

THE SPATIAL AND TEMPORAL DISTRIBUTION OF
ELEMENTS IN SEDIMENT OF SOUTHERN
TERENGGANU COASTAL WATER

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Plans are on the move to develop Terengganu as a tourism destination by the year 2015 and this will consequently set off the human population increase. It is believed that these factors could generate environmental impact in the state of Terengganu particularly the near-shore marine environment. The understanding of these near-shore areas is always an important key to create environmental awareness. Therefore, the objectives of this study were to determine the distributions of elements, sediment characteristics as well as organic carbon content in sediment of Southern Terengganu coastal water to provide baseline information for a better understanding of the environmental conditions in the area.

The study was conducted at three transects with total number of 24 stations during September 2006, March 2007, September 2007 and November 2007. In this study, 17 elements in the fine-grained fraction (<63 μm) were determined using Inductively Coupled Plasma Mass Spectrometry (ICPMS) after total acid digestion. Organic carbon contents were analyzed using wet dichromate titration method and sediment characteristics were determined using dry sieving and Particle Size Analyzer (PSA).

The variation of elements in sediment of Southern Terengganu coastal water for all the sampling period was ranged from 2.08% to 16.22% dry weights for Al; 0.16% to 16.37% dry weights for Fe; 0.18% to 18.83% dry weights for Ca; 0.01% to 5.94% dry weights for Na; 0.04% to 8.22% dry weights for Mg; 103.31 $\mu\text{g/g}$ to 1448.93 $\mu\text{g/g}$ dry weights for Mn; 31.91 $\mu\text{g/g}$ to 1232.97 $\mu\text{g/g}$ dry weights for Ba; 8.26 $\mu\text{g/g}$ to 374.12 $\mu\text{g/g}$ dry weights for Cr; 3.13 $\mu\text{g/g}$ to 342.60 $\mu\text{g/g}$ dry weights for Ni; 28.27 $\mu\text{g/g}$ to 543.12 $\mu\text{g/g}$ dry weights for Zn; 1.44 $\mu\text{g/g}$ to 86.06 $\mu\text{g/g}$ dry weights for Cu; 0.12 $\mu\text{g/g}$ to 53.58 $\mu\text{g/g}$ dry weights for Co; 1.74 $\mu\text{g/g}$ to 169.56 $\mu\text{g/g}$ dry weights for Li; 0.09 $\mu\text{g/g}$ to 48.63 $\mu\text{g/g}$ dry weights for Ga; 0.06 $\mu\text{g/g}$ to 129.80 $\mu\text{g/g}$ dry weights for Pb; 0.01 $\mu\text{g/g}$ to 4.89 $\mu\text{g/g}$ dry weights for Be; 0.08 $\mu\text{g/g}$ to 4.90 $\mu\text{g/g}$ dry weights for Cd.

Characteristics of sediment in the study area consist mostly of coarse sand to medium silt only (0.22 ϕ – 6.99 ϕ). Most of the station exhibit poorly sorted (1.00 ϕ – 2.00 ϕ) and positively skewed sediment (+0.10 ϕ to +0.30 ϕ). The sediment kurtosis is entirely very leptokurtic to extremely

leptokurtic during all the seasons ($> 1.50 \sigma$). As the location of the study area is near to the coast, quartz is found dominantly in the study area compared to clay minerals which are found in moderate or low amount. Sediment in the study area is also new and has undergone rapid sedimentation as there is significant abundance of olivine.

Meanwhile, the organic carbon content in sediment of Southern Terengganu coastal water ranged between 0.46% to 2.44% during September 2006; 0.30% to 2.18% during March 2007; 0.17% to 2.82% during September 2007; and 0.29% to 3.28% during November 2007. Elements in this study area also do not show significant correlation neither with organic carbon nor particle size.

Enrichment factor reveals that only Cd is significantly enriched meanwhile Index of geoaccumulation indicated Ca, Zn, Li, Pb and Cd are moderately polluted compared with the rest of elements that appear unpolluted. Normalization to Al point out that most of the stations here were found to be receiving elements from natural sources with only a few stations receiving anthropogenic inputs. In brief, most of the elements concentration was steadily maintained throughout all the season except for Ni, Cu, Co, Li, Ga, and Cd where there are significant increases in recent time. This element should be monitored in the future together with Cr, Zn and Pb distributions.

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**TABURAN ELEMEN BERDASARKAN TEMPAT DAN MASA DI
DALAM SEDIMEN PERAIRAN PANTAI TERENGGANU SELATAN.**

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Pelbagai rancangan telah dicadangkan untuk memajukan Terengganu sebagai destinasi pelancongan menjelang tahun 2015. Rancangan sebegini dipercayai berpotensi untuk menyumbang kepada peningkatan populasi penduduk Terengganu. Faktor ini boleh memberi kesan kepada alam sekitar di negeri Terengganu terutamanya kawasan persekitaran berhampiran pantai. Oleh itu, pemahaman tentang kawasan sebegini adalah amat penting untuk mewujudkan kesedaran kepada penduduk mengenai alam sekitar. Sehubungan itu, kajian ini dijalankan bertujuan untuk menentukan taburan elemen-elemen, ciri-ciri sedimen serta kandungan karbon organik di dalam sedimen di kawasan perairan pantai Terengganu Selatan supaya dapat memperolehi maklumat asas bagi memahami keadaan alam sekitar di kawasan itu.

Kajian ini telah dijalankan pada tiga transek dengan sejumlah 24 stesen pada September 2006, Mac 2007, September 2007 and November 2007. Dalam kajian ini, 17 elemen dalam sedimen halus ($<63 \mu\text{m}$) telah ditentukan dengan menggunakan 'Inductively Coupled Plasma Mass Spectrometry' (ICPMS) selepas penghadaman asid sepenuhnya. Kandungan karbon organik dianalisis dengan teknik pentitratan dikromat basah dan ciri-ciri sedimen pula ditentukan dengan menggunakan kaedah ayak kering dan 'Particle Size Analyzer' (PSA).

Variasi elemen-elemen di dalam sedimen kawasan perairan Terengganu Selatan bagi semua sesi penyampelan berada dalam lingkungan 2.08% sehingga 16.22% berat kering bagi Al; 0.16% sehingga 16.37% berat kering bagi Fe; 0.18% sehingga 18.83% berat kering bagi Ca; 0.01% sehingga 5.94% berat kering bagi Na; 0.04% sehingga 8.22% berat kering bagi Mg; 103.31 $\mu\text{g/g}$ sehingga 1448.93 $\mu\text{g/g}$ berat kering bagi Mn; 31.91 $\mu\text{g/g}$ sehingga 1232.97 $\mu\text{g/g}$ berat kering bagi Ba; 8.26 $\mu\text{g/g}$ sehingga 374.12 $\mu\text{g/g}$ berat kering bagi Cr; 3.13 $\mu\text{g/g}$ sehingga 342.60 $\mu\text{g/g}$ berat kering bagi Ni; 28.27 $\mu\text{g/g}$ sehingga 543.12 $\mu\text{g/g}$ berat kering bagi Zn; 1.44 $\mu\text{g/g}$ sehingga 86.06 $\mu\text{g/g}$ berat kering bagi Cu; 0.12 $\mu\text{g/g}$ sehingga 53.58 $\mu\text{g/g}$ berat kering bagi Co; 1.74 $\mu\text{g/g}$ sehingga 169.56 $\mu\text{g/g}$ berat kering bagi Li; 0.09 $\mu\text{g/g}$ sehingga 48.63 $\mu\text{g/g}$ berat kering bagi Ga; 0.06 $\mu\text{g/g}$ sehingga 129.80 $\mu\text{g/g}$ berat kering bagi Pb; 0.01 $\mu\text{g/g}$ sehingga 4.89 $\mu\text{g/g}$ berat kering bagi Be; 0.08 $\mu\text{g/g}$ sehingga 4.90 $\mu\text{g/g}$ berat kering bagi Cd.

Ciri-ciri sedimen di kawasan kajian merangkumi jenis pasir kasar sehingga jenis lumpur sederhana sahaja (0.22 ϕ – 6.99 ϕ). Kebanyakan stesen menunjukkan penyisihan yang lemah (1.00 ϕ – 2.00 ϕ) dan 'skew' positif (+0.10 ϕ to +0.30 ϕ). 'Kurtosis' sedimen secara keseluruhannya adalah dalam julat 'leptokurtic' sehingga sangat 'leptokurtic' pada semua musim (> 1.50 ϕ). Quartz dijumpai secara dominan dibandingkan dengan mineral liat yang dijumpai pada kuantiti sederhana sehingga rendah disebabkan lokasi kawasan kajian adalah berhampiran dengan kawasan persisiran,. Sedimen di kawasan kajian didapati masih baru dan telah mengalami sedimentasi secara pantas berdasarkan kehadiran olivine yang banyak.

Sementara itu, kandungan karbon organik dalam sedimen kawasan pesisiran pantai Terengganu Selatan adalah dalam lingkungan 0.46% sehingga 2.44% semasa September 2006; 0.30% sehingga 2.18% semasa Mac 2007; 0.17% sehingga 2.82% semasa September 2007; dan 0.29% sehingga 3.28% semasa November 2007. Elemen-elemen di kawasan kajian ini tidak menunjukkan hubungan korelasi yang baik dengan karbon organik dan saiz partikel.

Faktor pengkayaan menunjukkan Cd mengalami pengkayaan yang paling ketara manakala indeks geoakumulasi menunjukkan Ca, Zn, Li, Pb dan Cd memberikan kesan pencemaran yang sederhana dibandingkan dengan elemen lain yang tidak menunjukkan kesan pencemaran langsung. Normalisasi berdasarkan Al menunjukkan bahawa kebanyakan stesen menerima elemen-

elemen daripada sumber semulajadi dan hanya beberapa stesen menerima sumber antropogenik. Secara ringkasnya, kepekatan kebanyakan elemen adalah stabil sepanjang semua musim kecuali bagi Ni, Cu, Co, Li, Ga dan Cd yang telah menunjukkan peningkatan yang ketara sejak kebelakangan. Elemen-elemen ini perlu dipantau dan diberikan perhatian bersama dengan taburan Cr, Zn dan Pb.