

CHAPTER 3

RESULTS

3.1 Data of quality control

Analytical performance based on standard reference materials, CASS-2 of the Institute for Environmental Chemistry, Canada, MAG-1 of the Geological Division Reference Materials US Geological Survey USA and BCSS-1 of the National Research Council Canada were similarly prepared and analyzed for recovering.

The recovery percent of standard reference material (CASS-2) for dissolved cadmium, copper, iron, nickel and lead were 115.79, 94.52, 105.00, 94.97 and 110.53% respectively (Table 3-1).

Table 3-1 Analysis of certified reference sea water (CASS-2) for dissolved trace metals.

Element	Cd	Cu	Fe	Ni	Pb
Certified value ($\mu\text{g/l}$)	0.019 \pm 0.004	0.675 \pm 0.039	1.20 \pm 0.12	0.298 \pm 0.036	0.019 \pm 0.006
Measured value ($\mu\text{g/l}$)	0.022 \pm 0.001	0.638 \pm 0.036	1.26 \pm 0.13	0.283 \pm 0.039	0.021 \pm 0.002
Recovery (%)	115.79	94.52	105.00	94.97	110.53

The percent recovery of standard reference material (MAG-1) for suspended particulate cadmium, copper, iron, nickel, lead and aluminium were 93.17, 101.00, 109.88, 85.19, 112.35 and 93.87% respectively (Table 3-2).

Table 3-2 Analysis of certified reference marine mud (MAG-1) for suspended particulate trace metals.

Element	Cd(ng/g)	Cu($\mu\text{g/g}$)	Fe(%)	Ni($\mu\text{g/g}$)	Pb($\mu\text{g/g}$)	Al(%)
Certified value	454.00	30.00 \pm 3.00	4.86 \pm 0.26	54.00 \pm 8.00	25.00 \pm 4.00	8.65 \pm 0.15
Measured value	423.00 \pm 2.00	30.30 \pm 0.94	5.34 \pm 0.32	46.00 \pm 8.50	28.09 \pm 3.22	8.12 \pm 1.22
Recovery (%)	93.17	101.00	109.88	85.19	112.35	93.87

The percent recovery of standard reference material (BCSS-1) for nickel in sediment was 89.60% respectively (Table 3-3).

Table 3-3 Analysis of certified reference marine sediment (BCSS-1) for trace metals in sediment.

Element	Ni(mg/kg)
Certified value	55.30 \pm 3.60
Measured value	49.55 \pm 4.04
Recovery (%)	89.60

3.2 Horizontal distribution of dissolved and suspended trace metals

Water and particulate samples from 81 stations were collected during dry season, April-May 1996, and analyzed for dissolved and suspended cadmium, copper, iron, nickel and lead and their distributions were studied. Concentration of Cd, Cu, Fe, Ni and Pb are shown in Appendix C.

3.2.1 Cadmium

Cadmium concentration was very low both in dissolved and suspended particulate forms, compared with others elements. The concentration of dissolved cadmium was higher than the suspended particulate cadmium (Fig. 3-1). High concentrations of dissolved cadmium were found in the Gulf of Thailand than East Coast of Malay Peninsula, especially at bottom layer (Fig. 3-2 and Fig.3-3).

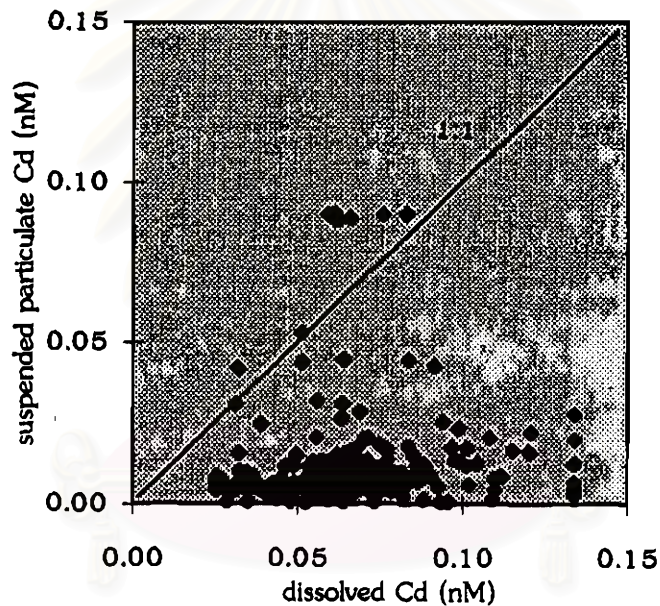


Fig.3-1 Relationship between dissolved and suspended particulate cadmium

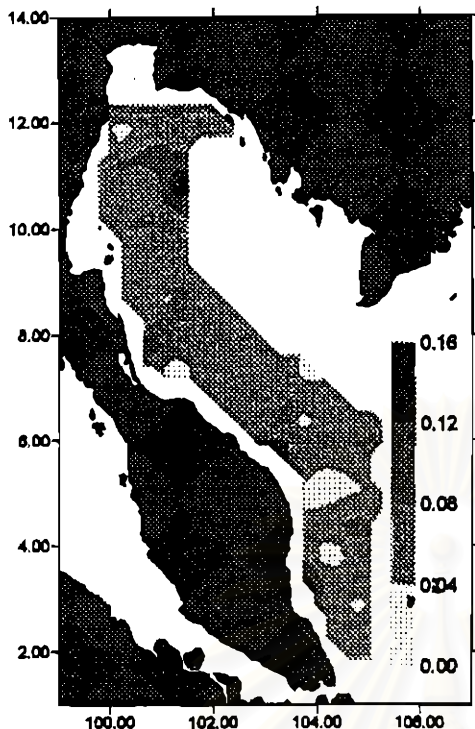


Fig.3-2 Distribution of dissolved Cd (nM) at surface layer

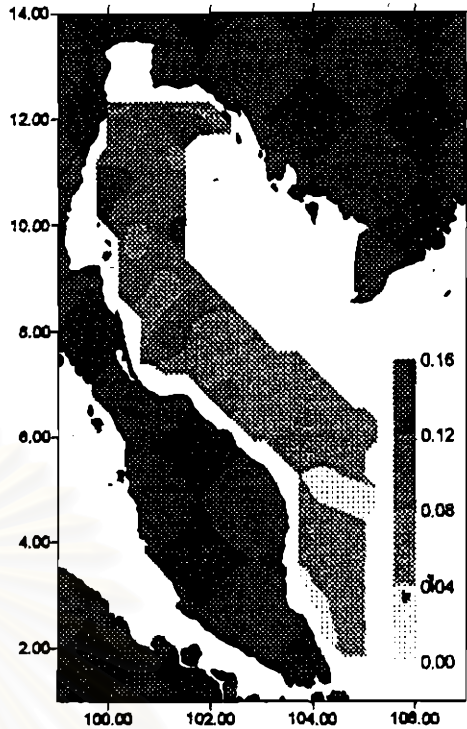


Fig.3-3 Distribution of dissolved Cd (nM) at bottom layer

Concentrations of suspended particulate cadmium were low, compared with dissolved cadmium. The suspended particulate cadmium at surface layer and bottom layer were found in high concentration at stations 4, 5 and Lower Gulf of Thailand (Fig.3-4 and Fig.3-5).

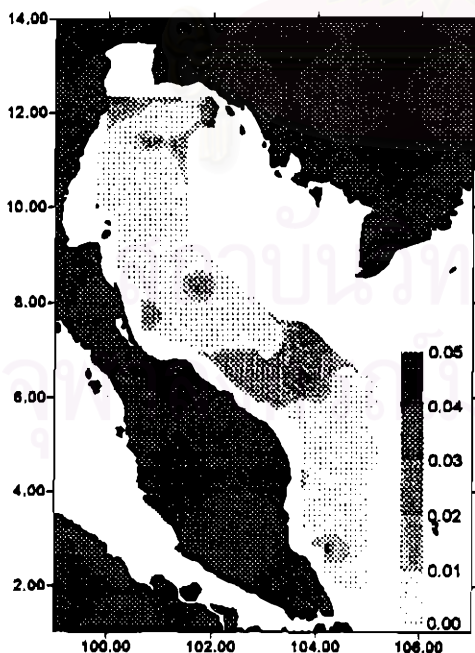


Fig.3-4 Distribution of suspended particulate Cd (nM) at surface layer

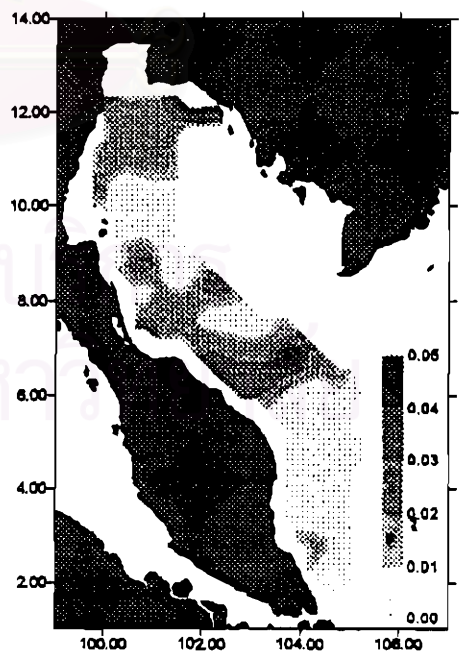


Fig.3-5 Distribution of suspended particulate Cd (nM) at bottom layer

3.2.2 Copper

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Distribution of copper in seawater showed that concentrations of dissolved form was higher than that of suspended particulate form (Fig. 3-6). Concentration of dissolved copper at surface layer was found to be high near the coast, especially near the Upper Gulf of Thailand and Songkhla coast (Fig.3-7). Dissolved copper at bottom layer was also found to be high near the Upper Gulf of Thailand and Nakhon Si Thammarat coast (Fig.3-8).

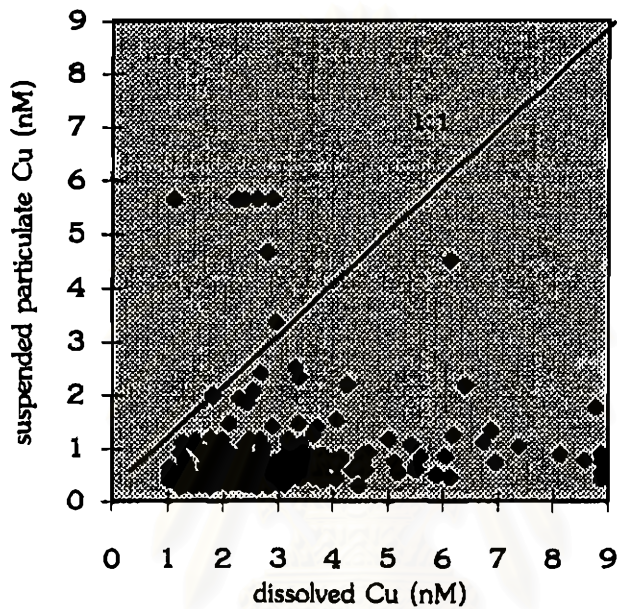


Fig.3-6 Relationship between dissolved and suspended particulate copper

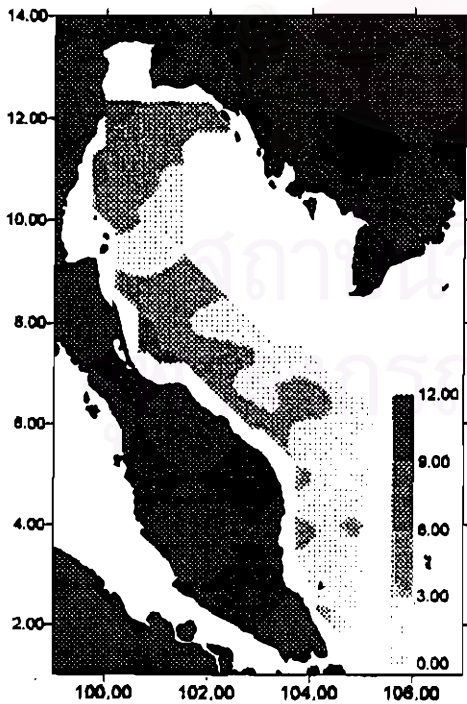


Fig.3-7 Distribution of dissolved Cu (nM) at surface layer

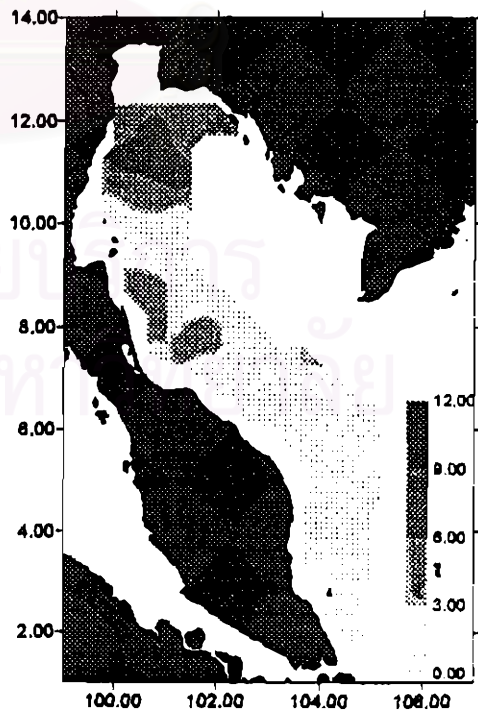


Fig.3-8 Distribution of dissolved Cu (nM) at bottom layer

Distributions of suspended particulate copper were show some high concentration at certain stations of surface layer and bottom layer in the off-shore area (Fig. 3-9 and Fig. 3-10). The average concentration of suspended particulate copper was 0.96 nM at the surface layer and 0.98 nM at the bottom layer.

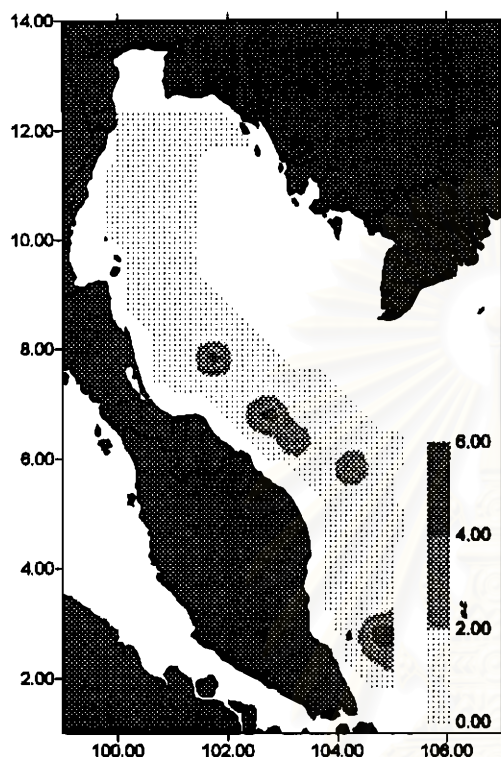


Fig.3-9 Distribution of suspended particulate Cu (nM) at surface layer

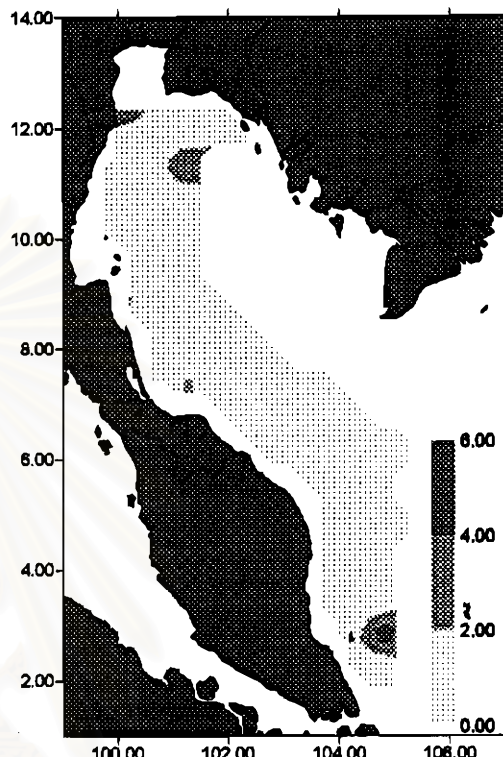


Fig.3-10 Distribution of suspended particulate Cu (nM) at bottom layer

3.2.3 Iron

Concentrations of dissolved iron were high compared with the others elements both in dissolved and suspended forms. Dissolved iron concentration varied from 1.96 nM in the southern part of the study area to 59.80 nM in the coastal area. Concentration of suspended particulate iron was higher than that of the dissolved iron (Fig. 3-11).

There were some high values of dissolved iron at surface layer near the Upper Gulf of Thailand, off Songkhla and off Kuala Trengganu (Fig.3-12). Dissolved iron at bottom layer has average value higher than the surface. The distribution pattern for the bottom layer was patchy and high concentration was found near Nakorn Si Thammarat coast (Fig.3-13).

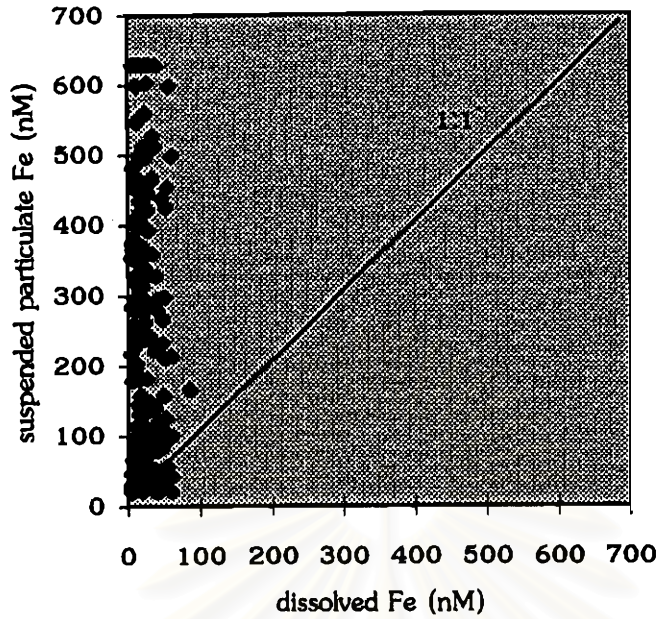


Fig.3-11 Relationship between dissolved and suspended particulate iron

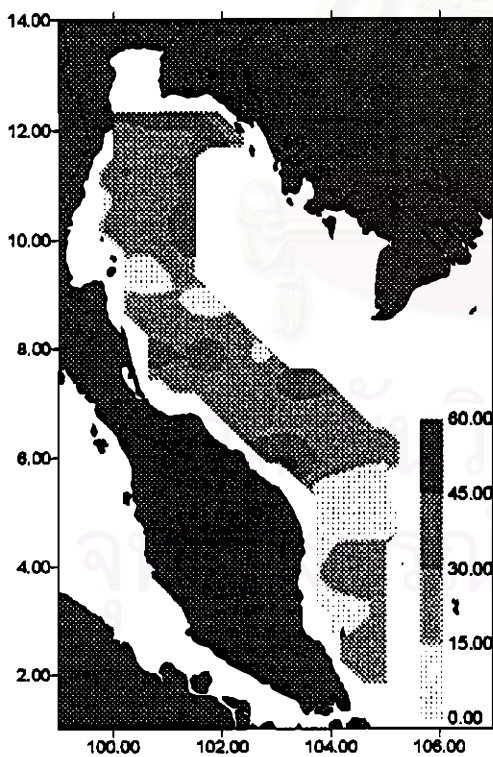


Fig.3-12 Distribution of dissolved Fe (nM) at surface layer

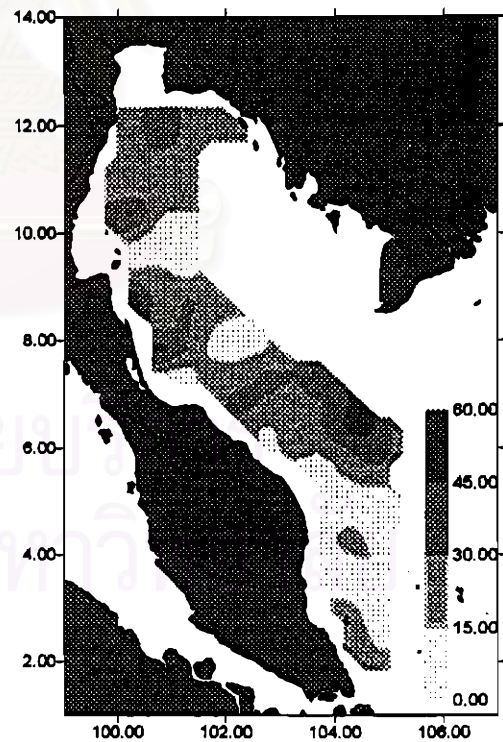


Fig.3-13 Distribution of dissolved Fe (nM) at bottom layer

Concentration of suspended particulate iron at bottom layer had higher concentration than surface layer. -There were some high concentration patches near Surat-Thani and Song-khla coast (Fig.3-14). Concentration of bottom suspended particulate iron was found high concentrations at Lower Gulf of Thailand, especially near coast (Fig.3-15)

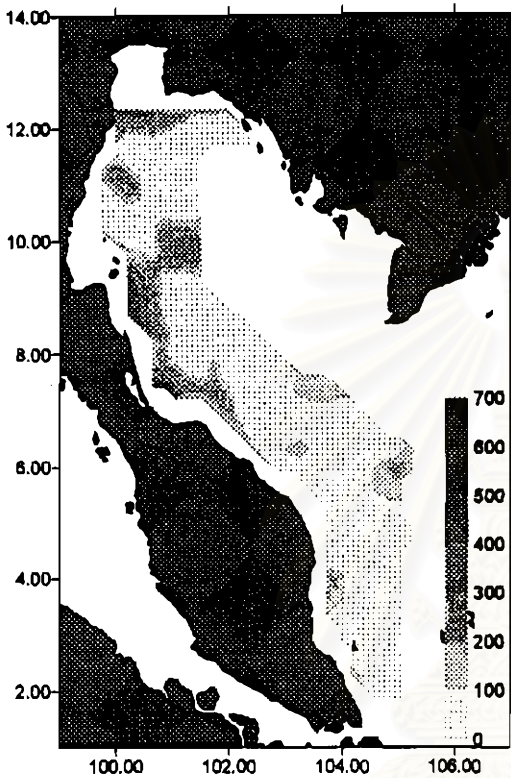


Fig.3-14 Distribution of suspended particulate Fe (nM) at surface layer

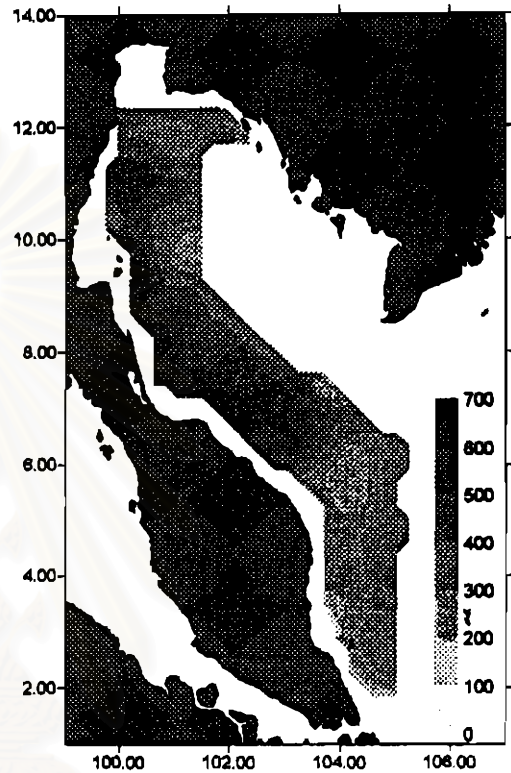


Fig.3-15 Distribution of suspended particulate Fe (nM) at bottom layer

3.2.4 Nickel

Concentration of nickel in dissolved form was higher than that in suspended form (Fig.3-16). Distribution of dissolved nickel, both of surface layer and bottom layer revealed that in the Gulf of Thailand the concentration was higher than that along the East Coast of Malay Peninsula (Fig.3-17 and Fig.3-18).

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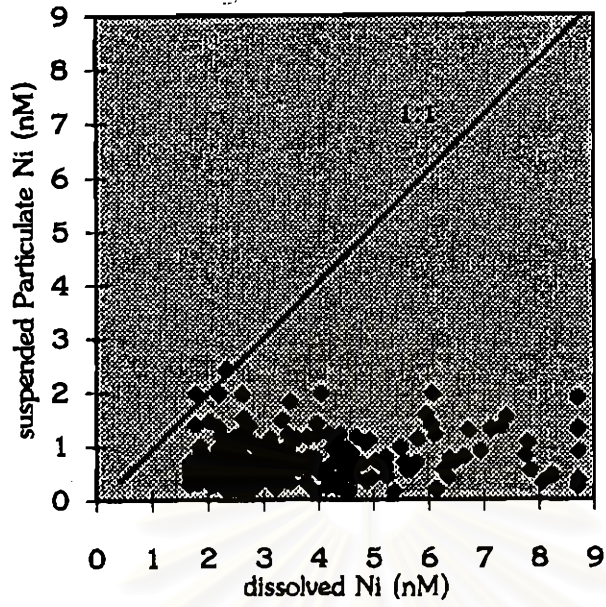


Fig.3-16 Relationship between dissolved and suspended particulate nickel

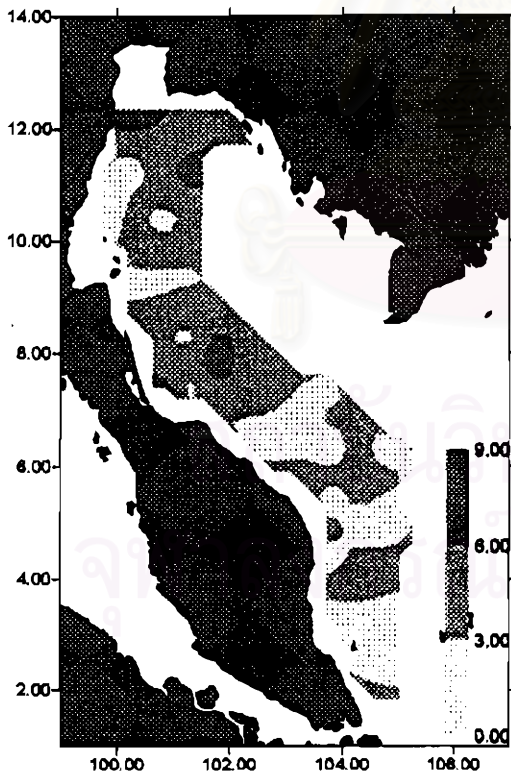


Fig.3-17 Distribution of dissolved Ni (nM) at surface layer

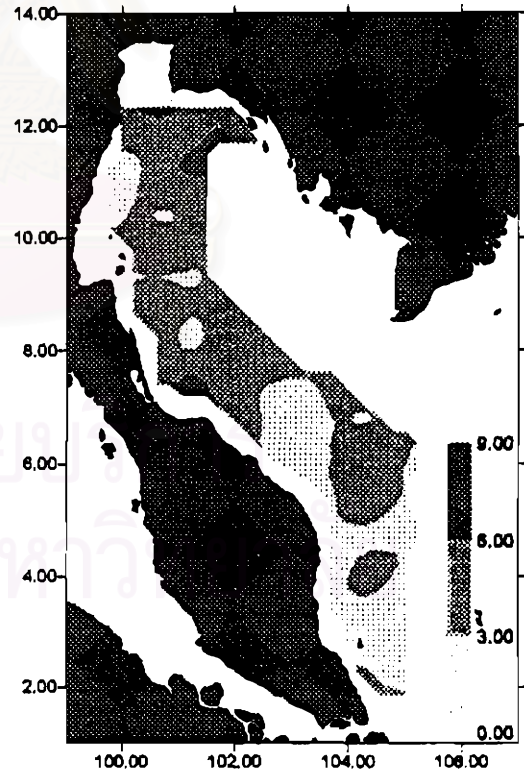


Fig.3-18 Distribution of dissolved Ni (nM) at bottom layer

Concentration of suspended particulate nickel at bottom layer was higher than that in the surface layer (Fig.3-19 and Fig.3-20). The suspended particulate nickel concentration at bottom layer was high near the coastal area, except in the Middle Gulf of Thailand.

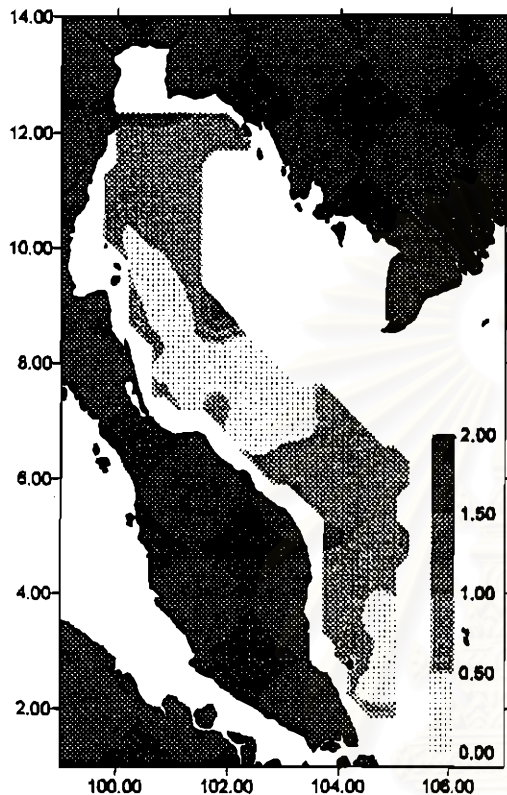


Fig.3-19 Distribution of suspended particulate Ni (nM) at surface layer

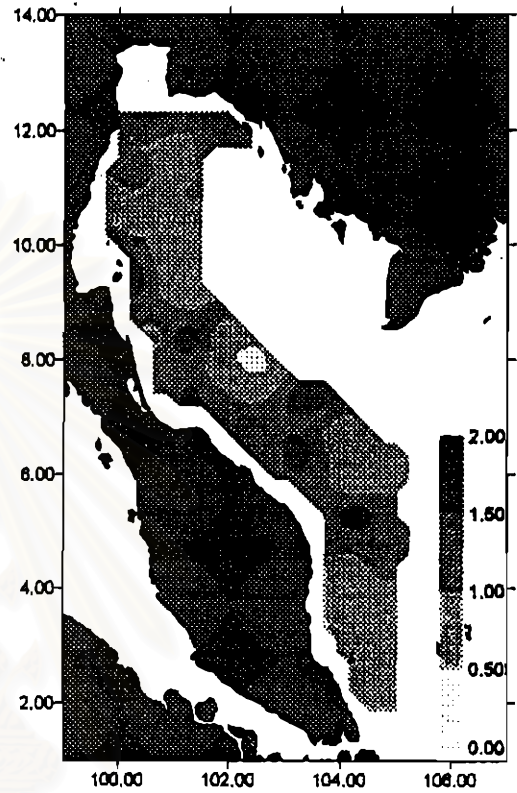


Fig.3-20 Distribution of suspended particulate Ni (nM) at bottom layer

3.2.5 Lead

Lead was found higher concentration in dissolved form than in suspended particulate form (Fig.3-21) but in middle Gulf of Thailand and off Malay Peninsula found higher concentration in suspended particulate form than dissolved form. The concentration of dissolved lead was high in some off shore areas. The distributions of dissolved lead at surface and bottom were similar as show in Figure 3-22 and Figure 3-23, high concentration was found near Prachaup Khiri Khan, Nakhon Si Thammarat, Narathiwat coast and southern part of Malay Peninsula.

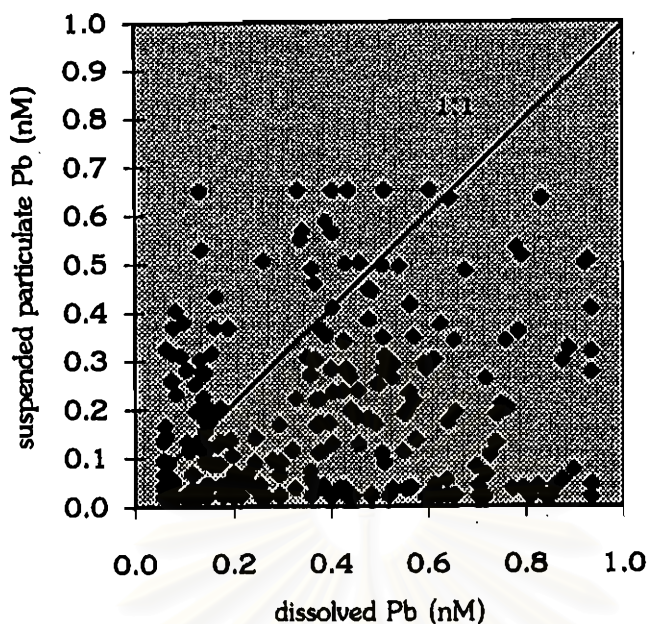


Fig.3-21 Relationship between dissolved and suspended particulate lead

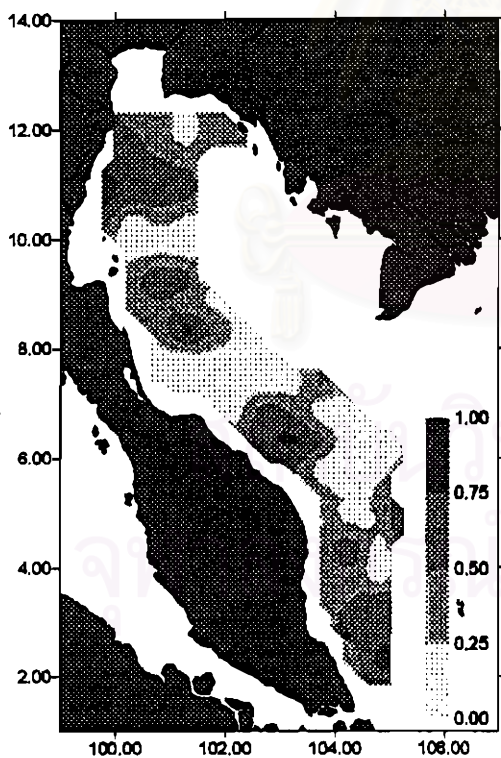


Fig.3-22 Distribution of dissolved Pb (nM) at surface layer

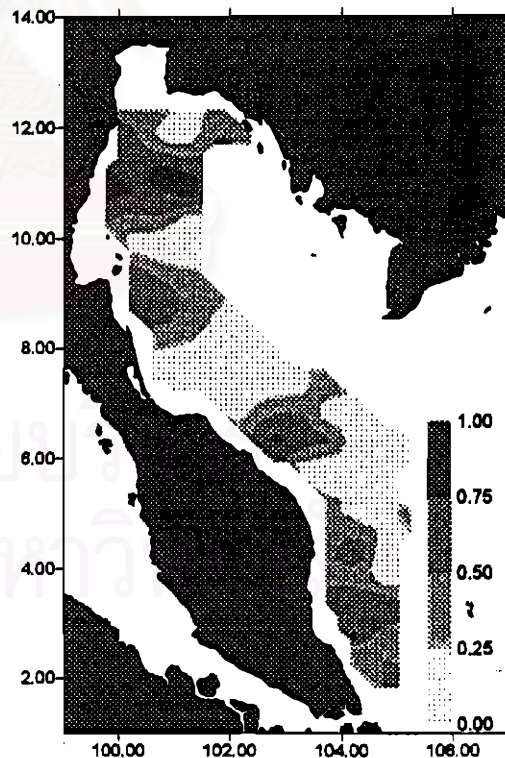


Fig.3-23 Distribution of dissolved Pb (nM) at bottom layer

Concentration of suspended particulate lead was high in the Northern Gulf of Thailand, especially in station 12 both at surface and bottom layer (Fig. 3-24 and Fig. 3-25).

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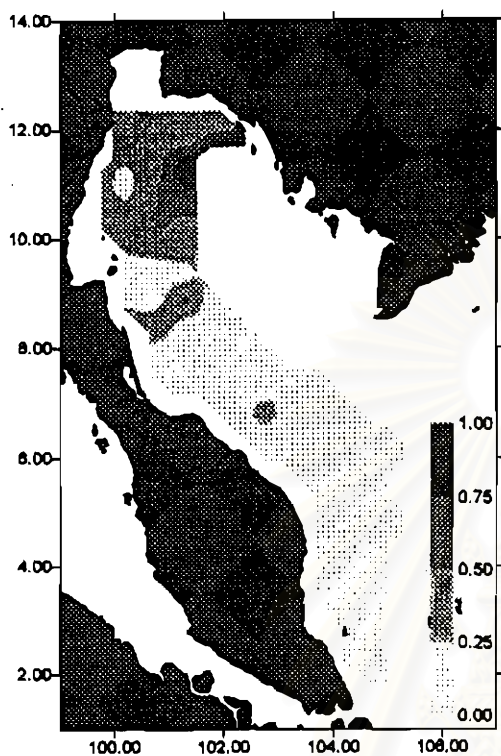


Fig.3-24 Distribution of suspended particulate Pb (nM) at surface layer

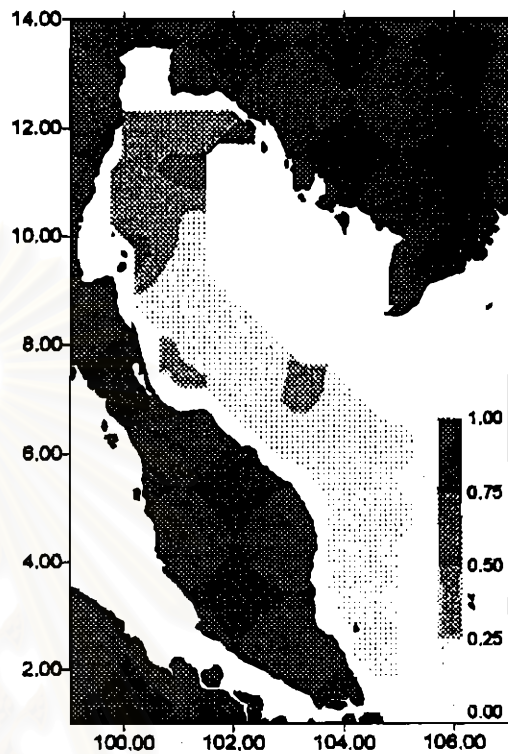


Fig.3-25 Distribution of suspended particulate Pb (nM) at bottom layer

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3.3 Trace metals in sediments

Surface sediment samples at 81 stations were collected and analyzed for nickel. The concentration of cadmium, copper, iron and lead data were taken from the study of Shazili *et al.*, 1997 in which analyze the same samples with this study (Appendix D).

Distribution of cadmium in sediment (Fig.3-26) shows high concentration near the Middle Gulf of Thailand and the East Coast of Malay Peninsula. Distribution of copper in sediment (Fig.3-27) shows high concentration near the Upper Gulf of Thailand. For the distribution of iron in sediment (Fig.3-28), a mean value of 12.85 (mg/g) was found. There were small variations between stations, and high concentration was found at station 35 and 67. In Figure 3-29, distribution of nickel in sediment is shown. There were some high concentration at off shore station. Distribution of lead in sediment (Fig.3-30) showed high concentration near the Upper and the Southern part of Gulf of Thailand at station 1, 5 and 45.

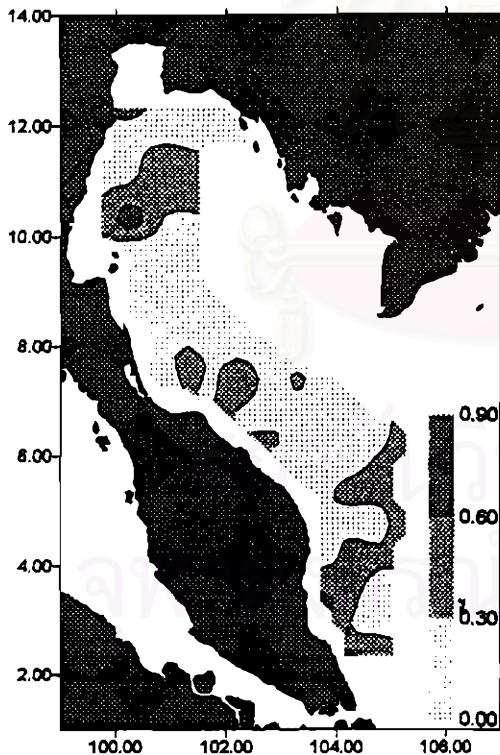


Fig.3-26 Distribution of Cd ($\mu\text{g/g}$) in sediment data from Shazili *et al.*, 1997

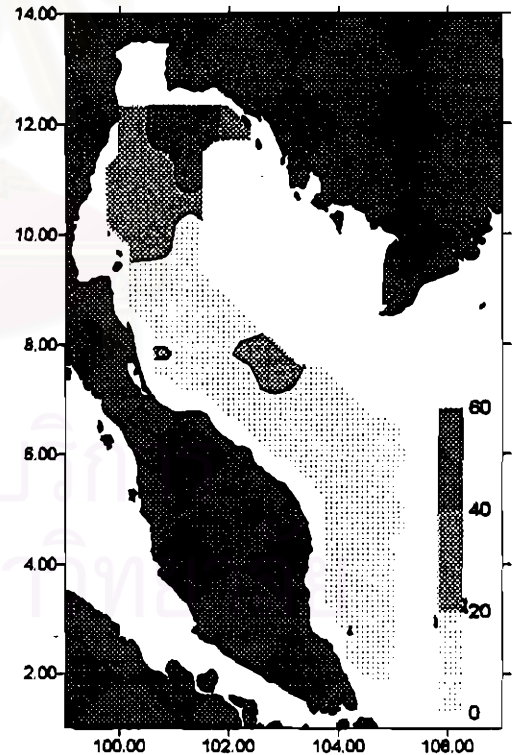


Fig.3-27 Distribution of Cu ($\mu\text{g/g}$) in sediment data from Shazili *et al.*, 1997

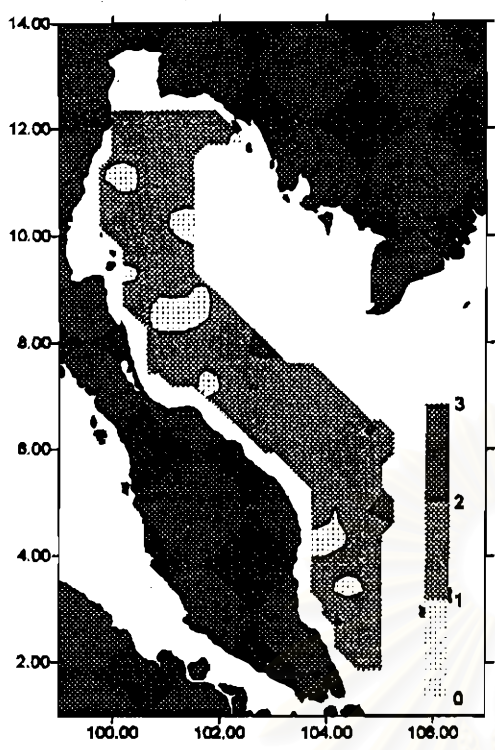


Fig.3-28 Distribution of Fe (mg/g) in sediment data from Shazili *et al.*, 1997

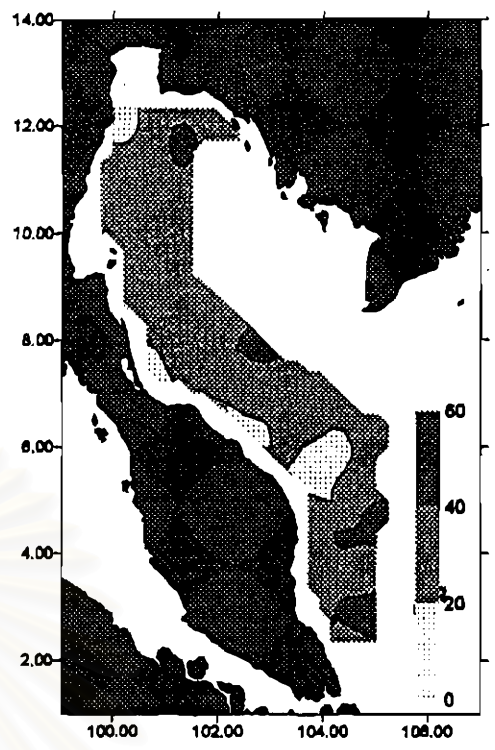


Fig.3-29 Distribution of Ni (µg/g) in sediment

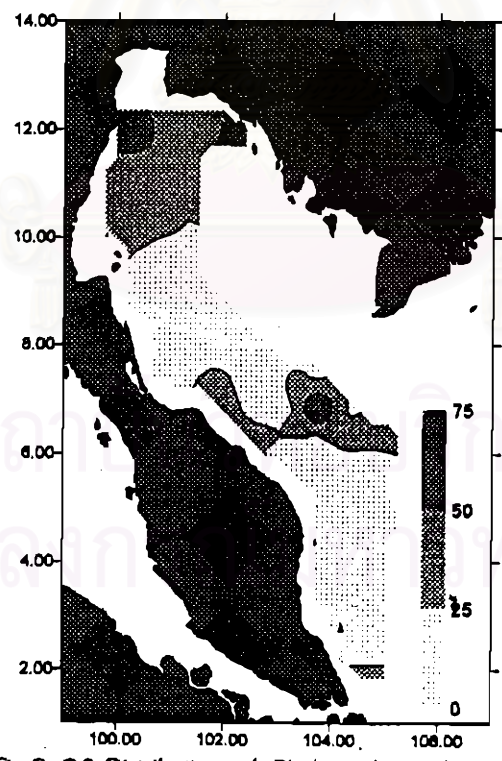


Fig.3-30 Distribution of Pb (µg/g) in sediment data from Shazili *et al.*, 1997

3.4 Vertical distribution

At stations 2, 3, 4, 5, 6, 17, 24, 26, 46, 51, 69 and 79 samples were collected for 5-7 depths to study the vertical distribution of trace metals. The distribution are shown in Figure 3-31-Figure 3-40.

Concentration of dissolved cadmium showed some increase of concentration at subsurface and bottom layer (Fig. 3-31). Lower concentration was observed at offshore stations (26, 46). Suspended particulate cadmium also showed some increasing at subsurface layer (Fig. 3-32). Very high values were observed at station 4 and station 5 which locate in the Eastern Sea Board. High concentration of dissolved copper were found at stations near the Upper Gulf of Thailand, station 2, 3, 4, 5 especially at subsurface layer (Fig. 3-33). Increase of concentration at mid depth was observed at some stations. Distributions of dissolved iron were in high concentration at the surface and bottom layer at station 46. Found high concentration at subsurface in stations 2 and 6 (Fig. 3-35). Suspended particulate iron showed high concentration at bottom layer. At station 24 high concentration of suspended particulate iron was found at surface layer indicating a source of iron input possible from weathering of high iron soil content in the Surat Thani area (Fig. 3-36). High concentration of dissolved nickel was found at station 1, 2, 6 and distribution of suspended particulate nickel showed high concentration at bottom layer, station 2, 3, 6, 24, 46 and 51 (Fig.3-37 and Fig.3-38). Dissolved lead was found in high concentration at off shore station while high concentration suspended particulate lead were found at station in the Gulf of Thailand (Fig.3-39 and Fig.3-40).

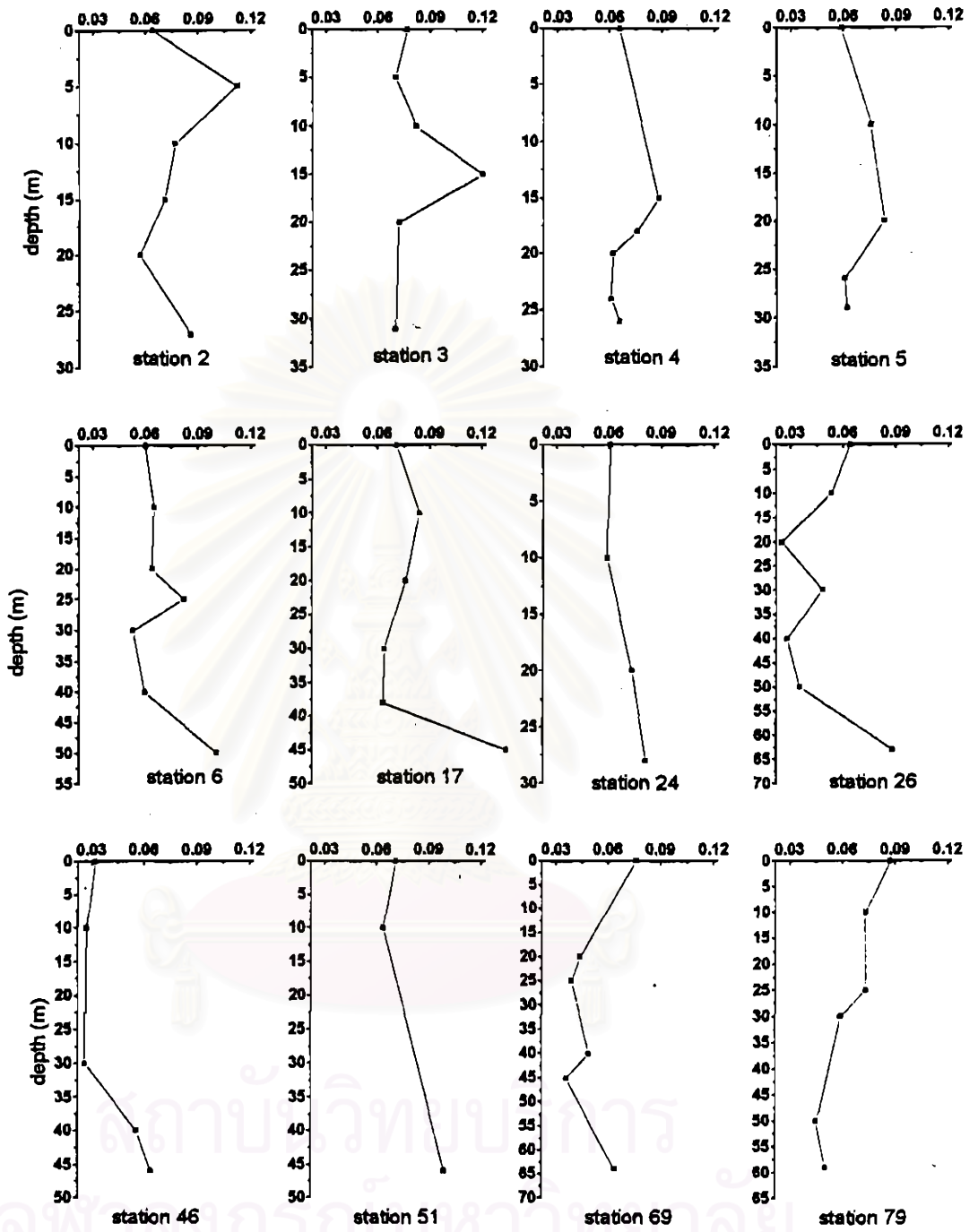


Fig. 3-31 Vertical profiles of dissolved Cd (nM) at station 2, 3, 4, 5, 6, 17, 24, 26, 46, 51, 69 and 79

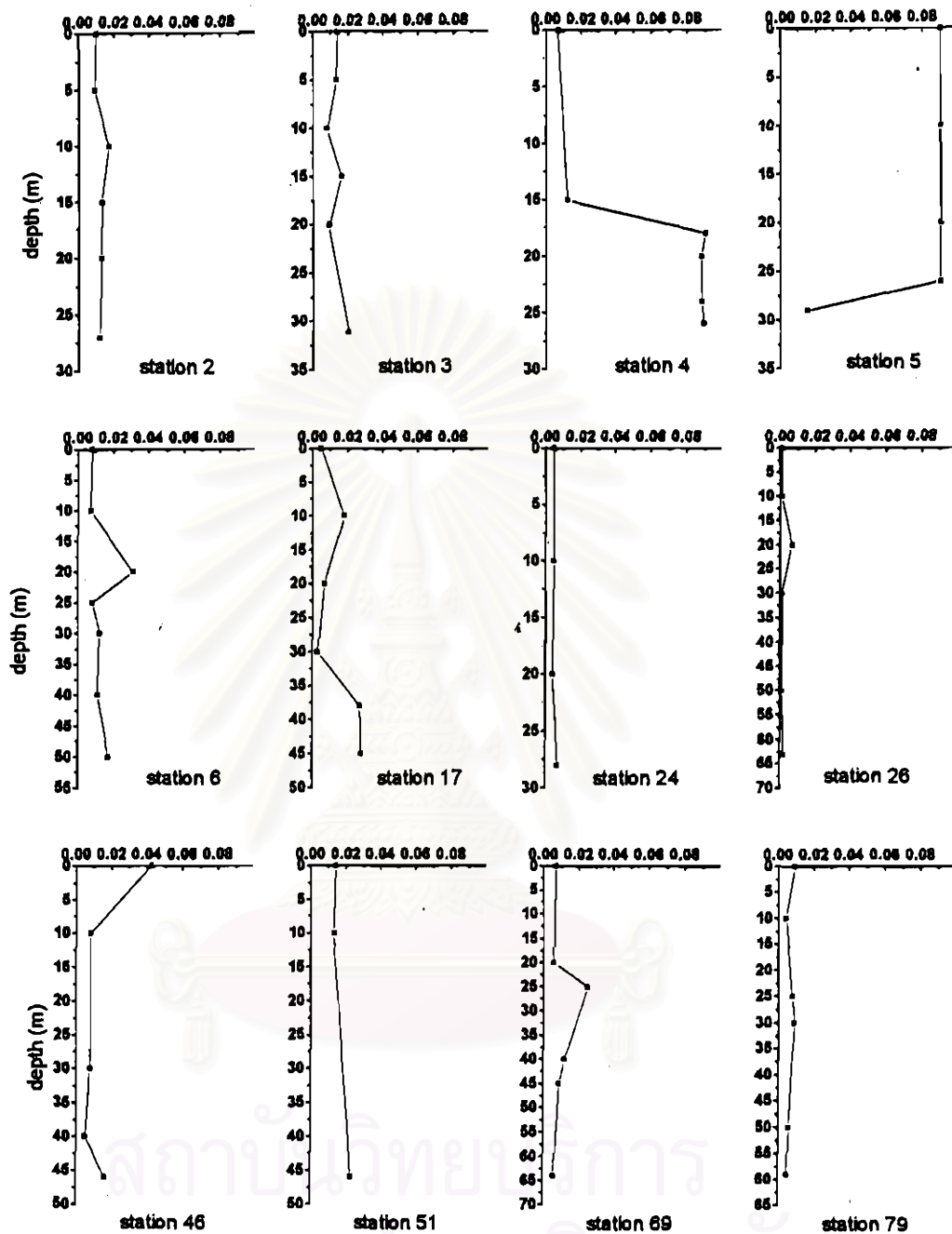


Fig. 3-32 Vertical profiles of suspended particulate Cd (nM) at stations 2, 3, 4, 5, 6, 17, 24, 26, 46, 51, 69 and 79

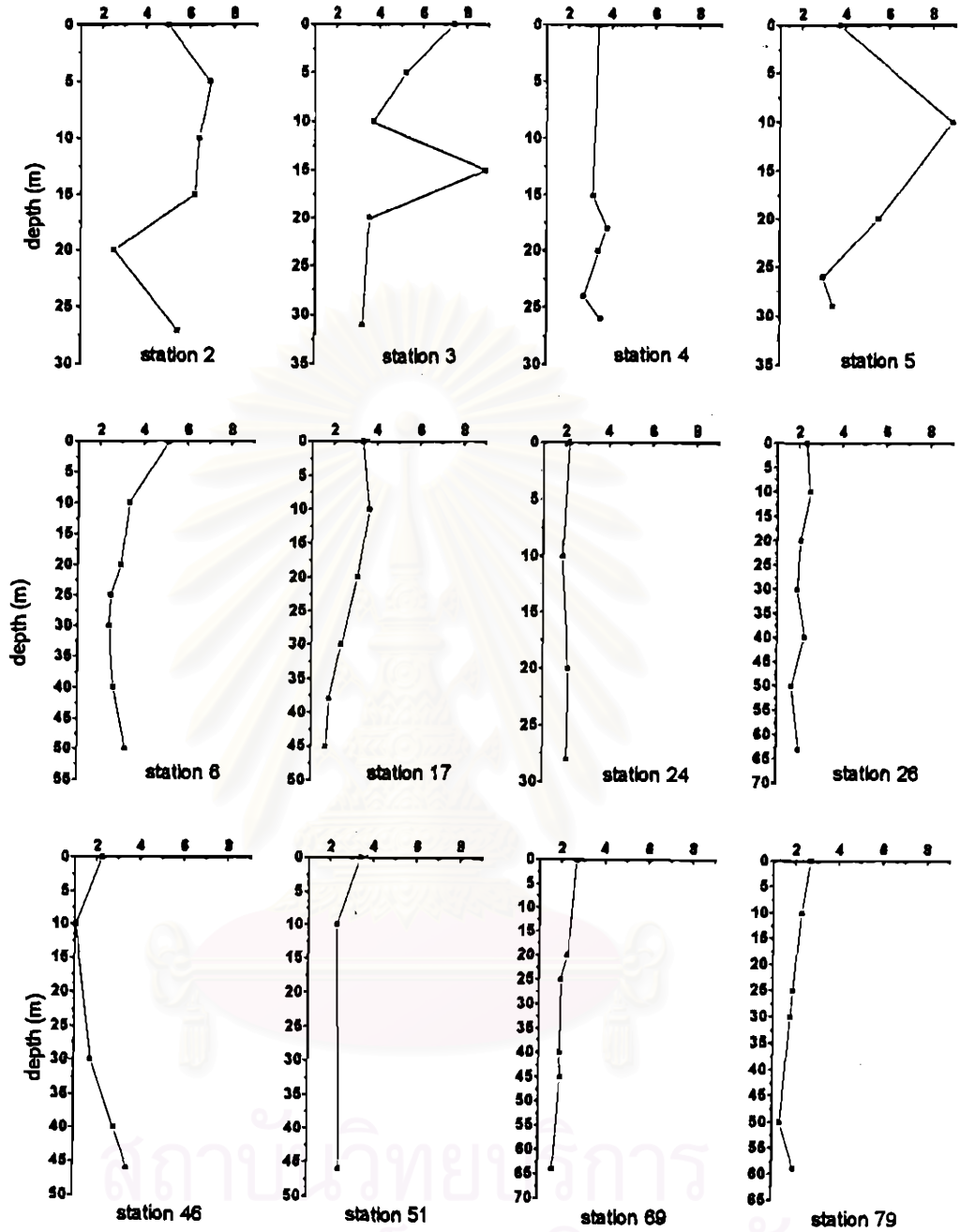


Fig. 3-33 Vertical profiles of dissolved Cu (nM) at stations 2, 3, 4, 5, 6, 17, 24, 26, 46, 51, 69 and 79

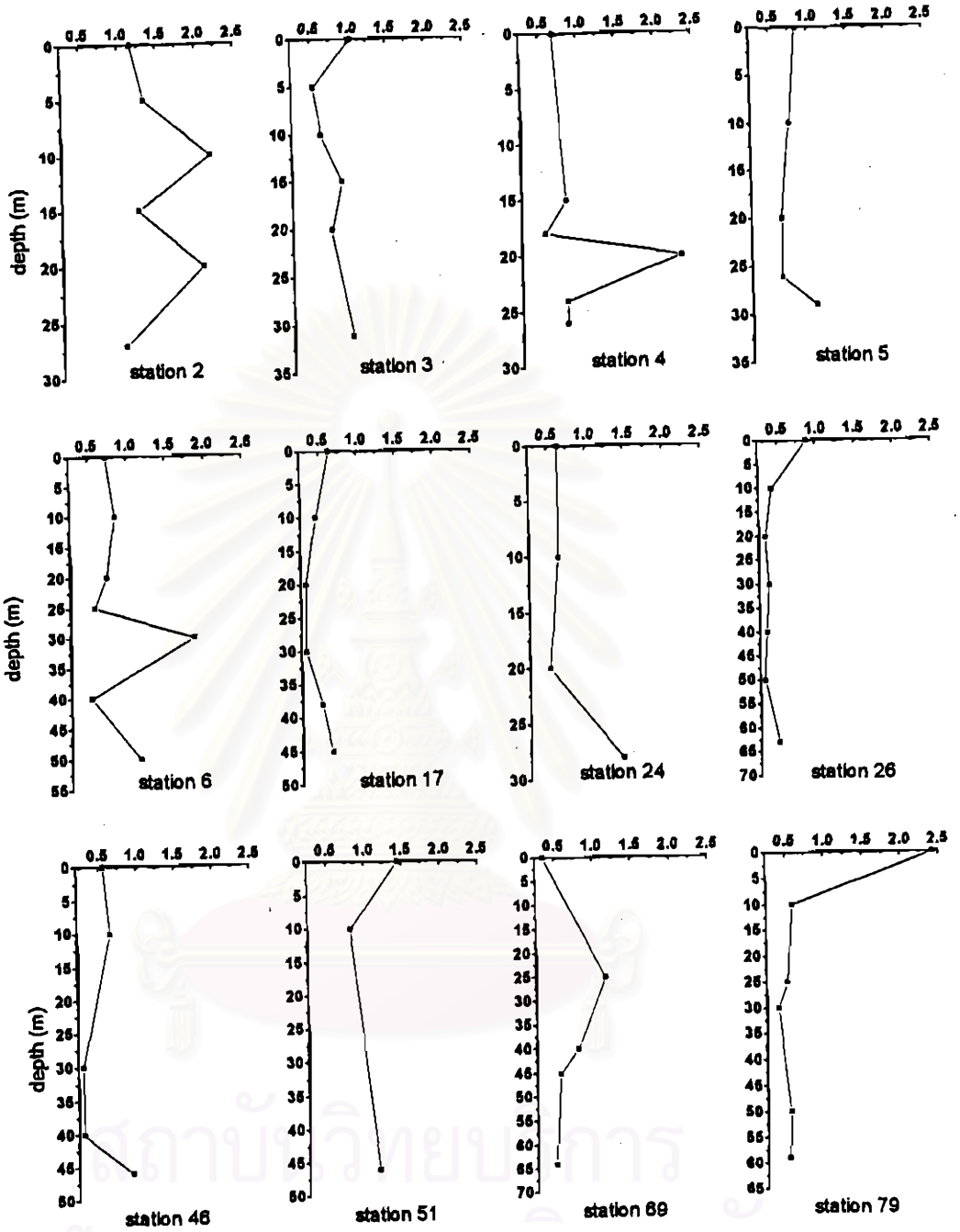


Fig. 3-34 Vertical profiles of suspended particulate Cu (nM) at station 2, 3, 4, 5, 6, 17, 24, 26, 46, 51, 69 and 79

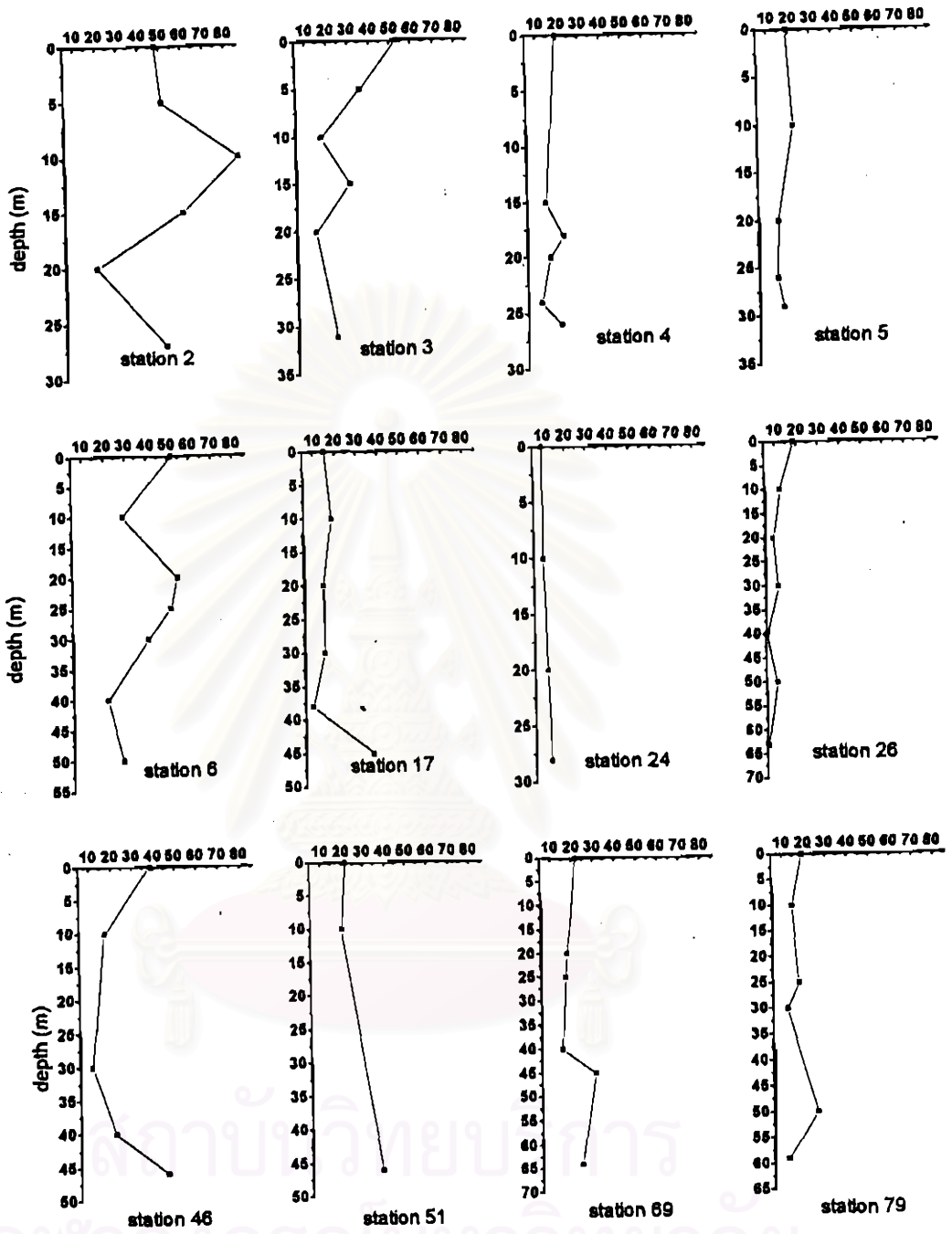


Fig. 3-35 Vertical profiles of dissolved Fe (nM) at stations 2, 3, 4, 5, 6, 17, 24, 26, 46, 51, 69 and 79

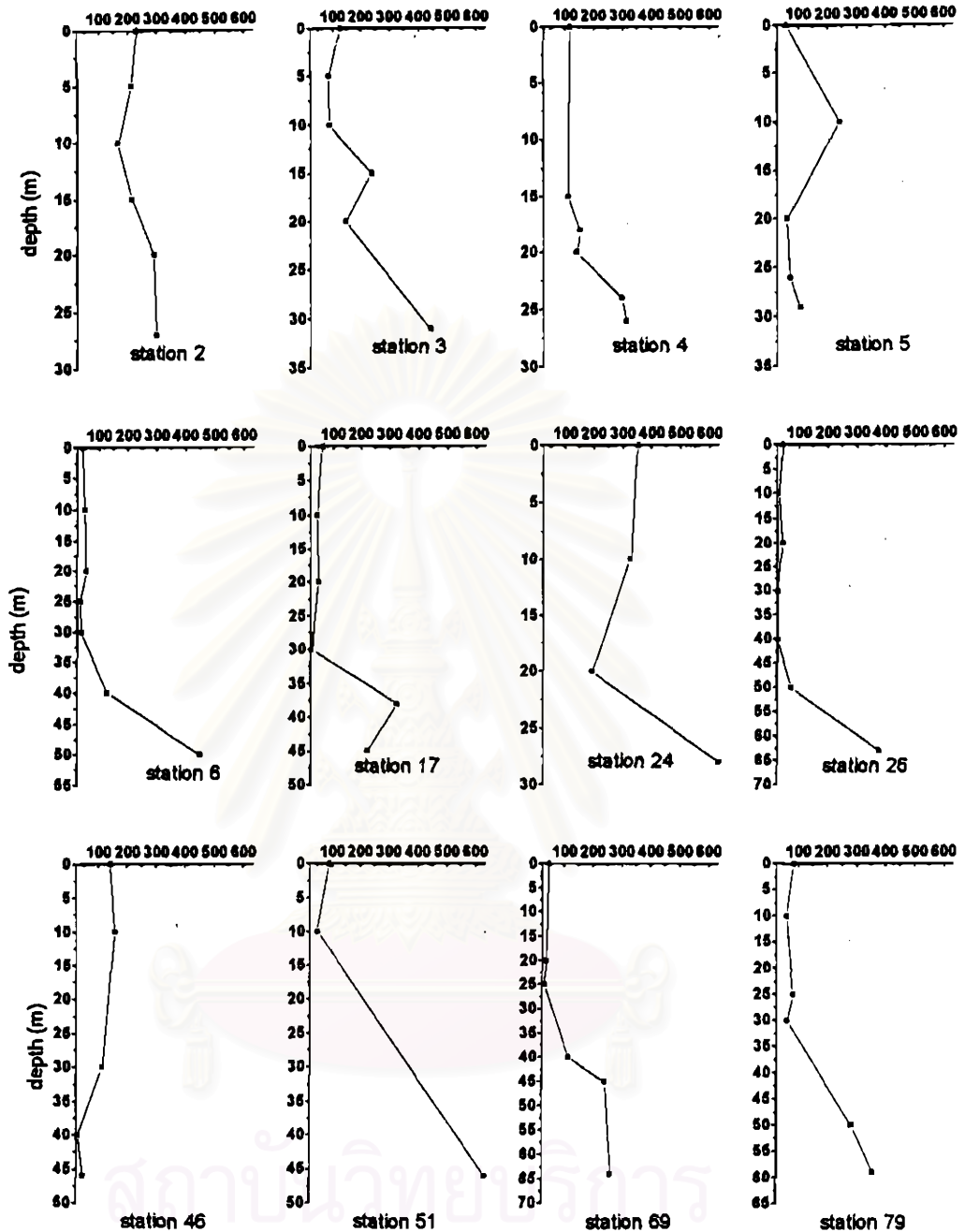


Fig. 3-36 Vertical profiles of suspended particulate Fe (nM) at stations 2, 3, 4, 5, 6, 17, 24, 26, 46, 51, 69 and 79

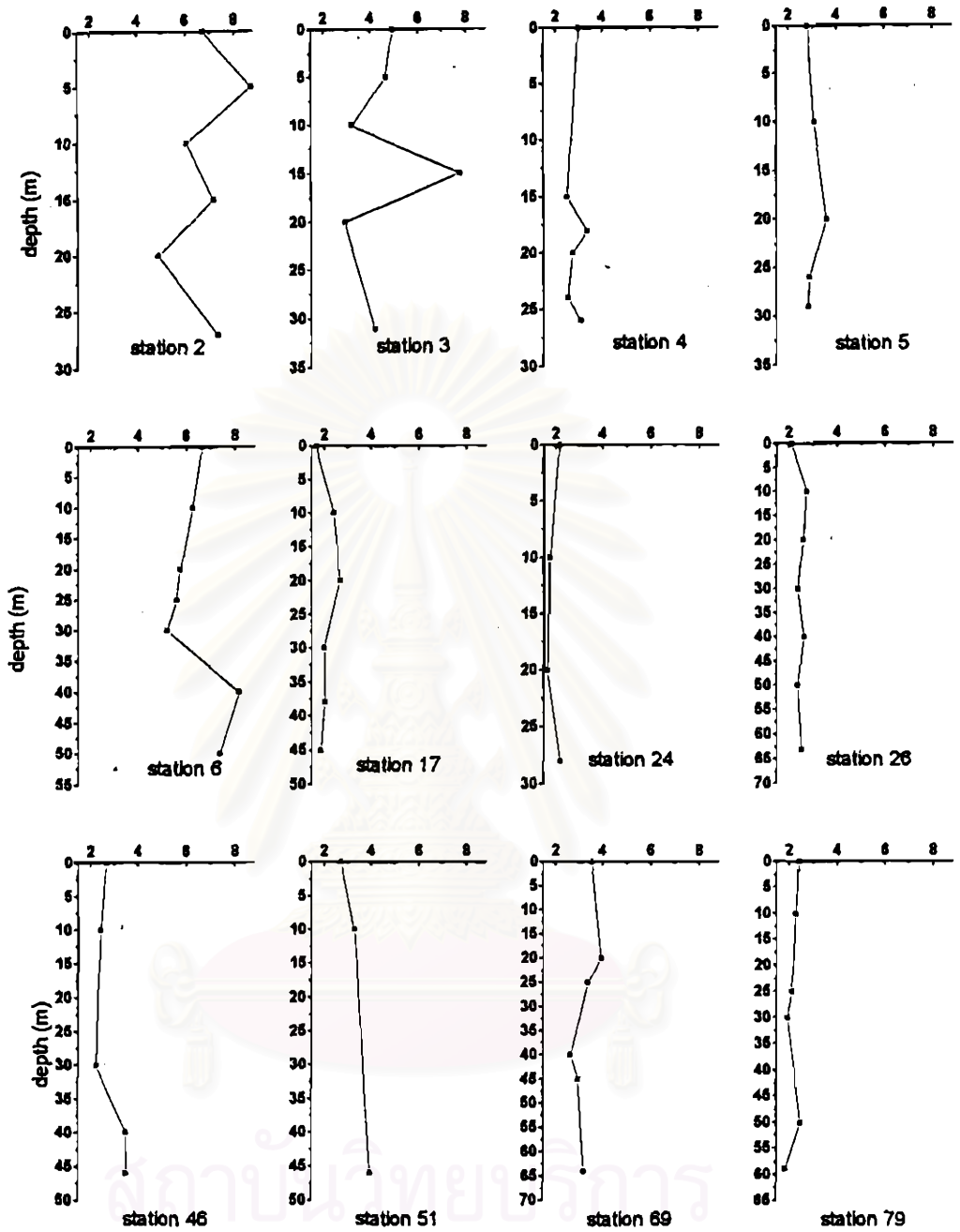


Fig. 3-37 Vertical profiles of dissolved Ni (nM) at stations 2, 3, 4, 5, 6, 17, 24, 26, 46, 51, 69 and 79

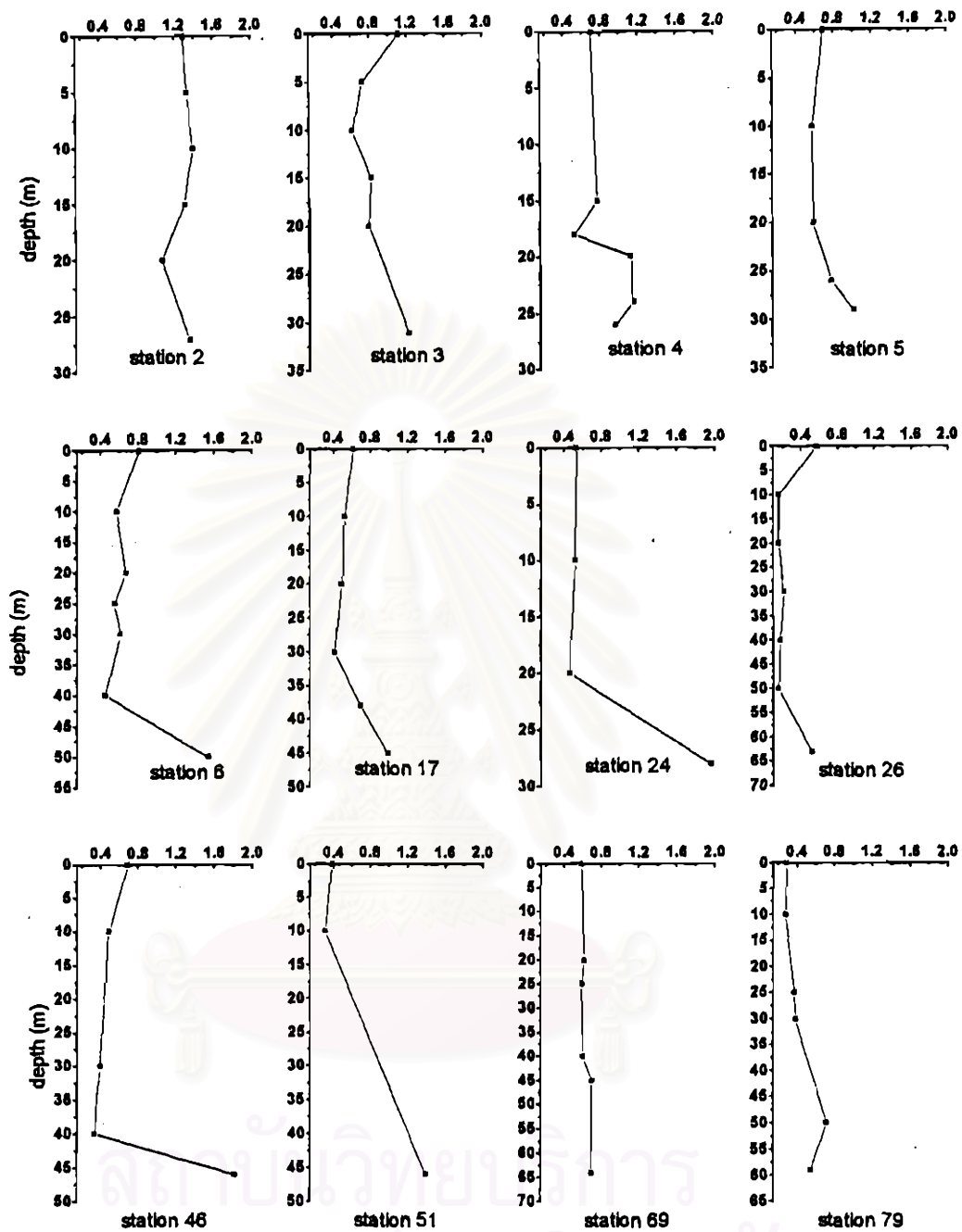


Fig. 3-38 Vertical profiles of suspended particulate Ni (nM) at stations 2, 3, 4, 5, 6, 17, 24, 26, 46, 51, 69 and 79

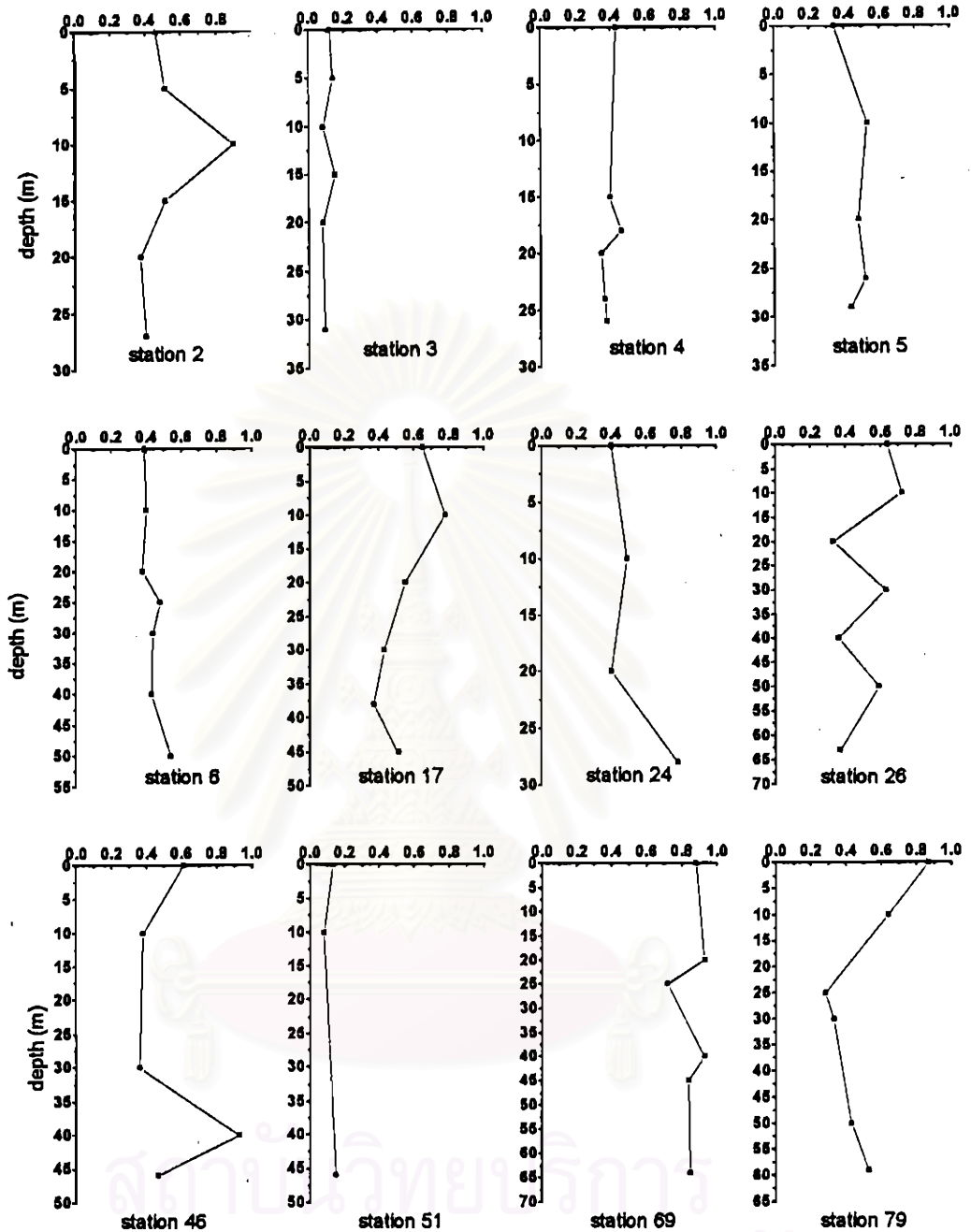


Fig. 3-39 Vertical profiles of dissolved Pb (nM) at stations 2, 3, 4, 5, 6, 17, 24, 26, 46, 51, 69 and 79

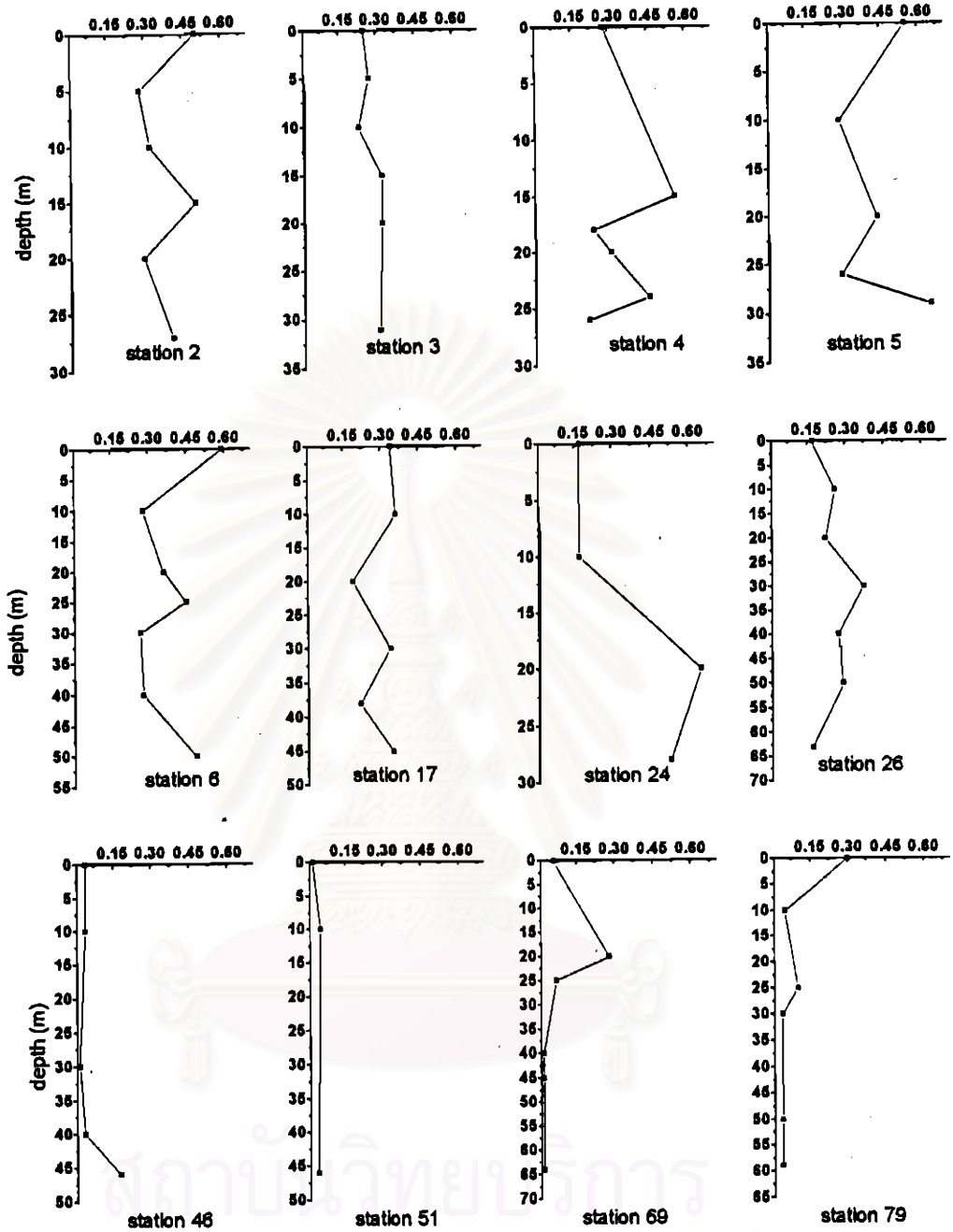


Fig. 3-40 Vertical profiles of suspended particulate Pb (nM) at stations 2, 3, 4, 5, 6, 17, 24, 26, 46, 51, 69 and 79