# The Possible Significances of Coals Encountered in Cored Sections from the Central Malay Basin: Implications for Sequence Stratigraphic Interpretation and Basin Character*

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## Abstract

Cores from E Group sections (Miocene) from the central Malay Basin have been the subject of studies to provide the basis for improved understanding of reservoir sequences. These studies included detailed core description and dense sampling for combined micropalaeontological and palynological analysis.

Reservoir sandstones in the cored sections were most probably deposited within river dominated shallow water deltas or sub-deltas in a lacustrine setting. Possible present day analogues may be found in the Catatumbo River delta in Lake Maracaibo, or alternatively in the Volga and Ural deltas prograding into the shallow waters of the Caspian Sea.

The coals studied have been shown to be of both freshwater and brackish origin, based on the palynological and micropalaeontological content. In all cases they represent phases of drying out of much of the basin, some being correlatable regionally. They are usually underlain by variably well-developed seat earths which show high levels of bioturbation/pedoturbation and also often contain marine to brackish water microfaunas. As such these seat earths often represent the most saline/marine sediments in a given genetic sequence. The coals are generally rootleted and the seat earths are pale grey in colour, indicative of soil zone leaching. Peat accumulation is invariably terminated by a flooding event. This may be freshwater or brackish, indicated by the palaeontology and bioturbation index.

The conclusion drawn from these observations is that at various stages of the fill of the Malay Basin, much of the area was prone to regular drying out, with the establishment of widespread coal forming peat. River channels formed at the same time as the peat and dissected the area, which is thought to have been low relief, but occasionally flood events breached the channel margins and killing the peat mires, at

least locally. Peat accumulation was brought to a close by flooding of the basin, either with fresh or brackish water. This suggests there to have been a barrier to the basin, preventing or restricting the ingress of saline water. The presence of brackish water coals may approximately locate the paleo-coastal belt for a given cycle and the upward change in coal character indicates increasingly freshwater conditions. This in turn suggests that peat facies belts may have been migrating basin-wards during phases of falling sea levels, resulting in the establishment of more widespread peat swamps.

# The possible significances of coals encountered in cored sections from the central Malay Basin; implications for sequence stratigraphic interpretation and basin character.

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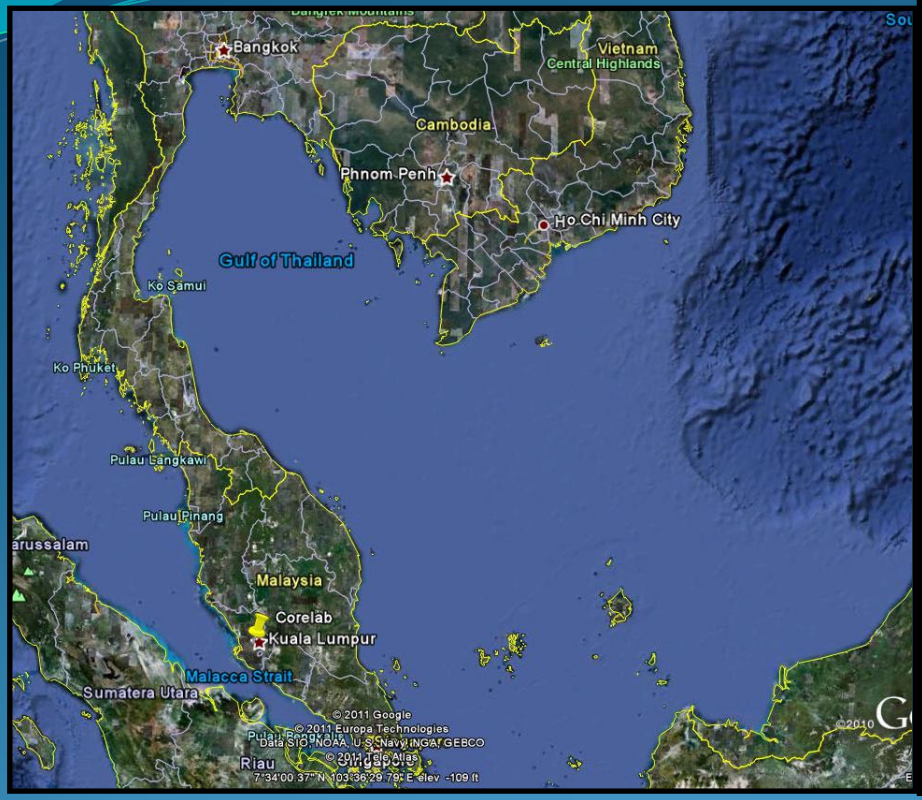
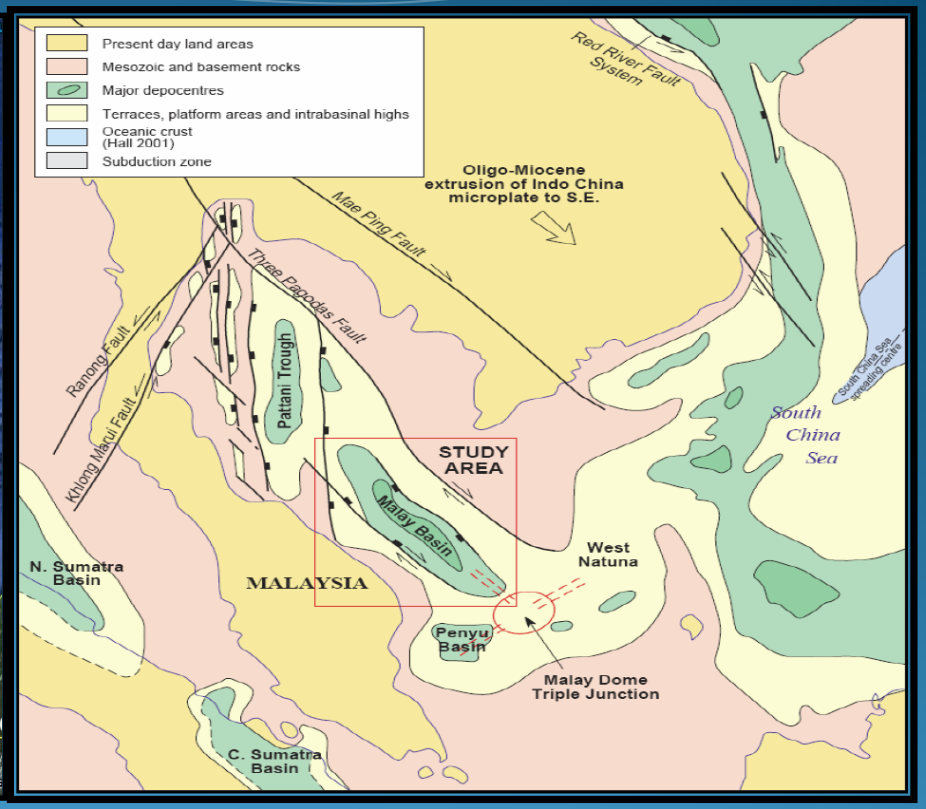
Mandor (Photo: © Anshari, 2005)

# STUDY LOCATION




**The Malay Basin is a Tertiary extensional basin located in the centre of Sundaland the continental core of SE Asia.**

**It occupies the southern part of the Gulf of Thailand, extending northwards into the Pattani Trough and to the southeast into the adjoining Penyu and West Natuna basins.**

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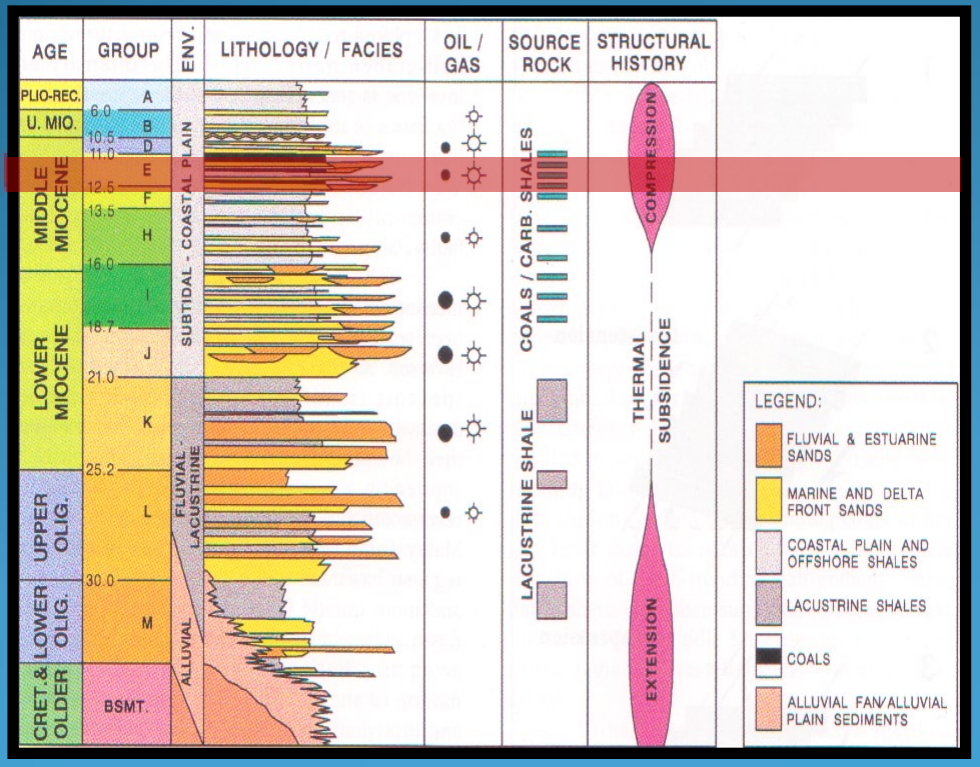
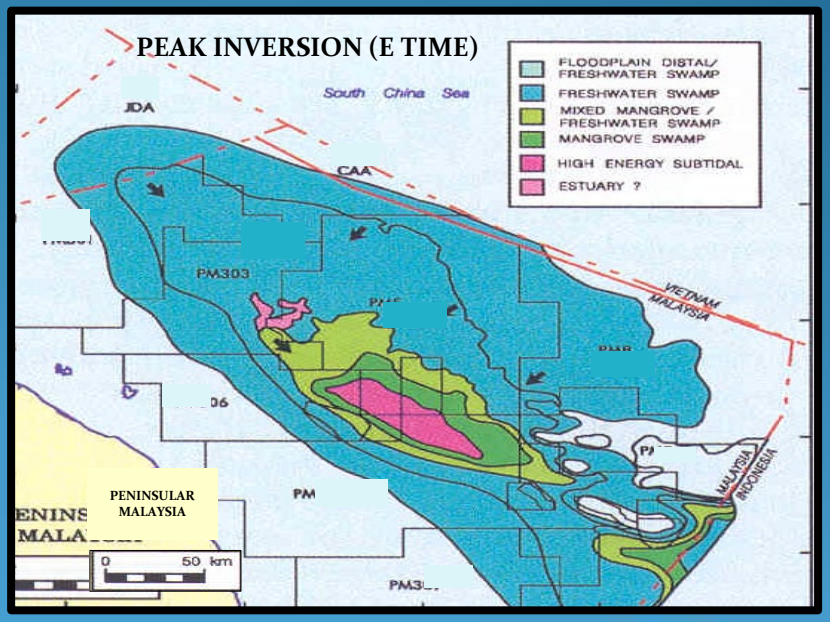
# INTRODUCTION

- Cores recovered from two recent wells in the 'E' Group, central Malay basin, have been the subject of detailed sedimentological and palaeontological analysis, aimed at providing a highly detailed interpretation of depositional environments.

- Results have shed light not only on the specific sequences but have implications for the broader understanding of the fill to the Malay Basin

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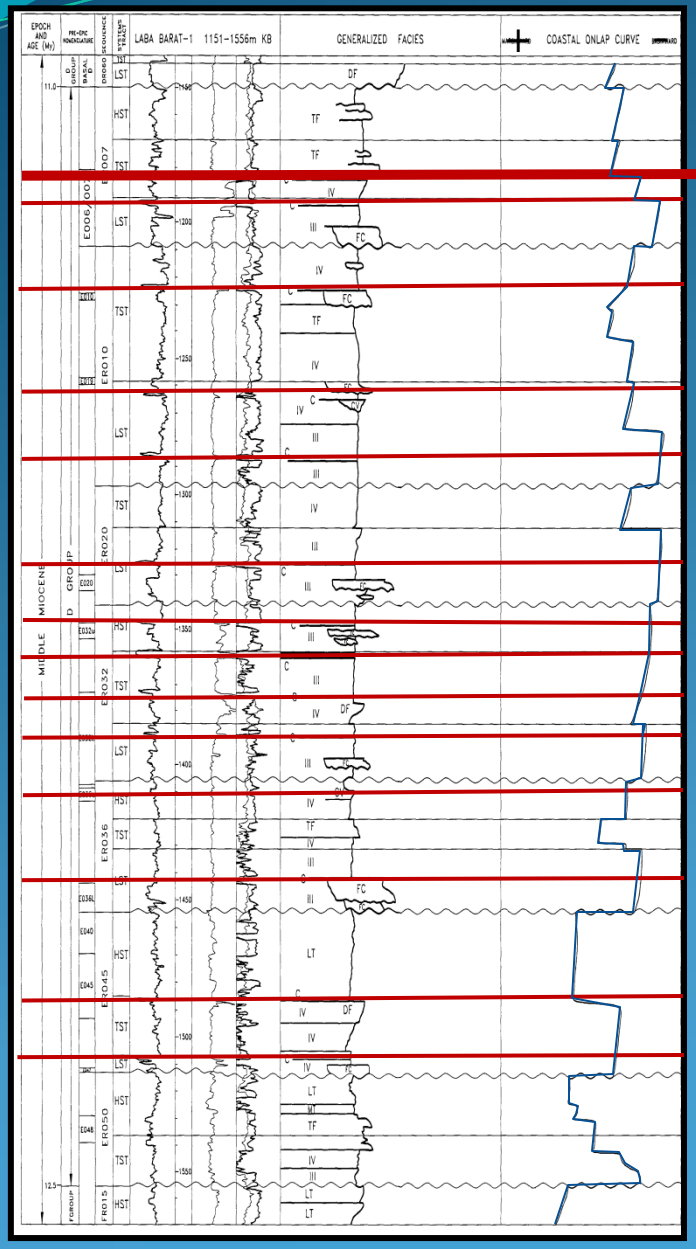
# E GROUP REPRESENTATIVE SECTION




## SME COAL (Top of E Group)

- Repeated cycles defined by coal horizons
- 15 + coals present in type well but up to
- 30 present in other sections
- Duration of E group uncertain, maybe 1.5 My
- Approximate cycle duration hard to determine
- ? Relationship between ‘sequence boundaries ‘ systems tracts, interpreted coastal onlaps and coals is not consistent.

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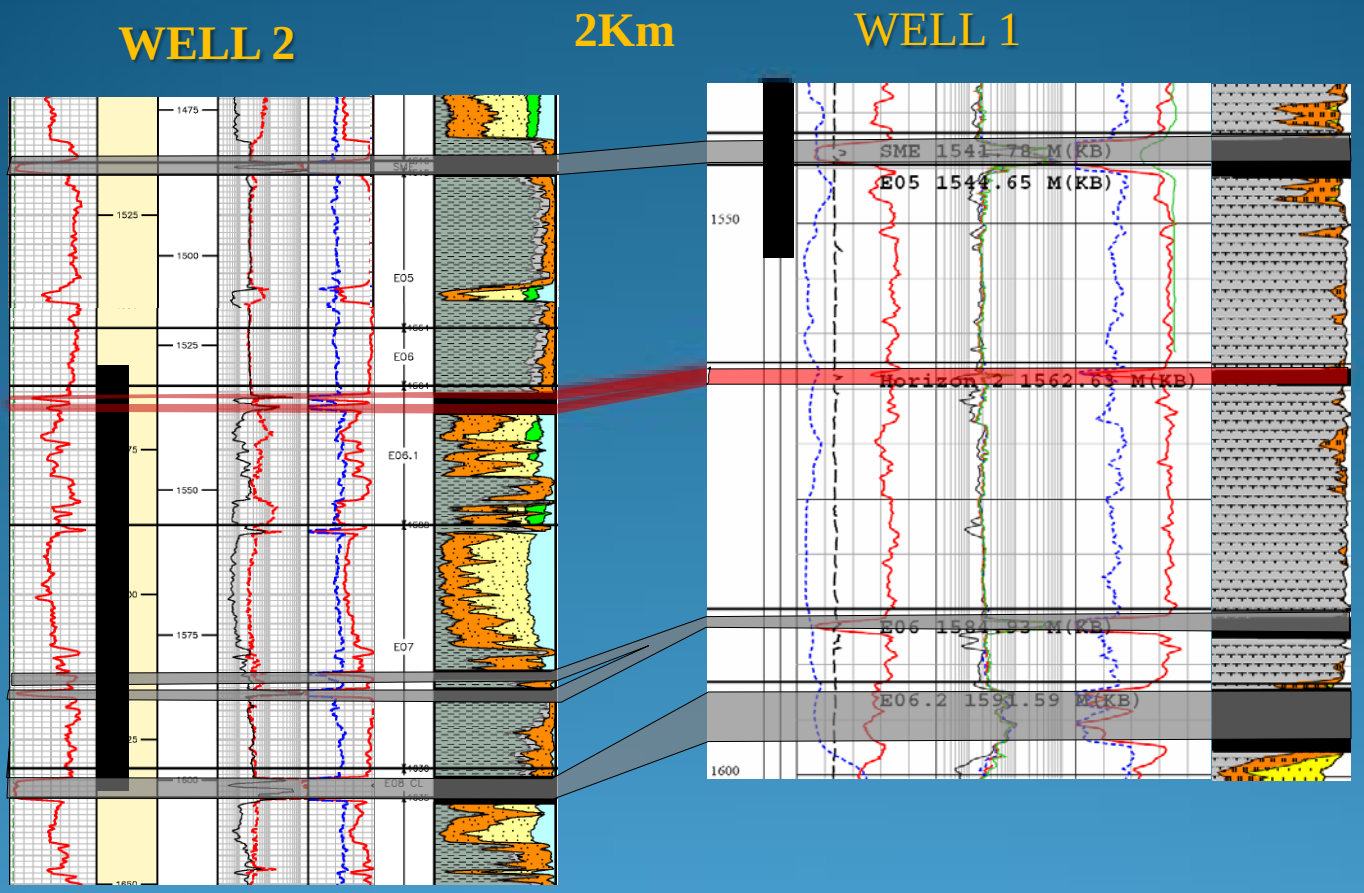
# THE CORED SECTIONS




'D"Group
SME Coal, Well 1

'E'Group

Well 2 Coal

- Two cored sections from the upper part of the E Group
- Well 1 penetrates the SME coal
- Well 2 penetrates the underlying 3 coals, of which the topmost is discussed.
- Core recovery is 100%

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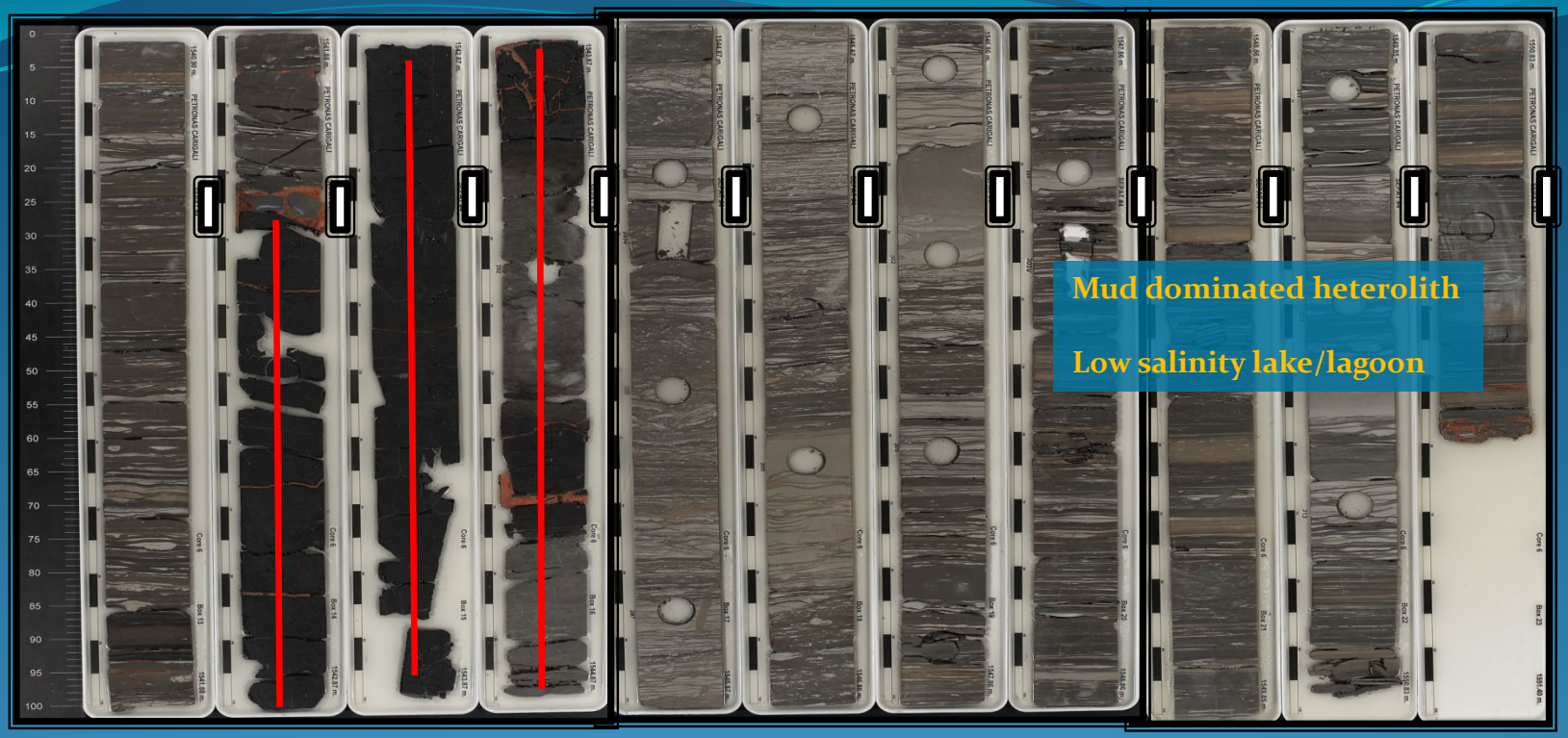
# WELL 1 CORED SECTION LITHOFACIES




- 1.75 metres coal overlying mudstone dominated heteroliths that show sanding up profile and low levels of bioturbation.
- Previously interpreted as tidal flat deposits
- Seat earth shows highest levels of bioturbation.
- No beach deposit between lagoonal mudstones and mangrove peat

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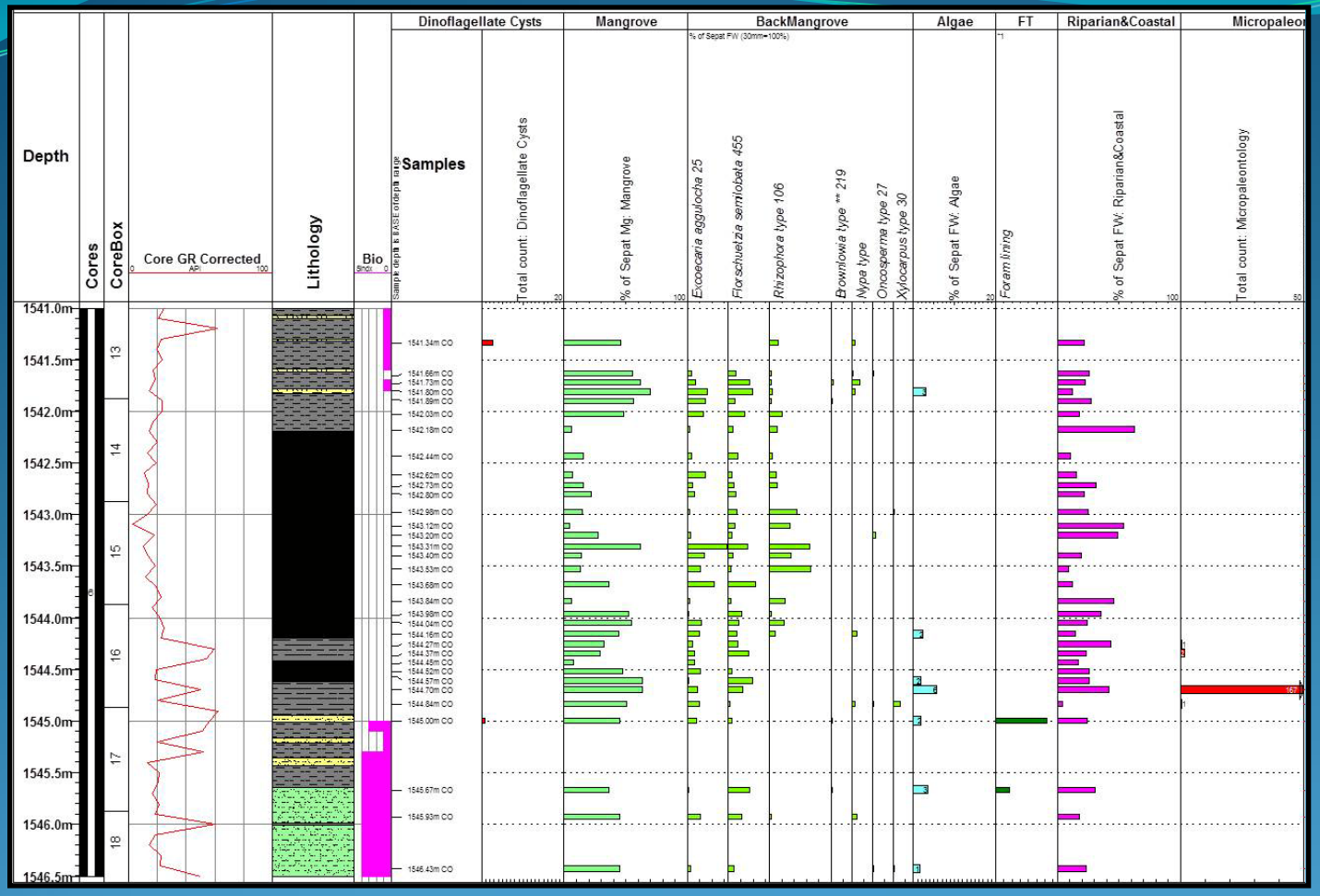
# WELL 1 BIOFACIES




- Dense sampling over the coal and adjacent intervals.
- Most marine section is the seat earth, foraminifera present.
- Mangrove pollen present in the seat earth and lower part of coal bed.
- Main coal contains predominantly lacustrine and riverine forms.
- Section is predominantly low salinity

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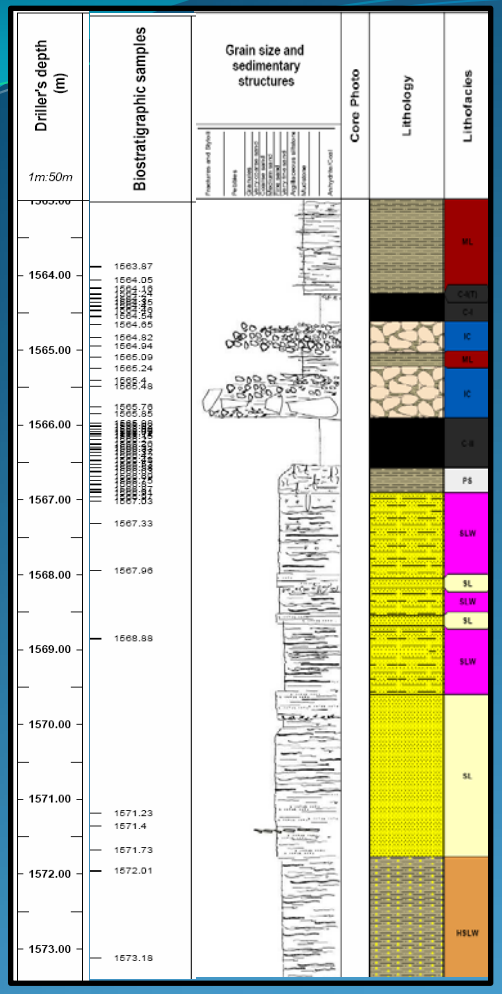
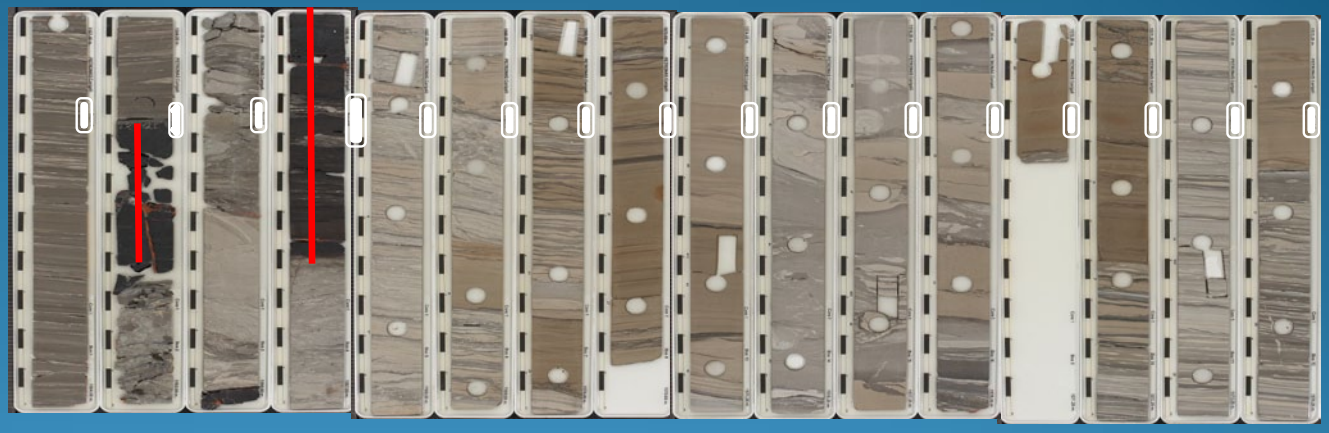
# WELL 2 CORED SECTION LITHOFACIES



- Coal capped thick sequence which becomes sandier upwards.
- Minimal bioturbation except beneath the coal.
- Sandstones generally developed as single event beds.
- No beach deposit between lagoonal mudstones and mangrove peat.

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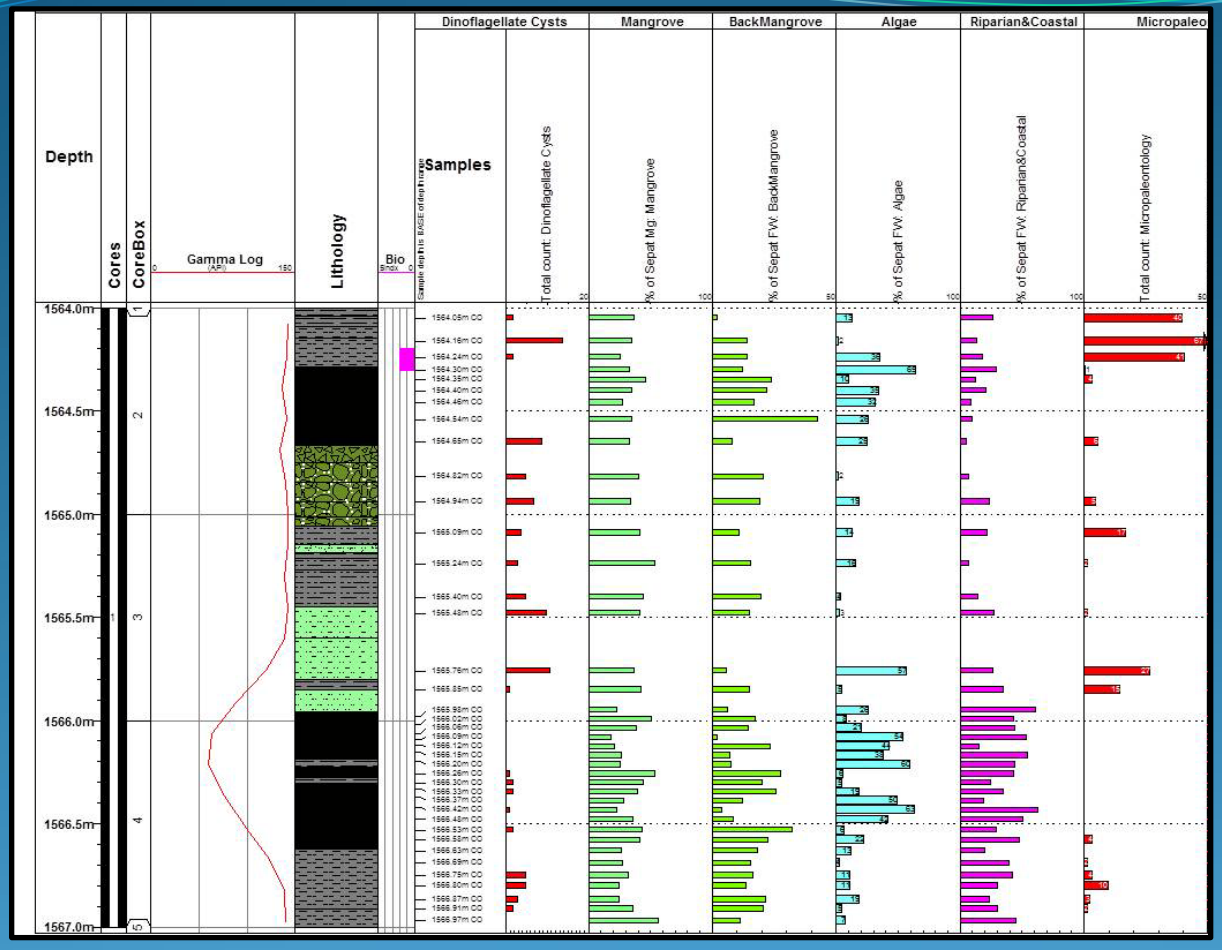
# WELL 2 BIOFACIES




- Highlights the occurrence of marine signatures in the seat earth.
- Lower coal shows some marine influence.
- Changes in mangrove pollen and freshwater indicator levels reflect the complex nature of the parent peat

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# LACUSTRINE DELTAS

- Dominance of coarsening upward sequences of event beds suggests widespread development of subaqueous mouthbars or small scale deltas.

- Mouthbars prograded into a largely freshwater to slightly brackish body of water.

- Channels fill deposits a minor component of the overall depositional system.

- The low salinity precludes tidal influence, for which no physical evidence has been seen in the study intervals.

- Possible analogues may exist in Lake Maracaibo or the Caspian Sea.

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# Potential Partial Analogue, Volga delta






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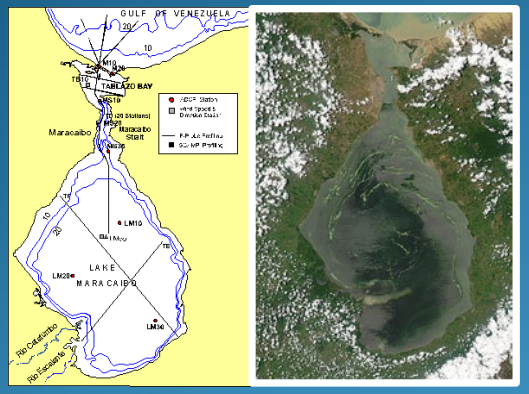
# LAKE MARACAIBO, VENEZUELA


- Large body of fresh to slightly brackish water
- Restricted connection to Caribbean
- Shallow, less than 25 metres over most of its area
- Large freshwater influx
- River dominated birds foot delta





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# IMPLICATIONS FOR BASIN CHARACTERISTICS

- Dominance of non-marine sequences requires a physical barrier to the basin, preventing ingress of saline water.

- Dominance of non-saline sequences precludes tidal influence

- Barrier may be tectonic in origin or relate to cyclical changes in sea level in the proto S China Sea.

- Presence of the most marine faunal and floral signatures in seat earths records the timing of maximum saline ingress into the basin.

- Local presence of coals with mangrove signatures locates a palaeocoastline.

- Occurrence of coals above the most marine sections indicate that peats formed during the falling stage and through to the succeeding flooding event.

- For much of its history the Malay Basin may have been a land area rather than a marine or lacustrine basin.

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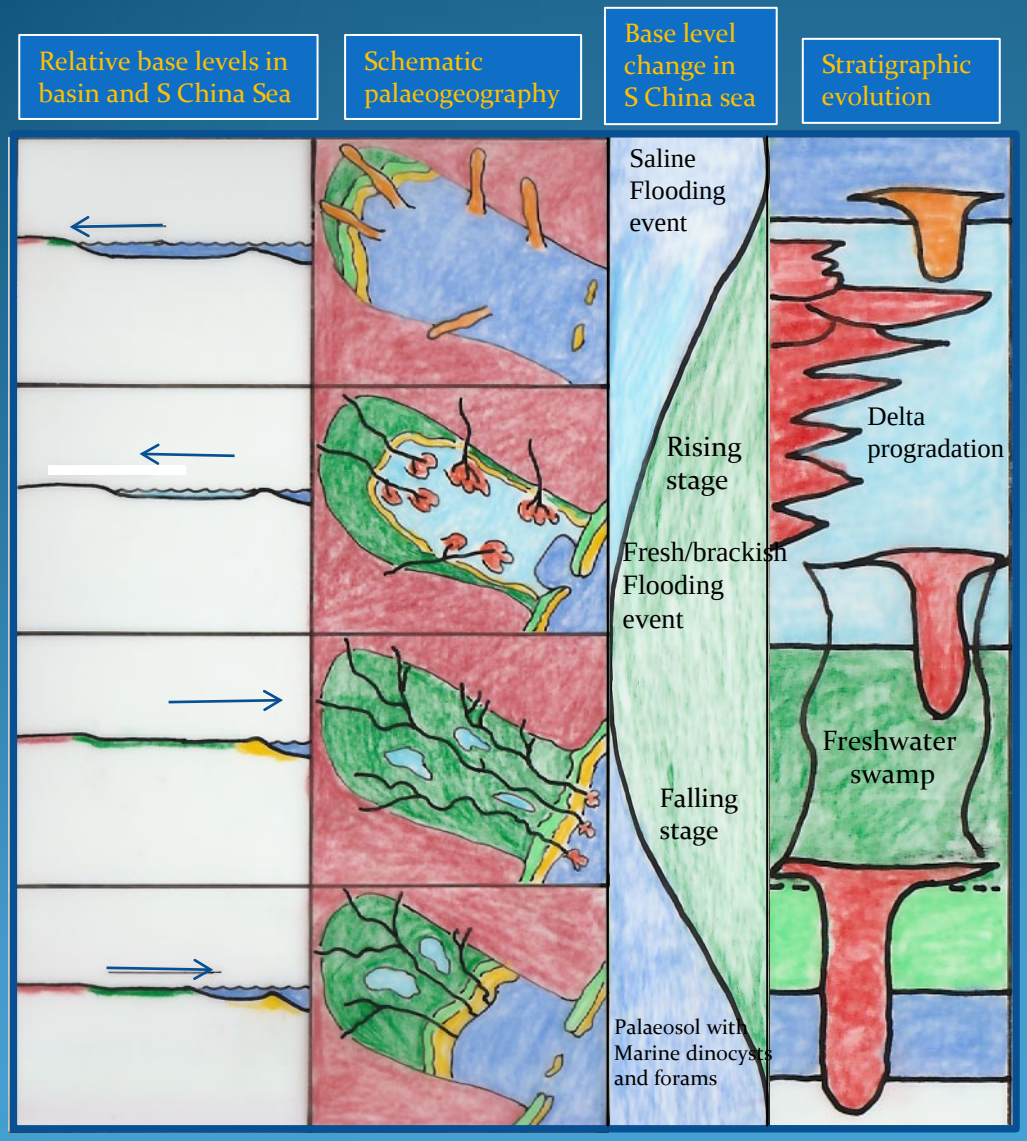
# STRATIGRAPHIC MODEL FOR MALAY BASIN E GROUP




- Maximum connection to open sea.
- Brackish to freshwater faunas
- Possible tidal influence
- Infill of incised alleys and drowned river valleys
- Minor freshwater influence.
- No significant development of widespread reservoirs.

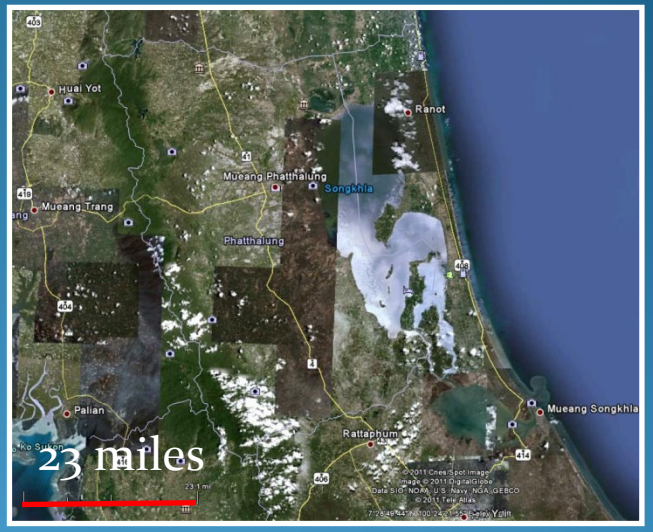
- Backwards migration of the coastal system, with the plugging of connections to the open sea., possibly by barrier systems formed due to long shore drift.
- A freshwater or brackish lake develops over much of the basin area.
- Fluvially influenced dendritic deltas rapidly prograde across much of the basin.
- Reservoirs may be developed in the deltas or in shoreline systems, depending on the extent of marine connection.

- Drop in water levels results in basinward migration of the coastal belt.
- Incised valleys feeding from basin margins and axially along the basin.
- With migration of the coastal belt, mangrove derived peats may be overlain by freshwater peats .
- These will be diachronous, younging to the SE.
- Peat formation will continue after the lowstand maximum during transgression

# COASTLINE 'HEALING', SOUTH CHINA SEA

## Vinh van Phong, southern Vietnam


## Songkla, southern Thailand




**Longshore drift along the western coastline of the South China sea produces extended spits linking islands and creates large coastal lagoons**

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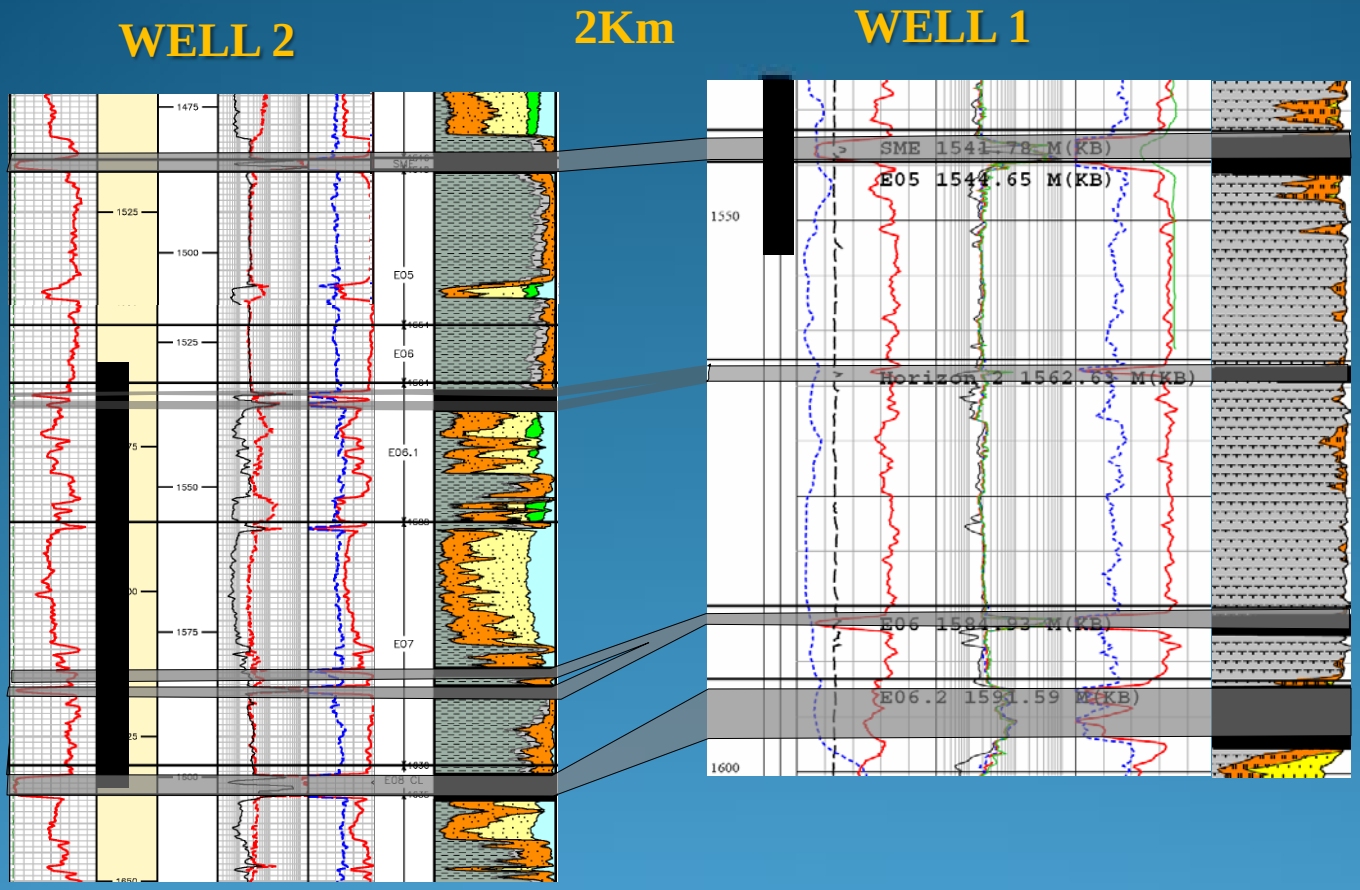
# THE CORED SECTIONS

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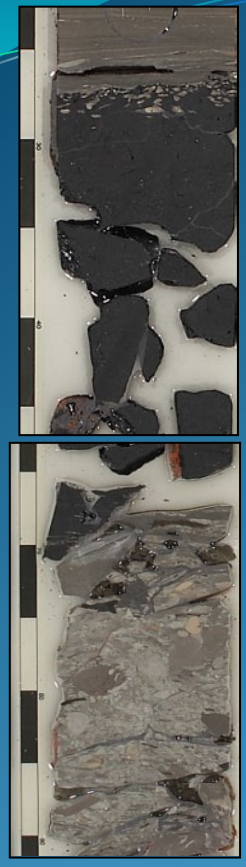
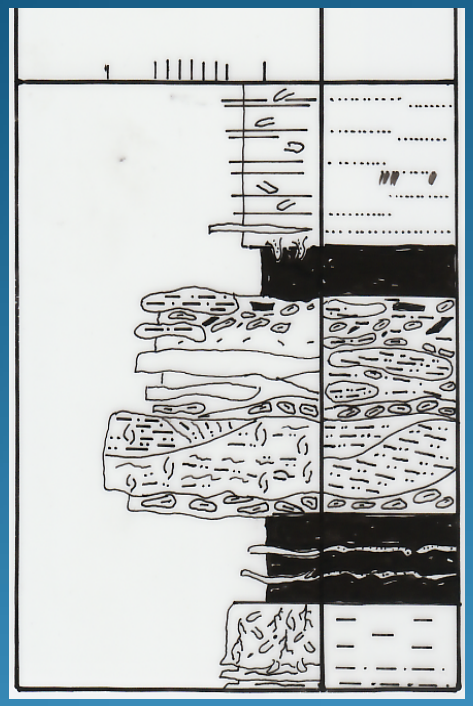
# WELL 2 CONGLOMERATIC INTERVAL





- Sharp base to conglomerate, not obviously erosive.
- Contains wide variety of clast types and clast sizes. No obvious extra-basinal clasts
- Chaotic fabric.
- Presence of marine algal spores and foraminifera.
- Sharp top, overlain by coal, no roots.

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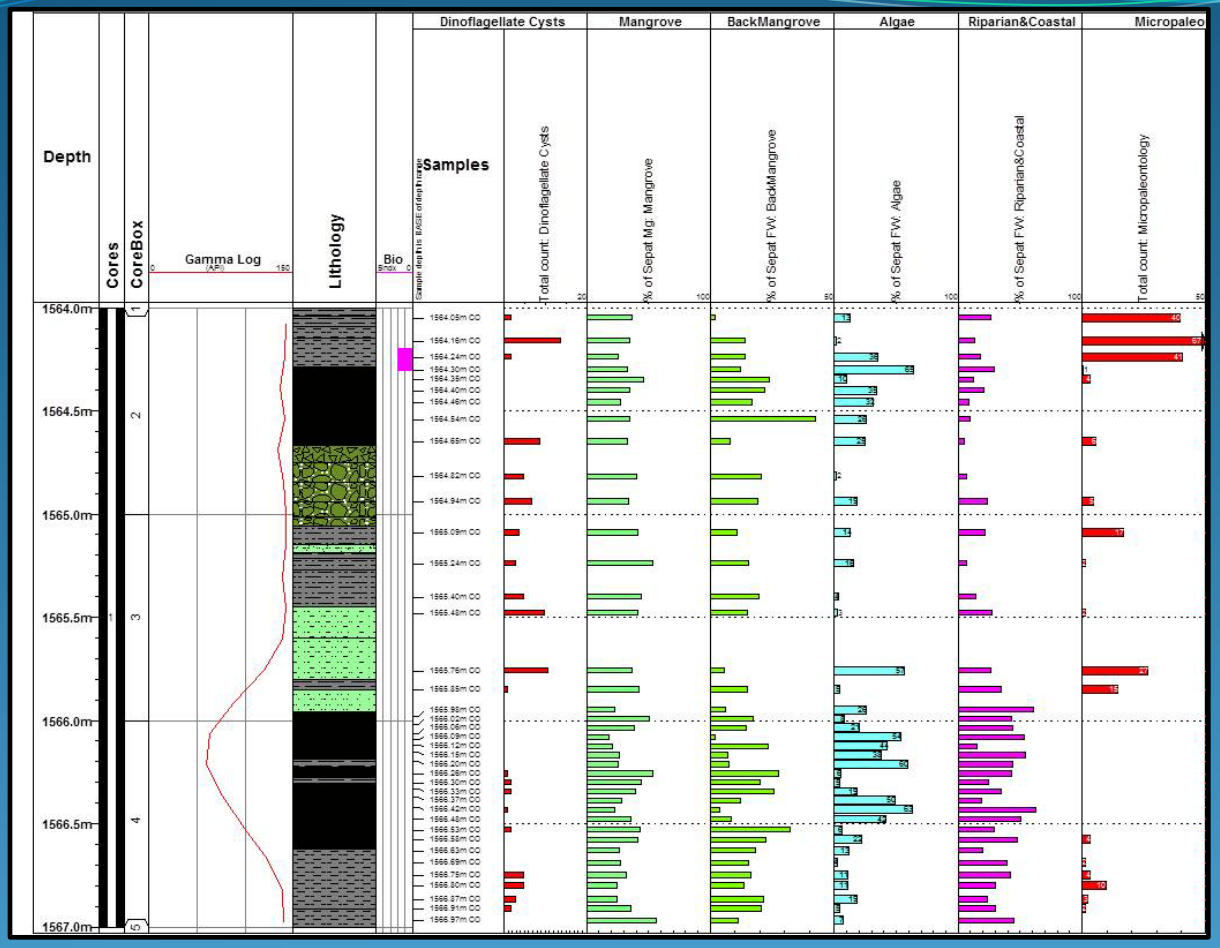
# WELL 2 BIOFACIES




- Highlight the occurrence of marine signatures in the basal seat earth.
- Lower coal shows brackish/mangrove signature reducing upwards.
- Upper coal has no marine signal
- Conglomerate contains mix of marine and freshwater signals

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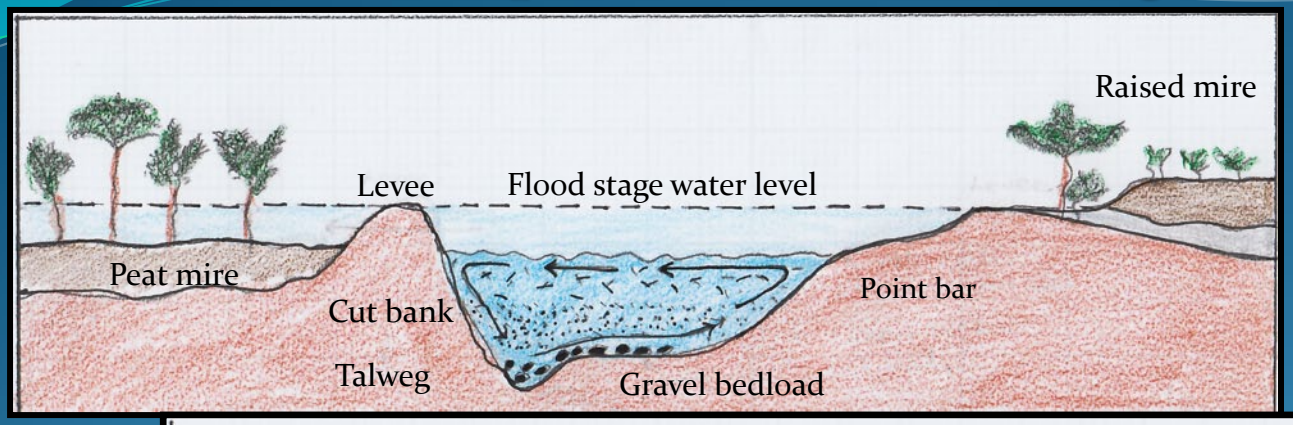
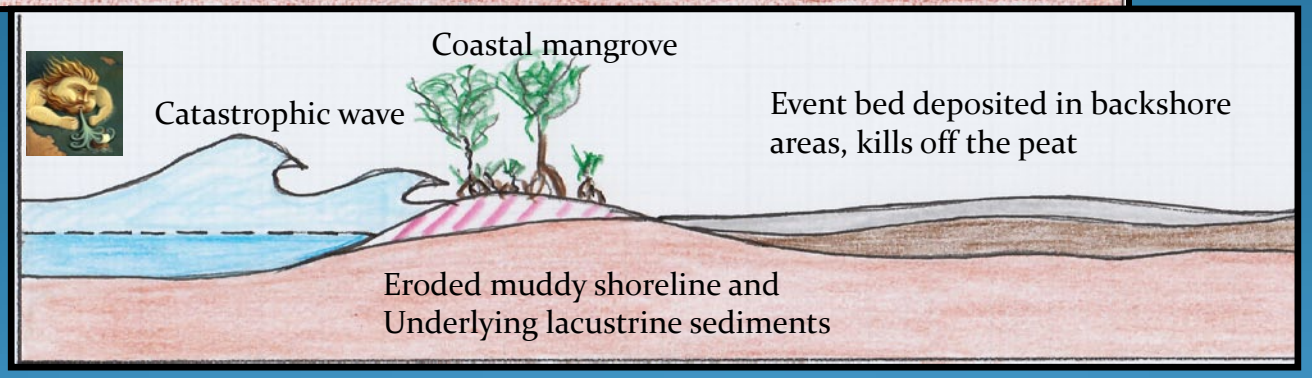
# Possible interpretations of the conglomeratic interval




Overbank flooding




Catastrophic wave

- The presence of tsunami deposits locates the palaeo-shoreline to within a few km. and most probably indicates an open connection to the S China Sea, consistent with the suggested model for sequence development.

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# CONCLUDING COMMENTS

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•Detailed biofacies analysis linked with careful sedimentological observation has proved to be a powerful tool in providing a better understanding of the complex environments and changes in environments within the Malay Basin E Group sequence.

• The availability of cored sections has been vital to this analysis

• This improved understanding reflects on both local environments of deposition, important for field scale modeling, and also on basin scale interpretation and modeling for exploration projects and new play identification.

• The complex, high frequency cyclicity revealed by this work requires re-evaluation of the application of conventional sequence stratigraphic terminologies and concepts and highlights the importance of appropriately scaled stratigraphic analysis.

• Such work will be the key to continued exploration and development successes in the Malay Basin.

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# THANKYOU

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