

GEOCHEMISTRY AND CHARACTERISTICS OF MARINE
SEDIMENT IN JOHOR COASTAL WATERS, SOUTH CHINA SEA
MALAYSIA

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JOHOR COASTAL WATERS, SOUTH CHINA SEA MALAYSIA**

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GEOCHEMISTRY AND CHARACTERISTICS OF MARINE SEDIMENT IN MOUTH ESTUARIAL WATERS, SOUTH CHINA SEA, MALAYSIA

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January 2007

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**This thesis is especially dedicated to my beloved family
Thank you for all the support**

A geochemical study was carried out in the South China Sea (SCS) by using two cruises, *Survei Kelantan* (October 6 - 12, 2004) and *Survei Kelantan* (March 1 - 10, 2005), in order to determine the vertical profiles of heavy metals. Sample sites (5 stations) were selected with a Smith-Beltz's sediment sampler and a Philips AAS for vertical sediment and water analysis. The study was to determine the sediment characteristics, organic carbon content and heavy metal contents of these sites.

The trace elements such as total SCS varied from 0.30 to 5.14 µg/g (dry wt) and in very fine sand to both the pre and the post monsoon seasons. The sediment of this region in total SCS was mainly influenced by river discharge to both seasons. Sediment distribution in total SCS was controlled during the pre-monsoon season but had become more homogeneous during the post-monsoon season.

Abstract of the thesis presented to the Senate of Universiti Malaysia Terengganu in fulfillment of the requirements for the degree of Master of Science.

GEOCHEMISTRY AND CHARACTERISTICS OF MARINE SEDIMENT IN JOHOR COASTAL WATERS, SOUTH CHINA SEA MALAYSIA.

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A geochemical study was carried out in the Johor coastal waters, South China Sea (SCS) during two seasons, pre-monsoon (October 6 - 12, 2004) and post-monsoon (March 1 - 10, 2005), in order to determine the temporal variation of heavy metals. Sample from 48 stations were collected with a Smith McIntyre sediment sampler and a Phleger corer for surface sediment and core sediment. The study was to determine the sediment characteristics, organic carbon content and heavy metal contents of these waters.

The mean sediment size in Johor SCS varied from 0.30 to 5.14 phi (coarse sand to very fine sand) in both the pre and the post monsoon seasons. The settlement of finer sediment in Johor SCS was mainly influenced by river discharge in both seasons. Sediment distribution in Johor SCS was scattered during the pre-monsoon seasons but had become more concentrated into a smaller range in the post-monsoon season.

Organic carbon varied from 0.29 to 2.65% and 0.78 to 8.62% in the pre- and the post-monsoon season respectively. The correlation between mean sediment size and organic carbon was almost negligible with r^2 equal to 0.0236 and 0.0006 for pre- and post-monsoon respectively.

The concentrations of Pb, Co, Cu, Cd, and Zn in Johor SCS varied over to the seasonal change from pre-monsoon to post-monsoon season ($p < 0.05$), except for Fe and Mn. The correlation between heavy metals and mean particle size was negligible. Correlation values in the pre-monsoon season ranged from 0.0002 to 0.0060, while those of the post-monsoon ranged from 0.0001 to 0.0106.

Enrichment factor (EF) analysis indicated that most metals originated from natural sources, that is unpolluted, except for Pb which showed moderate enrichment. The concentration of heavy metals decreased during the post-monsoon season. This may have been caused by river runoff or by the action of the bottom current during the monsoon season. However, results indicate that, the lower EF values do not necessarily indicate zero pollutions, a few stations near the coastal zone show a higher level of heavy metal concentration. These sources may be from anthropogenic activities such as sewage, sea dumping, industrial runoff, sand mining, waste disposal and other anthropogenic activities.

The sedimentation rate in Johor SCS was found to be 0.43cm y^{-1} and 0.38cm y^{-1} for St.24 and St.28, respectively. This was determined by using the nuclide method of

^{210}Pb . Sediment accumulation in Johor SCS could be due to delivery of current sediment from the adjacent rivers, particularly during the NE monsoon season.

Lastly, the sedimentological and geochemical profile indicates that the coastal Johor waters were still within environmentally secure levels. However, monitoring should be carried out annually, especially in the coastal zone, which has a higher accumulation of pollutants. The study also discovered that the transition season between the pre monsoon and post monsoon has a beneficial effect on the coastal environments, where it results in an overall reduction of the resident time of pollutants in the sediment of the Johor South China Sea.

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu
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**GEOKIMIA DAN KRITERIA BAGI SEDIMEN MARIN DI PERAIRAN
JOHOR, LAUT CHINA SELATAN, MALAYSIA.**

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Satu kajian geokimia telah dijalankan di Laut China Selatan di kawasan Perairan Pantai Johor. Kajian dijalankan pada dua musim iaitu pra monsun (6 – 12 Oktober 2004) dan selepas monsun (1 – 10 Mac 2005) untuk menentukan variasi masa logam berat. Sampel dari 48 stesen telah diambil menggunakan penyampel Smith McIntyre dan Phleger corer untuk sampel permukaan serta sampel dasar. Kajian yang dibuat adalah bagi menentukan dan melaporkan kriteria mendapan (sedimen), kandungan karbon organik dan logam berat yang terkandung di perairan ini.

Min saiz sedimen di kedua – dua musim (pra monsun dan selepas monsun) adalah bervariasi diantara 0.30 hingga 5.14 phi (daripada pasir kasar hingga pasir yang sangat halus). Pembentukan sedimen halus di Johor LCS adalah dipengaruhi oleh bahan buangan daripada sungai di kedua – dua musim. Pembahagian sedimen di Johor LCS adalah dalam keadaan yang berselerak pada musim pra monsun, tetapi berubah menjadi teratur dan agak rapat pada musim selepas monsun.

Karbon organik di Johor LCS adalah bervariasi di antara 0.29 hingga 2.65% pada musim pra monsun manakala pada musim pasca monsun, variasinya adalah antara 0.78 hingga 8.62%. hubungan kolerasi diantara saiz sedimen dan bahan organik adalah sangat lemah atau rendah ketika pra monsun dan hampir boleh diabaikan selepas musim monsun dimana masing – masing menunjukkan nilai r^2 dari 0.0236 ke 0.0006.

Kepekatan Pb, Co, Cu, Cd dan Zn di Johor LCS adalah bervariasi pada waktu perubahan musim daripada pra monsun kepada selepas monsun ($p < 0.05$). Walaubagaimanapun, kolerasi antara Fe and Mn adalah tidak berubah. Kolerasi antara logam berat dan min saiz partikel adalah sangat lemah dan boleh diabaikan. Kadar kolerasi di waktu pra monsun adalah di antara 0.0002 ke 0.0060 manakala diwaktu selepas monsun kadarnya adalah dari 0.0001 ke 0.0106.

Analisa faktor pengkayaan (EF) menunjukkan kebanyakan logam berasal dari sumber semulajadi yang tidak terdedah kepada pencemaran, kecuali Pb yang menunjukkan pengkayaan sederhana. Kepekatan logam berat menjadi semakin berkurangan selepas musim monsun. Ini kemungkinan disebabkan oleh kehadiran arus di dasar sewaktu musim monsun lalu mengakibatkan sedimen diangkut ke laut lepas. Walau bagaimanapun, kajian ini juga mendapati nilai EF yang rendah tidak bermakna tiada pencemaran yang berlaku. Beberapa stesen yang terletak berhampiran zon persisir pantai menunjukkan peningkatan nilai kepekatan logam berat. Sumber – sumber ini kemungkinan berpunca daripada aktiviti anthropogenik seperti pembuangan sisa kumbuan, pembuangan toksid berjadual daripada perindustrian berat, perlombongan pasir, pengumpulan sisa pepejal dan lain-lain aktiviti anthropogenik .

Kadar sedimentasi di perairan Laut China Selatan, Johor dikenalpasti pada ukuran 0.43cmy^{-1} pada teras Stn. 24 dan 0.38cmy^{-1} pada teras Stn.28. Keputusan ini dikenalpasti melalui analisa nuklid ^{210}Pb . Penimbunan sedimen di perairan Johor berkemungkinan disebabkan oleh aliran mendapan daripada muara sungai terutama ketika musim monsun NE.

Akhir sekali, profil sedimentologi dan geokimia menunjukkan bahawa kawasan persisiran perairan Johor adalah dalam keadaan tahap persekitaran yang selamat. Walau bagaimanapun, pemantauan haruslah dijalankan setiap tahun terutama di kawasan zon persisiran yang mempunyai tahap timbunan pencemaran yang tinggi. Kajian juga menunjukkan peralihan musim di antara pra monsun dan selepas monsun mempunyai kesan yang baik ke atas kawasan pantai dan persekitaran berhampiran pantai, yang mana ia menyebabkan keseluruhan penurunan pada tahap pencemaran dalam sedimen di Laut China Selatan, Johor.