

DISSOLVED, LEACHABLE AND PARTICULATE TRACE
METALS IN THE SOUTHERN TERENGGANU COASTAL WATER,
SOUTH CHINA SEA

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ADIANA BINTI GHAZALI

Thesis Submitted in Fulfillment of the Requirement for the Degree of Master of
Science in the Institute of Oceanography
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To My Beloved Father & Mother,

Ghazali Mohamed

Zaliha Mohd Nor

To My Beloved Family & Friends

Thank You for all the supports

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

DISSOLVED, LEACHABLE AND PARTICULATE TRACE METALS IN THE SOUTHERN TERENGGANU COASTAL WATER, SOUTH CHINA SEA

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JANUARY 2011

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The distribution of the trace metals Al, Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn between dissolved, particulate and total leachable phase in the South China Sea off the Terengganu coast was studied. Seawater samplings were carried out in May 2007, September 2007 and November 2007. The concentrations of dissolved trace metals were in the range of 2.42 $\mu\text{g/L}$ – 47.00 $\mu\text{g/L}$ for Al, 0.002 $\mu\text{g/L}$ – 0.19 $\mu\text{g/L}$ for Cd, 0.07 $\mu\text{g/L}$ – 0.45 $\mu\text{g/L}$ for Cr, 0.12 $\mu\text{g/L}$ – 1.24 $\mu\text{g/L}$ for Cu, 2.26 $\mu\text{g/L}$ – 124.73 $\mu\text{g/L}$ for Fe, 0.04 $\mu\text{g/L}$ – 3.54 $\mu\text{g/L}$ for Mn, 0.08 $\mu\text{g/L}$ – 2.86 $\mu\text{g/L}$ for Ni, 0.03 $\mu\text{g/L}$ – 0.49 $\mu\text{g/L}$ for Pb and 0.47 $\mu\text{g/L}$ – 9.78 $\mu\text{g/L}$ for Zn. Meanwhile, the concentrations of particulate trace metals were in the range of 5418 $\mu\text{g/g}$ – 1006648 $\mu\text{g/g}$ for Al, 45 $\mu\text{g/g}$ – 365 $\mu\text{g/g}$ for Cd, 23 $\mu\text{g/g}$ – 3570 $\mu\text{g/g}$ for Cr, 84 $\mu\text{g/g}$ – 11968 $\mu\text{g/g}$ for Cu, 202 $\mu\text{g/g}$ – 134681 $\mu\text{g/g}$ for Fe, 21 $\mu\text{g/g}$ – 2885 $\mu\text{g/g}$ for Mn, 11 $\mu\text{g/g}$ – 10156 $\mu\text{g/g}$ for Ni, 2 $\mu\text{g/g}$ – 56983 $\mu\text{g/g}$ for Pb and 435 $\mu\text{g/g}$ – 9719 $\mu\text{g/g}$ for Zn. The range of

total leachable trace metals concentrations were 0.07 $\mu\text{g/L}$ – 122.52 $\mu\text{g/L}$ for Al, 0.02 $\mu\text{g/L}$ – 1.29 $\mu\text{g/L}$ for Cd, 0.03 $\mu\text{g/L}$ – 309.57 $\mu\text{g/L}$ for Cr, 0.07 $\mu\text{g/L}$ – 7.05 $\mu\text{g/L}$ for Cu, 3.57 $\mu\text{g/L}$ – 1222.55 $\mu\text{g/L}$ for Fe, 0.001 $\mu\text{g/L}$ – 28.30 $\mu\text{g/L}$ for Mn, 0.04 $\mu\text{g/L}$ – 156.58 $\mu\text{g/L}$ for Ni, 0.03 $\mu\text{g/L}$ – 0.51 $\mu\text{g/L}$ for Pb and 1.27 $\mu\text{g/L}$ – 12.85 $\mu\text{g/L}$ for Zn. Concentrations of dissolved, particulate and total trace metals were highest at the near-shore stations and in the northern part of the sampling area. The Northeast monsoon affects the distribution of particulate trace metals in particular. This is shown by the distribution pattern of the particulate phase metals. In the beginning of the Northeast monsoon, in November 2007, particulate Al, Cu, Cr, Fe, Mn, Ni, Pb and Zn concentration were highest in the northwestern region of the study area. This suggests the re-suspension of these metals from the bottom sediments. Dissolved metal concentrations were higher in the dry season of May 2007 except Ni. Dissolved Al, Mn and Pb, particulate Cd, Cr, Cu, Fe, Ni and Zn, and total leachable Al, Cd, Cu, Fe and Mn were enriched in the sea surface but relatively depleted in bottom waters. Dissolved Cd, Cr, Cu, Fe, Ni and Zn, particulate Al, Mn and Pb, and total leachable Cr, Ni, Pb and Zn showed enrichment in the bottom layer. The calculated distribution coefficient, K_D further supports the finding that particulate metal concentrations were higher in the monsoon season. The present study shows that the source of metal input into the Dungun-Kemaman coast is primarily the Dungun River while other less contribution were from the Kemaman, Kerteh and Paka River.

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu sebagai memenuhi keperluan untuk Ijazah Master Sains.

LOGAM SURIH TERLARUT, JUMLAH TERLARUT-LESAP DAN PARTIKULAT DI PERAIRAN PANTAI SELATAN TERENGGANU, LAUT CHINA SELATAN

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Taburan logam surih Al, Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn di antara fasa terlarut, partikulat dan jumlah terlarut-lesap di dalam Laut China Selatan di perairan Selatan Terengganu telah dikaji. Aktiviti penyampelan telah dijalankan pada Mei 2007, September 2007 dan November 2007. Kepekatan logam-logam terlarut berada di dalam julat 2.42 $\mu\text{g/L}$ – 47.00 $\mu\text{g/L}$ untuk Al, 0.002 $\mu\text{g/L}$ – 0.19 $\mu\text{g/L}$ untuk Cd, 0.07 $\mu\text{g/L}$ – 0.45 $\mu\text{g/L}$ untuk Cr, 0.12 $\mu\text{g/L}$ – 1.24 $\mu\text{g/L}$ untuk Cu, 2.26 $\mu\text{g/L}$ – 124.73 $\mu\text{g/L}$ untuk Fe, 0.04 $\mu\text{g/L}$ – 3.54 $\mu\text{g/L}$ untuk Mn, 0.08 $\mu\text{g/L}$ – 2.86 $\mu\text{g/L}$ untuk Ni, 0.03 $\mu\text{g/L}$ – 0.49 $\mu\text{g/L}$ untuk Pb dan 0.47 $\mu\text{g/L}$ – 9.78 $\mu\text{g/L}$ untuk Zn. Sementara itu, kepekatan logam-logam partikulat berada di dalam julat 5418 $\mu\text{g/g}$ – 1006648 $\mu\text{g/g}$ untuk Al, 45 $\mu\text{g/g}$ – 365 $\mu\text{g/g}$ untuk Cd, 23 $\mu\text{g/g}$ – 3570 $\mu\text{g/g}$ untuk Cr, 84 $\mu\text{g/g}$ – 11968 $\mu\text{g/g}$ untuk Cu, 202 $\mu\text{g/g}$ – 134681 $\mu\text{g/g}$ untuk Fe, 21 $\mu\text{g/g}$ – 2885 $\mu\text{g/g}$ untuk Mn, 11 $\mu\text{g/g}$ – 10156 $\mu\text{g/g}$ untuk Ni, 2 $\mu\text{g/g}$ – 56983 $\mu\text{g/g}$ untuk Pb

dan 435 $\mu\text{g/g}$ – 9719 $\mu\text{g/g}$ untuk Zn. Julat kepekatan logam terlarut-lesap adalah 0.07 $\mu\text{g/L}$ – 122.52 $\mu\text{g/L}$ untuk Al, 0.02 $\mu\text{g/L}$ – 1.29 $\mu\text{g/L}$ untuk Cd, 0.03 $\mu\text{g/L}$ – 309.57 $\mu\text{g/L}$ untuk Cr, 0.07 $\mu\text{g/L}$ – 7.05 $\mu\text{g/L}$ untuk Cu, 3.57 $\mu\text{g/L}$ – 1222.55 $\mu\text{g/L}$ untuk Fe, 0.001 $\mu\text{g/L}$ – 28.30 $\mu\text{g/L}$ untuk Mn, 0.04 $\mu\text{g/L}$ – 156.58 $\mu\text{g/L}$ untuk Ni, 0.03 $\mu\text{g/L}$ – 0.51 $\mu\text{g/L}$ untuk Pb dan 1.27 $\mu\text{g/L}$ – 12.85 $\mu\text{g/L}$ untuk Zn. Kepekatan logam-logam terlarut, partikulat dan jumlah terlarut-lesap adalah tinggi di stesen di persisiran pantai dan di bahagian utara kawasan kajian. Berdasarkan pola taburan logam partikulat yang diperolehi, monsun Timur-laut telah dikenalpasti mempengaruhi taburan logam partikulat di kawasan kajian. Di permulaan monsun Timur-laut, pada November 2007, kepekatan partikulat Al, Cu, Cr, Fe, Mn, Ni, Pb dan Zn adalah tinggi menghala ke arah barat-laut kawasan kajian, kesan daripada proses pembentukan semula sedimen terampai. Kepekatan logam terlarut adalah tinggi di musim kering iaitu Mei 2007 kecuali Ni. Kepekatan logam terlarut Al, Mn dan Pb, partikulat Cd, Cr, Cu, Fe, Ni dan Zn, serta logam terlarut-lesap Al, Cd, Cu, Fe dan Mn adalah tinggi di permukaan laut tetapi rendah di dasar laut. Kepekatan logam terlarut Cd, Cr, Cu, Fe, Ni dan Zn, partikulat Al, Mn dan Pb, serta logam terlarut-lesap Cr, Ni, Pb dan Zn adalah tinggi di dasar laut. Kepekatan logam partikulat pada musim monsun disokong dengan pekali taburan, K_D yang telah dikira. Kajian ini telah menunjukkan bahawa sumber utama kemasukan logam surih ke perairan Dungun-Kemaman berpunca daripada Sungai Dungun manakala kemasukan logam surih dari Sungai Kemaman, Kerteh dan Paka adalah kurang.