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DOCTOR OF PHILOSOPHY

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RESPONSE OF INCISED VALLEY SYSTEMS WITH SEA LEVEL CHANGE DURING LATE PLEISTOCENE-HOLOCENE AT PENYU BASIN, SUNDA SHELF

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Thesis Submitted in Fulfillment of the Requirements for the
Degree of Doctor of Philosophy in the
School of Marine and Environment sciences
Universiti Malaysia Terengganu

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DEDICATION

Dedicated to:

My parents for whom I am here, my son Umar, who is my inspiration,
my wife Moonmoon, who supports in all aspect,
my elder brother Mr. Hafiz, whose support and finance make it happened.

Abstract of the thesis presented to the Senate of Universiti Malaysia Terengganu
in the fulfillment of the requirement for the degree of the
Doctor of Philosophy.

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Main Supervisor : Associate Professor Edlic Sathiamurthy, Ph.D.

Co-supervisor : Professor Karl Stattegger, Ph.D.

School : School of Marine and Environmental Sciences

Valley incision and infilling, as well as the fluvial response of uppermost Pilong formation in Penyu Basin located offshore of present-day Pahang River Basin, Peninsular Malaysia during Late Pleistocene-Mid Holocene was studied. A detailed study of time slices, horizon surfaces and vertical sections of three-dimensional (3D) volume data, high-resolution two-dimensional (2D) CHIRP acoustic profiles, and seabed bathymetric data provided a very good opportunity to delineate the changes of the deglacial fluvial pattern as well as its internal morphology and its evolution through geologic time. Based on the fluvial origin, plan-view pattern and internal architecture, six classes of deglacial fluvial sequences have been categorized.

The lowermost sequence is classified as straighter incised valley system with incised dendritic tributary valley system that is characterized by braided channel system followed by high sinuous meander belt associated with confined meander channel system. Later, fluvial regress response from meander belt to a braided valley system

that may be characterized by the onset of Younger Dryas (YD) event or smaller regressive cycle within the transgressive phase. Further, the braided valley system was reverted into a meander belt again that may be distinguished as termination of YD event or smaller regressive cycle. Low sinuosity channel system and the presence of dendritic drainage and tidal creeks is overlain by a younger meander system is characterized by low energy and avulsive system at lower course fluvial system associated with the nearshore environment. Deltaic distributary channel system was recognized in the uppermost fluvial system just before complete submergence.

High-resolution CHIRP acoustic profiles illustrate the incision and infilling pattern, internal channel morphology and their lateral shifting and vertical aggradations. Three distinct facies was categorized in the studied transects. The lower unit (unit-III) is denoted as possible Late Pleistocene highstand facies. A prominent sequence boundary is characterized by erosional surface possibly demarcates the lowstand condition during last glacial maximum (LGM). During the early transgressive phase, the valley system started to infill and also started to respond as vertical aggradation and lateral shifting probably due to base-level fluctuations. Several deglacial phases of the incision and infilling appeared within the unit. In general, the channel size tends to decrease upward in depth and width, as well as channel bank gradient. The fluvial facies is bounded by a ravinement surface that is characterized by high-amplitude reflector surface that is demarcated the transitional facies between fluvially dominated sediment with tide dominated sediment reflects an estuarine condition. A continuous stratified shallow marine cover is overlain the ravinement surface. The seafloor bathymetry shows few depression conditions that neither

follows the lowstand incised valley/channel system nor the last active channel system. Evidence of fluvial morphology during possible lowstand to flooding of the area suggest the downstream control i.e., sea level fluctuation was possibly the main active forcing to change the fluvial system. This forcing may also couple with other climate-induced upstream control e.g., fluvial discharge, sediment supply, and tectonics.

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu
Sebagai memenuhi keperluan untuk ijazah Doktor Falsafah.

TINDAK BALAS PEMOTONGAN LEMBAH SEMASA PERUBAHAN ARAS LAUT PADA AKHIR PLEISTOSEN-HOLOSIN DI PENYU BASIN, PENTAS SUNDA.

MD MOSTAFIZUR RAHMAN

Ogos 2016

Penyelia Utama : Profesor Madya Edlic Sathiamurthy, Ph.D.

Penyelia Bersama : Profesor Karl Stattegger, Ph.D.

Pusat Pengajian : Pusat Pengajian Sains Marin dan Sekitaran

Pemotongan dan pengisian lembah bersama tindakbalas formasi pilong terawal di dalam Lembangan Penyu yang terletak di luar perairan Sungai Pahang, Semenanjung Malaysia di akhir era Pleistosin-pertengahan Holosin telah dikaji. Kajian terperinci ini merangkum waktu, permukaan mendatar dan bahagian menegak data profil imej tiga dimensi (3D), imej profil akustik CHIRP dua dimensi (2D) beresolusi tinggi, corak kesan nyah-glasieran dan morfologi dalaman beserta evolusi masa geologi. Berdasarkan corak awal fluvial, corak pandangan pelan dan reka bentuk dalaman, enam urutan fluvial terhadap nyah-glasieran telah dapat dikategorikan.

Urutan yang paling bawah dikelaskan sebagai sistem pemotongan lembah secara menegak di mana sistem pemotongan lembah sungai berbentuk dendrit dicirikan oleh sistem sungai beralur diikuti dengan jalinan meander sungai yang sangat berlekuk yang berasosiasi dengan sistem sungai bermeander jenis terhad. Seterusnya, tindakbalas penyusutan fluvial daripada lingkaran meander sungai menjadi sistem

lembah beralur yang mungkin dicirikan oleh permulaan episod Dryas Awal (YD) atau kitaran penyusutan yang lebih kecil di dalam fasa transgesif. Kemudian, sistem lembah beralur tersebut dipesongkan menjadi kembali ikatan meander yang mungkin dibezakan sebagai pengasingan episod YD atau kitaran regresif yang lebih kecil. Sistem saluran kurang melengkung dan kehadiran saliran dendritik beserta anak-anak sungai pasang surut adalah ditindih oleh sistem meander yang lebih muda yang dicirikan oleh sistem sungai avulsif dan bertenaga rendah di dalam sistem fluvial yang lebih rendah berasosiasi dengan sekitaran berhampiran pantai. Sistem saluran delta telah dikenalpasti di dalam sistem sungai teratas sebelum ianya tenggelam sepenuhya.

Profil akustik CHIRP resolusi tinggi menggambarkan corak pemotongan dan pegisian, saluran morfologi dalaman dan pergerakan lateral beserta enapan-enapan menegak. Tiga fasies berbeza telah dikategorikan di dalam transek kajian. Unit yang lebih rendah (unit III) ditandakan berkemungkinan daripada fasies lebihan ruangan enapan di akhir era Pleistosin. Sempadan urutan utama dicirikan oleh permukaan hakisan yang mungkin menentukan keadaan enapan terawal selepas kenaikan paras laut ketika pengglasieran terakhir yang maksimum (LGM). Semasa fasa transgresif awal, sistem lembah telah mula terisi dan mula untuk memberikan tindak balas kepada enapan menegak dan pergerakan lateral berkemungkinan disebabkan oleh paras pasang surut terawal. Beberapa fasa nyah-glasieran terhadap pemotongan dan pengisian unit telah muncul. Secara amnya, saiz saliran cenderung untuk berkurang secara menaik dengan bertambahnya kedalaman, lebar dan gradien tebing sungai. Fasies fluvial disempadani oleh permukaan terisi sedimen yang dicirikan oleh permukaan reflektor beramplitud tinggi yang mempunyai fasies transisi di antara

sedimen fluvial yang di dominasi oleh sedimen pasang surut dominan yang mencerminkan keadaan suatu muar. Stratigrafi laut cetek yang berterusan ditindih oleh permukaan permukaan terisi sedimen. Bathymetry permukaan laut menunjukkan beberapa keadaan yang terimpak yang mana kedua-duanya tidak mengikut pengisian sistem lembah enapan terawal ketika kenaikan paras laut mahupun sistem saliran aktif yag terakhir. Bukti morfologi sungai semasa enapan terawal sebelum peningkatan paras laut sehingga limpahan sungai menunjukkan pengawalan hilir. Sebagai contoh turun naik paras laut berkemungkinan adalah daya aktif utama yang merubah system fluvial. Daya ini berkemungkinan juga bersama-sama pengawalan-cuaca di kawasan hilir seperti pelepasan fluvial, bekalan sedimen dan tektonik.