CHAPTER 1
INTRODUCTION

1.1 Background

Increasing amount of industries with a growing population results in increasing of many trace metals concentration in the coastal area. Many trace metals are not usually eliminated from the aquatic ecosystem by natural processes. Toxic metals such as mercury, cadmium, arsenic and copper tend to accumulate in bottom sediments from which they may be released by various processes of remobilization and changing forms and can move up to biologic chain, thereby reaching human beings where they produce chronic and acute ailments (Forstner and Wittmann, 1981).

Trace quantities of certain elements exert a positive or negative influence on plant, animal and human life. No organic life can develop and survive without the role of metal ions. Iron, the most abundant element, on earth is probably the most well-known metal in biologic systems. Iron(II) complex consisting of the globin protein for example. Copper is recognized as an essential element and exists in combination with the blood protein of snails. Essential trace metals become toxic when the nutritional supply becomes excessive. The various factors influencing the toxicity of trace metals in aquatic organisms are. 1. Metal species in water (organic, inorganic, soluble, particulate) 2. Physical factors, such as temperature, pH and salinity 3. Condition of organism such as sex, age, size, activity and adaptation to metals.

1.2 Trace metals distribution

Bruland (1983) identified seven types of trace metal distributions in the aquatic ecosystem as:

1.2.1 Conservative: Conservative profile shows a constant concentration relative to salinity as a result of the low reactivity of the element in sea water. Trace elements that appear to have conservative distributions are the hydrated cations Rb^+ and Cs^+, and the anions molybdate (MoO_4^{2-}).

1.2.2 Nutrient-type: Nutrient-type profile exhibits depletion at surface and enrichment at depth as a result of the environment of the element in the biogeochemical cycle. This cycle results in removal of the element from surface waters by phytoplankton and biologically produced particulate material, and its subsequent regeneration into solution at depth when the biological debris sinks and is oxidized or resolubilized. Three variants of the nutrient - type profile are : (a) A shallow regeneration cycle leading to a mid - depth maximum which is similar to that found for the labile nutrients phosphate and nitrate. Cadmium and arsenic (V) are examples of nutrient-type trace elements with such a distribution; (b) A deep regeneration cycle leading to deep maxima is observed similar to that which occurs for silicate and alkalinity, examples of nutrient - type trace elements showing deep maxima include Ba, Zn, and Ge; (c) a combination of shallow and deep regeneration cycles is inferred from the profiles of certain nutrient - type trace elements such as Ni and Se.

Distributions of cadmium , copper and nickel at four stations in the eastern part of the Atlantic Ocean showed nutrient-like distributions. Cadmium and phosphate relationships (Cd-PO_4) has a slope of 2.1×10^{-4} for $PO_4 < 1.3$ µM and 4×10^{-4} for $PO_4 > 1.3$ µM (Yeat *et al.*, 1995).

The dominant mechanism in control of concentration for most metals appears to be adsorption on biologically produced particulate matter. Some proportion of the metals removed from the surface water by this mechanism are put back into solution in deeper water by bacterial decomposition of the particles. As a result, many trace metals display distribution in the water column resembling those of the inorganic nutrients (Wangersky, 1986).

The presence of a significant correlation between chlorophyll-a and suspended Cu concentration in the photic layer, during the period of active photosynthetic production, shows a possibility for the algae to assimilate or adsorb the copper form the environment during the spring bloom (Fabiano *et al.*, 1985).

1.2.3 Surface enrichment and depletion at depth: Trace elements in this class are derived primarily to surface water and are removed rapidly and permanently from the sea water. Their oceanic residence times are short with respect to the ocean' s mixing time. Processes leading to surface enrichment are : (a) trace elements delivered to the oceans predominantly via the atmosphere and subsequently scavenged throughout the water column exhibit this type of profile - the best known example of an element distributed in this way is lead, both common lead and ^{210}Pb; (b) if the element is predominantly delivered via rivers or by releasing from shelf sediments, it can mix horizontally into surface waters leading to surface maxima - examples of elements distributed in this way include dissolved Mn as well as ^{228}Ra; (c) special cases in which selected oxidation states, or particular chemical forms, of various elements are known to exhibit this type of profile - insitu production within the surface waters by biologically mediated reduction processes coupled with redox equilibration throughout the water column has led to this type of distribution for Cr(III), As(III), and I(-1).

1.2.4 Mid-depth minima: Mid-depth minima can result from a surface input, regeneration at or near the ocean bottom, or scavenging throughout the water column. Aluminium and copper have been reported to show this type of profile.

1.2.5 Mid-depth maxima: Mid-depth maxima can be resulted from hydrothermal activity. Manganese and ^{3}He are the best known examples of elements showing this type of profile.

1.2.6 Mid-depth maxima or minima within sub-oxic layers: Sub-oxic layers are widely distributed, being found typically in the eastern tropical Pacific and northern Indian Oceans. Trace elements maxima or minima can occur in such regions because of reduction processes either in the water column or in the adjacent slope sediments; (a) maxima occur if the reduced from of the element is relatively soluble compared to its oxidized form-some examples include Mn(II) and Fe(II); (b) minima occur when the reduced form is relatively insoluble, or liable to become associated with solid phases,e.g. Cr(III).

1.2.7 Maxima or minima, associated with anoxic waters: Areas with restricted water circulation, such as the Cariaco Trench can become anoxic with the production of reducing conditions due to the SO_4^{2-} - H_2S redox couple: (a) maxima occure when the reduced form of the trace element is more soluble than the form existing under oxic conditions - examples of such reduced forms include Mn(II); (b) minima occur when the reduced form is relatively insoluble or liable to become associated with solid phase, e.g. Cr(III).

1.3 Study area

The Gulf of Thailand is a semi-enclosed gulf and connected to the South China Sea. The Gulf is located between latitudes 6 and 14 °N and longitudes 99 and 105 °E. The mouth of the Gulf is defined according to the International Hydrographic Organization by a straight line connected the Cape of Camau (the southernmost tip of Vietnam) and the coastal town of Tumpat in North Malaysia near Thailand-Malaysia border. The area dimension of the Gulf is approximately 400 km by 800 km. The average depth is about 50 meters (Snidvongs, 1998). East Coast of Malay Peninsula is locates between latitudes 1 and 6 °N. This area is a part of the South China Sea. Bottom depth of the study area was between 22 and 78 meters, where the deeper locations are in the middle of the Gulf of Thailand and off shore of Malay Peninsula. The depth contour of the study area is shown in Figure 1-1.

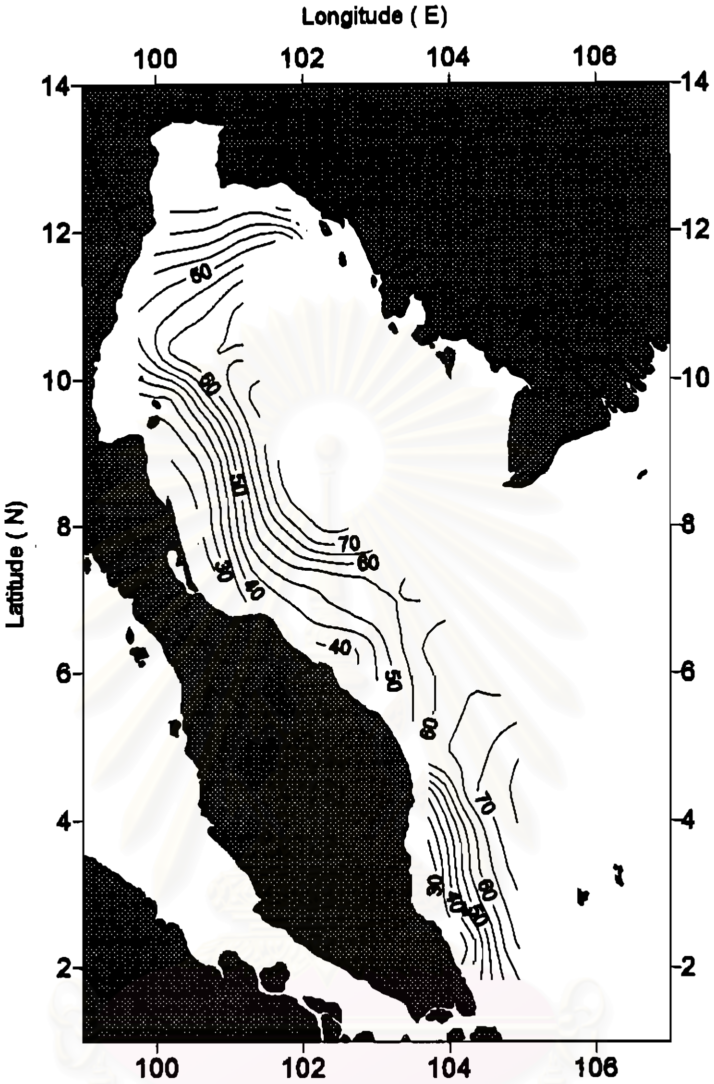

Fig.1-1. Depth contour of the study area (m)

Previous studies on trace metals in the Gulf of Thailand and East Coast of Malay Peninsula were limited and patchy, most of the studies were conducted in specific areas such as estuaries, coastal area and area of extensive industrial activities. In September-October 1996, Hungspreugs *et al.*, 1998 collected samples from 14 stations in the Gulf of Thailand and 5 stations in East Coast of Malay Peninsula. Concentration ranges of dissolved cadmium, copper, nickel and lead found were 0.02-0.08, 1.89-16.52, 0.51-2.55 and 0.10-0.72 nM, respectively (Appendix A). The study also showed some high concentrations of dissolved metals at bottom layer near the Upper Gulf of Thailand which may be an indication of the release of metals from sediment of the Upper Gulf of Thailand and/or Eastern Sea Board areas.

In this study, water and sediment samples at stations were covering the whole area of the Gulf of Thailand and the eastern of Thai-Malaysian Peninsula coast. Vertical profiles at selected stations were also performed. The objectives of the study are 1) To study the horizontal and vertical distribution of Cd, Cu, Fe, Ni and Pb in the Gulf of Thailand and East Coast of Malay Peninsula. 2) To study the correlation of trace metals between different forms and the correlation of trace metals with the environmental variables.