TRACE METALS IN SEDIMENTS OF THE SOUTH CHINA SEA

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Introduction

Malaysia is a maritime nation and surrounded by the Strait of Malacca, South China Sea and the Sulu Sea off Sabah yet few studies on the metal contents of sediments off these areas have ever been carried out. In a study on the geochemistry of the surficial sediments off Sabah and in the Sulu Sea, the distribution of some metals were related to depth of the water column (Calvert et al. 1993) as well as sediment mineralogy. A study of the trace metal concentration in the Johor Strait showed that the concentrations of some elements were lower than in average Earth crust material. The objectives of this study were to chart out the metal geochemistry of the whole of the South China Sea and relate this distribution to world average values. The influence of large rivers flowing into the sea from the Borneo mainland may have effects on the seabed extending far beyond the coast and this was studied in relation to the trace metal distribution in the seabed. The effects of the monsoon on sediment metal and distribution were also studied.

Materials and Methods

The methodology for sample collection, preparation and metal analyses adopted in the present study was similar to that used by Wood et al. (1997). Sediment samples were collected using a Smith McIntyre grab during the pre-monsoon and the post-monsoon periods using the research vessel MV SEAFDEC. Sampling stations were located 30 nautical miles (nm) apart extending from 30nm to 180nm offshore. The top 3cm of sediment were carefully collected with a clean plastic spatula and kept in acid-cleaned glass bottles. About 1g aliquots of this silt and clay fraction was then totally digested in a mixture of nitric, perchloric, hydrofluoric and hydrochloric acids in open PTFE beakers (Katz and Jenniss, 1983). The digest was then made up to 50ml with Milli-Q water. For quality assurance, a standard reference material (1646a Estuarine Sediment) from the National Institute of Standards and Technology was analysed for metals. Metals were analysed using by AAS. Analyses of NBS 1646a Estuarine Sediment (National Bureau of Standards) indicated good recoveries of all metals.

Results and Discussion

For the sediments of the Gulf of Thailand and of the east coast of Peninsular Malaysia, metal concentration ranges were: 0.41-0.19μgg^{-1}Cd, 10-36μgg^{-1}Cu, 7.02-27.8μgg^{-1}Pb, 15.3-352μgg^{-1}Zn, 20.5-122μgg^{-1}Cr, 209-720μgg^{-1}Mn, 0.79-5.96%Al and 0.71-2.82%Fe. Fe, Cd and Zn concentrations between the Gulf of Thailand and the east coast peninsular Malaysia sediments showed no significant differences between the pre- and post-monsoon periods. However Al, Cr, Cu, Mn and Pb were significantly higher in Gulf sediments. For the post-monsoon results Al, Cu and Mn were significantly higher in Gulf sediments. The results indicate that over most of the area studied the observed metals concentrations were generally uniform and reflect average or lower than average values compared with reported crustal abundance (Hanson et al. 1986). The range of metal concentrations measured for sediments off Sabah, Sarawak and Brunei were: 1.01 – 18.9 μgg^{-1} for Pb, 7.52 – 100.0 μgg^{-1} for Cu , 14.4 – 137 μgg^{-1} for Zn, 10.1 – 87.6 μgg^{-1} for Cr, 157 – 1890 μgg^{-1} for Mn, 0.83 – 9.83 % for Al and 0.16 – 4.47 % for Fe. Concentrations of Al, Fe, Cr, Zn and to a lesser extent Pb were lowest at stations directly off the Rajang River Basin extending north-westward to the deeper stations. Mn showed a clear increase in concentration with depth of water while Zn was highest at the deeper stations and in the region off Bintulu extending north-westward. Copper concentrations in sediments were lower than the established value for the Earth crust. Concentrations of Cu normalised to Al gave ratios of between 2 and 8 x10^{-4} with most of samples taken within the study area having ratios of 2 – 4. These values are lower than the standard Cu:Al values of 7.12 x10^{-4} for shale and 8.14 x10^{-4} for continental sands and silts (Windom et al. 1989; Hanson et al. 1986). Most of the samples from the study area have a Pb:Al ratio of <2.0 which is lower than the standard value of 2.91 x10^{-4} in continental shelf sands and silts but is similar to average shale (1.52 x10^{-4}). Zinc concentrations were between 14.3 and 114 μgg^{-1} and Zn:Al ratios between 8 – 20 x10^{-4} . These ratios are higher than the standard value of 8.6 – 9.15 x10^{-4} for the Earth's crust. Input of sediment and particulates from the very large Rajang River probably influences the sedimentary characteristics of the seabed which may change between the pre-monsoon and the post-monsoon periods.

Conclusions

The concentrations of Fe and Pb in this region are similar to natural values for continental shelf sands and silts and for Earth crust materials, as indicated by similar element:Al ratios (Hanson et al. 1986). The ratios of Pb, Cu, Cr, Ni and to a lesser extent Mn, and Al, however indicate that values in this region are lower than natural values by up to two times. Differences in sediment particle size, organic content and mineralogy may account for this difference.

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