

GEOCHEMICAL AND SEDIMENTOLOGICAL CHARACTERISTICS OF
THE SOUTH CHINA SEA SEDIMENTS OFF TERENGGANU
DURING THE PRE AND POST MONSOON SEASONS

LIENHONG JIA

FACULTY OF SCIENCE AND TECHNOLOGY
KOLEJ UNIVERSITI SAINS DAN TEKNOLOGI MALAYSIA
2004

1100028950

PERPUSTAKAAN
KOLEJ UNIVERSITI SAINS & TEKNOLOGI MALAYSIA
(KUSTEM)

201098

Pengarang Liew Dor Jia		No. Panggilan	
Judul Geochemical and Sedimentological . . .			
Tarikh	Waktu Pemulangan	Nombor Ahli	Tanda tangan
20/8/05	3.25pm	UK 9237	J
21/8/05	1.00pm	UK 9237	en.
21/8/05	10.00 pm	UK 9237	J
09/03/07	1.40 pm	UK-10334	J

**GEOCHEMICAL AND SEDIMENTOLOGICAL CHARACTERISTICS OF
THE SOUTH CHINA SEA SEDIMENTS OFF TERENGGANU DURING THE
PRE AND POST MONSOON SEASONS**

By

Liew Dor Jia

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

**Department of Marine Science
Faculty of Science and Technology
KOLEJ UNIVERSITI SAINS DAN TEKNOLOGI MALAYSIA
2004**

This project report should be cited as:

Liew, D. J. 2004. Geochemical and sedimentological characteristics of the South China Sea sediments off Terengganu during the pre and post monsoon seasons. Undergraduate thesis, Bachelor of Science (Marine Science), Faculty of Science and Technology, Kolej Universiti Sains dan Teknologi Malaysia, Terengganu. 94p.

No part of this project may be reproduced by any mechanical, photographic, or electronic process, or in the form of photographic 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 of the project.

1100028950



**DEPARTMENT OF MARINE SCIENCE
FACULTY OF SCIENCE AND TECHNOLOGY
KOLEJ UNIVERSITI SAINS DAN TEKNOLOGI MALAYSIA**

**APPROVAL AND CERTIFICATION FORM
RESEARCH PROJECT I AND II**

I certify that the research report entitled: Geochemical And Sedimentological Characteristics Of the South China Sea Sediments Off Terengganu During The Pre And Post Monsoon Seasons by LIEW DOR JIA, Matric No. UK 5669 have been read and all corrections recommended by the examiners have been done. This research report is submitted to the Department of Marine Science in partial fulfillment of the requirements for the degree of Bachelor of Science in Marine Science, Faculty of Science and Technology, Kolej Universiti Sains dan Teknologi Malaysia.

Approved by

Supervisor

ASSOC. PROF. DR. KAMARUZZAMAN B. YUNUS
Head
Department of Marine Science
Faculty of Science and Technology Malaysia
Kolej Universiti Sains dan Teknologi Malaysia
(KUSTEM)
21030 Kuala Terengganu.

Name:

Stamp:

Date: 23/3/04

Head of Department

Name:

ASSOC. PROF. DR. KAMARUZZAMAN B. YUNUS
Head
Department of Marine Science
Faculty of Science and Technology Malaysia
Kolej Universiti Sains dan Teknologi Malaysia
(KUSTEM)
21030 Kuala Terengganu.

Stamp:

Date: 23/3/04

ACKNOWLEDGEMENTS

First and foremost, I would like to thank Assoc. Prof. Dr. Kamaruzzaman bin Haji Yunus, my supervisor for being generous in sharing his knowledge and also exposing me to what this research is all about. His guidance and patience has made my research possible and successful.

Secondly, I would like to thank Dr. Nor Antonina binti Abdullah for her advice and invaluable opinions for my project. My appreciation also goes to seniors, Jan, Waq, Willy and Ong. Thank you for sharing their experiences, assistance in collecting the samples as well as analyzing the samples in MINT.

Thanks also goes to the Faculty of Science and Technology for allowing me to use their facilities. I would also like to thank the laboratory assistants of Oceanography Laboratory, En. Sulaiman, En. Raja Razali, En. Kamarun and En. Kamari for their helping hands.

My deep gratitude goes to my family, my parents and brother for their unconditional love and support. Thanks also to my housemates: Soong, Fang, Heng and Chai Ping who tolerated me emotionally during my hard days in completing this project. I am also grateful to Siew Peng, Meng Ho, Rohana, Zairil and Nizam for discussing and solving the problems I encountered.

Last but not least, in order not to leave anyone out, thank you to all who were involved directly or indirectly during the completion of my project.

TABLE OF CONTENTS

CONTENTS	PAGE
ACKNOWLEDGEMENTS	ii
TABLE OF CONTENTS	iii
LIST OF TABLES	vi
LIST OF FIGURES	vii
LIST OF ABBREVIATIONS/ SYMBOLS	x
LIST OF APPENDICES	xi
ABSTRAK	xii
ABSTRACT	xiii
1.0 INTRODUCTION	1
1.1 OBJECTIVES	3
2.0 LITERATURE REVIEW	4
2.1 South China Sea	4
2.2 Monsoon	5
2.3 Marine Sediment	6
2.4 Particle Size	7
2.5 Organic Carbon	8
2.6 Heavy Metal	9
2.6.1 Copper (Cu)	10
2.6.2 Zinc (Zn)	11
2.6.3 Lead (Pb)	12
2.6.4 Cobalt (Co)	13

3.0	METHODOLOGY	14
3.1	Study Area	14
3.2	Sampling	16
3.3	Laboratory Analysis Preparation	16
	3.3.1 Apparatus Preparation	16
	3.3.2 Sample Preparation	17
3.4	Sediment Size Analysis	17
	3.4.1 Dry Sieving	17
	3.4.2 Particle Size Analyzer (PSA)	18
	3.4.3 Moment Method	19
3.5	Organic Carbon	20
3.6	Teflon Bomb Method	21
	3.6.1 Digestion of Sample Using Teflon Bomb Method	21
	3.6.2 Blank Sample Preparation	22
	3.6.3 Recovery Test	22
4.0	RESULTS	23
4.1	Particle Size Analysis	23
	4.1.1 Mean Size	23
	4.1.2 Sorting (Standard Deviation)	24
	4.1.3 Skewness	25
	4.1.4 Kurtosis	26
4.2	Organic Carbon	28
4.3	Heavy Metal	29
	4.3.1 Standard Curve	29
	4.3.2 Recovery Test	32

4.3.3	Copper (Cu)	33
4.3.4	Zinc (Zn)	34
4.3.5	Lead (Pb)	35
4.3.6	Cobalt (Co)	36
5.0	DISCUSSION	37
5.1	Sedimentological Characteristics	37
5.2	Organic Carbon Distribution	44
5.2.1	Relationship Between Organic Carbon And Particle Mean Size	46
5.3	Heavy Metal Distribution	48
5.3.1	Relationship Between heavy Metal And Particle Mean Size	49
5.3.2	Relationship between Heavy Metal And Organic Carbon	54
5.3.3	Normalization	59
5.3.4	Enrichment Factor	64
6.0	CONCLUSION	66
	REFERENCES	67
	APPENDICES	71
	CURRICULUM VITAE	94

LIST OF TABLES

TABLE		PAGE
3.1	Coordinates of 30 sampling stations	14
4.1	Kurtosis value and its characteristics during the pre and post monsoon seasons	27
4.2	Results of analysis of Estuarine Sediment (NBS 1646a)	32
5.1	Element concentration in earth's crust	65
5.2	Enrichment factor for respective element during pre and post monsoon	65

LIST OF FIGURES

FIGURE		PAGE
3.1	Location of sampling stations	15
4.1	Sediment mean size (ϕ) during the pre and post monsoon seasons	23
4.2	Sediment sorting (ϕ) during the pre and post monsoon seasons	24
4.3	Sediment skewness (ϕ) during the pre and post monsoon seasons	25
4.4	Sediment kurtosis (ϕ) during the pre and post monsoon seasons	26
4.5	Percentage of organic carbon during the pre and post monsoon seasons	28
4.6(a)	Standard curve for Cu	29
4.6(b)	Standard curve for Zn	29
4.6(c)	Standard curve for Pb	30
4.6(d)	Standard curve for Co	30
4.6(e)	Standard curve for Li	31
4.6(f)	Standard curve for Al	31
4.7	Cu concentration during the pre and post monsoon seasons	33
4.8	Zn concentration during the pre and post monsoon seasons	34
4.9	Pb concentration during the pre and post monsoon seasons	35
4.10	Co concentration during the pre and post monsoon seasons	36
5.1	Relationship between sorting and mean size	40
5.2(a)	Distribution of mean size (ϕ) during the pre monsoon season	41
5.2(b)	Distribution of mean size (ϕ) during the post monsoon season	41
5.3(a)	Distribution of sorting (ϕ) during the pre monsoon season	42

5.3(b)	Distribution of sorting (\emptyset) during the post monsoon season	42
5.4(a)	Distribution of skewness (\emptyset) during the pre monsoon season	43
5.4(b)	Distribution of skewness (\emptyset) during the post monsoon season	43
5.5(a)	Distribution of organic carbon (%) during the pre monsoon season	45
5.5(b)	Distribution of organic carbon (%) during the post monsoon season	45
5.6(a)	Relationship between organic carbon and particle mean size during the pre monsoon season	47
5.6(b)	Relationship between organic carbon and particle mean size during the post monsoon season	47
5.7(a)	Relationship between Cu and particle mean size during the pre monsoon season	50
5.7(b)	Relationship between Cu and particle mean size during the post monsoon season	50
5.8(a)	Relationship between Zn and particle mean size during the pre monsoon season	51
5.8(b)	Relationship between Zn and particle mean size during the post monsoon season	51
5.9(a)	Relationship between Pb and particle mean size during the pre monsoon season	52
5.9(b)	Relationship between Pb and particle mean size during the post monsoon season	52
5.10(a)	Relationship between Co and particle mean size during the pre monsoon season	53
5.10(b)	Relationship between Co and particle mean size during the post monsoon season	53
5.11(a)	Relationship between Cu and organic carbon during the pre monsoon season	55
5.11(b)	Relationship between Cu and organic carbon during the post monsoon season	55
5.12(a)	Relationship between Zn and organic carbon during the pre monsoon season	56

5.12(b)	Relationship between Zn and organic carbon during the post monsoon season	56
5.13(a)	Relationship between Pb and organic carbon during the pre monsoon season	57
5.13(b)	Relationship between Pb and organic carbon during the post monsoon season	57
5.14(a)	Relationship between Co and organic carbon during the pre monsoon season	58
5.14(b)	Relationship between Co and organic carbon during the post monsoon season	58
5.15(a)	Normalization graph for Cu during pre monsoon season	60
5.15(b)	Normalization graph for Cu during post monsoon season	60
5.16(a)	Normalization graph for Zn during pre monsoon season	61
5.16(b)	Normalization graph for Zn during post monsoon season	61
5.17(a)	Normalization graph for Pb during pre monsoon season	62
5.17(b)	Normalization graph for Pb during post monsoon season	62
5.18(a)	Normalization graph for Co during pre monsoon season	63
5.18(b)	Normalization graph for Co during post monsoon season	63

LIST OF ABBREVIATIONS/ SYMBOLS

%	percentage
°C	degree Celsius
Ø	phi
g	gram
g.cm ⁻³	gram per centimeter cube
mg.L ⁻¹	milligram per liter
L	liter
µm	micrometer
mm	millimeter
mL	milliliter
ppm	part per million
ppb	part per billion
Cu	Copper
Zn	Zinc
Pb	Lead
Co	Cobalt
Li	Lithium
Al	Aluminium
EDTA	Ethylendiamenetetra Acid
GPS	Global Positioning System
PSA	Particle Size Analyzer
ICP-MS	Inductively Coupled Plasma-Mass Spectrometry

LIST OF APPENDICES

APPENDIX		PAGE
1	Data of sedimentological characteristics during the pre monsoon	71
2	Data of sedimentological characteristics during the post monsoon	72
3	<i>t</i> -test results for sedimentological characteristics	73
4	Wentworth particle size classification	75
5	Sorting, skewness and kurtosis characteristics	76
6	Data of organic carbon during the pre monsoon	77
7	Data of organic carbon during the post monsoon	79
8	<i>t</i> -test results for organic carbon	81
9	Data of heavy metal during the pre monsoon	82
10	Data of heavy metal during the post monsoon	83
11	<i>t</i> -test results for heavy metal	84
12	Correlation results for organic carbon and mean size	86
13	Correlation results for heavy metal and mean size during pre monsoon	87
14	Correlation results for heavy metal and mean size during post monsoon	88
15	Correlation results for heavy metal and organic carbon during pre monsoon	89
16	Correlation results for heavy metal and organic carbon during post monsoon	90
17	Apparatus used during sampling	91
18	Apparatus used in particle size analysis	92
19	Apparatus used in heavy metal analysis	93

ABSTRAK

Saiz partikel sedimen telah dikaji untuk musim sebelum dan selepas monsun. Min saiz sedimen adalah lebih rendah selepas monsun. Julat min saiz bagi musim sebelum dan selepas monsun adalah $-0.01 \text{ } \emptyset$ hingga $6.80 \text{ } \emptyset$ dan $0.03 \text{ } \emptyset$ hingga $6.32 \text{ } \emptyset$ masing-masing. Peratusan karbon organik berada dalam julat 0.60% hingga 2.34% sebelum monsun dan 0.24% hingga 1.68% selepas monsun. Kolerasi antara peratusan karbon organik dengan min saiz partikel adalah lemah. Kepekatan purata Cu pada musim sebelum dan selepas monsun adalah masing-masing $14.47 \pm 6.44 \text{ } \mu\text{g.g}^{-1}$ dan $9.97 \pm 5.14 \text{ } \mu\text{g.g}^{-1}$. Bagi Zn pula, kepekatan purata adalah $56.33 \pm 24.90 \text{ } \mu\text{g.g}^{-1}$ sebelum monsun dan $60.74 \pm 17.51 \text{ } \mu\text{g.g}^{-1}$ selepas monsun. Pb mempunyai kepekatan purata sebanyak $18.89 \pm 5.76 \text{ } \mu\text{g.g}^{-1}$ sebelum monsun manakala $17.06 \pm 5.81 \text{ } \mu\text{g.g}^{-1}$ selepas monsun. Kepekatan purata untuk Co pula adalah $7.66 \pm 2.49 \text{ } \mu\text{g.g}^{-1}$ sebelum monsun dan $7.65 \pm 3.61 \text{ } \mu\text{g.g}^{-1}$ selepas monsun. Logam berat yang terpilih tersebut mempunyai kolerasi yang lemah dengan min saiz partikel dan juga peratusan karbon organik. Pernormalan dan faktor pengkayaan menunjukkan sumber bagi Cu, Zn, Pb dan Co adalah semulajadi.

ABSTRACT

Sediment particle size was studied during the pre and post monsoon seasons. The value of sediment mean size was found to be lower during the post monsoon seasons. The mean size ranged between $-0.01 \text{ } \emptyset$ to $6.80 \text{ } \emptyset$ and $0.03 \text{ } \emptyset$ to $6.32 \text{ } \emptyset$ during both the pre and post monsoon seasons respectively. The organic carbon content ranged between 0.60 % to 2.34 % during the pre monsoon season and 0.24 % to 1.68 % during the post monsoon season. Correlation between organic carbon content and particle mean size was found to be weak. Cu had an average concentration of $14.47 \pm 6.44 \text{ } \mu\text{g.g}^{-1}$ and $9.97 \pm 5.14 \text{ } \mu\text{g.g}^{-1}$ during the pre and post-monsoons, respectively. Zn had an average concentration of $56.33 \pm 24.90 \text{ } \mu\text{g.g}^{-1}$ and $60.74 \pm 17.51 \text{ } \mu\text{g.g}^{-1}$ during the pre and post-monsoons, respectively. Pb had an average concentration of $18.89 \pm 5.76 \text{ } \mu\text{g.g}^{-1}$ and $17.06 \pm 5.81 \text{ } \mu\text{g.g}^{-1}$ during the pre and post-monsoons, respectively. Co had an average concentration of $7.66 \pm 2.49 \text{ } \mu\text{g.g}^{-1}$ and $7.65 \pm 3.61 \text{ } \mu\text{g.g}^{-1}$ during the pre and post-monsoons, respectively. The selected heavy metals had a weak correlation with both particle mean size and organic carbon content. Normalization and enrichment factor showed that the source for Cu, Zn, Pb and Co was of natural origin.