Geological Society of Malaysia – Circum-Pacific Council for Energy and Mineral Resources
Tectonic Framework and Energy Resources of the Western Margin of the Pacific Basin
November 27 – December 2, 1992, Kuala Lumpur, Malaysia

Sequence stratigraphy of the Middle Miocene–Pliocene southern offshore Sandakan Basin, East Sabah

ROBERT H.F. WONG

PETRONAS
Exploration Department
P.O. Box 12444
50778 Kuala Lumpur

Abstract: A sequence stratigraphic study was performed in the southern offshore Sandakan Basin with the aim of deriving a workable chronostratigraphic scheme and identifying plays,including stratigraphic traps. The data set includes 1800 km of high quality 1990 seismic and 8 wells. The study area can be divided into a structurally complex landward northern province and a relatively undisturbed basinward southern province.

Three chronostratigraphic units were identified,each bounded by Type 1 third-order sequence boundaries. Each unit consists of third to fourth-order sequences which can be correlated from landward coastal plain facies to basinward bathyal facies. Unit 1 (Middle Miocene-early Upper Miocene) is characterised by moderate progradation, moderate aggradation; Unit 2 (middle Upper Miocene) by high progradation, low aggradation; and Unit 3 (late Upper Miocene-Pliocene) by high aggradation, low progradation.

The positions of the prominent shelf edges in Unit 1, Unit 2 and lower Unit 3 indicate a southeastward progradation from Middle to Upper Miocene. Pliocene progradation was probably eastwards as suggested by N-S growth faults in the northeastern part of the study area, and is interpreted to have occurred within a ramp setting, as prominent shelf edges are lacking.

The study led to the recognition of two play-types in the southern province, both associated with lowstand systems tract sediments. The first is a slope fan play in Unit 1. The second is a basin floor fan play in Unit 2.

Comparison of the locally derived onlap chart and the global onlap chart of Haq *et al.* (1987) highlighted some differences. The main difference is major Upper Miocene progradation in the study area versus Upper Miocene aggradation in the global chart, testifying to the importance of the interplay of local tectonics and sedimentation in the Sandakan Basin.

INTRODUCTION

A sequence stratigraphic study of the Middle Miocene-Pliocene was conducted in the southern offshore Sandakan Basin, East Sabah, Malaysia. The study area is located within the Malaysian sector of the southern offshore Sandakan Basin just north of the Dent Peninsula, as shown in Figure 1.

The study was carried out with the following objectives:

1) To derive a chronostratigraphic scheme that would improve upon the previous lithostratigraphic scheme which is applicable only to a restricted area.
2) To identify play-types including stratigraphic traps such as basin floor fans and slope fans.

PREVIOUS LITHOSTRATIGRAPHIC SCHEME

Figure 2 illustrates the previous lithostratigraphic scheme of the study area. This scheme closely follows the geology of the Dent Peninsula located to the south of the study area. An example (Haile and Wong, 1964) of the previous lithostratigraphic correlation between two wells is exhibited in Figure 3. This rather coarse correlation is based on loosely constrained biostratigraphy and poor seismic data. A better correlation based on an accurate chronostratigraphic scheme is crucial for successful petroleum exploration in the study area. This new, chronostratigraphic correlation was required, to enable more precise mapping of reservoir, seal and source.

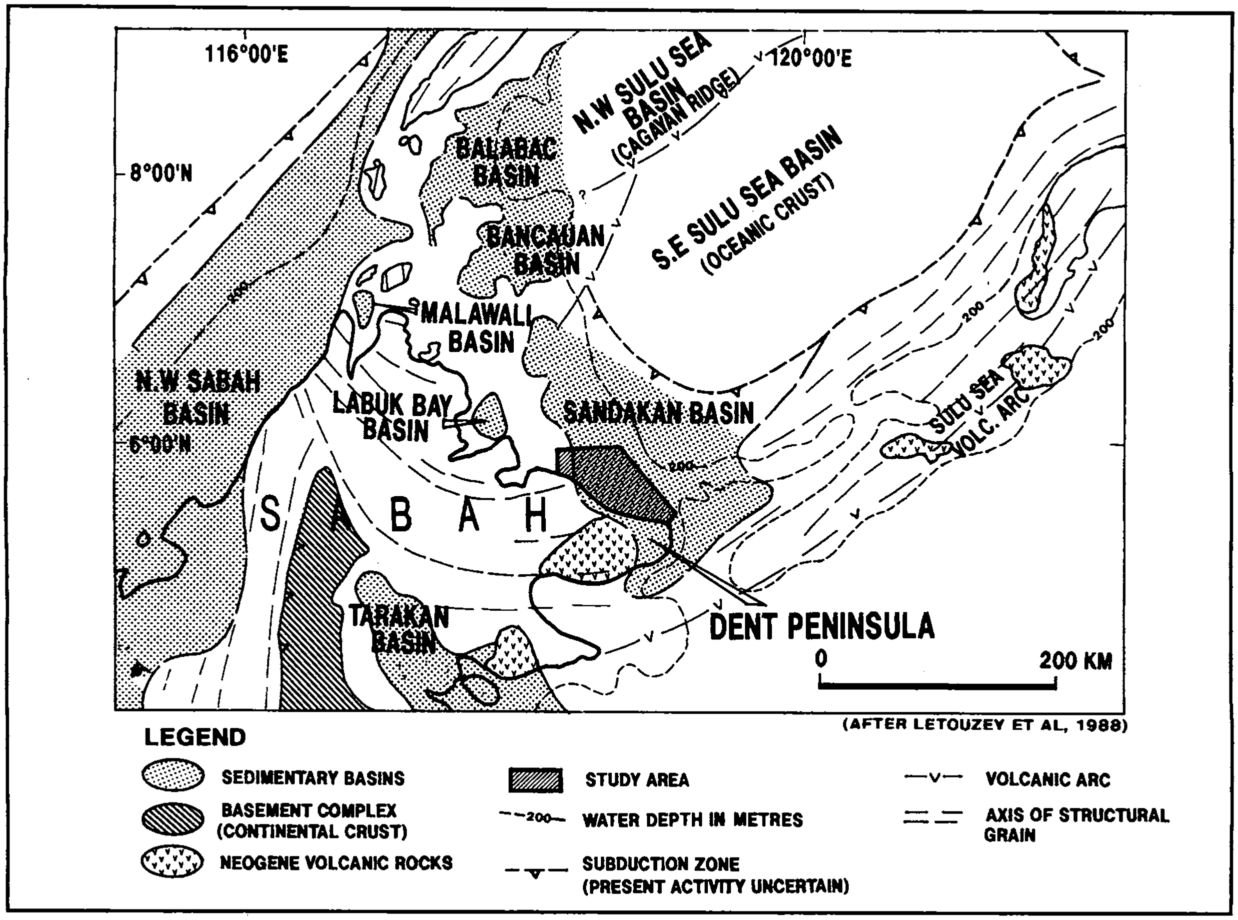

Figure 1. Sabah-Sulu Sea area, tectonic framework.

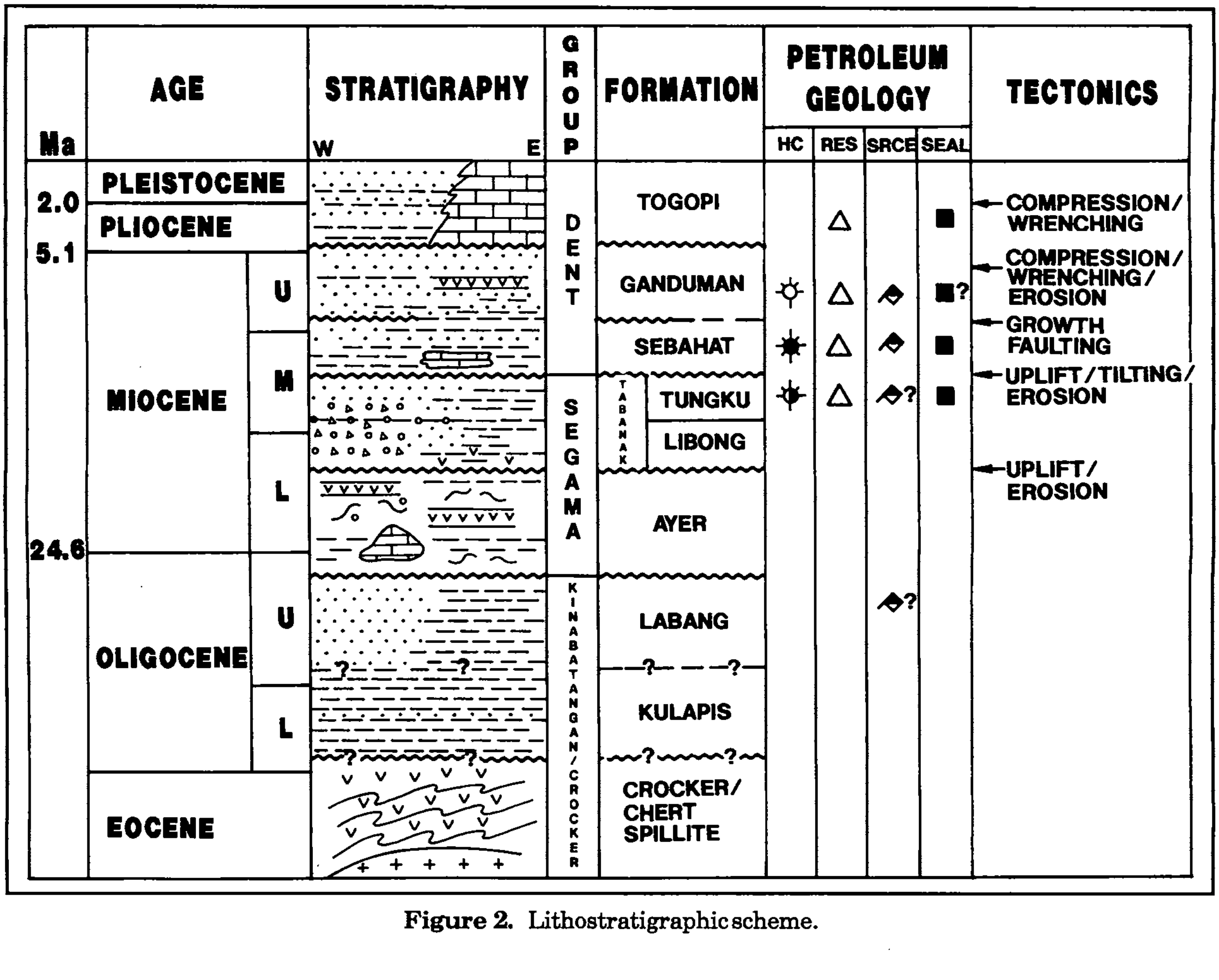

Figure 2. Lithostratigraphic scheme.

DATA AVAILABILITY

The data available for this study include seismic, well and outcrop data. The seismic data comprised 1800 km of high quality 1990 vintage with an average grid size of 3 km x 3 km, and limited reprocessed 1968, 1971 and 1973 vintages. The location of the 1990 seismic grid is shown in Figure 4.

The well data comprised eight wells with GR and sonic logs, a biostratigraphic review of ditch cuttings from five of the wells and lithofacies descriptions of 110 m of cores from selected wells. The biostratigraphic review included foraminifera, calcareous nannoplankton and quantitative palynological analyses which provided both age zonation and depositional environment interpretation. No synthetic seismograms were available, hence, time-depth curves were used to tie wells to the seismic data. Such ties are believed to be sufficiently accurate for the study purpose. The location of the eight wells is also shown in Figure 4.

STRUCTURAL SETTING

The study area can be divided into northern and southern structural provinces, which are separated by the northeast-southwest Segama-Pegasus Ridge (Fig 5). The sediments in the northern province were deposited in a more landward environment and have undergone various phases of deformation from Middle Miocene to Pleistocene. The western part of this province is characterised by northeast-southwest wrench-related flower structures whereas the eastern part is dominated by growth faults.

In contrast to this, the basinward southern province encompasses a zone of relatively undisturbed sediments. Subsidence and sedimentation with little or no structuring since the Middle Miocene characterises this province.

INTERPRETATION PROCEDURE

The study involved sequence boundary mapping (Mitchum *et al.*, 1985) using seismic data tied to well data, seismic facies analysis (Mitchum *et al.*, 1977, part 6) and systems tract identification from well logs (Van Wagoner *et al.*, 1990). Depositional models were derived once the various sequences and their component systems tracts were defined. Consequently, prospects and leads which included stratigraphic traps of slope fans and basin floor fans were identified from the depositional models. Finally, more precise dating of the sequence boundaries could then be attempted by constructing a local coastal onlap chart (Vail *et al.*, 1977, part 3) and comparing it with the global onlap chart of Haq *et al.* (1987).

Figure 6 indicates the location of four of the 1990 seismic lines used in the study. Sequence stratigraphic interpretation on segments of these lines will be discussed.

INTERPRETATION EXAMPLE

Figures 7 and 8 show Line No. 1, Part 1 (northwest segment) and Part 2 (southeast segment) respectively. Figures 9 and 10 illustrate the interpreted versions of these segments, showing three chronostratigraphic units, each bounded by Type-1 third-order sequence boundaries. When combined, these three units make up a second-order event with an age range of about 17 Ma.

Each unit comprises one or more third-order sequences. A sequence boundary within each unit can be readily recognised seismically by a strong flat event on the shelf changing abruptly with a pronounced shelf edge (circled) to an oblique clinoform and then flattening again towards the basin plain. The location of well No. 6 which bottomed in Middle Miocene outer neritic shales is also shown on this line.

Various seismic facies can also be observed on Line No. 1. They include hummocky, discontinuous reflectors (in Unit 2 and lower Unit 3); parallel, continuous reflectors (in all three Units); mounded with internal parallel reflectors (in upper Unit 3); oblique-shingled clinoforms (in Unit 2); sigmoidal-oblique clinoforms with associated chaotic reflectors (in Unit 1 and lower Unit 3); and parallel to gently mounded reflectors at toes of clinoforms (mainly in Units 1 and 2). Seismic reflection terminations include onlaps in Unit 1 and lower Unit 3 and toplaps in Unit 2.

SEQUENCE BOUNDARY MAPPING

The interpreted sequence boundaries were correlated and mapped and the pronounced shelf edges indicated. The intervening sequences are designated Unit 1-Seq. A–E; Unit 2-Seq. A–C; and Unit 3-Seq. A. Younger sequences of Unit 3 (Unit 3-Seq. B–E) which are lacking in pronounced shelf-edges, are identified on well-logs by recognition of valley incisions.

Figure 11 indicates the seismically-defined Middle-Upper Miocene shelf edges. Overall progradation is towards the southeast. Pliocene progradation is interpreted to be towards the east as suggested by N-S growth faults in the northeastern part of the study area and is interpreted to have occurred in a ramp setting, as indicated by the lack of prominent shelf edges.

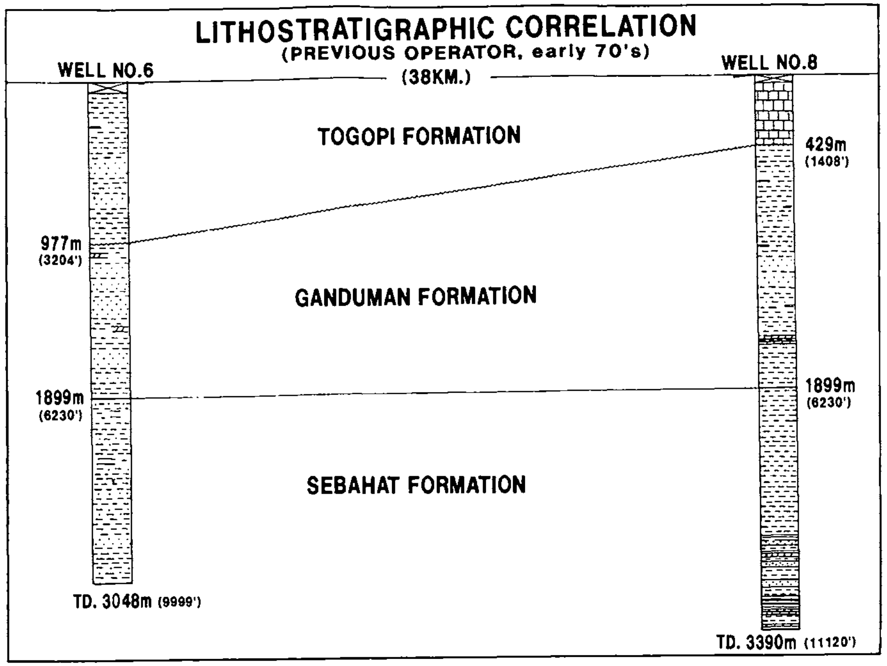

Figure 3. Lithostratigraphic correlation of well No: 6 and well No: 8.

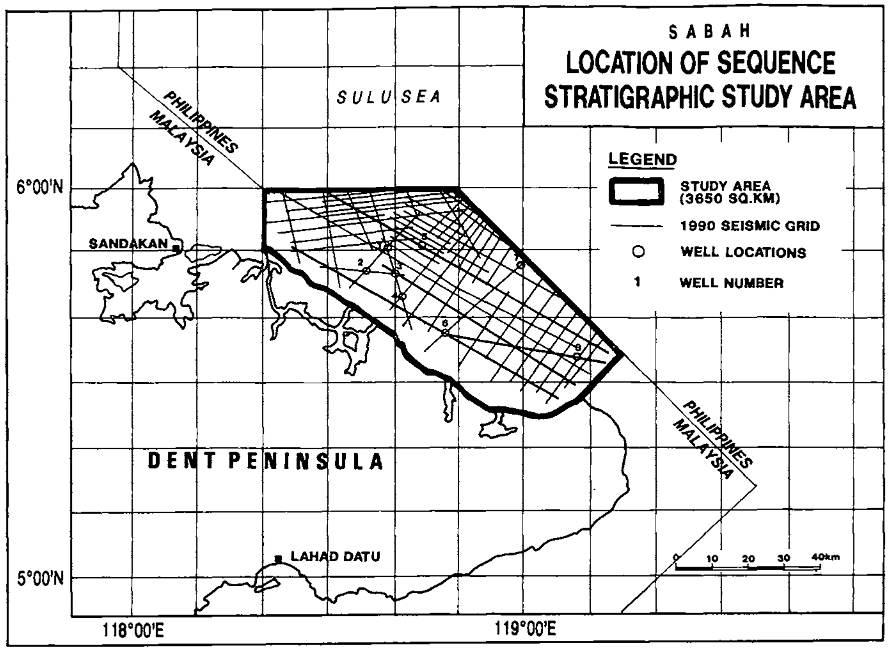

Figure 4. Location of sequence stratigraphic study area.

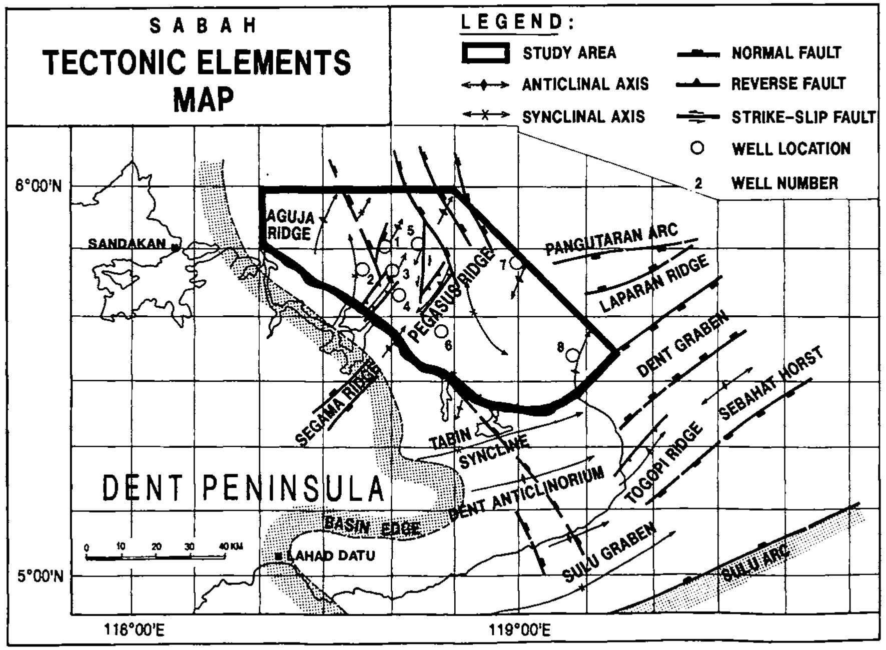

Figure 5. Tectonic elements map.

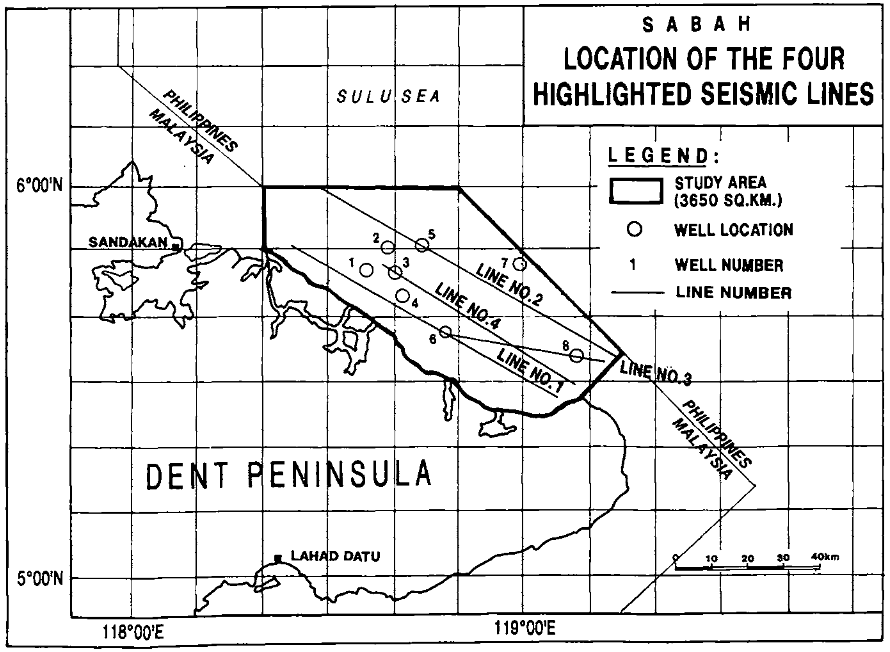

Figure 6. Location of the four highlighted seismic lines.

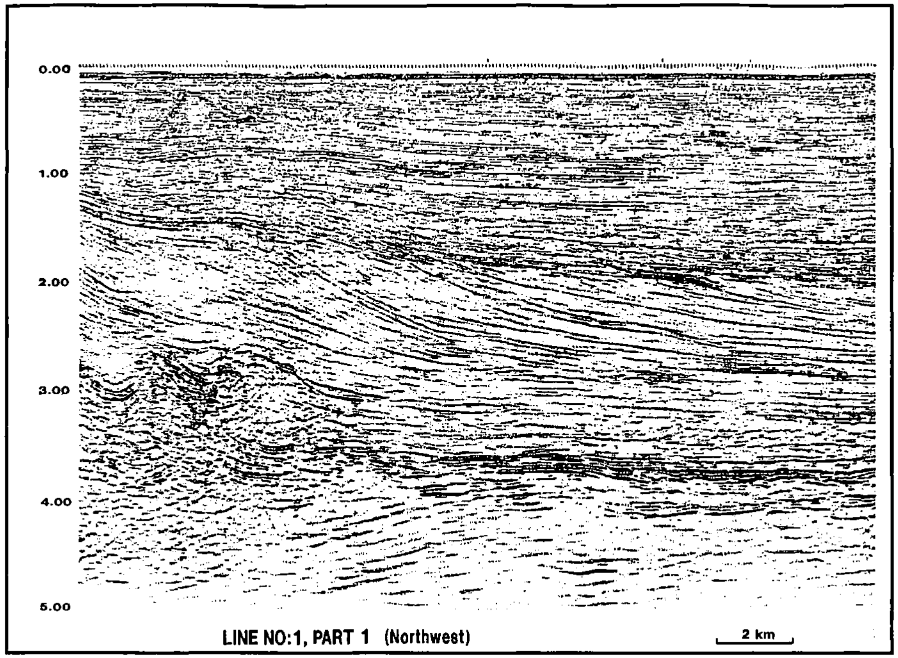

Figure 7. Uninterpreted line No: 1, Part 1.

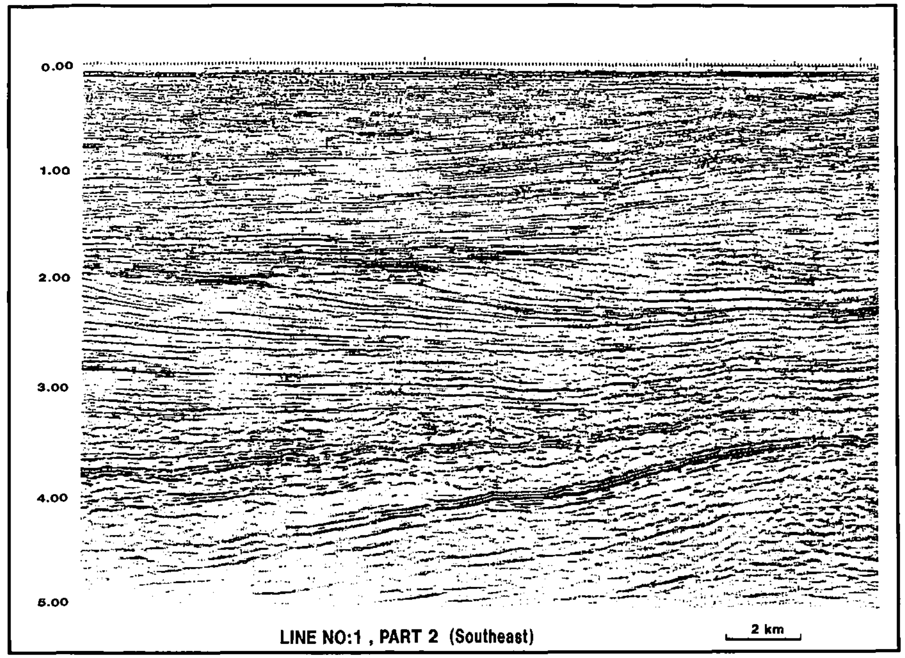

Figure 8. Uninterpreted line No: 2, Part 2.

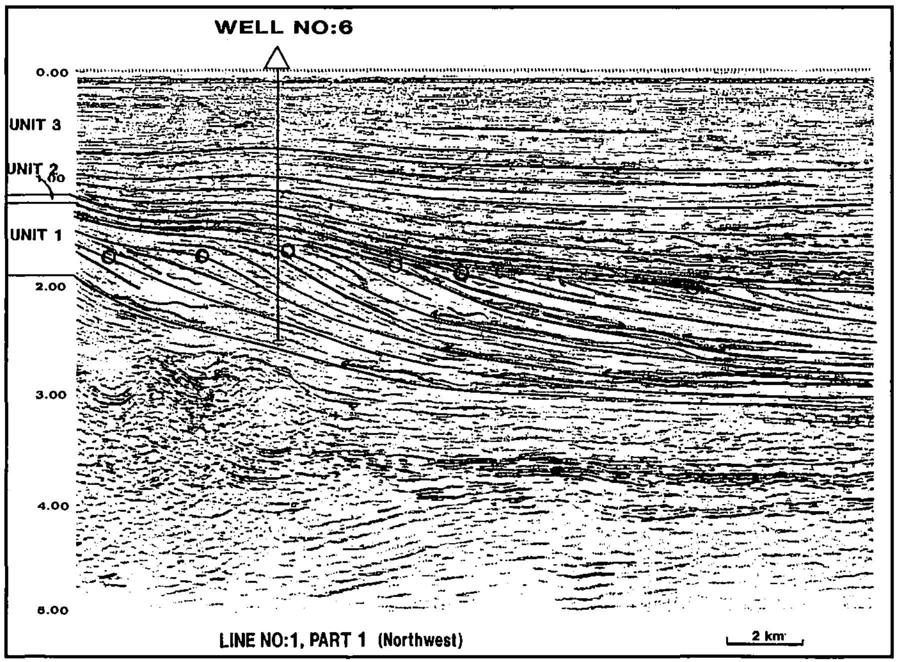

Figure 9. Interpreted line No: 1, Part 1.

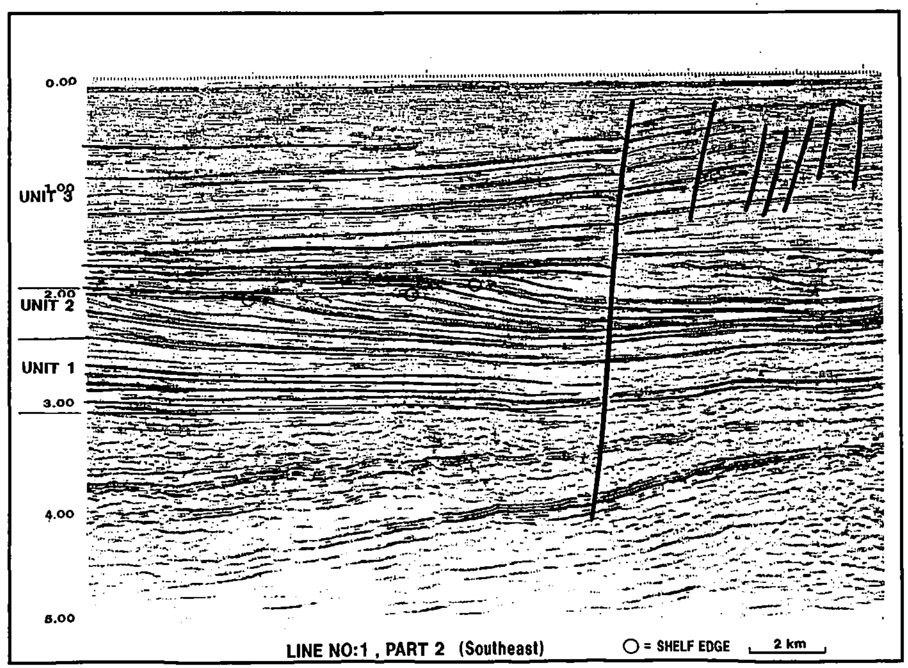

Figure 10. Interpreted line No: 1, Part 2.

The five shelf edges in Unit 1 are moderately spaced and the three in Unit 2 are widely spaced whereas Unit 3 is lacking in pronounced shelf edges (with only one recognised). The spacing of the shelf edges implies that Unit 1 is characterised by moderate progradation, moderate aggradation; Unit 2 by high progradation, low aggradation; and Unit 3 by low progradation, high aggradation (Mitchum *et al.*, 1985). Thick shale and carbonate deposition supports the interpretation of this particular style of sedimentation in Unit 3.

SEISMIC FACIES ANALYSIS

Figure 12 summarises the various interpreted seismic facies in the study area. Hummocky, discontinuous reflectors represent sand-prone coastal plain-coastal facies. Parallel, continuous reflectors are indicative of sand to silt deposition in a coastal to inner neritic environment. Mounded with internal parallel reflectors are images of platform-type carbonates. Oblique-shingled clinoforms suggest moderate-high energy deposition of sand prone middle-outer neritic facies (Beng, 1982). Sigmoidal-oblique clinoforms with associated chaotic reflectors are representative of low-moderate energy deposition of silt to shale in a middle neritic to bathyal environment (Beng, 1982). Finally, parallel to gently mounded reflectors at toes of clinoforms reflect deposition of sandy to silty turbidites.

Most of these interpretations are supported by wells drilled in the study area.

SYSTEMS TRACT IDENTIFICATION FROM WELL-LOGS

Sequence boundaries can be seismically defined (Mitchum *et al.*, 1985) but systems tracts are more readily recognised in well logs (Van Wagoner *et al.*, 1990). An example of the interpreted systems tracts in coastal-inner neritic sediments of Unit 1-Seq. B at Well No: 5 (Fig. 13) which has been correlated to the boxed section of Line No. 2 (Fig. 14) is shown. The seismic facies indicates a zone of continuous, parallel reflectors.

At the basal part of the sequence is the incised-valley-fill estuarine sands belonging to the lowstand systems tract. The sharp contact between these sands and the underlying inner neritic shales is the sequence boundary. The incised-valley-fill sands are topped by a parasequence set boundary. The

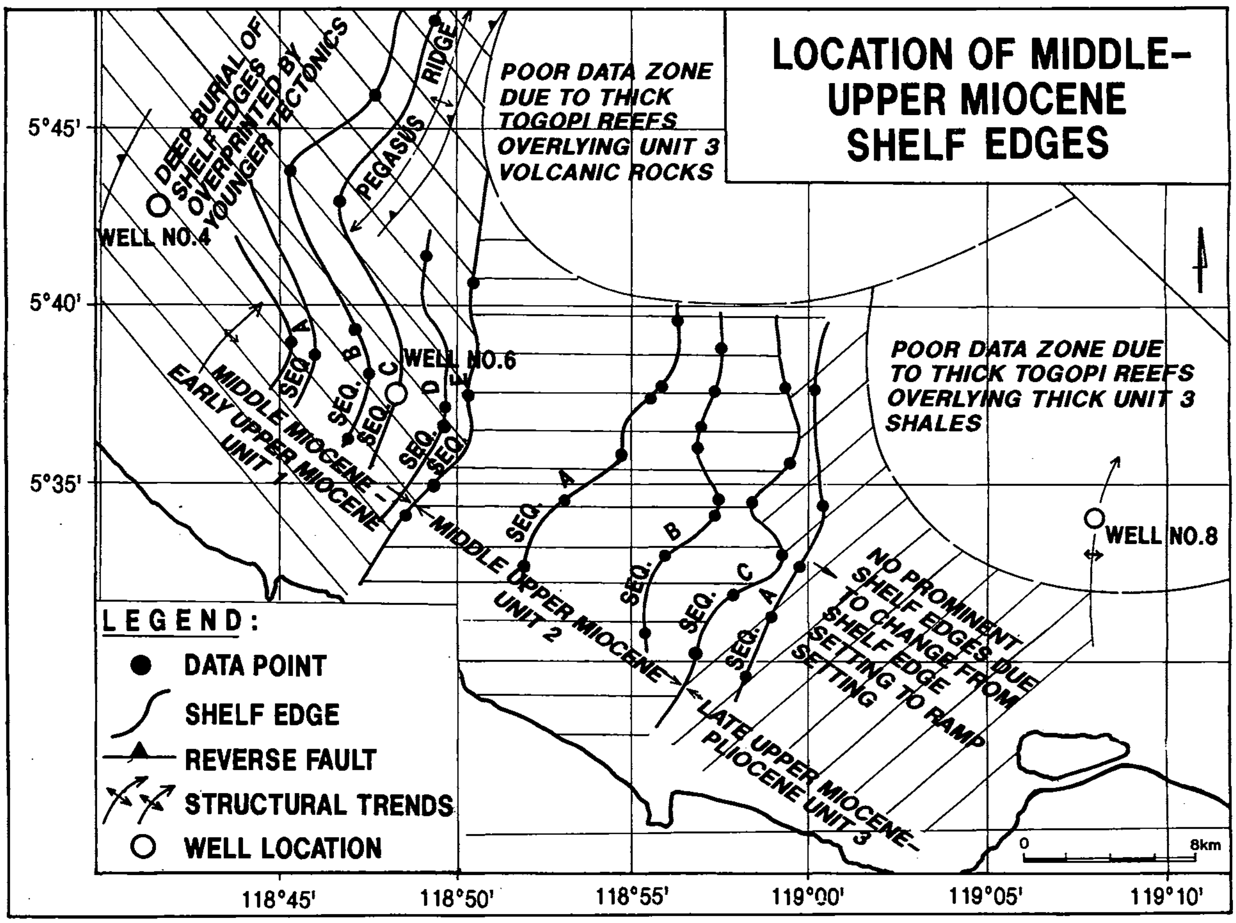

Figure 11. Location of Middle-Upper Miocene shelf edges.

SEISMIC REFLECTION CONFIGURATION	SEISMIC EXPRESSION	INTERPRETATION	
		DEPOSITIONAL ENVIRONMENT	LITHOLOGY
HUMMOCKY,DISCONTINUOUS REFFLECTORS		COASTAL PLAIN-COASTAL	SAND PRONE
PARALLEL, CONTINUOUS REFLECTORS		COASTAL-INNER NERITIC	SAND TO SILT
MOUNDED WITH INTERNAL PARALLEL REFLECTORS		INNER NERITIC	CARBONATE REEF
OBLIQUE-SHINGLED CLINOFORMS		MIDDLE-OUTER NERITIC	SAND PRONE
SIGMOIDAL-OBLIQUE CLINOFORMS WITH ASSOCIATED CHAOTIC REFLECTORS		MIDDLE-OUTER NERITIC, BATHYAL	SILT TO SHALE
PARALLEL TO GENTLY MOUNDED REFLECTORS AT TOES OF CLINOFORMS		BATHYAL	SAND TO SILT

Figure 12. Seismic reflection configuration of the study area.

transgressive systems tract is made up of three backstepping parasequences, indicating that the overall rate of deposition was less than the rate of accommodation. Each parasequence is topped by a parasequence boundary. The maximum flooding surface, signified by a maximum GR value, marks the top of the transgressive systems tract. It is also a parasequence set boundary. The highstand systems tract consists of three progradational parasequences indicating that the overall rate of deposition is greater than the rate of accommodation. The parasequences are also separated by parasequence boundaries. The top of the highstand systems tract is a sequence boundary which is demarcated by the sharp contact with the next incised-valley-fill estuarine sands.

The interpreted systems tracts in the fluvial-coastal plain facies of Unit 2 at Well No: 6 are shown in Figure 15. They are matched with the boxed section of Line No. 1 (Fig. 16). The seismic facies exhibit hummocky, discontinous events.

The systems tracts are characterised by blocky/fluvial sands of incised-valley-fills probably deposited during the late stage of lowstand systems tracts. They possess sharp lower and upper contacts. The lower contact is the sequence boundary and the upper contact is the parasequence set boundary. Overlying the incised-valley-fill sandstones are the shaly to silty sediments of the transgressive systems tracts. The highstand systems tracts are not seen here because of erosion and rapid sedimentation. The character of these systems tracts in Unit 2 attests to the high rate of deposition/rate of accommodation.

The interpreted systems tracts in neritic-bathyal facies of Unit 3-Seq. C at Well No: 8 is demonstrated in Figure 17 which is tied to the boxed section of Line No. 3 (Fig. 18). The seismic facies reveal a zone of predominantly chaotic reflectors. A monotonous shaly interval is observed

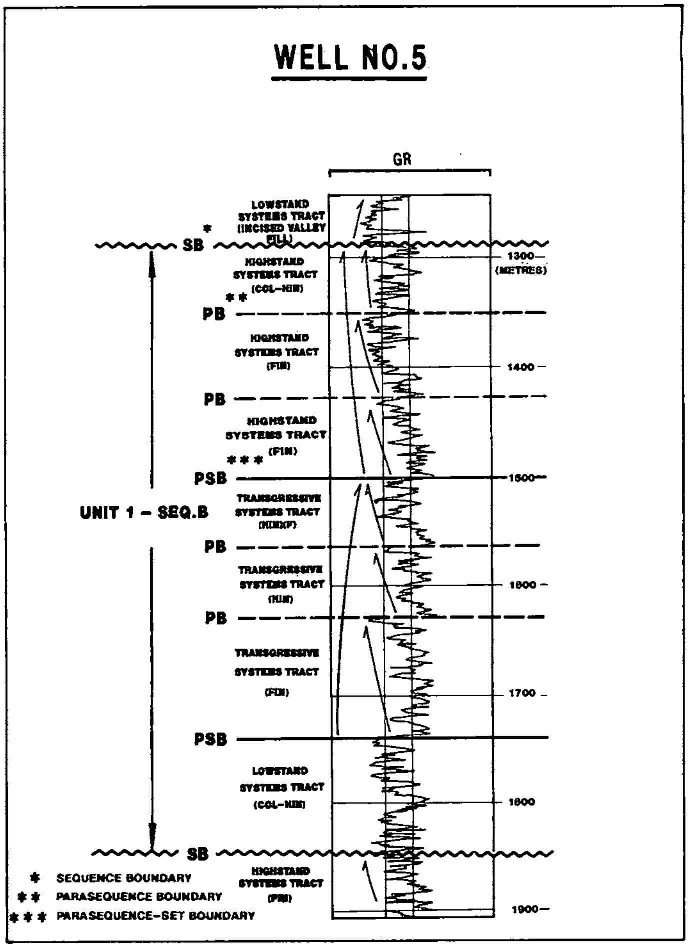

Figure 13. Interpreted systems tracts in coastal-inner neritic facies of Unit 1–Seq. B at well No: 5.

on the well-log but systems tracts can be identified by their subtle coarsening or fining-upward patterns (Mitchum *et al.*, 1990). The sequence begins with a coarsening upward prograding complex. Overlying it is the thin, fining upward transgressive systems tract with maximum GR value. The sequence is capped by a thick, coarsening upward highstand systems tract with two intervening parasequence

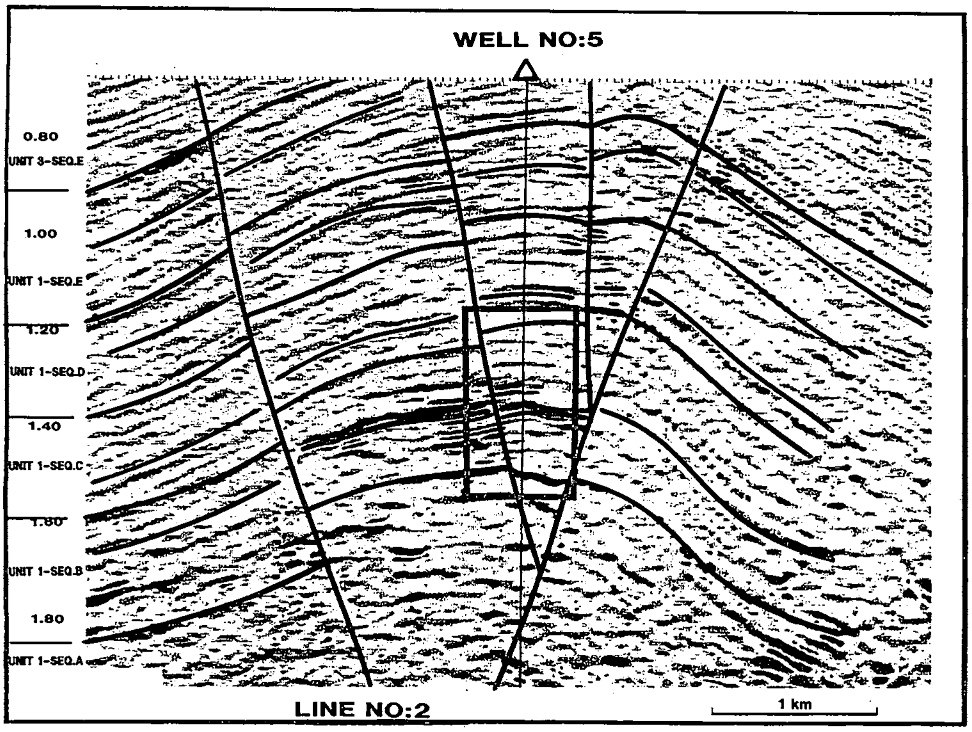

Figure 14. Interpreted line No: 2 across well No: 5.

boundaries. An incised-valley-fill estuarine sandstone atop the highstand systems tract marks the beginning of another sequence.

DEPOSITIONAL MODELS

Depositional models of Units 1, 2 and 3 were derived from sequence boundary mapping, seismic facies analysis and systems tracts identification.

Unit 1 (Middle Miocene-early Upper Miocene) is characterised by moderate aggradation, moderate progradation, thick but areally restrictive shelfal members, steeply dipping oblique-sigmoidal clinoforms, prominent shelf edges and well-defined onlaps.

Unit 2 (middle Upper Miocene) is characterised by low aggradation, high progradation, thin but areally extensive shelfal members, gently dipping shingled-oblique clinoforms, well-defined onlaps and prominent shelf edges.

Unit 3 (late Upper Miocene-Pliocene) is characterised by high aggradation, low progradation, thick shelfal members, sigmoidal clinoforms (in the lower sequences), a dominant ramp setting (in the upper sequences) and is lacking in prominent shelf edges.

The various depositional models are depicted in Figure 19.

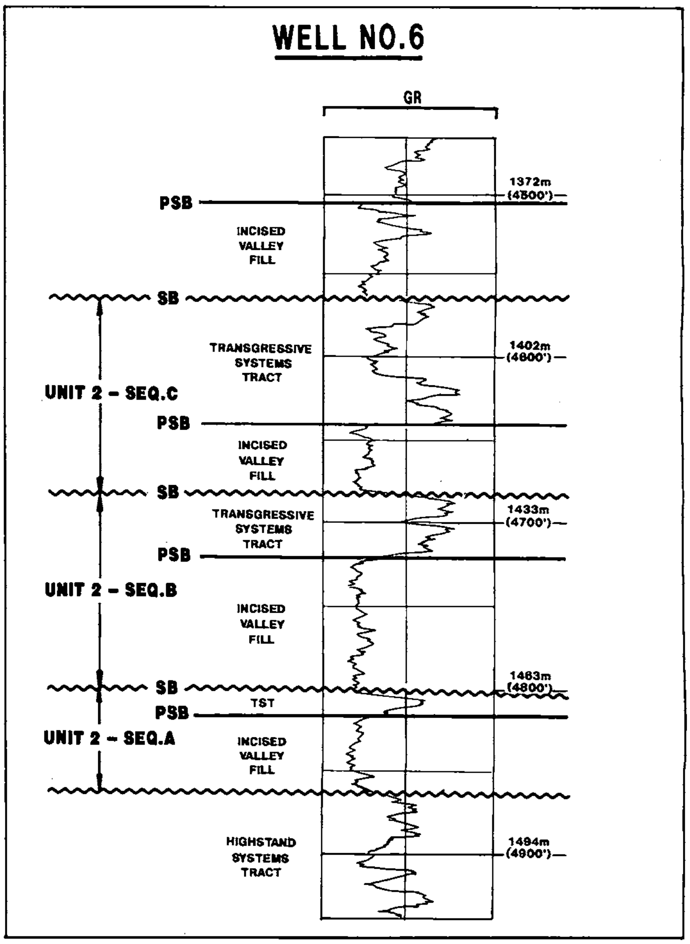

Figure 15. Interpreted system tracts in fluvial-coastal plain facies of Unit 2 at well No: 6.

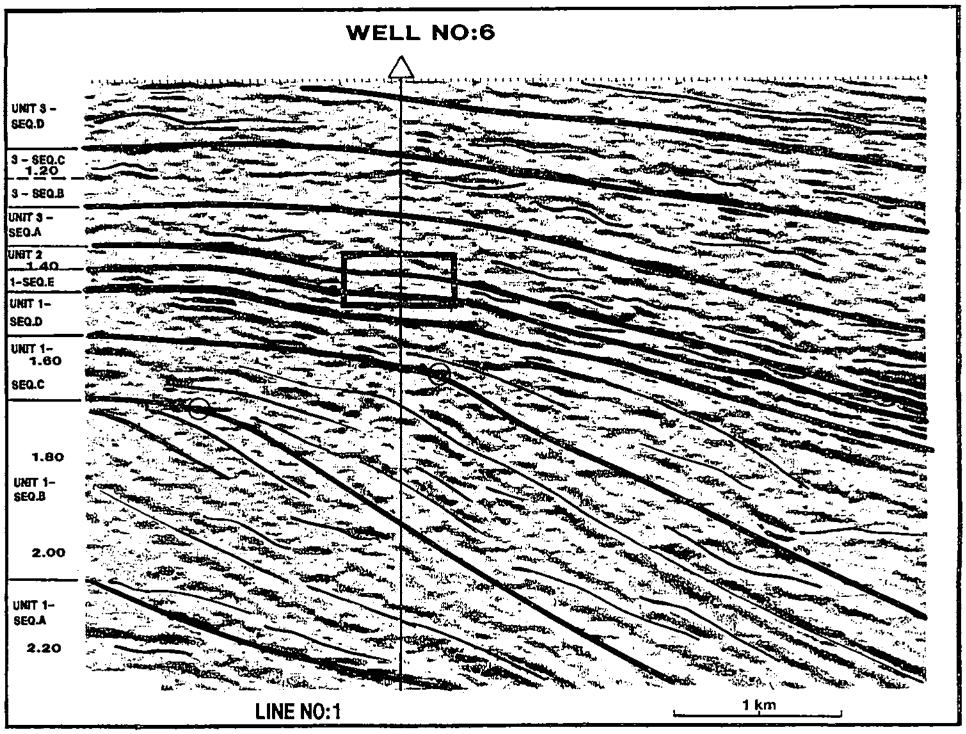

Figure 16. Interpreted line No: 1 across well No: 6.

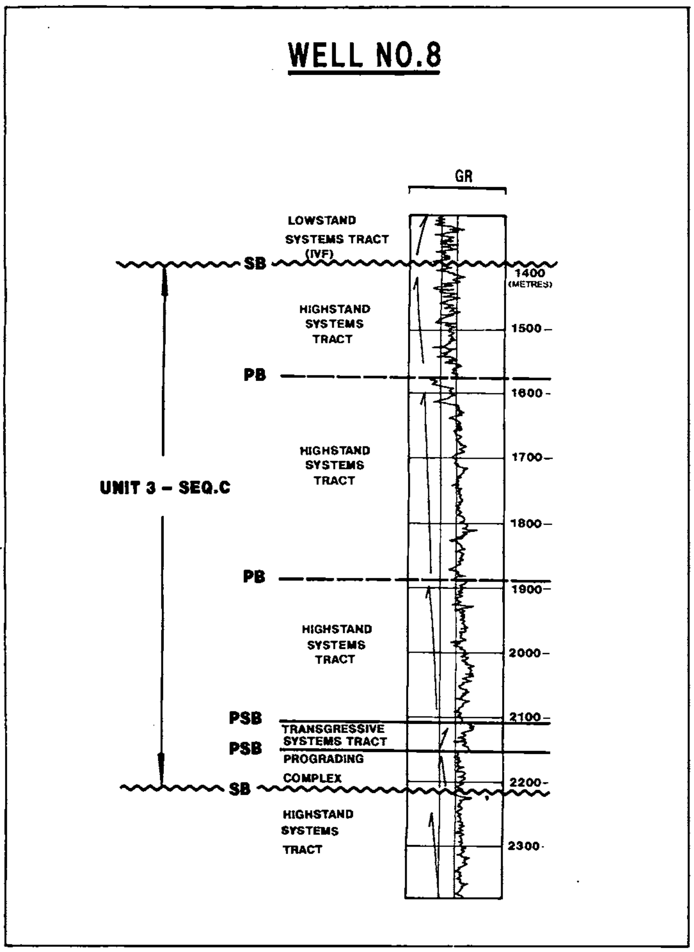

Figure 17. Interpreted systems tracts in neritic-bathyal facies of Unit 3–Seq. C at well No: 8.

INTERPRETED SLOPE FAN AND BASIN FLOOR FAN

Stratigraphic traps of slope fans and basin floor fans were thought likely to be developed within Unit 1 and Unit 2.

Figure 20 demonstrates examples of interpreted slope, and basin floor fans respectively overlying the bases of Unit 1-Seq. E and Unit 2-Seq. A sequence boundaries. Their location are shown on Figure 21.

The interpreted slope fan is recognised by a high amplitude event onlapping the upper shelf slope and downlapping the lower shelf slope. Overlying sediments are observed to downlap and onlap the top of this fan, indicating a depositional hiatus.

The interpreted basin floor fan sits on the basin floor near the foot of the shelf slope. It is identified by bidirectional downlaps (Mitchum, 1985). Overlying strata are also observed to downlap the top of this fan.

Both the slope fan and basin floor fan are considered potentially attractive targets for petroleum exploration but require further seismic coverage for detailed mapping. The overlying deepwater shales provide the seal. Source rocks are believed to be terrestrially derived and deposited within these deepsea sediments.

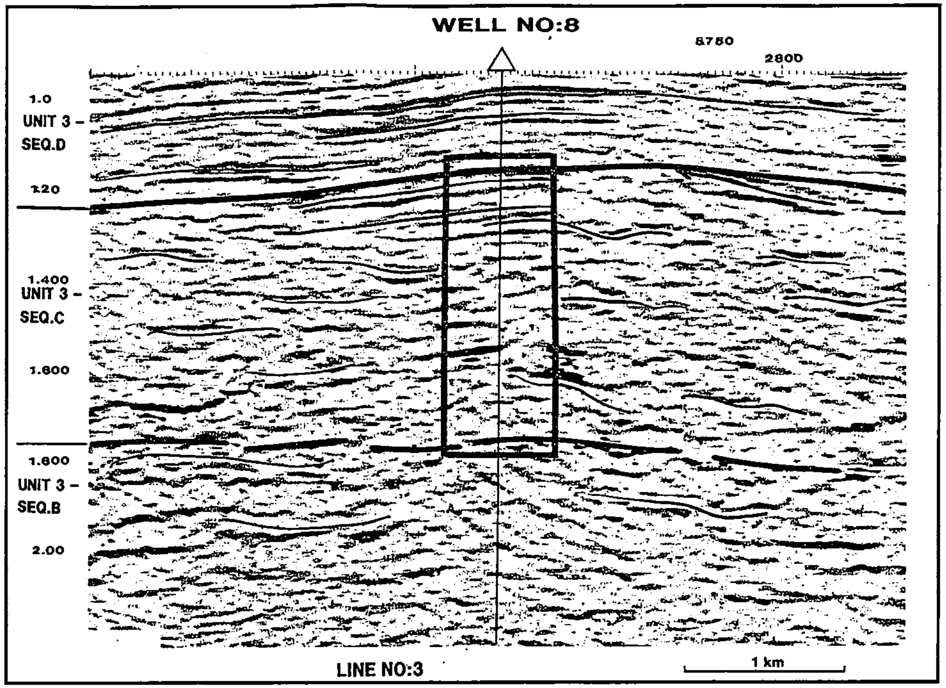

Figure 18. Interpreted line No: 3 across well no. 8.

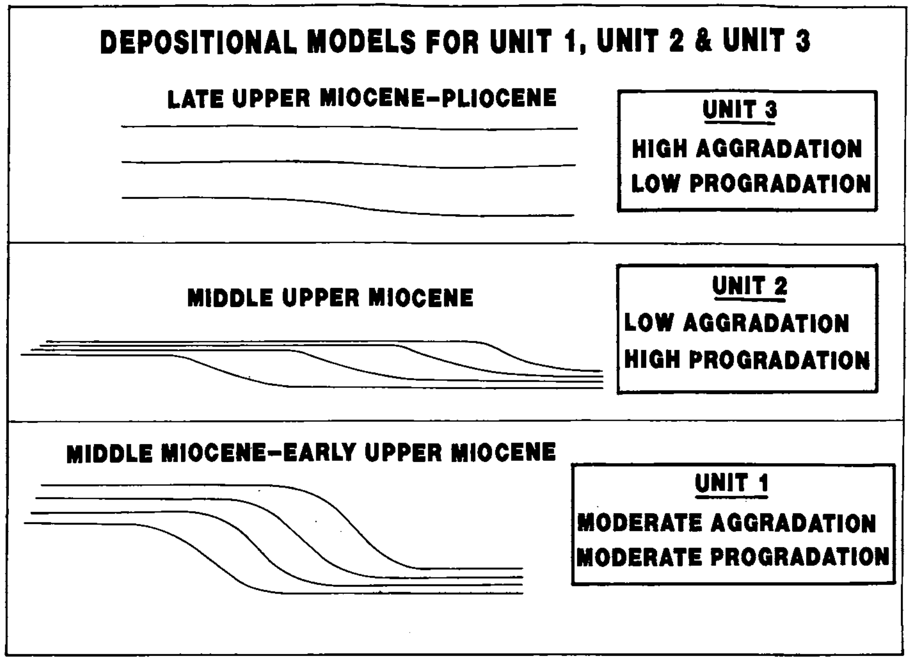

Figure 19. Depositional models of Unit 1, Unit 2 and Unit 3.

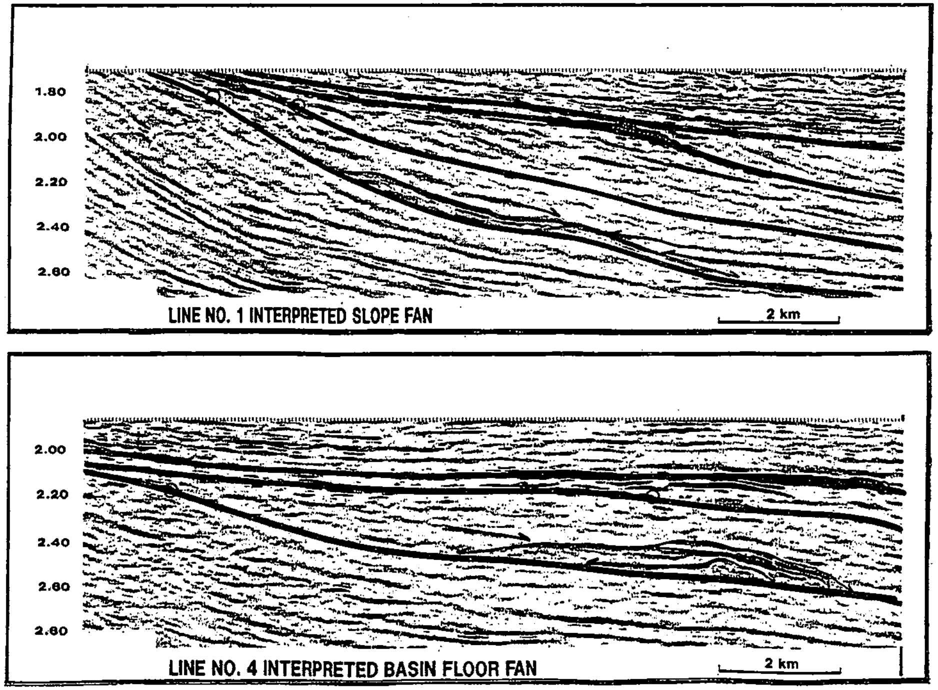

Figure 20. Interpreted slope fan and basin floor fan.

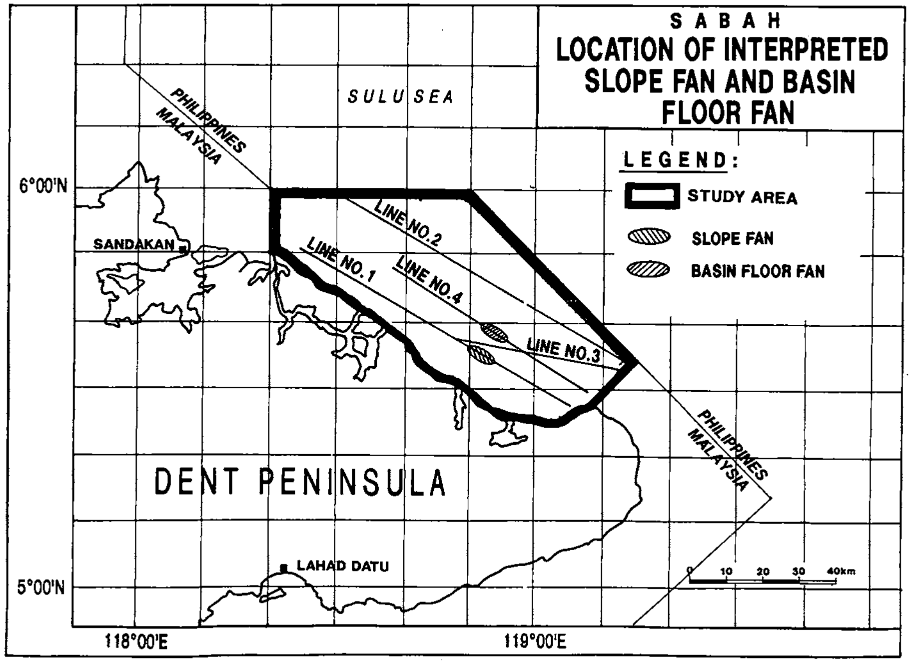

Figure 21. Location of interpreted slope fan and basin floor fan.

SEQUENCE BOUNDARY DATING

Biostratigraphic dating of wells, using the current scheme, gives only a range of ages. More precise dating can be attempted by construction of the localised coastal onlap chart and comparing it with the global onlap chart of Haq *et al.* (1987).

The amount of coastal onlap can be measured beginning from the base of interpreted shelf edge of Unit 1-Seq. A. In the upper sequences of Unit 3, which were deposited predominantly within a ramp setting, incised valleys measured on well logs are indications of minimum fall in sea-level. Well No. 6 was bottomed in Unit 1-Seq. A and biostratigraphic dating indicates an early Middle Miocene age. Hence, the localised coastal onlap chart is compared with Middle Miocene-Pliocene sequences of the global onlap chart of Haq *et al.* (1987) (Fig. 22).

The first two sequences of Unit 1 and the two oldest sequences of the Middle Miocene in the global chart exhibit a similar aggradation pattern indicating that the tops of Unit 1-Seq. A and Unit 1-Seq. B are probably the 15.5 Ma and 13.8 Ma sequence boundaries respectively.

Minor progradation is observed in Unit 1-Seq. C and Unit 1-Seq. D ending with a major drop in sea-level. Major progradation is seen in the two uppermost Middle Miocene sequence of the global onlap chart, also ending with a major fall in sea-level. It may be concluded that these two sequences are similar in age, the difference in the amount of progradation perhaps being due to the lesser sediment supply to the Sandakan Basin than other studied basins during these periods. Hence, 12.5 Ma and 10.5 Ma ages may be applied to the tops of Unit 1-Seq. C and Unit 1-Seq. D respectively.

The top of Unit 1-Seq. E corresponds to a major angular unconformity in the northern portion of the study area. This tectonically enhanced sequence boundary (Vail *et al.*, 1990) initiated the major Upper Miocene progradation which began at the base of Unit 2-Seq. A and ended at the top of Unit 2-Seq. C. The sequences in this unit are characterised by widely spaced shelf edges and are probably of fourth-order with higher cyclicity of occurrences. They are localised and are only deposited between wells No. 6 and No. 8. The base and top of this unit probably correspond to the 8.2 Ma and 6.3 Ma sequence boundaries respectively.

Unit 3 displays late Upper Miocene to Pliocene aggradation which is comparable to that of the global chart. Hence, the five sequences in Unit 3, from the oldest to the youngest, probably correspond to the 5.5 Ma, 4.2 Ma, 3.8 Ma, 3.0 Ma and 2.4 Ma respectively.

It must be emphasized that the ages of these sequence boundaries are only probable because both third and fourth order sequences are likely to occur and they do not necessarily correspond perfectly with the global onlap chart of Haq *et al.* (1987). In comparing the localised coastal onlap chart with the global chart, the main difference is in the major Upper Miocene progradation in the study area versus the Upper Miocene aggradation in the global onlap chart. This difference highlights the importance of the interplay of local tectonics and sediment supply (Vail *et al.*, 1990) in the Sandakan Basin.

NEW CHRONOSTRATIGRAPHIC SCHEME

A new chronostratigraphic scheme is generated based on the result of this study. The new scheme subdivides the Middle Miocene-Pliocene into 3 chronostratigraphic units (Units 1, 2 and 3), each bounded by a Type-1 third-order sequence boundary. Each unit is further divided into third or fourth order sequences which can be correlated from coastal plain to bathyal facies. This new scheme can be correlated to the onshore stratigraphy (Fig. 23), and compared with the lithostratigraphic scheme in Figure 2.

Unit 1 which consists of five sequences is correlated to upper Libong Tuffite, Tungku and lower Sebahat Formations. Unit 2, comprising three sequences, is correlated to the upper Sebahat and lower Ganduman Formations. Unit 3, consisting of at least five sequences, is correlated to the upper Ganduman and Togopi Formations.

Figure 24 depicts the new chronostratigraphic correlation based on this study. It is more precise than and should be compared with the previous lithostratigraphic correlation (Fig. 3). The new correlation will assist greatly in the understanding of the distribution of source, reservoir and seal, and may ultimately be an aid in the discovery of commercial hydrocarbons.

CONCLUSIONS

These are the various conclusions derived from this study:

1. Three chronostratigraphic units (Units 1, 2 and 3) are recognised, each bounded by a Type-1 third-order sequence boundary.
2. Unit 1 (Middle Miocene-early Upper Miocene) consists of five third-order sequences, and is characterised by moderate progradation, moderate aggradation.

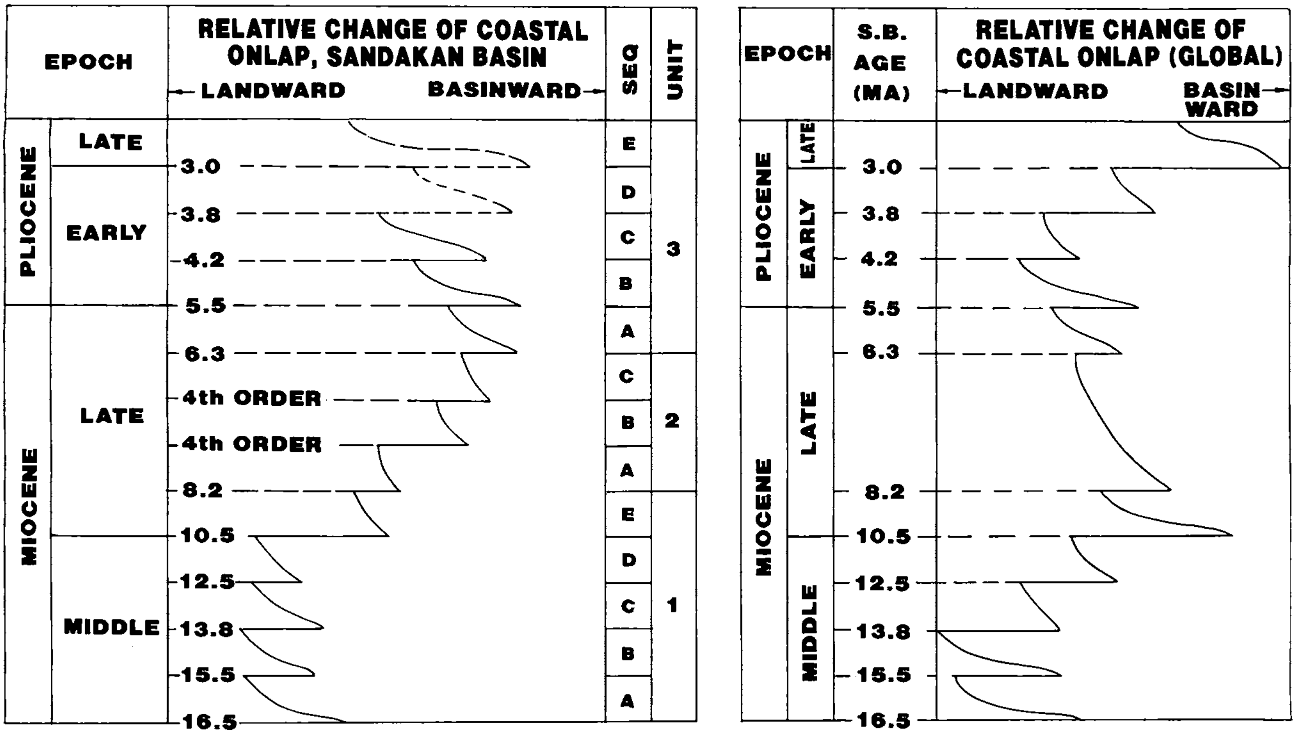

Figure 22. Comparison between coastal onlap chart of Sandakan Basin and global onlap chart of Haq *et al.* (1987).

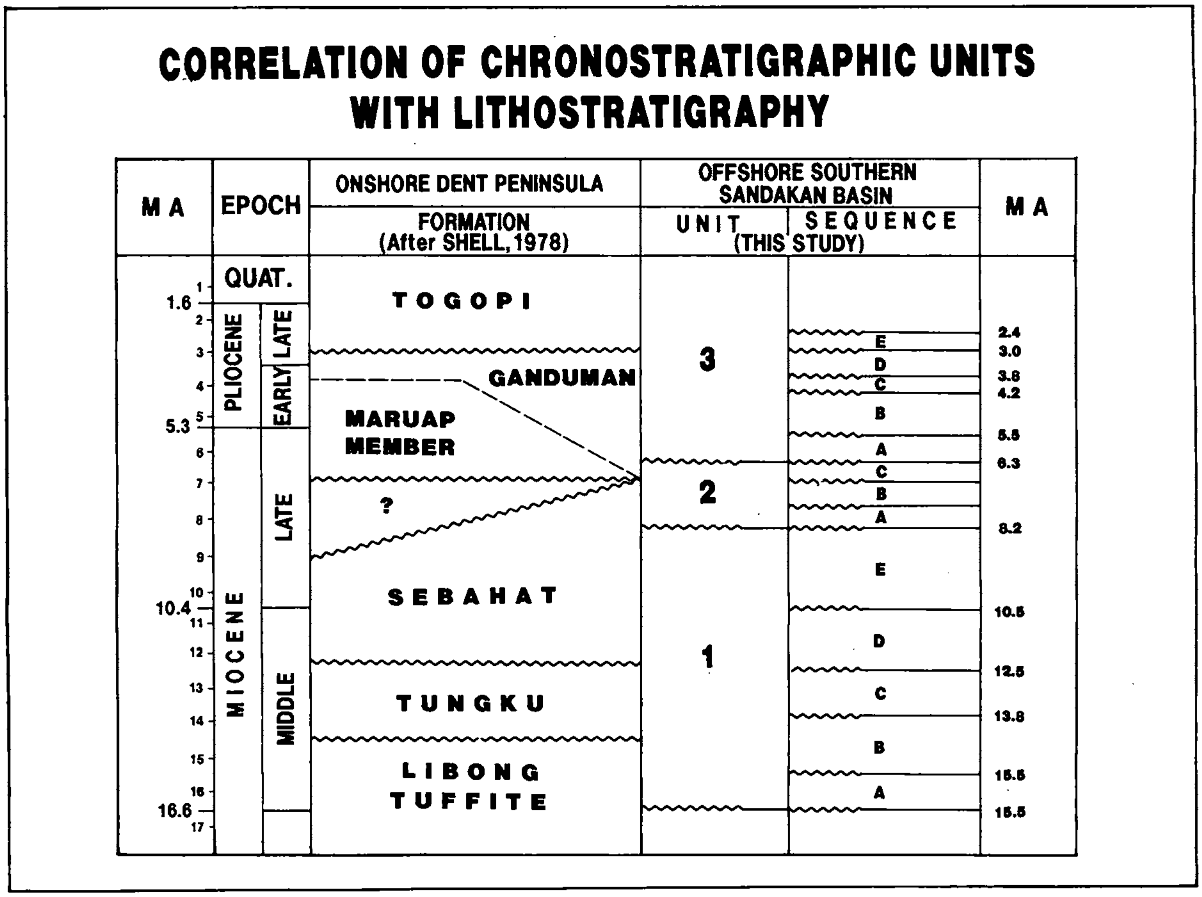

Figure 23. Correlation of chronostratigraphic units with lithostratigraphy.

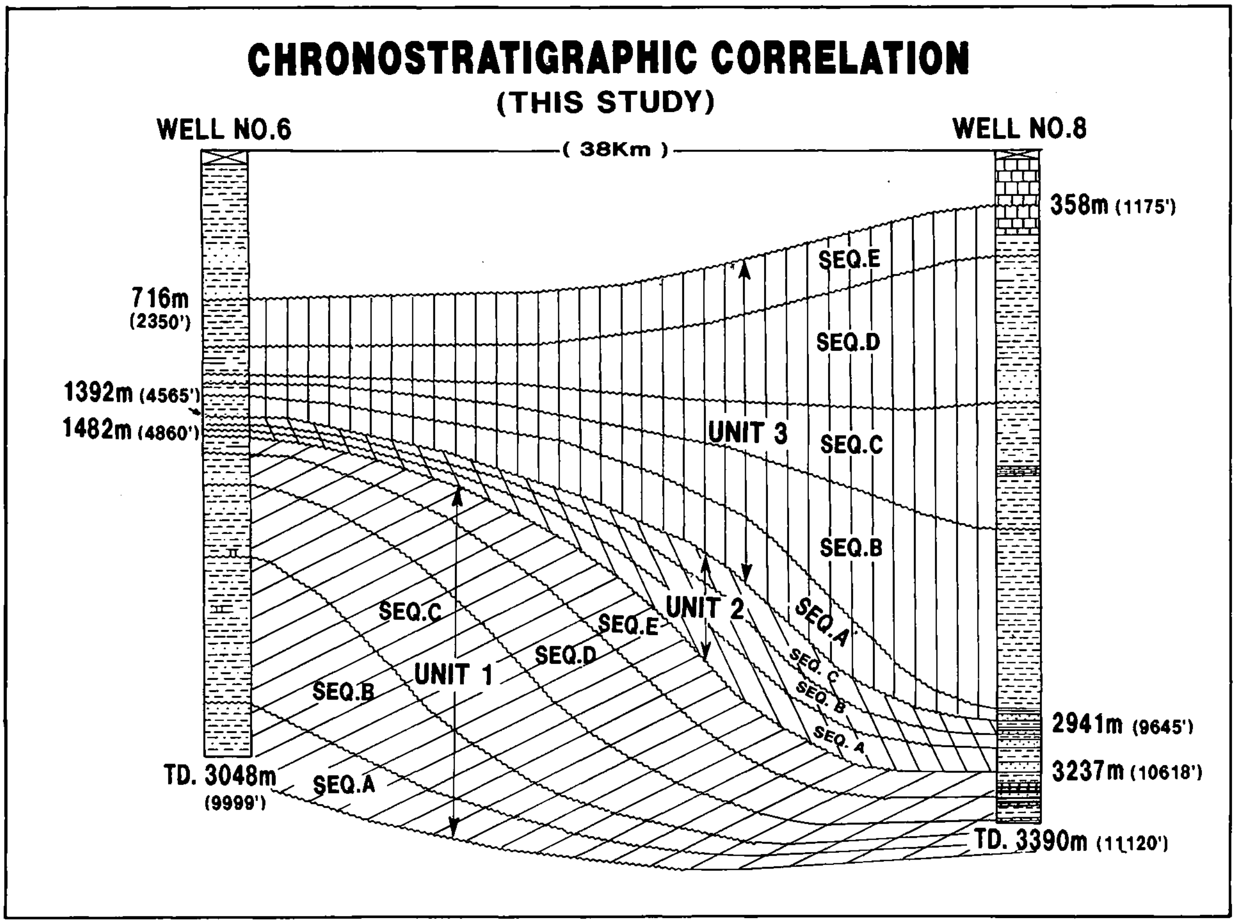

Figure 24. Chronostratigraphic correlation of well No: 6 and well No: 8.

3. Unit 2 (middle Upper Miocene) comprises three fourth-order sequences, and is characterised by high progradation, low aggradation.
4. Unit 3 (late Upper Miocene-Pliocene) includes five third-order sequences, and is characterised by low progradation, high aggradation, with deposition of thick shales and carbonates.
5. Middle-Upper Miocene progradation occurred in a shelf-break setting and is observed to be directed towards the southeast. Pliocene progradation occurred in a ramp setting and is interpreted to be directed towards the east.
6. Stratigraphic traps consisting of a slope fan and a basin floor fan were identified in the study area. They were deposited within Unit 1-Seq. E and Unit 2-Seq. A respectively.
7. Major Upper Miocene progradation is observed in the study area which differs from the Upper Miocene aggradation in the global onlap chart of Haq *et al.* (1987). This discrepancy highlights the importance of the interplay of local tectonics and sedimentation in the Sandakan Basin.

ACKNOWLEDGEMENTS

The author would like to thank PETRONAS and WMC Petroleum for their permission to publish this paper.

REFERENCES

BERG, O.R, 1982. Seismic detection and evaluation of delta and turbidite sequences. Their application to the exploration for the subtle traps. *In*: Halbouty, M.T. (Ed.), The deliberate search for the subtle trap. *AAPG Memoir* 32, 57-75.

HAILE, N.S. AND WONG N.P.Y, 1964. Geology and Mineral Resources of the Dent Peninsula. *Malaysian Geological Survey, Memoir* 16.

HAQ, B.U., HARDENBOL, J AND VAIL, P.R., 1987. The chronology of fluctuating sea level since the Triassic. *Science*, V235, 1156-1167.

HO, K.F., 1978. Stratigraphic framework for oil exploration in Sarawak. *Geol. Soc. Malaysia Bull.*, 10, 1-13

LETOUZEY, J., SAGE, L. AND MULLER, C., 1988. *Geological and structural map of Eastern Asia, introductory notes.* AAPG, Tulsa, Oklahoma.

MITCHUM, R.M., JR., 1985. Seismic expression of submarine fans. *In*: Berg. O.R. and Woolverton, D.G. (Eds.), Seismic stratigraphy II-an integrated approach. *AAPG Memoir 39*, 117-136.

MITCHUM, R.M., JR. AND ULIANA, M.A., 1985. Seismic stratigraphy of carbonate depositional sequences, Upper Jurassic-Lower Cretaceous, Neuquen Basin, Argentina. *In*: Berg, O.R. and Wolverton, D.G. (Eds.), Seismic stratigraphy II-an integrated approach. *AAPG Memoir 39*, 255-274.

MITCHUM, R.M., JR., VAIL, P.R. AND SANGREE J.B., 1977. Seismic stratigraphy and global changes of sea-level-part 6: stratigraphic interpretation of seismic reflection patterns in depositional sequences. *In*: Payton, C.E. (Ed.), Seismic stratigraphy-application to hydrocarbon exploration. *AAPG Memoir 26*, 117-134.

MITCHUM, R.M., JR., SANGREE, J.B., VAIL, P.R. AND WORNARDT, W.W., 1990. Seismic stratigraphy in Late Cenozoic expanded sections, Gulf of Mexico. *In*: Gulf Coast Section, Society of Economic Paleontologists and Mineralogists, *Eleventh Annual Research Conference, Program and Abstracts*, 237-256.

VAIL, P.R., MITCHUM, R.M., JR. AND THOMPSON, S., III, 1977. Seismic stratigraphy and global changes of sea-level, part 3: relative change of sea-level and coastal onlap. *In*: Payton, C.E. (Ed.), Seismic stratigraphy-application to hydrocarbon exploration. *AAPG Memoir 26*, 63-81.

VAIL, P.R., AUDEMARK, P., BOWMAN, S.A., EISNER, P.N. AND PEREZ-CRUZ, G., 1990. *The stratigraphic signatures of tectonics, eustasy and sedimentation – an overview.* Department of Geology and Geophysics, Rice University, Houston, Texas.

VAN WAGONER, J.C., MITCHUM, R.M., JR., CAMPION, K.M. AND RAHMANIAN, V.D., 1990. Siliciclastic sequence stratigraphy in well logs, cores and outcrops: Concepts for high-resolution correlation of time and facies. *AAPG Methods in Exploration Series, No. 7.*

Manuscript received 17 February 1993
Manuscript revised 10 May 1994