UNIVERSITI PUTRA MALAYSIA

MORPHOLOGICAL, SEDIMENTARY AND CHEMICAL CHANGES IN BEACHES AT HARMUL, MAJEES AND ZAFARAN, OMAN

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MORPHOLOGICAL, SEDIMENTARY AND CHEMICAL CHANGES IN BEACHES AT HARMUL, MAJEES AND ZAFARAN, OMAN

By

Wahid Mohammed Abdullah Al-Shuely

Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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DEDICATION

To the people whom I love most, my mother, my wife, my children;
Dua'a, Abdullah, Sajda, Balqees, Taqwa, Ammar, and my brothers and sisters.

To those who helped me achieve my goal, all what I can say is
thank you, and ALLAH bless you all.

DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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WAHID MOHAMMED AL-SHUELY

Date: 24 March 2011

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I certify that an Examination Committee has met on **date of viva voce to** conduct the final examination of **Wahid Mohammed Abdullah Al-Shuely** on his **PhD** thesis entitled **MORPHOLOGICAL, SEDIMENTARY AND CHEMICAL CHANGES IN BEACHES AT HARMUL, MAJEES, AND ZAFARAN, OMAN** in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Degree of Doctor of Philosophy.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of **Doctor of Philosophy**. The members of the Supervisory Committee were as follows:

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia
in fulfilment of the requirement for the degree of
Doctor of Philosophy

MORPHOLOGICAL, SEDIMENTARY AND CHEMICAL CHANGES IN BEACHES AT HARMUL, MAJEES AND ZAFARAN, OMAN

By

WAHID MOHAMMED AL-SHUELY

March 2011

Chair: Associate Professor Zelina Zaiton Ibrahim, PhD

Faculty: Environmental Studies

This thesis examines the morphological changes of three beaches close to Sohar Industrial Are (SIA), a newly developed industrial area north of the Batinah Region in Oman. The construction work on the port breakwaters started in 1999 and was complete 2002. Three sites were selected for this project: Harmul, located north of SIA, Majees south of SIA, and Zafaran, about nine kilometers south of Majees. The main purpose of this thesis is study the changes likely to occur on beaches north and south of SIA. Major focus will be on beach profiles and sediment characterization with respect to mean, sorting, skewness, particle distribution, particle density, and bulk density. Sediment samples were also analyzed for 11 heavy metals including: vanadium (V), chromium (Cr), manganese (Mn), nickel (Ni), copper (Cu), selenium

(Se), mercury (Hg), cadmium (Cd), lead (Pb), zinc (Zn) and arsenic (As) using microwave digestion followed by Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). No previous study had been conducted on these beaches. Although a comprehensive master plan was developed for Sohar industrial area, which included a strategic environmental impact assessment, the master plan contained little information on physical and chemical characteristics of beaches north and south of the industrial area. A total of 252 surface sediment samples were collected in four site visits over 12 months: November 2005, February 2006, June 2006, and November 2006. Each site was divided into seven stations. Three sediment samples were collected from each station from highwater, intertidal and surf zones. Beach profiles showed little seasonal variations in 67% of profiles surveyed and about 24% showed big seasonal variations. Almost 81% of all samples were fine sand and 19% were medium sand. Moderately sorted sediments represented 56% of all samples, whereas 22% of samples were moderately well sorted and 22% were poorly sorted. Half of the samples were near symmetrical, whereas 39% of the samples were coarsely skewed and 11% were fine skewed. Sediment trend analysis showed that *wadis* were the main source of sediments in the study area. June 2006 samples had a higher particle density than November 2006 samples. There was no significant difference in sediment bulk density between the three sites for June 2006 samples ($p = 0.203$) but significant difference was found in November 2006 samples ($p=0.015$). The concentrations of chromium, manganese, and vanadium were higher in Harmul than Majees and Zafaran. Arsenic concentration was generally low except in few stations. It is concluded that the impacts of Sohar industrial area on these beaches are

still not apparent but more research is needed to identify any impacts in its early stage and set prevention and mitigation measure programs to reduce the anticipated impacts of Sohar industrial area on the beach environment.

Abstrak tesis yang dikemukan kepada Senat Universiti Putra Malaysia Sebagai memenuhi keperluan untuk ijazah Doctor Falsafah

MORFOLOGI, MENDAPAN DAN PERUBAHAN KIMIA DI PANTAI HARMUL, MAJEES DAN ZAFARAN, OMAN

Oleh

WAHID MOHAMMED AL-SHUELY

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Tesis ini mengkaji perubahan morfologi di tiga pantai berhampiran dengan kawasan perinduttrian Sohar (SIA). kawasan utara daerah Batinah negara Oman. Kerja peminaan di pelabuhan pemecah ombak bermula pada 1999 dan siap pada 2002. Tiga tapak telah dipilih untuk projek ini: Harmul terletak di utara kawasan perindustrian besar yang sedang dalam pembinaan, manakala Majees di selatan kawasan perindustrian tersebut dan Zafaran, sembilan kilometer daripada Majees di sebelah selatan. Tujuan utama thesis ini ialah menykaji perubahan yang berlaku di utaran dan selatan SIA. Fokus tesis ini adalah pada pencirian enapan dari segi min, pengisihan, kepencongan, taburan zarah, ketumpatan zarah dan ketumpatan pukal. Sampel enapan di analisa bagi 11 logam berat: vanadium (V), kromium (Cr), mangan (Mn), nikel (Ni), kuprum (Cu), selenium (Se), raksa (Hg), kadmium (Cd), plumbum (Pb), zink (Zn) dan arsenik (As) dengan menggunakan pencernaan mikrogelombang di ikuti dengan Spektrometri Jisim-Plasma Terganding Beraruhan (*Inductively*

Coupled Plasma-Mass Spectrometry atau ICP-MS). Sebelum ini, tiada kajian yang dijalankan pada pantai-pantai tersebut. Walaupun satu pelan induk komprehensif telah dibangunkan untuk kawasan perindustrian Sohar, termasuk satu penilaian strategik kesan terhadap alam, pelan induk tersebut mengandungi sedikit maklumat mengenai ciri-ciri fizikal dan kimia pantai-pantai di sebelah utara dan selatan kawasan perindustrian tersebut. Sebanyak 252 sampel enapan permukaan diambil daripada empat lawatan tapak sepanjang 12 bulan: November 2005, Februari 2006, Jun 2006 dan November 2006. Setiap tapak dibahagikan kepada tujuh stesen. Tiga sampel enapan telah diambil daripada setiap stesen ketika air pasang, antara pasang surut dan zon buih. 67% profil pantai yang dikaji tidak menunjukkan variasi bermusim yang ketara dan kira-kira 24% menunjukkan variasi bermusim yang ketara. Hampir 81% dari seluruh sampel pasir halus dan 19% adalah pasir sedang. Cukup sedimen diurutkan mewakili 56% dari seluruh sampel, sedangkan 22% dari sampel yang cukup baik ditapis dan 22% adalah buruk ditapis. Separuh dari sampel berhampiran simetris, sedangkan 39% dari sampel kasar miring dan 11% baik-baik saja miring. analisis kecenderungan sedimen menunjukkan bahawa wadi adalah sumber utama dari sedimen di kawasan kajian. Penumpuan kromium, mangan dan vanadium adalah lebih tinggi di Harmul berbanding dengan Majees dan Zafaran. Secara umum, penumpuan arsenik adalah rendah kecuali di beberapa stesen. Untuk kesimpulan, kesan kawasan perindustrian Sohar terhadap pantai-pantai ini masih belum ketara tetapi kajian yang lebih banyak perlu dijalankan bagi mengenalpasti sebarang kesan dalam peringkat awal ini dan menetapkan langkah-langkah program

pencegahan dan program tebatan untuk mengurangkan kesan-kesan yang dijangka daripada kawasan perindustrian Sohar kepada persekitaran pantai.

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