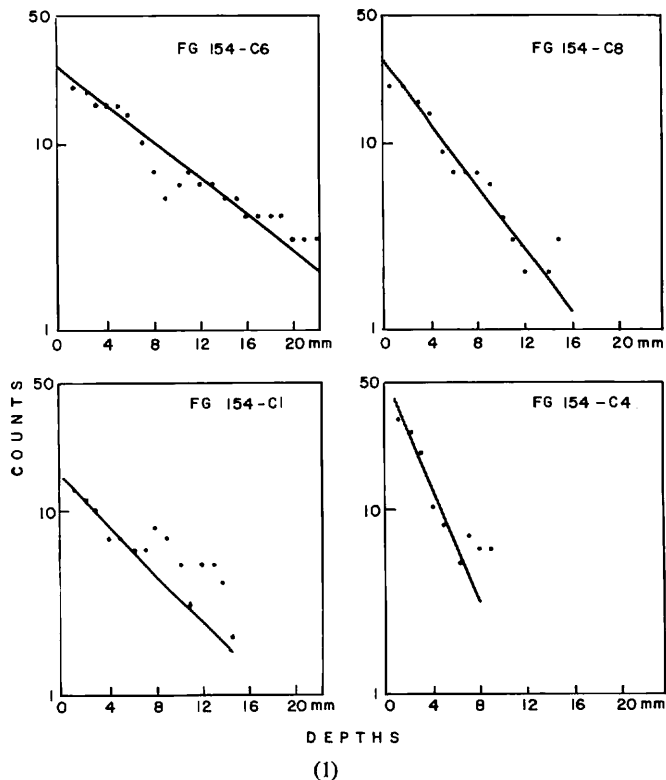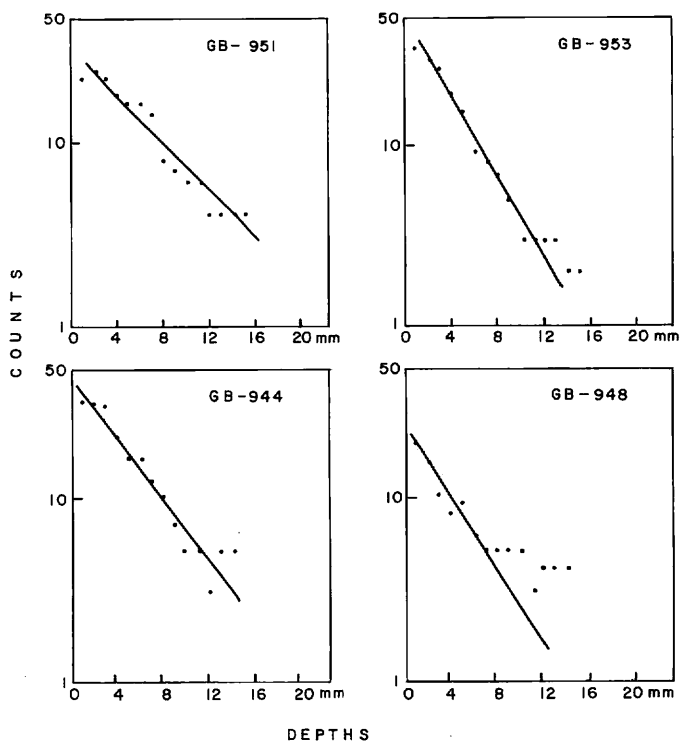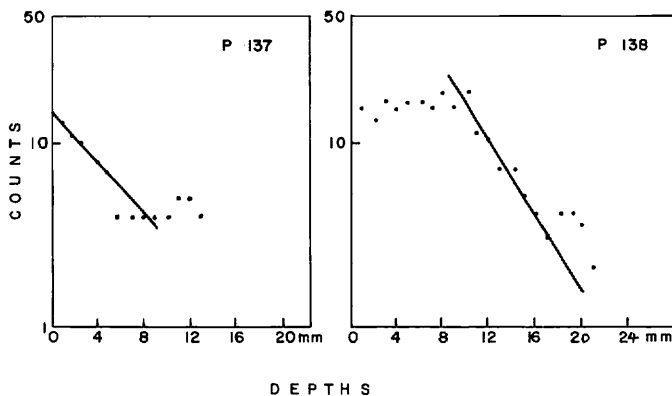

(1)

Fig. XX-2 Total alpha activity of nodules examined in this study. The curves represent the lines of best fit used to determine nodule growth rates. The data points were corrected for background and ^{231}Pa activity.

(2)

(3)

The ^{230}Th profiles for several nodules, however, suggest that the corrected activity curves (Fig. XX-2) cannot be interpreted solely as a decay of ^{230}Th. They may reflect migration of ^{230}Th and its daughters (McDOUGALL, 1979). In nodule P138 the activity increases from the surface to a depth of 0.8 mm.

Table XX-1 Nodule locations and depths; nodule types, coverage, and growth rates.

Site No.	Nodule No.	Latitude N	Longitude W	Depth (m)	Nodule Type[1]	Abundance[2] (kg/m²)	Growth Rate (mm/m.y.)
1481A	P137	10°00.72′	167°49.70′	5291	SPs		3.72
1481A2	P138	09°59.21′	167°47.38′	5270	SPs		3.19
1481A1	FG154C1	09°59.88′	167°49.73′	5300	SPs	17.6	2.87
1481A1	FG154C4	09°59.78′	167°46.80′	5284	SPs	1.1	2.23
1481A1	FG154C6	09°59.73′	167°44.82′	5253	SPs	7.3	5.00
1481A1	FG154C8	09°59.68′	167°42.86′	5249	SPr	3.2	4.26
1477	G(B)944	09°51.02′	167°53.51′	5197	SPr	0.5	4.47
1481	G(B′)948	10°01.36′	167°48.83′	5287	DPS(r)	12.2	3.19
1484	G(B′)951	09°59.48′	167°39.60′	5244	SPr	1.8	4.68
1489	G(B)953	11°59.78′	174°59.37′	5370	Ss	43.8	3.25
						Av.	3.68

1. Nodule type is discussed elsewhere in this cruise report.
2. Nodule abundance was determined by weighing wet nodules onboard ship.

Results

The growth rates of nodules from the Central Pacific Basin are within the rather narrow range of 2.23 to 5.0 mm/m.y., within the range of values reported by McDougall (1979) and Ku (1977). These rates, however, tend to fall below the mean of 6.8 mm/m.y. for Pacific Ocean nodules. As these nodules all come from a relatively small area, the narrow range of values is not unexpected, but the reason for the relatively slow growth is not known.

The growth rates of nodules from the Central Pacific Basin exhibit a weak relation with nodule type (Table XX-1). Nodules with a granular surface texture (SPr) are growing at a slightly faster rate than nodules with a smooth surface texture (SPs). Their mean growth rates are 4.47 mm/m.y. and 3.35 mm/m.y., respectively.

Heye and Marchig (1977) and Piper and Williamson (1977) reported a positive correlation between the Mn/Fe ratio of nodules and their growth rate. This observation agrees with the relation between nodule type and growth rate; within the Central Pacific Basin the SPr nodules tend to have higher Mn/Fe ratios than the SPs nodules (Moritani et al., 1979).

We are presently analyzing additional nodules from this area to permit calculation of total metal accumulation rates at the seafloor. Counting times will be increased to 8 months to reduce counting errors.

References

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