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Spatial distribution of organic carbon contents of Langkawi island coastal waters, Malaysia

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ABSTRACT

The distribution of total organic carbon content (TOC) in surface sediments of 5 zones in the area of Langkawi Island coastal waters were analysed by using wet oxidation dichromate method. A total of 51 samples were obtained using Ekman Grab from Kuah coastal area (Zone A), Cenang coastal area (Zone B), Datai River (Zone E), Kilim River (Zone D) and Pulau Tuba waters (Zone E). In this study, the highest mean of organic carbon was found in zone A (2.27±0.59), followed by zone C (2.09±0.14), zone D (2.01±0.15), zone E (1.89±0.28) and the lowest is in zone B (1.72±0.38). A relatively weak positive relationship was also found between the organic carbon content and the sediments grain size.

Key words: total organic carbon, Langkawi Island, coastal waters, surface sediment sample.

INTRODUCTION

Estuarine and coastal bay areas are active sites where huge amount of organic matter is introduced into the ocean system through river runoff, in situ primary production and anthropogenic impacts. The primary source of the naturally occurs organic carbon is the plant material and animals are considered as a secondary source of organic carbon as they decayed and decomposed within the sediments. Interaction between a complex mixture of organics and inorganics introduced into the sediment enhances active material cyclings in time and space. However, different factors may control the partitioning and also the bioavailability of the hydrophobic organic compound and heavy metal pollutants within the benthic ecosystem. These factors include various sediment characteristics, such as grain size distribution, mineral composition and organic content (Lambert 1967; Forstner 1977; Khalaf *et al*. 1981).

Only limited work has been done on the organic matter, both in the sediment and in the suspended sediment in Malaysian rivers. Although there have been many studies of the distribution of particulate organic carbon in suspended matter in sea water and in the bottom sediments in South China Sea and adjacent seas (Ichikawa 1987; Muller 1977), data on the coastal water and rivers of Malaysia are still limited. In recent years, the study area especially near the river and mangrove areas has been heavily impacted by discharges from municipal and industrial outflows. This was due to the rapid development of the area via expansion of the industrialization area as well as the increase in population. A lot of development activities were done in the area as it is one of the most attractive tourist sites in Malaysia. Resorts and hotels are the main industry in the area and is the catalyst for other supportive industries to develop around the same area. The aim of this work was to determine the total organic carbon distribution in the area, their source and mode of incorporation in their sediments with regards to the sedimentological conditions of the area.

MATERIAL AND METHODS

Samples Collection

Five major zones were selected within this study area. These zones include the Kuah coastal area (Zone A), Cenang coastal area (Zone B), Datai River (Zone E), Kilim River (Zone D) and Pulau Tuba waters (Zone E). A total of 51 samples were collected by using Ekman Grab during 2008. The top samples which have a direct contact with the grab were gently scrapped out to prevent contamination. Samples were then placed in a bottle samples and frozen prior to analyses. Samples were brought to the laboratory and dried to constant weight at 80ºC and sieved through 63µm stainless steel sieve.

Analytical Procedure

The samples were then sieved through a 63µm, without dispersion agent, to avoid contamination of the samples. The sediment were then labelled and stored at room temperature for the laboratory analysis. The organic carbons in this study were determined using the Walkley Black wet oxidation method (Allisson 1965). 0.5 g of dried samples is added with 10ml of potassium dichromate. The mixture was shaken for a few minutes, and then 20 ml of concentrated H_2SO_4 was added to the test tube and was shaken again. If the mixture did not turn to dark blue in colour, few more drops of potassium dichromate were added. The total volume of potassium dichromate used was recorded.

The test tube was then placed in 500 mL beaker containing water and heated on a hot plate for a maximum duration of 30 minutes. The sample was then cooled at the room temperature and distilled water was added in the conical flask. 5ml of concentrated phosphoric acid and 1 ml of diphenylamine indicator solution were added before the samples were titrated with ferrous sulphate solution. The volume of ferrous sulphate was recorded when the titration process was completed. Organic carbon content was calculated as follow:

% organic carbon = (V1 – V2) x 0.03 x 100 / sample weight (g)

where

V1 = the volume of dichromate being used (ml)

V2= the volume of ferrous sulphate being used in titration (ml)

This analysis included several replicates of “blank” sample in order to determine the background content of organic carbon in water. Glucose sample were employed to ensure the reliability of the acids solutions. In this study glucose reading should fall in the range of 34% - 36%. The total titration volume of the “blank” sample was deducted from the total titration volume used in the experimental in the samples.

RESULTS AND DISCUSSIONS

Generally, the distribution of organic carbon (Figure 1) ranged from 1.08% to 3.40% in Pulau Langkawi waters. The highest mean of organic carbon was found in Zone A (2.27±0.59%), followed by Zone C (2.09±0.14%), Zone D (2.01±0.15%), Zone E (1.89±0.28%) and the lowest is in Zone B (1.72±0.38%).

In Zone A, the % of organic carbon is high due to the location of the sampling area which is situated near to the mainland and can be categorized as a most developed town and a center of business areas and also as a tourist attractive place. The high concentration of organic carbon observed near Zone A could be attributed to organic matter from the industrial and municipal wastewater. When compared with other studies, the organic carbon content in the study areas were relatively lower than those reported by Ichikawa *et al*. (1987) in the Port Dickson and Al-Ghadban *et al*. (1990) in the Arabian Gulf. These daily activities like transportation of tourist using boats and residential areas may introduce high organic matter flux into the coastal water in that area. Finny and Huh (1989) reported that the organic carbon content is associated with urban waste, domestic sewage and

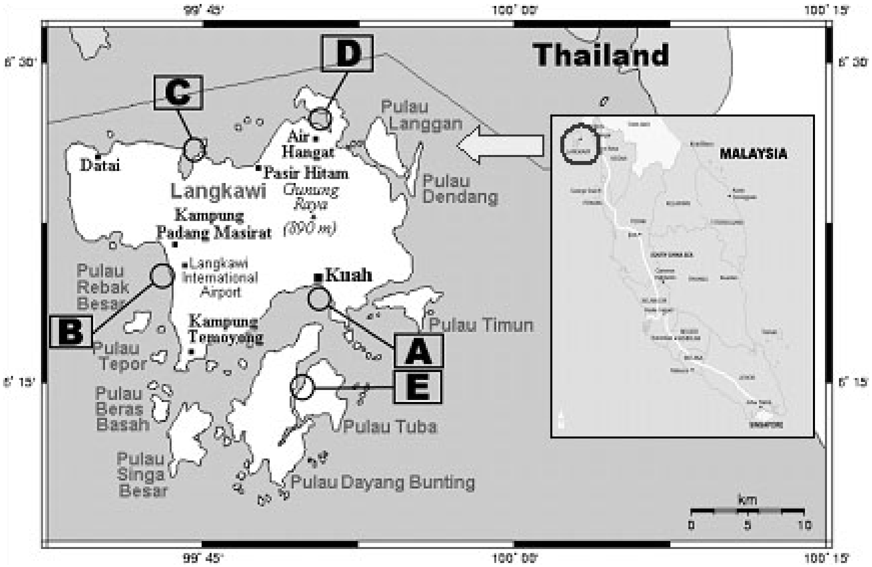

Fig. 1: Study Area in 5 Zones in Langkawi Island

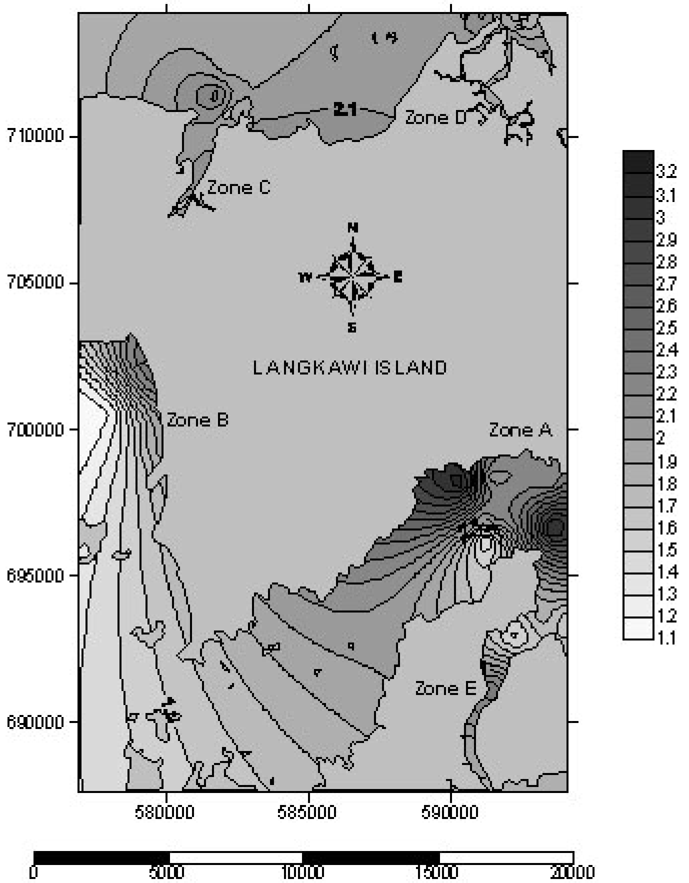

Fig. 2: Distribution of Organic Carbon contents in Zone A, B and C of Langkawi coastal waters

cage culture. Besides that, as reported by Hasrizal (2007), the high organic matter content might also come from spillage and oil dumped from boat activities as well as in the area, there are a lot of jetties and boats.

In zone B, the content of organic carbon is relatively higher at the stations near the mainland compared to the stations seaward. The organic matter flux was probably due to the direct discharge of domestic sewage or insufficiently treated waste that come from the mainland activities. In the stations seaward, the contents of organic carbon decreased as it is located quite far from the mainland. Lower organic carbon content might be due to relatively low primary productivity and rapid decomposition in the open ocean compare to the near shore marine environment (Kamaruzzaman, 2007).

Meanwhile, in zone C, D and E, the high content of organic carbon is probably derived from the higher plants material, as the study area is surrounded by mangrove trees. However, their average value was higher than the sediment from the open ocean (Muller 1977; Yamamuro and Kayanne 1995). It would be probably that primary productivity input terrestrial organic matter, preferential decomposition, and grazing by benthic organisms are dominantly found in zone C, D and E environment.

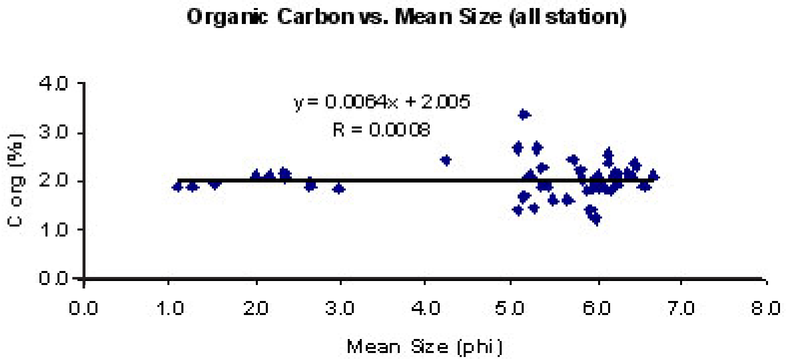

Fig. 3: Relationship between organic carbon and particle mean size during dry season

In this study, a weak positive correlation was observed between organic carbon and sediment (Figure 3). In an ideal situation, higher organic carbon content values are associated with lower sediment particle size (El-Wakeel and Riley 1957). However, in the studt areas sediment, such a correlation is not evident probably owing to factors like higher percentages of sand in the study areas and also due to the strong current movement and circulation. According to Rashid *et al.* (1973), the finer size of sediments contains higher contents of organic materials. However there are other factors that may also control the partioning and the bioavailability of the organic materials in the sediment. These include mineral composition, the adsorption of organic matter to the surface of individual grains at the specific surface area of the same sediments, and the possible of sheltering of organic matters in small pores in the sediments particle (Keil *et al*., 1994).

CONCLUSION

The concentration of organic carbon was particularly high in the coastal area of Langkawi Island. It is likely that the high concentration of organic carbon were due to the river outfall of organic matter, land run-off and human sea based activities.

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