

**LITHOFACIES ANALYSIS AND RESERVOIR
POTENTIAL OF THE BELAIT FORMATION,
LABUAN ISLAND, MALAYSIA**

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ABSTRACT

LITHOFACIES ANALYSIS AND RESERVOIR POTENTIAL OF THE BELAIT FORMATION, LABUAN ISLAND, MALAYSIA.

The Neogene sedimentary rocks of the Labuan Island consist of two lithostratigraphic units – the Setap Shale Formation (Middle Miocene) and the Belait Formation (Late Miocene). The sandstones are very fine to conglomeratic, moderately well-sorted to well-sorted, texturally and mineralogically mature quartz arenites, with subordinate subliarenites. The field characteristic of the clastic sequence of the Neogene sediments were studied using lithofacies analysis and interpreted to have deposited within the prograding shoreface sequence consists of upward coarsening unit. Combining information from trace fossils and sedimentary structures allow the subdivision of the sequence into deposits of the foreshore (Lithofacies A), upper shoreface (Lithofacies B), lower shoreface (Lithofacies C), and distal lower shoreface to inner shelf (Lithofacies D). The sedimentary structures found can be interpreted as a product of a combination of both bed load sediment transport and sediment falling out of suspension. The Neogene reservoir interval comprises two lithofacies association; storm and wave-dominated middle shoreface to inner-shelf (Lithofacies Association 1), and wave-dominated upper shoreface and foreshore (Lithofacies Association 2). Very good quality reservoir rocks were represented by Lithofacies B (average RQI is 1.322). The poorest quality of reservoir rocks is Lithofacies D (average RQI is 0.108). Low reservoir permeability (generally less than 1mD) and porosity (less than 20%) are interpreted to be the result of early compaction, cementation, and diagenesis. The Belait sandstone diagenetic processes include clay infiltration, compaction and cementation (quartz overgrowth, calcite, kaolinite, trace amount of K-feldspar overgrowth, and illite). Quartz is the dominant pore occluding cement and generally occurred as small euhedral crystal, locally as large pyramidal crystals in the primary pores. Pressure solution derived from grain contact is the main contributor of quartz overgrowth. Calcite occurs as pore filling. Kaolinite locally developed similarly like 'book sheets' and authigenic illite exhibits fibrous morphology filling pores. These clays enhance ineffective microporosity. Porosity and permeability data exhibit good inverse correlation with cement. However, some data points indicate multiple controls on permeability. Reservoir quality thus controlled by other factors such as pore occluding cement, textural parameters (grain size, pore size, and sorting), depositional environment, and diagenesis.

ABSTRAK

Batuan sedimen Neogene di Pulau Labuan terdiri daripada dua unit litostratigrafi – Formasi Setap Shale (Miocene Tengah) dan Formasi Belait (Miocene Lewat). Batu pasirnya bersaiz sangat halus hingga konglomerat, bertenturan sederhana hingga sangat baik, dan dikelaskan sebagai arenit kuarza hingga sublitarenit yang matang dari segi tekstur dan mineral. Ciri-ciri jujukan klastik batuan sedimen Neogene telah dikaji menggunakan pendekatan analisis litofasis. Ini menghasilkan interpretasi bahawa sedimen tersebut telah dimendapkan di kawasan progradasi laut cetek yang terdiri daripada jujukan mengkasar keatas. Dengan menggabungkan maklumat daripada fosil surih dan struktur-struktur sedimen, pembahagian jujukan Neogene telah dipecahkan kepada mendapan pesisir depan (Litofasis A), pantai atas (Litofasis B), pantai bawah (Litofasis C), dan pantai bawah distal hingga pelantar dalam (Litofasis D). Struktur sedimen yang terbentuk adalah hasil daripada kombinasi pengangkutan bahan sedimen dari beban lapisan dan pergolekan secara turun naik. Batuan penakung tersebut terdiri daripada dua asosiasi litofasis; pantai tengah hingga lembangan dalam yang dipengaruhi ribut dan ombak (Asosiasi Litofasis 1), dan pantai atas hingga pesisir depan yang dipengaruhi oleh ombak (Asosiasi Litofasis 2). Litofasis B adalah batuan penakung yang paling baik (RQI purata 1.322) Litofasis D adalah batuan penakung yang paling rendah kualitinya (RQI purata 0.108). Ketelapan batuan penakung yang rendah (<1mD) dan keporosan (<20%) dipercayai kerana pengaruh daripada proses pepadatan awal, penyimenan, dan diagenesis. Proses diagenetik batu pasir Belait termasuklah pengisian rongga oleh lempung, pepadatan, dan penyimenan oleh kuarza lampau besar, kalsit, kaolinit, dan sedikit K-feldspar lampau besar dan illit. Kuarza adalah mineral dominan sebagai simen yang mengisi rongga, dan secara umumnya wujud sebagai kristal euhedral. Secara lokalnya, kuarza membentuk kristal piramid yang besar dalam rongga. Kesan tekanan pada persentuhan butiran merupakan penyebab utama kewujudan kuarza lampau besar. Kalsit wujud sebagai pengisi rongga. Kaolinit bertabiat seperti buku dan illit bersifat autigen bergentian. Ia memberi kesan keporosan yang tidak efektif. Data keporosan dan ketelapan menunjukkan korelasi secara berbalik dengan simen. Sesetengah data menunjukkan faktor lain yang mempengaruhi ketelapan. Antaranya adalah simen, parameter-parameter tekstur (saiz butiran, rongga, dan tentuaturan), sekitaran pengendapan, dan diagenesis.

LIST OF CONTENTS

	Page
TITLE	i
DECLARATION	ii
CERTIFICATION	iii
ACKNOWLEDGEMENT	iv
ABSTRACT	vi
<i>ABSTRAK</i>	vii
LIST OF CONTENTS	viii
LIST OF TABLES	xiii
LIST OF FIGURES	xvii
LIST OF PHOTOGRAPHS	xxx
LIST OF PHOTOMICROGRAPHS	xliv
LIST OF ABBREVIATIONS	lii
CHAPTER 1: INTRODUCTION	
1.1 General Background	1
1.2 Research Objectives	3
1.3 Research Importance	3
1.4 Problem Statements and Justifications	4

1.5	Study Area	7
1.5.1	Location	7
1.5.2	Geography	10
1.5.3	Geomorphology	12

CHAPTER 2: MATERIALS AND METHODOLOGIES

2.1	Introduction	16
2.2	Preliminary Researches	16
2.3	Materials	18
2.4	Field Studies	18
2.4.1	General geology studies	18
2.4.2	Sedimentology and lithofacies studies	19
2.5	Sampling Methods	19
2.6	Laboratory Investigations	19
2.6.1	Thin Section Petrography	20
2.6.2	Grain Size Analysis	21
2.6.3	X-Ray Diffraction (XRD)	25
2.6.4	Scanning Electron Microscopy (SEM) and Energy Dispersive X-Ray (EDX)	27
2.6.5	Petrophysical Analyses	29
2.7	Data Analyses and Interpretations	39
2.8	Report Writing	39

CHAPTER 3: LITERATURE REVIEWS

3.1	Introduction	40
3.2	General Backgrounds of the Neogene Basins and Deposits	40
3.3	Summary of Tectonic Settings	42
3.4	Outlined of Previous Geological Works	45
3.5	Historical Development of Stratigraphical Terminology and Lithostratigraphic Units of the Labuan Island	46
3.6	Lithostratigraphic Units of the Study Area	62
3.6.1	The Crocker Formation	66

3.6.2	The Temburong Formation	67
3.6.3	The Setap Shale Formation	69
3.6.4	The Belait Formation	71
3.7	Sedimentology, Facies, and Interpretation of Depositional Environments and Modeling	74
3.8	Geochemical and Source Rock Studies	80
3.9	Diagenesis, Reservoir Characteristic and Reservoir Potential	83
3.10	Conclusions Remarks	84

**CHAPTER 4: GENERAL GEOLOGY, AND LITHOFACIES ANALYSIS
AND DEPOSITIONAL ENVIRONMENT**

4.1	Introduction	86
4.2	Field Observation and Mapping	87
4.2.1	The Crocker Formation	92
4.2.2	The Temburong Formation	100
4.2.3	The Setap Shale Formation	104
4.2.4	The Belait Formation	115
4.2.5	Quaternary Alluvium	154
4.3	Structural Geology	154
4.3.1	Regional Context	155
4.3.2	Local Context	156
4.4	Geological Process/History	167
4.4.1	Jurassic to Late Cretaceous	167
4.4.2	Palaeocene and Eocene	167
4.4.3	Oligocene to Upper Miocene	167
4.4.4	Upper Miocene to Eocene	169
4.4.5	Pliocene to Quaternary	172
4.5	Lithofacies Analysis (Outline of Lithofacies Description of the Neogene Formations)	173
4.5.1	Lithofacies A: Planar and Bioturbated Sandstones	175
4.5.2	Lithofacies B: Trough Cross-stratified Sandstones	182

4.5.3	Lithofacies C: Hummocky and Swaley Cross-stratified Sandstones	195
4.5.4	Lithofacies D: Association of Interbedded of Thin Sandstones and Shales	213
4.6	Lithofacies Associations and Models of the Neogene Sediments	226
4.6.1	Lithofacies Association 1 (LA 1): Storm and Wave-Dominated Middle Shoreface to Inner-Shelf	227
4.6.2	Lithofacies Association 2 (LA 2): Wave-Dominated Upper Shoreface and Foreshore	231
4.7	Palaeocurrent Analysis	234
4.8	Lateral Distribution of Lithofacies in the Neogene Sedimentary Rocks of the Labuan Island	240
4.9	Depositional Model of the Labuan Island	246
4.9.1	Phase One	247
4.9.2	Phase Two	248
4.9.3	Phase Three	248
CHAPTER 5: PETROPHYSICAL PROPERTIES, RESERVOIR POTENTIAL AND DIAGENESIS		
5.1	Introduction	249
5.2	Lithofacies A (Planar and Bioturbated Sandstones)	250
5.2.1	Grain Size Analysis; Textural Parameters of the Sandstones	250
5.2.2	Mineralogical Features	254
5.2.2	Reservoir Characterizations	267
5.3	Lithofacies B (Trough Cross-stratified Sandstones)	271
5.3.1	Grain Size Analysis; Textural Parameters of the Sandstones	271
5.3.2	Mineralogical Features	274
5.3.3	Reservoir Characterizations	285
5.4	Lithofacies C (Hummocky and Swalley Cross-stratified Sandstones)	289
5.4.1	Grain Size Analysis; Textural Parameters of the Sandstones	289
5.4.2	Mineralogical Features	293
5.4.3	Reservoir Characterizations	302

5.5	Lithofacies D (Association of Interbedded of Thin Sandstones and Shales)	307
5.5.1	Grain Size Analysis; Textural Parameters of the Sandstones	307
5.5.2	Mineralogical Features	310
5.5.3	Reservoir Characterizations	320
5.6	Discussion and Summary	323
5.6.1	Grain Size Analysis	323
5.6.2	Mineralogical Features	324
5.6.3	Sandstone Maturity	327
5.6.4	Provenance and Tectonic Settings	328
5.6.5	Climate and Sandstone Composition	331
5.6.6	Porosity vs. Permeability Relationship	332
5.6.7	Sandstone Diagenetic Evidences	336
5.6.8	Diagenesis and Diagenetic Evolution	343
5.6.9	Controlling Factors on Reservoir Quality	351
CHAPTER 6: CONCLUSION		
6.1	Conclusion	364
6.1.1	Geological History/Process	364
6.1.2	Lithofacies Analysis	365
6.1.3	Lithofacies Association	366
6.1.4	Petrophysical Properties and Reservoir Potential	366
6.1.5	Diagenetic Process	367
6.1.6	Reservoir Potential	367
REFERENCES		369

LIST OF TABLES

	Page
Table 1.1 Sampling and/or Mapping Locations representing four lithostratigraphic units of the Labuan Island	9
Table 2.1 Sorting value for graphically obtained statistics expressed as verbal descriptive summaries (after Folk, 1980).	24
Table 2.2 Skewness value for graphically obtained statistics expressed as verbal descriptive summaries (after Folk, 1980).	24
Table 2.3 Kurtosis (K_G) value for graphically obtained statistics expressed as verbal descriptive summaries (after Folk, 1980)	25
Table 2.4 Reservoir permeability classification (Selly, 1978)	38
Table 3.1 Nomenclature of Labuan sedimentary units as proposed by Niethammer <i>et al.</i> , (1915)	47
Table 3.2 Lithostratigraphy of Labuan as deduced by Heybroek and Crews (1954)	48
Table 3.3 Present division of the rocks into informal units and subunits reported by Lee (1977)	55
Table 3.4 History of nomenclature of Labuan sedimentary units as reported by Niethammer (1915), Heybroek and Crews (1954), Wilson (1964), and Lee (1977), modified after Lee (1977)	56

Table 4.1	Comparison of Quantitative Terms Used in Description of Layered Rocks (McKee and Weir, 1953; in Brenner, 1984)	87
Table 4.2	Relationship between lithostratigraphic units and positive lineaments	159
Table 4.3	Bioturbation Index (BI) where each grade is described in terms of the sharpness of the primary sedimentary fabric, burrow abundance and amount of burrow overlap. The percentage is just a guide and not an absolute division (Tucker, 2003)	174
Table 5.1	Grain Size Distribution of Lithofacies A of the Belait Formation (Sample A1)	251
Table 5.2	Grain Size Distribution of Lithofacies A of the Belait Formation (Sample A2)	252
Table 5.3	Summary result for grain size analysis of the Lithofacies A (classification is based on Folk, 1980)	253
Table 5.4	Summary of detrital minerals distribution based on 200-point modal counting for Lithofacies A (planar and bioturbated sandstones) of the Belait Formation, Labuan Island	255
Table 5.5	Core samples characteristics of Lithofacies A	267
Table 5.6	Petrophysical properties of the Lithofacies A	267
Table 5.7	Grain Size Distribution of Lithofacies B of the Belait Formation (Sample B1)	271

Table 5.8	Grain Size Distribution of Lithofacies B of the Belait Formation (Sample B2)	272
Table 5.9	Summary result for grain size analysis of the Lithofacies A (classification is based on Folk, 1980)	274
Table 5.10	Summary of detrital minerals distribution based on 200-point modal counting for Lithofacies B (trough cross-stratified sandstones) of the Belait Formation, Labuan Island	275
Table 5.11	Core samples characteristics of Lithofacies B	285
Table 5.12	Petrophysical properties of the Lithofacies B	285
Table 5.13	Grain Size Distribution of Lithofacies C of the Belait Formation (Sample C1)	290
Table 5.14	Grain Size Distribution of Lithofacies C of the Belait Formation (Sample C2)	291
Table 5.15	Summary result for grain size analysis of the Lithofacies C (classification is based on Folk, 1980)	292
Table 5.16	Summary of detrital minerals distribution based on 200-point modal counting for Lithofacies C (hummocky and swalley cross-stratified sandstones) of the Belait Formation, Labuan Island	294
Table 5.17	Core samples characteristics of Lithofacies C	302
Table 5.18	Petrophysical properties of the Lithofacies C	302

Table 5.19	Grain Size Distribution of Lithofacies D of the Belait Formation (Sample D1)	307
Table 5.20	Grain Size Distribution of Lithofacies D of the Belait Formation (Sample D2)	308
Table 5.21	Summary result for grain size analysis of the Lithofacies D (classification is based on Folk, 1980)	310
Table 5.22	Summary of detrital minerals distribution based on 200-point modal counting for Lithofacies D (association of interbedded sandstones and shales) of the Belait Formation, Labuan Island	311
Table 5.23	Core samples characteristics of Lithofacies D	320
Table 5.24	Petrophysical properties of the Lithofacies D	320
Table 5.25	Multigroup, Multivariant Linear Discriminant Functions of the Belait Lithofacies	325

LIST OF FIGURES

	Page
Figure 1.1	7
Location of the study area (Labuan) in Sabah map showing that it is located at the western part of Borneo Island	
Figure 1.2	8
Base map of the Labuan Island (study area) showing sixteen localities involved for mapping and/or sampling	
Figure 1.3	13
Drainage system of the study area showing two main patterns which is dendritic and multibasinal	
Figure 1.4	15
Topography map of the study area showing flat to undulating topography with the highest elevation is 85m	
Figure 2.1	17
Flow chart illustrates the approaches, materials and methodologies applied in this study	
Figure 2.2	35
Illustration showing how permeability is measured for a rock specimen. A fluid of viscosity μ is passed through a sample of known-sectional area, A and length, L . The rate of flow is measured, together with pressure differential recorded on gauges at either end of the sample. Permeability was then calculated according to Darcy's Law, as described in the text (Selly, 1978)	
Figure 2.3	37
Klinkenberg permeability from permeability vs. reciprocal mean pressure graph	
Figure 3.1	44
Tectonic setting of Sabah. The opening of the South China Sea Basin and Celebes Sea played a major role in the tectonic evolution of Sabah (after Tongkul, 1998)	

Figure 3.2	Geological map of Labuan Island of Heybroek and Crews (1954)	49
Figure 3.3	Probable stratigraphy of Labuan Island and Padas Valley area as proposed by Wilson (1964). Modified after Wilson (1964)	51
Figure 3.4	Geological map of Labuan Island proposed by Wilson (1964)	52
Figure 3.5	Geological map of Labuan Island proposed by Yin (1985)	57
Figure 3.6	Geological map of Labuan Island proposed by Tongkul (2001) based on paleontological data by Shell	58
Figure 3.7	Labuan geology by Mazlan (1994) from Heybroek's. The "Layang-layangan Units" were originally mapped as part of the Belait Fm. but is now included in the Temburong Formation	59
Figure 3.8	Proposed stratigraphical subdivision of Northern Labuan by Mazlan Madon (1994), based on geological map of Figure 3.7	60
Figure 3.9	Geological map of Labuan Island proposed by Zuhar (2009)	61
Figure 3.10	Geological map of Labuan Island based on Wilson (1964) with modification Mazlan Madon (1994); in Hutchison (2005)	63
Figure 4.1	Lithostratigraphic column of the Labuan Island	89

Figure 4.2	Proposed geological map of the Labuan Island; exhibiting four lithostratigraphic units – the Crocker Formation, the Temburong Formation, the Setap Shale Formation, and the Belait Formation (in descending age)	90
Figure 4.3	Cross section (a) A – B; (b) C – D; and (c) E – F	91
Figure 4.4	Detailed measured rock sections illustrated throughout this thesis, are drawn using the above keys. Modified after Selly (1978)	95
Figure 4.5	Sedimentological log 1 and 2 of the Outcrop Profile C2, the first 44m (Tanjung Punei) representing the Crocker Formation	96
Figure 4.6	Sedimentological log 3 of the Outcrop Profile C2, the last 16.6m (Tanjung Punei) representing the Crocker Formation	97
Figure 4.7	Sedimentological log 1 and 2 of the Outcrop Profile T1 (Unit I, at Patau-patau Road representing Unit I of the Temburong Formation	101
Figure 4.8	Sedimentological log 1 and 2 of the Outcrop Profile T1 (Unit II), at Patau-patau Road representing Unit II of the Temburong Formation	103
Figure 4.9	Sedimentological log of the Outcrop Profile S1, at Kampung Bukit Kalam I of the Setap Shale Formation	106
Figure 4.10	Litholog 1 and 2 of the Outcrop Profile S2, at Kampung Bukit Kalam II of the Setap Shale Formation	109

Figure 4.11	Litholog 1 and 2 of the Outcrop Profile S3 (Kampung Durian Tunjung) of the Setap Shale Formation	112
Figure 4.12	Figure 4.12: Litholog 3 and 4 of the Outcrop Profile S3 (Kampung Durian Tunjung) of the Setap Shale Formation	113
Figure 4.13	Litholog 5 and 6 of the Outcrop Profile S3 (Kampung Durian Tunjung) of the Setap Shale Formation	114
Figure 4.14	Litholog 1 and 2 of the Outcrop Profile B1 (Bethune Head) of the Belait Formation	119
Figure 4.15	Litholog 3 and 4 of the Outcrop Profile B1 (Bethune Head) of the Belait Formation	120
Figure 4.16	Litholog 5 and 6 of the Outcrop Profile B1 (Bethune Head) of the Belait Formation	121
Figure 4.17	Litholog 1 and 2 of the Outcrop Profile B2 (Kubong Bluff) of the Belait Formation	123
Figure 4.18	Litholog 1 and 2 of the Outcrop Profile B3 (Tanjung Kubong Road) of the Belait Formation	126
Figure 4.19	Litholog 3 and 4 of the Outcrop Profile B3 (Tanjung Kubong Road) of the Belait Formation	127
Figure 4.20	Litholog 5 and 6 of the Outcrop Profile B3 (Tanjung Kubong Road) of the Belait Formation	128
Figure 4.21	Sedimentological log of the Outcrop Profile B4 (Kampung Ganggarak, Unit I) of the Belait Formation	132

Figure 4.22	Litholog 1 and 2 of the Outcrop Profile B4 (Kampung Ganggarak, Unit II) of the Belait Formation	133
Figure 4.23	Litholog 1 and 2 of the Outcrop Profile B5 (Pohon Batu Road) of the Belait Formation	135
Figure 4.24	Litholog 3 of the Outcrop Profile B5 (Pohon Batu Road) of the Belait Formation	136
Figure 4.25	Sedimentological log of the Outcrop Profile B6 (Ladang Andy) of the Belait Formation	138
Figure 4.26	Sedimentological log of the Outcrop Profile B7 (Kampung Pohon Batu) of the Belait Formation	140
Figure 4.27	Litholog 1 and 2 of the Outcrop Profile B8 (Tanjung Layang-layangan, Unit I) of the Belait Formation	143
Figure 4.28	Litholog 3 and 4 of the Outcrop Profile B8 (Tanjung Layang-layangan, Unit I) of the Belait Formation	144
Figure 4.29	Litholog 5 of the Outcrop Profile B8 (Tanjung Layang-layangan, Unit I) of the Belait Formation	145
Figure 4.30	Litholog 1 and 2 of the Outcrop Profile B8 (Tanjung Layang-layangan, Unit II) of the Belait Formation	147
Figure 4.31	Litholog 1 and 2 of the Outcrop Profile B9 (Membedai) of the Belait Formation	149
Figure 4.32	Litholog 3 and 4 of the Outcrop Profile B9 (Membedai) of the Belait Formation	150

Figure 4.33	Litholog 5 and 6 of the Outcrop Profile B9 (Membedai) of the Belait Formation	151
Figure 4.34	Sedimentological log of the Outcrop Profile B10 (Tanjung Batu) of the Belait Formation	153
Figure 4.35	Map showing the location of Labuan Island and major structural elements of the surrounding area (Mazlan, 1997)	156
Figure 4.36	Positive lineaments and rock units relations of the study area. Note that most of the positive lineaments are tabulated and scattered within the Crocker Formation and the Temburong Formation	158
Figure 4.37	Rose diagram of positive lineaments of the study area	160
Figure 4.38	Rose diagram of negative lineaments of the study area	160
Figure 4.39	Contoured plots to sedimentary bedding planes	161
Figure 4.40	Bedding poles plots of the study area – Schmidt net, lower hemisphere	162
Figure 4.41	Suggestion model for geological history/process of the Labuan Island.	171

Figure 4.42	Idealized hummocky cross stratification sequence as conceptualized by Dott and Bourgeois (1982). Basal storm amalgamated lamina sets are overlain by wave ripple lamina sets that become bioturbated by opportunistic species during periods of relative quiescence. Relative time frame represented by each element of succession is denoted to the left of the sequence. Total thickness range of the succession is shown to the right.	212
Figure 4.43	Rose diagrams showing the palaeocurrent pattern based on strike-dip of cross bedding. Symbols S1 (Kampung Bukit Kalam I) and S3 (Kampung Durian Tunjung).	236
Figure 4.44	Rose diagrams showing the palaeocurrent pattern based on strike-dip of cross bedding. Symbols B1-B10 correspond to the studied locality as listed in Table 1.1.	238
Figure 4.45	Map showing the average palaeocurrent directions for each measured sections in the Labuan Island	239
Figure 4.46	Pie diagram representing the distribution of Lithofacies of the Neogene sediments, Labuan Island	240
Figure 4.47	Correlation of Section A involving Locality B1, B2, B3 and B4	242
Figure 4.48	Correlation of Section B involving Locality B5, B6, B37 and B8	243
Figure 4.49	Correlation of Section C involving Locality S1, S2, and S3	244
Figure 4.50	Correlation of Section D involving Locality B9 and B10	245