SEDIMENTOLOGY AND GEOCHEMISTRY OF REDANG ISLAND SEDIMENTS, TERENGGANU

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I dedicated this thesis to my beloved Mak and Abah,
my lovely brothers and sisters
and also my adorable family members
with lots of love

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A study on the sediment characteristics and geochemistry of Redang Island sediment was conducted during pre and post-monsoon seasons. The sediments were collected around the Redang Island using UNIPERTAMA VII. The sediments were analyzed for their sedimentological characteristics using dry sieve method, soil pH, mineralogy; using X-ray diffractometer (XRD) and scanning electron microscope energy dispersive x-ray spectroscopy (SEM-EDS) and the concentrations of metals and rare earth elements (REEs) were determined using an inductively coupled plasma mass spectroscopy (ICP-MS). The organic carbon content was determined using wet oxidation method. Generally, sediments during both monsoons are coarse sand, poorly sorted, negatively skewed and extremely leptokurtic. No relationship was observed between mean size and sampling sites (R^2 = 0.05 pre-monsoon), (R^2 = 0.0017 post monsoon) and seasons. Soil pH showed no significant differences (p=0.147>0.05) between pre and post monsoons.

Quartz and calcite are the dominant minerals observed in the study area followed by kaolinite, illite and smectite which occurred in trace amounts. For the compounds, the highest percentage detected was SiO_2 (43%), followed by CaO (21%) and Al_2O_3 (17%) which indicate that the area is dominated by sand fractions and shell fragments. Other compounds detected in lesser percentage were Na_2O (3%), MgO (3%) and K_2O (2%). The concentrations of Al, As, Ba, Fe, Cd, Cu, Cr, Mn, Ni and Pb in sediments are lower compared to the crustal values with the exception of Zn. The pre monsoon season have higher metal contents compared to the post monsoon period. The REE patterns in sediments reflected the source rock patterns with an overall order of abundance light rare earth element (LREE)>> middle rare earth element (MREE)> heavy rare earth element (HREE) during both monsoons. The chondrite normalized patterns of REEs shows enrichment of LREEs over HREEs with La/Yb of 13.6 during pre monsoon and 14.1 during post monsoon. However chondrite normalized values shows no change in HREE ratios (Gd/Yb) between the pre monsoon (2.06) and post monsoon (2.08) periods. The metal enrichment factor (EF) values suggest that the sources of metals and rare earth elements are solely natural, as there was only deficiency to minimal enrichment of metals and REEs.

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu sebagai memenuhi keperluan untuk ijazah Sarjana Sains.

SEDIMENTOLOGI DAN GEOKIMIA KE ATAS SEDIMEN PULAU REDANG, TERENGGANU

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Kajian mengenai ciri-ciri sedimen dan geokimia logam di Pulau Redang telah dijalankan pada sebelum musim monsun dan selepas musim monsun. Sampel sedimen telah diambil di sekitar Pulau Redang dengan menggunakan kapal UNIPERTAMA VII. Sedimen tersebut dianalisis untuk ciri-ciri enapan dengan menggunakan kaedah penapisan kering, pH tanah, kajian mineral menggunakan kaedah *x-ray diffractometer* (XRD) dan *scanning electron microscope energy dispersive x-ray spectroscopy* (SEM-EDS) dan kepekatan kandungan logam dan logam bumi *lanthanide* (REE) ditentukan dengan menggunakan *inductively coupled plasma mass spectroscopy* (ICP-MS). Selain itu, kandungan karbon organik ditentukan dengan menggunakan kaedah pengoksidaan basah. Secara umumnya, sedimen di Pulau Redang bagi kedua-dua monsun diklasifikasikan sebagai enapan yang lebih kasar, kurang berjenis, mempunyai kecondongan negatif dan sangat *leptokurtic*. Tiada perkaitan yang dilihat antara saiz butiran dan kawasan kajian ($R^2=0.05$, sebelum monsun), ($R^2=0.0017$, selepas monsun) serta musimnya. Manakala, pH tanah tidak menunjukkan perbezaan yang nyata

(p=0.147>0.05) di antara sebelum dan selepas monsun. Kuarza dan kalsium karbonat adalah mineral yang mendominasi kawasan kajian diikuti *kaolinite*, *illite* dan *smectite* yang hanya didapati pada jumlah surih logam. Berdasarkan kandungan tanah, peratusan tertinggi yang dikesan ialah SiO_2 (43%), diikuti CaO (21%) dan Al_2O_3 (17%) yang menunjukkan kawasan ini di dominasi oleh pasir dan cangkerang. Kandungan lain yang dikesan dalam peratusan yang sedikit ialah Na_2O (3%), MgO (3%) dan K_2O (2%). Kepekatan logam-logam Al, As, Ba, Cd, Cr, Cu, Fe, Mn, Ni dan Pb di dalam sedimen adalah lebih rendah dibandingkan dengan kandungan logam di dalam kerak Bumi kecuali Zn. Sebelum monsun mempunyai kepekatan logam yang lebih tinggi dibandingkan dengan selepas monsun. Corak REE di dalam sedimen menggambarkan sumber taburan batuan, secara keseluruhannya elemen lebih dominan ialah elemen ringan (LREE) >> elemen sederhana (MREE)>> elemen berat (HREE) bagi kedua-dua monsun. Corak kenormalan dengan nilai *chondrite* menunjukkan terdapat pengkayaan LREE melebihi HREE iaitu La/Yb adalah 13.6 bagi sebelum monsun dan 14.1 bagi selepas monsun. Walaubagaimanapun, nilai kenormalan *chondrite* menunjukkan tiada perubahan bagi nisbah HREE (Gd/Yb) di antara sebelum monsun (2.06) dan selepas monsun (2.08). Faktor pengkayaan menunjukkan sumber logam tersebut adalah secara semulajadi yang mana pencemaran berlaku secara umumnya adalah bernilai rendah kepada pengkayaan mimimum oleh logam dan juga REE.