

GEOCHEMISTRY AND SEDIMENTOLOGICAL
CHARACTERISTICS IN SEDIMENT OF RAKA AND DUNGUJ
RIVERS

NOF HAZRAT BIN HASSIM

FACULTY OF SCIENCE AND TECHNOLOGY
UNIVERSITY COLLEGE OF SCIENCE AND TECHNOLOGY MALAYSIA

1975

**GEOCHEMICAL AND SEDIMENTOLOGICAL CHARACTERISTICS
IN SEDIMENT OF PAKA AND DUNGUN RIVERS**

BY

NOR HAZREN BIN HASSIM

**A Project report submitted in partial fulfillment of
the requirements for the degree of
Bachelor of Science
(Marine Science)**

**FACULTY OF SCIENCE AND TECHNOLOGY
UNIVERSITY COLLEGE OF SCIENCE AND TECHNOLOGY
MALAYSIA**

2005

UNIVERSITI MALAYSIA MALAKA
FACULTY OF SCIENCE AND TECHNOLOGY

iii

UNIVERSITI MALAYSIA MALAKA

UNIVERSITI MALAYSIA MALAKA
FACULTY OF SCIENCE AND TECHNOLOGY
UNIVERSITY COLLEGE OF
SCIENCE AND TECHNOLOGY

This project report should be cited as follows:

Nor Hazren H. 2005. Geochemistry and Sedimentological Characteristics In Sediment of Paka and Dungun Rivers. Undergraduate Thesis, Bachelor of Science (Marine Science). Faculty of Science and Technology Malaysia, University College of Science and Technology. 134pp

No part of this project report may be reproduced by any mechanical, photographic, or electronic process, or in the form of phonographic recording, nor may it be stored in a retrieval system, transmitted, or otherwise copied for public or private use, without written permission from the author and the supervisor(s) of the project

1100034593



**JABATAN SAINS SAMUDERA
FAKULTI SAINS DAN TEKNOLOGI
KOLEJ UNIVERSITI SAINS DAN TEKNOLOGI MALAYSIA**

**PENGAKUAN DAN PENGESAHAN LAPORAN
PROJEK PENYELIDIKAN I DAN II**

Adalah ini diakui dan disahkan bahawa laporan penyelidikan bertajuk:

Geochemistry and Sedimentological Characteristics in Sediment of Paka and Dungun Rivers.

oleh Nor Hazren Bin Hassim, No. Matrik UK 6480 telah diperiksa dan semua pembetulan yang disarankan telah dilakukan. Laporan ini dikemukakan kepada Jabatan Sains Samudera sebagai memenuhi sebahagian daripada keperluan memperoleh Ijazah Sarjana Muda - Sains Samudera, Fakulti Sains dan Teknologi, Kolej Universiti Sains dan Teknologi Malaysia.

Disahkan oleh:

Penyelia Utama

Nama: Prof Madya Dr Kamaruzaaman Bin Hj. Yunus

Cop Rasmi:

25/3/05
Tarikh:

.....
Tandatangan Penyelia Kedua (jika ada)

Nama:

Cop Rasmi:

Tarikh:

.....
Ketua Jabatan Sains Samudera

Nama:

Cop Rasmi:

Tarikh:

ACKNOWLEDGEMENTS

Firstly, I would like to express the warmest gratitude to Associate Prof. Dr. Kamaruzzaman for his fully guidance, advices and full time monitoring us from the “zero” to become a “hero” until we are enable to complete this project.

I would like to thank Mr. Kamari, Mr. Raja, Mr. Sulaiman and Mr. Kamarun – the heroes of Oceanography - as our main backbone of this project. Without all your power of experience of years in this field, we would be able to finish this project. Not forgotten to the staff of NETLOFT, our main “life” while we faced the water during sampling made and the land transport where brought us everywhere as needed. We would not be able to move even an inch without our main pulse.

My next gratitude is expressed especially to Big Brother Ong, Willi the genius and Waque for their absolute patient in guiding and teaching me everything from A-Z throughout the whole project. To my housemates Sai, Hilmi, Epul I do appreciate your helps and caring for me during the making of my precious final year project. My close, caring, heart-kind and true colleagues – T-ha, Ija, Shae, Diey, Amri, Nande and Sya – I do remember all our sweet and sour memories we gained together during this golden 3 years. Glad to be met with you all guys! The most important and greatest thank to my beloved Abah and Mama and you are always being the pearls of my hearts.

Nor Hazren bin Hassim, Bachelor of Marine Science (2005).

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENT	ii
TABLE OF CONTENTS	iii
LIST OF TABLES	vii
LIST OF FIGURES	viii
LIST OF APPENDICES	xi
LIST OF ABBREVIATIONS	xii
ABSTRACT	xiii
ABSTRAK	xiv
 CHAPTER	
1 INTRODUCTION	1
1.1 Background of the Study	1
1.2 Objectives of the Study	3
2 LITERATURE REVIEW	4
2.1 Sedimentation Process of Bottom Sediment	4
2.2 Heavy metals	6
2.2.1 Aluminium (Al)	7

2.2.2	Manganese (Mn)	8
2.2.3	Cobalt (Co)	9
2.2.4	Copper (Cu)	10
2.2.5	Chromium (Cr)	11
2.2.6	Iron (Fe)	12
2.3	Organic Carbon	13
2.4	Physico-chemical characteristics	14
2.4.1	Temperature	14
2.4.2	pH	15
2.4.3	Salinity	16
2.4.4	Dissolved oxygen	17
2.5	Sediment Particle Texture	19
2.5.1	Sorting	20
2.5.2	Kurtosis	20
2.5.3	Skewness	21
3	MATERIALS AND METHODS	23
3.1	Research Location	23
3.2	Sampling	27
3.3	Glassware Preparation	27
3.4	Sample preparation for trace metal analysis	27
3.5	Analytical Method	28
3.5.1	Dry-sieving Method	28

3.5.2	Particle Size Analysis	29
3.5.3	Teflon Bomb Digestion	29
3.5.3.1	Blank Sample (Blank Digestion) Preparation	31
3.5.4	Organic Carbon Analysis	31
4	RESULTS	33
4.1	Heavy Metals	33
4.1.1	Recovery Test	33
4.1.2	Standard Curve	34
4.1.3	ICP-OES Analysis	35
4.1.3.1	Aluminium (Al)	36
4.1.3.2	Manganese (Mn)	38
4.1.3.3	Cobalt (Co)	40
4.1.3.4	Copper (Cu)	42
4.1.3.5	Chromium (Cr)	44
4.1.3.6	Iron (Fe)	46
4.2	Particle Size	48
4.3	Physico-chemical characteristics	56
4.3.1	Temperature	56
4.3.2	pH	60
4.3.3	Dissolved Oxygen	64
4.3.4	Salinity	68
4.4	Organic Carbon	72

5	DISCUSSION	76
	5.1 Heavy Metals	76
	5.1.1 Heavy Metals Distribution in Sediment	76
	5.1.2 Correlation Between Heavy Metals and Particle Size	78
	5.1.3 Correlation Between Heavy Metals and Organic Carbon	86
	5.1.4 Normalization	94
	5.2 Enrichment Factor	97
	5.3 Sedimentological Characteristics Changes of Sediment	99
	5.4 Physico-chemical Characteristics	102
	5.4.1 Correlation between Physico-chemical Parameters	104
	5.5 Organic Carbon	112
	5.5.1 Correlation Between Organic Carbon and Particle Size	114
6	CONCLUSION	116
	REFERENCES	118
	APPENDIXES	124
	CURRICULUM VITAE	134

LIST OF TABLES

Table	Title	Page
3.1	Global Positioning System (GPS) location of sampling station at Paka River	23
3.2	Global Positioning System (GPS) location of sampling station at Dungun River	24
4.1	Recovery test using the SRM 1646 “Estuarine Sediment”	33
4.2a	Al, Mn, Co, Cu, Cr and Fe concentration (ppm) of Paka River sediment	35
4.2b	Al, Mn, Co, Cu, Cr and Fe concentration (ppm) of Dungun River sediment	35
4.3	Mean, sorting, skewness and kurtosis of Paka River samples.	48
4.4	Mean, sorting, skewness and kurtosis of Dungun River samples.	52
4.5	Organic carbon content of Paka River sample.	72
4.6	Organic carbon content of Dungun River sample.	74
5.1	r value between heavy metals and particle mean size for Paka and Dungun River sediment	78
5.2	r value between heavy metals and organic carbon for Paka and Dungun River sediment	86
5.3a	Enrichment factors for selected metals of Paka River	97
5.3b	Enrichment factors for selected metals of Dungun River	97

LIST OF FIGURES

Figure	Title	Page
3.1	Map of research locations; Dungun River	25
3.2	Map of research locations; Paka River	26
4.1a	Standard curve for Al and Mn	34
4.1b	Standard curve for Co and Cu	34
4.1c	Standard curve for Cr and Fe	34
4.2a	Al versus station of Paka River sediment	37
4.2b	Al versus station of Dungun River sediment	37
4.3a	Mn versus station of Paka River sediment	39
4.3b	Mn versus station of Dungun River sediment	39
4.4a	Co versus station of Paka River sediment	41
4.4b	Co versus station of Dungun River sediment	41
4.5a	Cu versus station of Paka River sediment	43
4.5b	Cu versus station of Dungun River sediment	43
4.6a	Cr versus station of Paka River sediment	45
4.6b	Cr versus station of Dungun River sediment	45
4.7a	Fe versus station of Paka River sediment	47
4.7b	Fe versus station of Dungun River sediment	47
4.8a	Mean size of sediment of Paka River	50
4.8b	Sorting of sediment of Paka River.	50
4.8c	Skewness of sediment of Paka River	51
4.8d	Kurtosis of sediment of Paka River.	51
4.9a	Mean size of sediment of Dungun River.	54
4.9b	Sorting of sediment of Dungun River.	54
4.9c	Skewness of sediment of Dungun River.	55
4.9d	Kurtosis of sediment of Dungun River.	55
4.10a	The graphs of temperature trend versus depth of Paka River.	56
4.10b	The graphs of temperature trend versus depth of Paka River.	57

4.11a	The graphs of temperature trend versus depth of Dungun River.	58
4.11b	The graphs of temperature trend versus depth of Dungun River.	59
4.12a	The graphs of pH distribution versus depth of Paka River.	60
4.12b	The graphs of pH distribution versus depth of Paka River.	61
4.13a	The graphs of pH distribution versus depth of Dungun River.	62
4.13b	The graphs of pH distribution versus depth of Dungun River.	63
4.14a	The graphs of dissolved oxygen distribution versus depth of Paka River.	64
4.14b	The graphs of dissolved oxygen distribution versus depth of Paka River.	65
4.15a	The graphs of dissolved oxygen distribution versus depth of Dungun River.	66
4.15b	The graphs of dissolved oxygen distribution versus depth of Dungun River	67
4.16a	The graphs of salinity distribution versus depth of Paka River.	68
4.16b	The graphs of salinity distribution versus depth of Paka River.	69
4.17a	The graphs of salinity distribution versus depth of Dungun River.	70
4.17b	The graphs of salinity distribution versus depth of Dungun River.	71
4.18a	Percentage of organic carbon of Paka River sediment	73
4.18b	Percentage of organic carbon of Dungun River sediment	75
5.1	Correlation between Al and mean size of Paka River sediment	80
5.2	Correlation between Mn and mean size of Paka River sediment	80
5.3	Correlation between Co and mean size of Paka River sediment	81
5.4	Correlation between Cu and mean size of Paka River sediment	81
5.5	Correlation between Cr and mean size of Paka River sediment	82
5.6	Correlation between Fe and mean size of Paka River sediment	82
5.7	Correlation between Al and mean size of Dungun River sediment	83
5.8	Correlation between Mn and mean size of Dungun River sediment	83
5.9	Correlation between Co and mean size of Dungun River sediment	84
5.10	Correlation between Cu and mean size of Dungun River sediment	84
5.11	Correlation between Cr and mean size of Dungun River sediment	85
5.12	Correlation between Fe and mean size of Dungun River sediment	85
5.13	Correlation between Al and organic carbon of Paka River sediment	88

5.14	Correlation between Mn and organic carbon of Paka River sediment	88
5.15	Correlation between Co and organic carbon of Paka River sediment	89
5.16	Correlation between Cu and organic carbon of Paka River sediment	89
5.17	Correlation between Cr and organic carbon of Paka River sediment	90
5.18	Correlation between Fe and organic carbon of Paka River sediment	90
5.19	Correlation between Al and organic carbon of Dungun River sediment	91
5.20	Correlation between Mn and organic carbon of Dungun River sediment	91
5.21	Correlation between Co and organic carbon of Dungun River sediment	92
5.22	Correlation between Cu and organic carbon of Dungun River sediment	92
5.23	Correlation between Cr and organic carbon of Dungun River sediment	93
5.24	Correlation between Fe and organic carbon of Dungun River sediment	93
5.25	Chemical elements distribution of Paka River versus Al scatter plot.	95
5.26	Chemical elements distribution of Dungun River versus Al scatter plot.	96
5.27	Correlation between temperature and pH of Paka River waters	106
5.28	Correlation between temperature and salinity of Paka River waters	106
5.29	Correlation between pH and dissolved oxygen of Paka River waters	107
5.30	Correlation between temperature dissolved oxygen of Paka River waters	107
5.31	Correlation between pH and salinity of Paka River waters	108
5.32	Correlation between dissolved oxygen and salinity of Paka River waters	108
5.33	Correlation between temperature and pH of Dungun River waters	109
5.34	Correlation between temperature and dissolved oxygen of Dungun River waters	109
5.35	Correlation between temperature and salinity of Dungun River waters	110
5.36	Correlation between pH and dissolved oxygen of Dungun River waters	110
5.37	Correlation between pH and salinity of Dungun River waters	111
5.38	Correlation between dissolved oxygen salinity of Dungun River waters	111
5.39	Correlation between organic carbon (%) and mean size of Paka River samples	115
5.40	Correlation between organic carbon (%) and mean size of Paka River samples	115

LIST OF APPENDICES

Appendix	Title	Page
A1	Instruments used in particle size analysis	123
A2	Instruments used in heavy metals analysis	124
C1	Categories of sorting, kurtosis and skewness	126
C2	Flowchart of Teflon Bomb Digestion Procedures	127
C3	Category of r value	128
C4	Contamination categories of enrichment factor	128
C5	T-test result for organic carbon comparison within Paka and Dungun River sample	128
C6	T-test result for mean, sorting, skewness and kurtosis within Paka River sample	129
C7	T-test result for mean, sorting, skewness and kurtosis within Dungun River sample	130
C8	T-test result for metals concentration within sediment of Paka River	131
C9	T-test result for metals concentration within sediment of Dungun River	132

LIST OF ABBREVIATIONS

° C	degree Celsius
Ø	phi
µm	micrometer
gcm ⁻³	gram per centimeter cube
mL	milliliter
L	Liter
mg/L	milligram per liter
ng/L	nanogram per liter
µg/L	microgram per liter
ppm	part per million
st.	station
Al	Aluminium
Cd	Cadmium
Cr	Cromium
Cu	Copper
Fe	Iron
Pb	Lead
Mn	Manganese
Zn	Zinc
ICP-OES	Inductively Coupled Plasma - Optical Emission Spectrofotometer
EDTA	Ethylene Diamine Tetra Acetic Acid

ABSTRACT

Particle size, organic carbon and heavy metals for sediment obtained from both rivers with differential streaming systems. Physical parameters show an increase of temperature will decrease pH, salinity and dissolved oxygen. The particle mean size of Paka River is $0.385 \pm 0.63 \text{ } \emptyset$ and $-0.056 \pm 0.84 \text{ } \emptyset$ for particle of Dungun River. Average calculated organic carbon content shows $1.3951 \pm 0.811 \%$ and $1.8370 \pm 0.733 \%$ for Paka and Dungun River respectively. Average trace metals concentration as detected via ICP-OES for Mn is 221.37 ppm, 1.98 ppm of Fe, 4.91 ppm Al, 90.12 ppm of Cr, 22.48 ppm of Co and 24.59 ppm Cu for Paka River. Dungun River sediment consist of Mn with 350.42 ppm, Fe with 2.00 ppm, 4.26 ppm of Al, 81.40 ppm Cr, 25.51 ppm Co and 13.60 ppm Cu. Correlation between particle size and organic carbon exhibited low correlation due to r values of 0.317 and 0.200 respectively. Heavy metals against particle mean size has shown moderately correlation, low correlation with exceptional for Co element of Paka River sediment and Dungun River exhibited mostly almost negligible relationship upon particle mean size with exceptional for Fe and Al that has low correlation with samples mean size and moderate correlation for Cu. Dungun River exhibited almost negligible relationship upon organic carbon and some metals are correlated to organic carbon in Paka River. Due to normalization and enrichment factors (EFs), heavy metals found are higher in Dungun River than Paka River but not a serious problem and the high value might have derived from the same pollution sources and consider anthropogenic input.

ABSTRAK

Saiz partikel, organik karbon dan logam berat bagi sediment yang diperolehi daripada kedua-dua batang sungai yang mempunyai sistem saluran yang berlainan. Parameter fizikal menunjukkan suhu meningkat dengan penurunan pH, oksigen terlarut dan kemasinan. Min saiz partikel dari Sungai Paka adalah $0.385 \pm 0.63 \text{ } \mu\text{m}$ dan $-0.056 \pm 0.84 \text{ } \mu\text{m}$ untuk partikel Sungai Dungun. Purata peratusan kandungan karbon organik menunjukkan Sungai Paka dan Dungun adalah $1.3951 \pm 0.811\%$ dan $1.8370 \pm 0.733\%$. Purata kepekatan logam yang dikesan oleh ICP-OES logam Mn dengan 221.37 ppm, 1.98 ppm Fe, 4.91 ppm Al, 90.12 ppm Cr, 22.48 ppm Co dan 24.59 ppm Cu untuk Sungai Paka. Sediment Sungai Dungun mengandungi Mn sebanyak 350.42 ppm, 2.00 ppm Fe, 4.26 ppm Al, 81.40 ppm Cr, 25.51 ppm Co dan 13.60 ppm Cu. Korelasi di antara saiz partikel dan organik karbon mempamerkan nilai korelasi yang rendah berdasarkan nilai r masing-masing sebanyak 0.317 dan 0.200. Logam berat melawan min saiz partikel menunjukkan korelasi yang sederhana dan rendah dengan pengecualian untuk Co dari Sungai Paka manakala Sungai Dungun tiada korelasi dengan pengecualian untuk Fe dan Al yang menunjukkan korelasi yang rendah dengan min saiz sampel dan korelasi yang sederhana untuk Cu. Berdasarkan normalisasi dan faktor pengkayaan, logam berat yang dijumpai di Sungai Dungun adalah lebih tinggi dan mungkin disebabkan oleh sumber antropogenik daripada aktiviti manusia dan ia bukanlah masalah yang serius.