PS"Deltaic" Reservoir Characteristics of Giant Fields of the Kutei and Baram Basins, Borneo*

Herman Darman[1] and Kusumo Handoyo[2]

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Abstract

A number of giant fields were discovered in the basins surrounding Borneo, mainly in the Baram and Kutei basins. There are similarities between the two oil provinces. The giant fields produce oil and gas mainly from Miocene deltaic to shallow marine sandstones, which are part of progradational sequences. The sandstone minerals in both basins are generally quartz dominated and originally came from the central part of the Borneo Island; the development of the reservoirs is controlled by similar sea level fluctuations and climate. Tectonics and local structures controlled the coastal morphology and local basin setting, which generated different reservoir facies and architecture.

The structures of the fields in the Kutei Basin are generally larger, but the reservoirs are discontinuous. Most sandstones in the Kutei Basin were developed in distributary mouth bars and sealed by delta flat and marine shales. Sandstone bodies are interconnected in part by channel cuts. Coal beds are common in the proximal depositional environment, and limestones are well developed in the distal part of the depositional system.

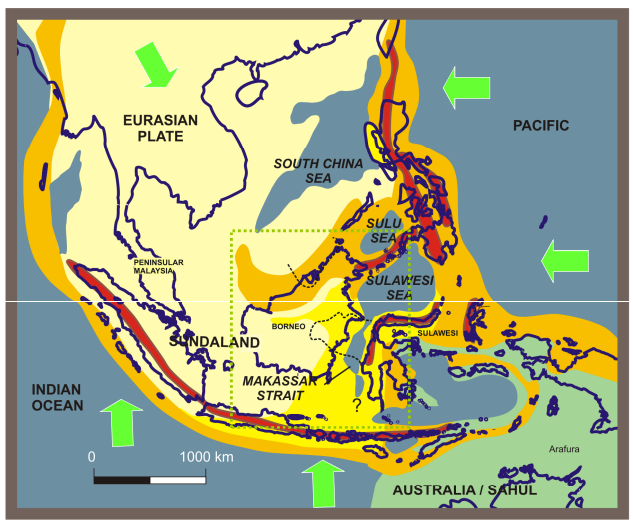
Coastal and shallow marine sandstones, which dominated the Baram Basin sandstone reservoirs, are more continuous laterally. The sand reservoirs are only associated with thin carbonaceous layers and thin limestones beds. Although the reservoir porosity and permeability of the fields in the Baram Basin are generally higher compare to those from the Kutei Basin, the field structure sizes are smaller.

“Deltaic” Reservoir Characteristics of Kutei and NW Borneo Giant Fields, Borneo

Herman Darman (Brunei Shell Petroleum) & Kusumo Handoyo (Chevron)

AAPG – International Conference and Exhibition – Perth, 2006

1.Introduction



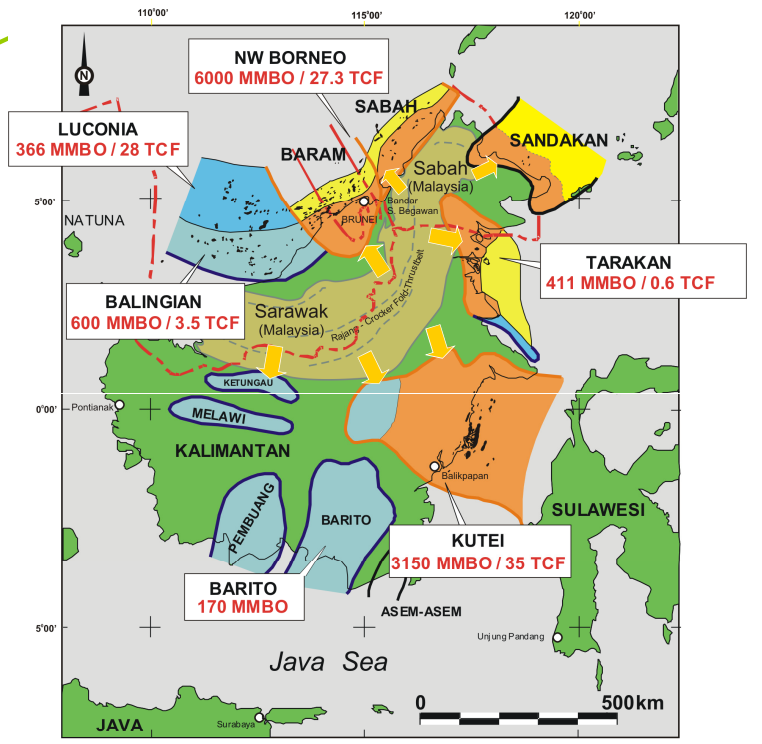
Legend

- Australian crust / Sahul Shelf
- Pre-Late Cretaceous Eurasian / Sunda Shelf
- Late Cretaceous accretionary crust
- Cenozoic accretionary crust
- Active volcanic arc
- Oceanic crust

After Doust & Lijmbach, 1997

Tectonic movement direction

- Borneo Island is surrounded by tectonic plates which move toward it.

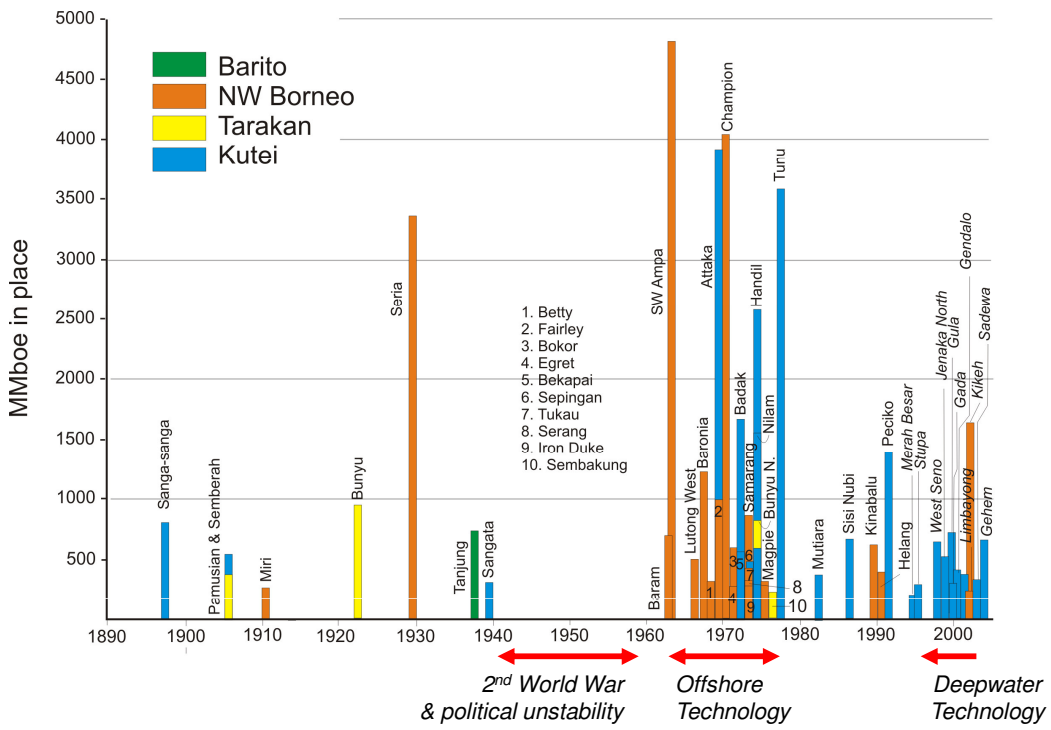


Legend

- Pliocene-Pleistocene clastics
- Miocene clastics
- Miocene carbonates
- Paleogene clastics
- Cretaceous - Miocene Rajang-Crocker range
- Oil and gas fields

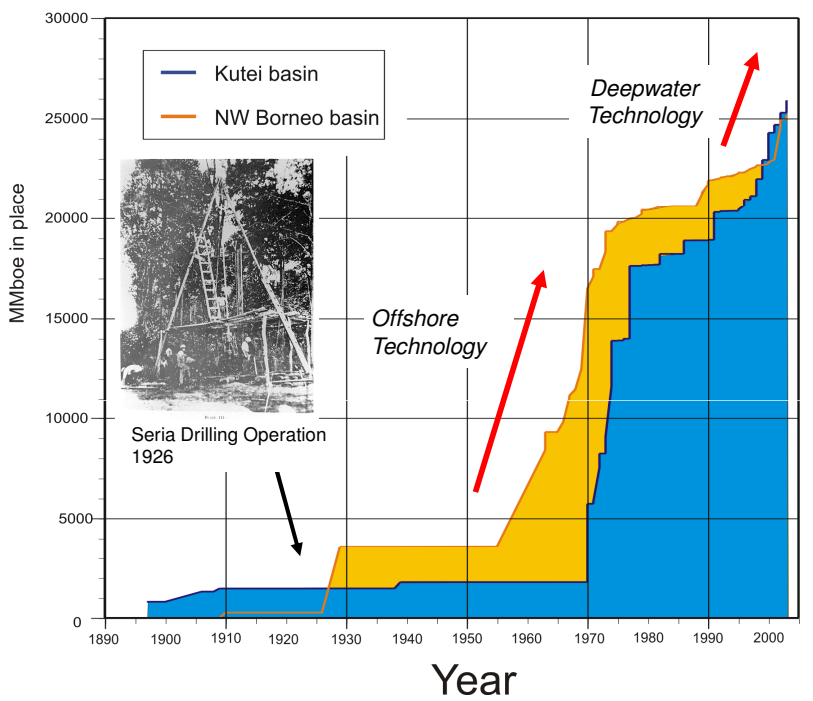
Sediment transport direction

2. Exploration History and Discoveries



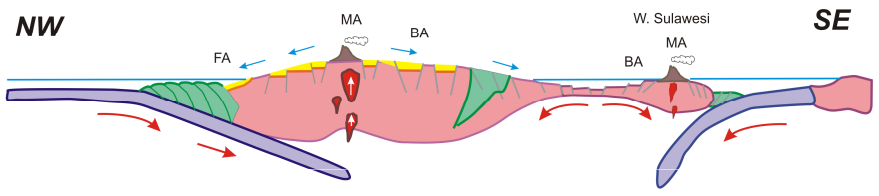
- 1st oil seeps discovery by western explorer: 1911 in Miri, NW Borneo
- 1st comercial oil discovery: 1898 in Sanga-sanga, Kutei Basin
- Northwest Borneo and Kutei basin are the most prolific basin compare to other basin surrounding Borneo

- The Borneo Island is surrounded by prolific petroleum basins and the majority of the sediments came from the same source: Rajang-Crocker Fold Thrust belt. This region is located in the middle of the island, uplifted due to tectonics.
- Those basins are controlled by the same sea level and climate.
- The giant fields occur in the NW Borneo and Kutei Basin. Are they the same, or mirror imaging each other, or different?
- This poster show the similarities and the differences between the two most prolific basins of Borneo

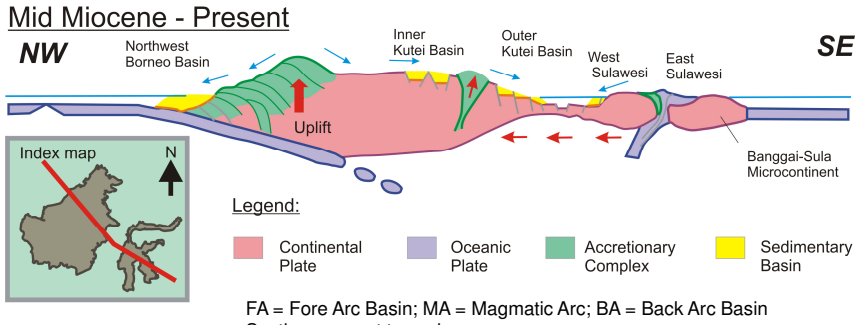


3. Regional Overview

Oligocene - Mid Miocene



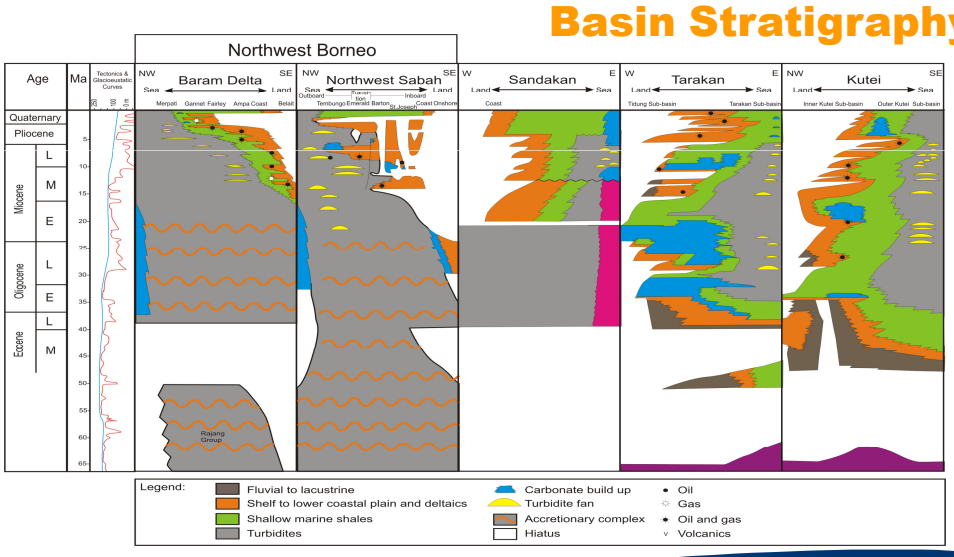
Mid Miocene - Present



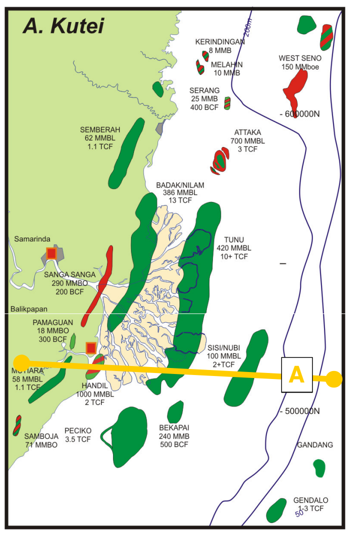
FA = Fore Arc Basin; MA = Magmatic Arc; BA = Back Arc Basin
Sections are not to scale
Modified after Asikin, 1995, in Bachtiar, et al, 1996

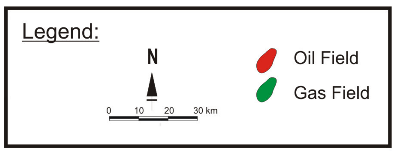
- Rajang-Crocker Fold Thrust belt (Kuching High), is the major provenance for both NW Borneo and Kutei basin. Granitic basement only provide sediments to the Kutei basin
- Northwest Borneo basin is relatively younger compare to the Kutei Basin

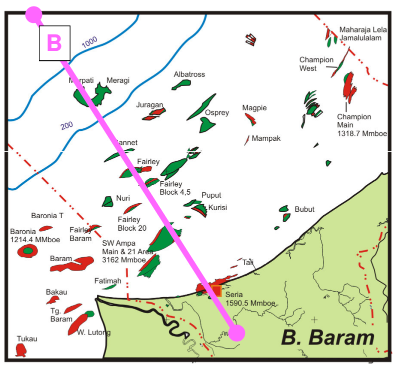
Basin Stratigraphy



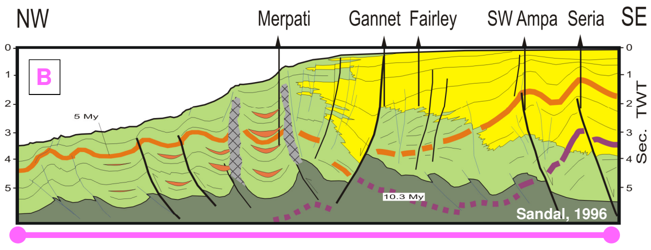
4. Geological setting

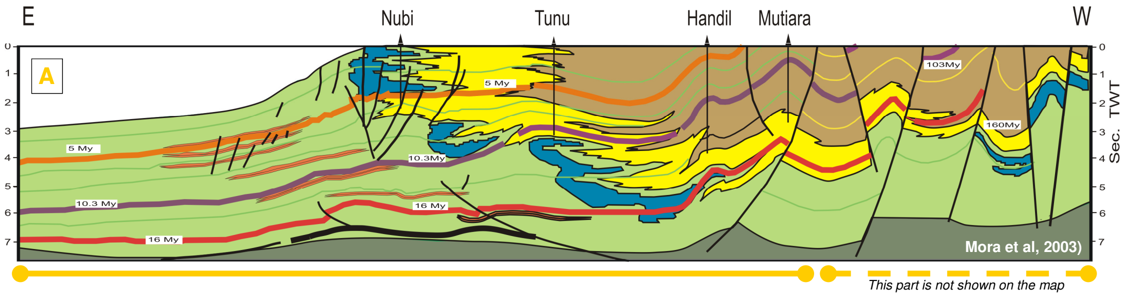






• Map and section are in common scale (1:100000 for map)





Note

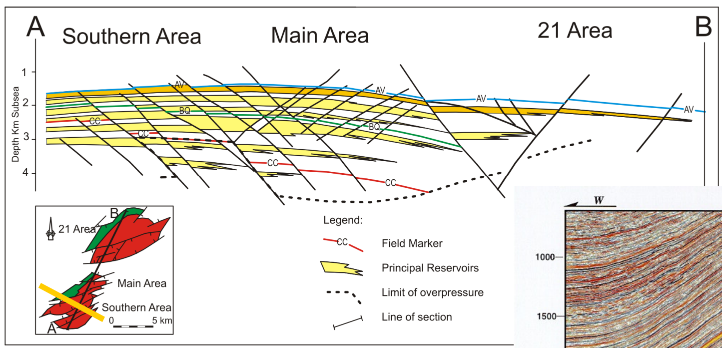
- Both NW Borneo and Kutei basin are filled by progradational sequences.
- Kutei Basin structure are generally less structured compare to NW Borneo
- Not much carbonate developed in the NW Borneo basin
- Sediments in NW Borneo is generally thicker.

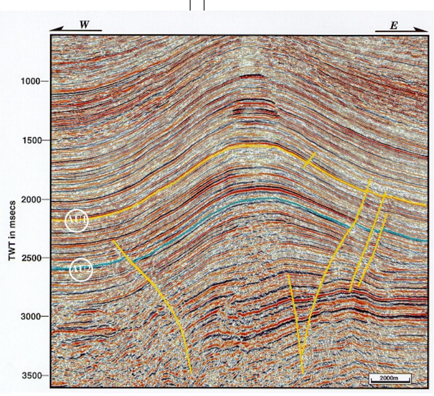
5. Reservoir Geometry

NW Borneo Field Examples

Kutei Basin Examples

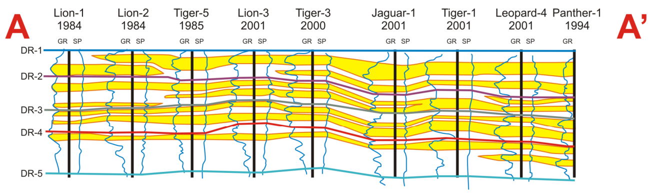
Southwest Ampa

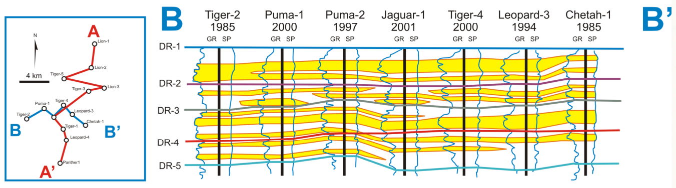




- Discovered in 1963, 4800 MMboe HCIP
- Principal sandstone reservoirs can extend more than 10 km
- Multiple sheet sand reservoirs in each fault block.

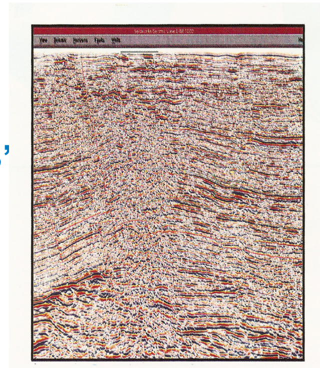
Attaka Field





Rosary, D., Sundari, E., Yuniyanto, Krisna, A., 2003, Facies analysis of the lower DR sands, based on core and wireline log interpretation, Attaka Field, Proceedings, Indonesian Petroleum Association 29th Annual Convention

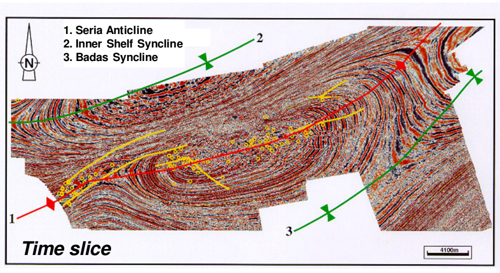
Seismic expression of the Attaka Field

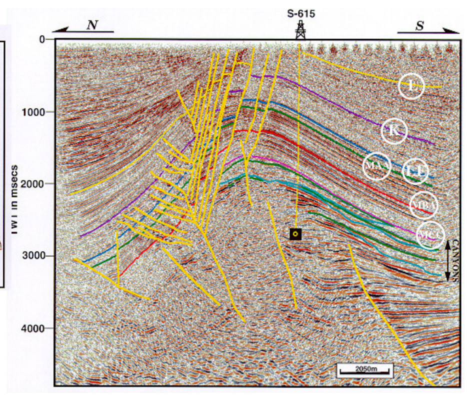


From Borland, et. al., 2000

- Discovered in 1970, 3944 MMboe HCIP
- Combination of individual channel sandstone and stack channel sandstone reservoirs.

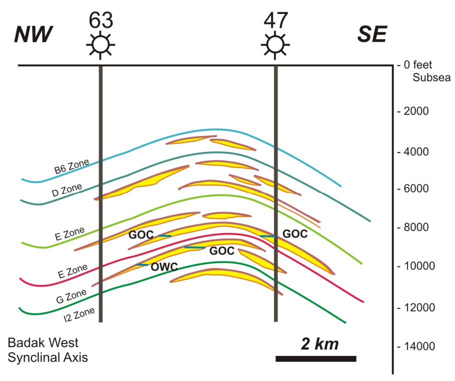
Seria Field

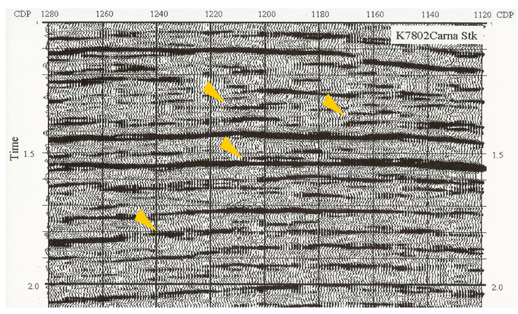




- Discovered in 1929, 3320 MMboe HCIP
- Has produce > 1 billion barrel in 75 years
- Multiple reservoirs, high net/gross, faulted blocks

Badak Field

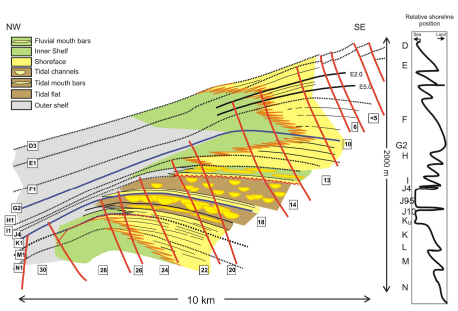


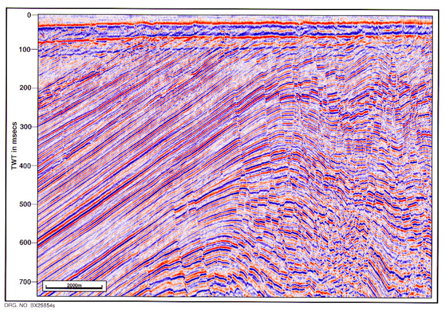


Example of channels

- Discovered in 1972, 1670 MMboe HCIP
- Distributary channel sandstone reservoirs

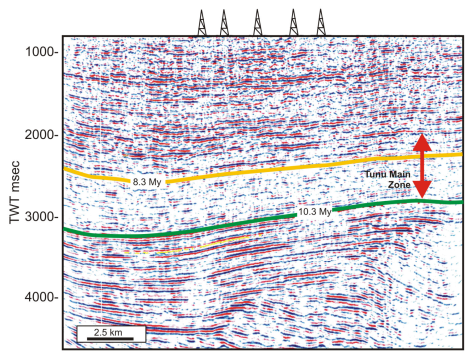
Champion Field

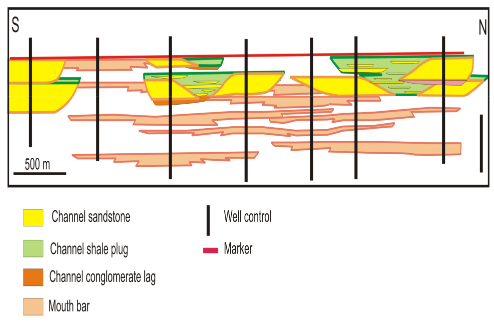




- Discovered in 1970, 4017 MMboe HCIP
- Combination of shoreface, tidal, and shelf sandstone reservoirs.
- Multiple reservoirs, high net/gross, faulted blocks

Tunu Field





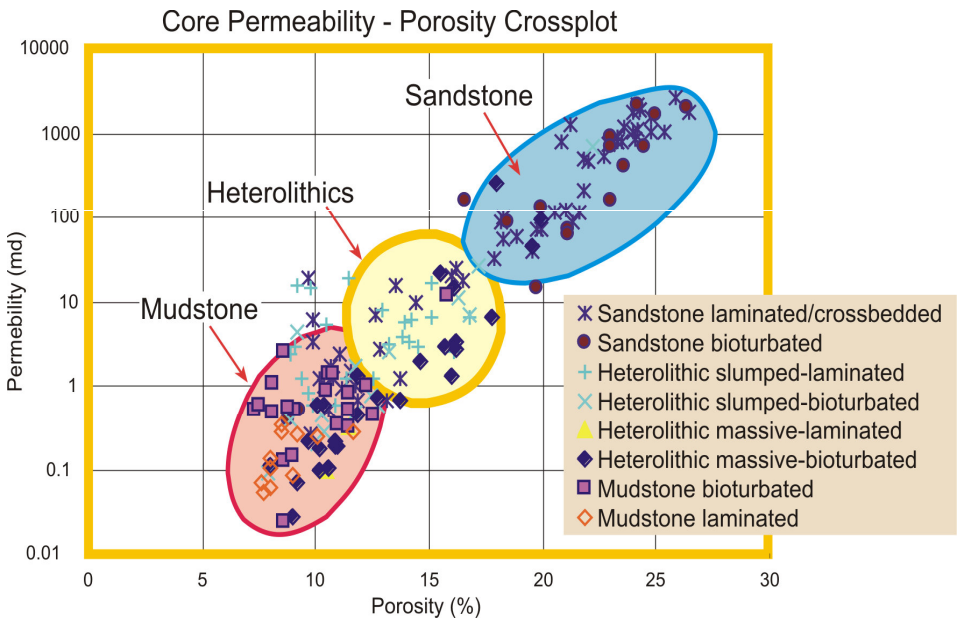
After Gardini, M., Moge, M., Duval, F., in Mora et al. 2003

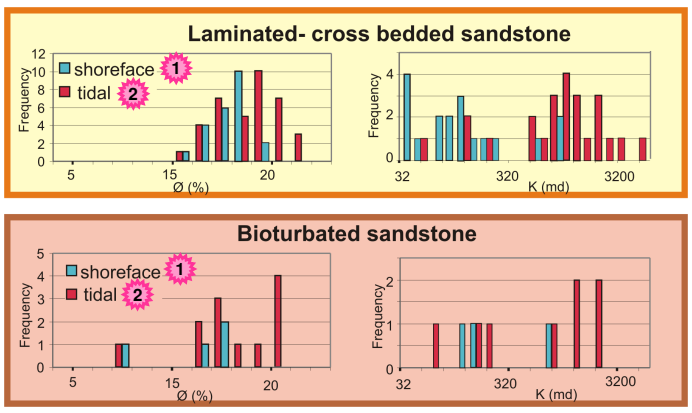
- Discovered in 1977, 3567 MMboe HCIP
- Mainly distributary channel sandstone reservoirs

NW Borneo	**Kutei**
• Dominated by shoreface and tidal 'sheet' sandstone reservoirs	• Dominated by distributary channel sandstone reservoirs

6. Reservoir Properties

NW BORNEO BASIN





After Lambiase et al, 2004

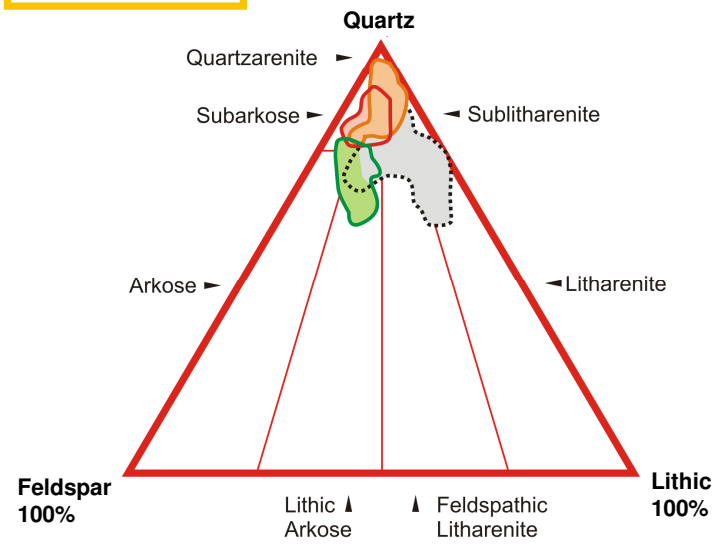
NW Borneo

- Dominated by tidal and shoreface sandstone reservoirs.
- Porosity – permeability plot do not separate tidal versus shoreface sandstone reservoirs.
- Generally tidal sands are slightly better reservoirs.
- Bioturbation generally give a negative impact on porosity and permeability

Kutei

- Dominated by fluvial and distributary channel sandstone reservoirs.
- Porosity – permeability plot indicate facies - reservoir property relationship, with fluvial sandstone as the best reservoir.

Index:
- Champion
- Southwest Ampa
- Crocker Fm
- South Furious



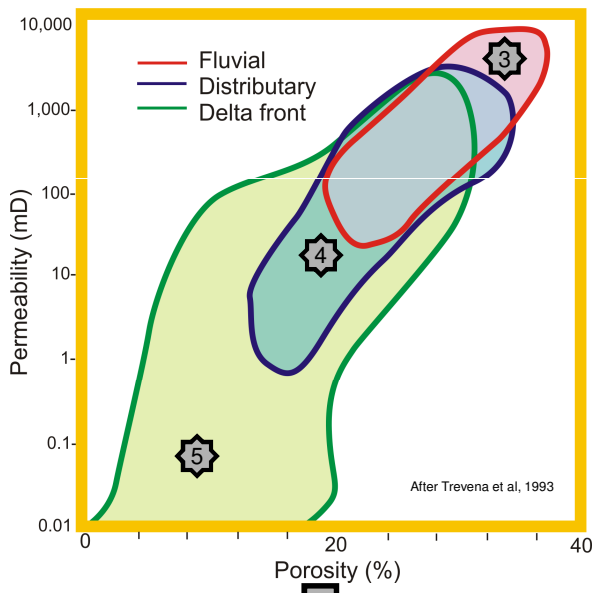
NW Borneo

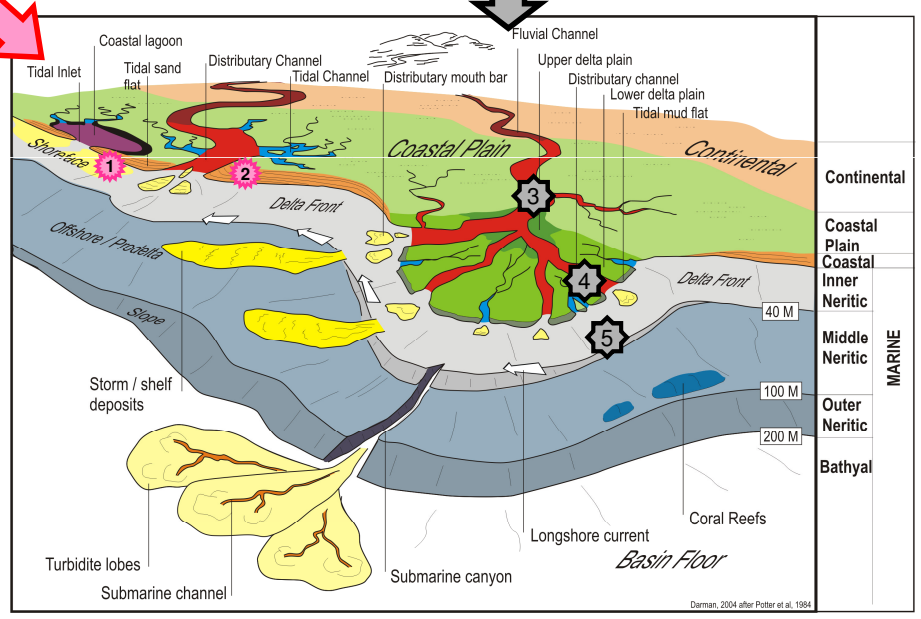
- Sand grain size are mainly fine to very fine. No quartz conglomerate.
- All sand reservoirs are quartz rich, up to 95%. The sandstones are much cleaner compare to Kutei sandstones.

Kutei

- Wide range of sand grains from very fine to conglomeratic.
- Combination of quartz and lithic dominant sandstones

KUTEI BASIN

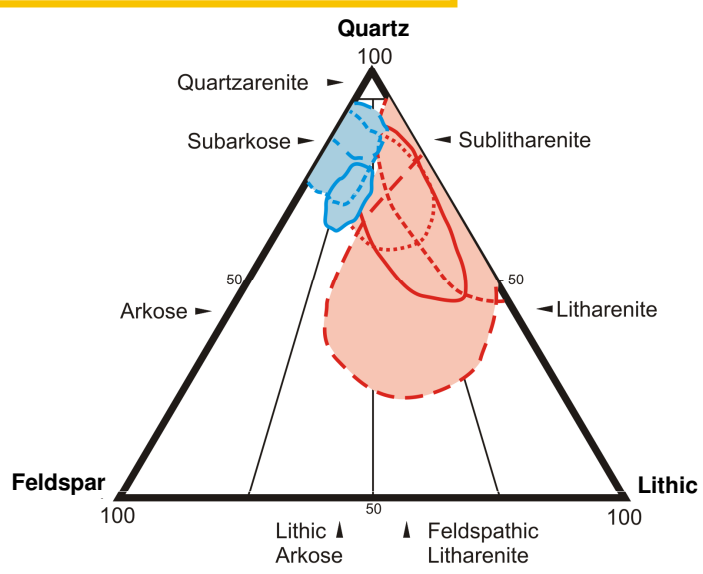




Index:

Attaka Field
- Shallow unit (Upper Late Miocene)
- Deltaic unit (Mid. Late Miocene)
- Intermediate unit (Lower Late Miocene)
- Deep unit (L.L. Mio - Mid Miocene)

Badak Field
- B,C,D unit (Late Miocene - Pliocene)
- E,F unit (Middle - Late Miocene)
- G unit (Middle - Late Miocene)



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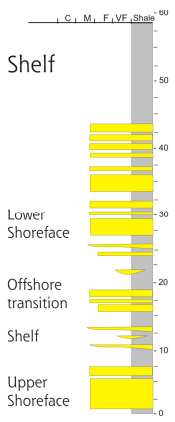
7. Outcrop Analogs

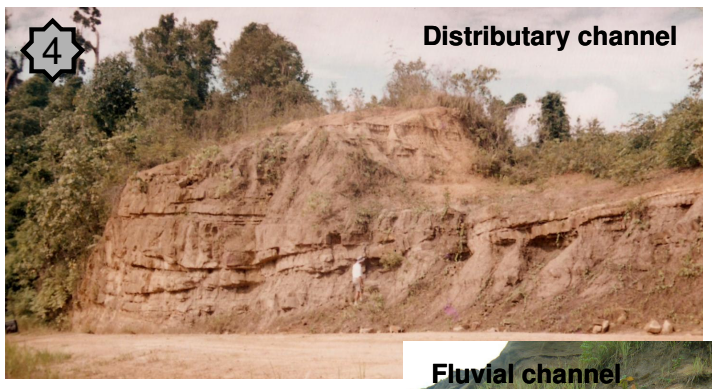
NW Borneo Facies

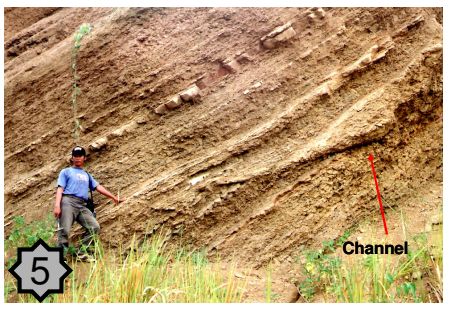


Tidal channel cross-bedded sandstone

Upper Shoreface, massive sandstone

Kutei Basin Facies



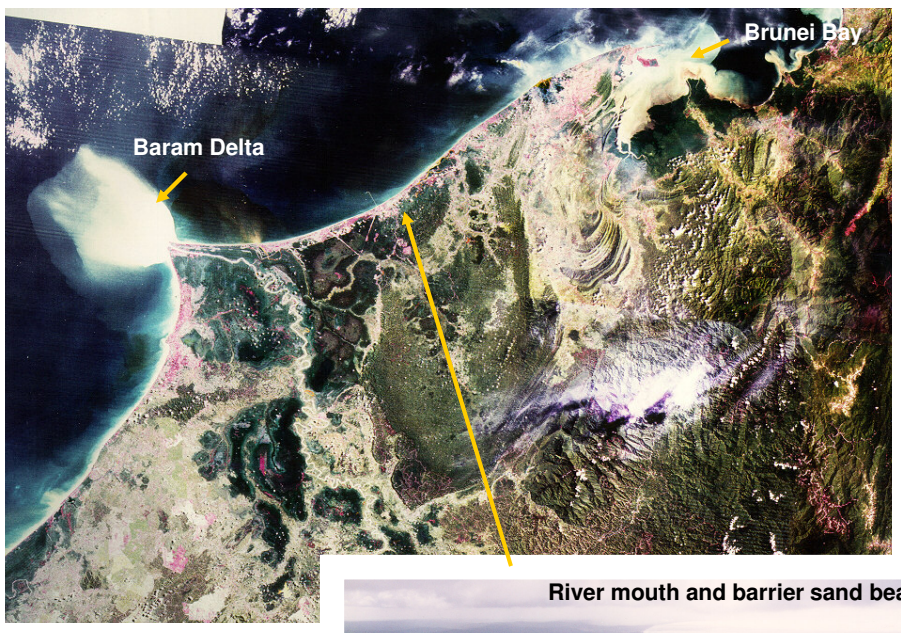


Delta front

NW Borneo	Kutei
• Dominated by tidal and shoreface sandstone reservoirs.	•Dominated by fluvial and distributary channel sandstone reservoirs. •Delta front sandstones are thin bedded and shally

8. Modern Analogs

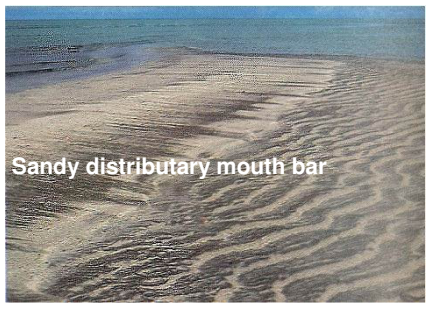
NW Borneo Facies



Baram Delta and Brunei Bay

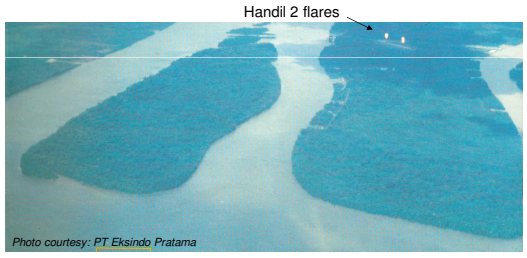
- Multiple sediment source
- Significant avulsion
- Sands are deposited along or parallel to the coast

Kutei Basin Facies

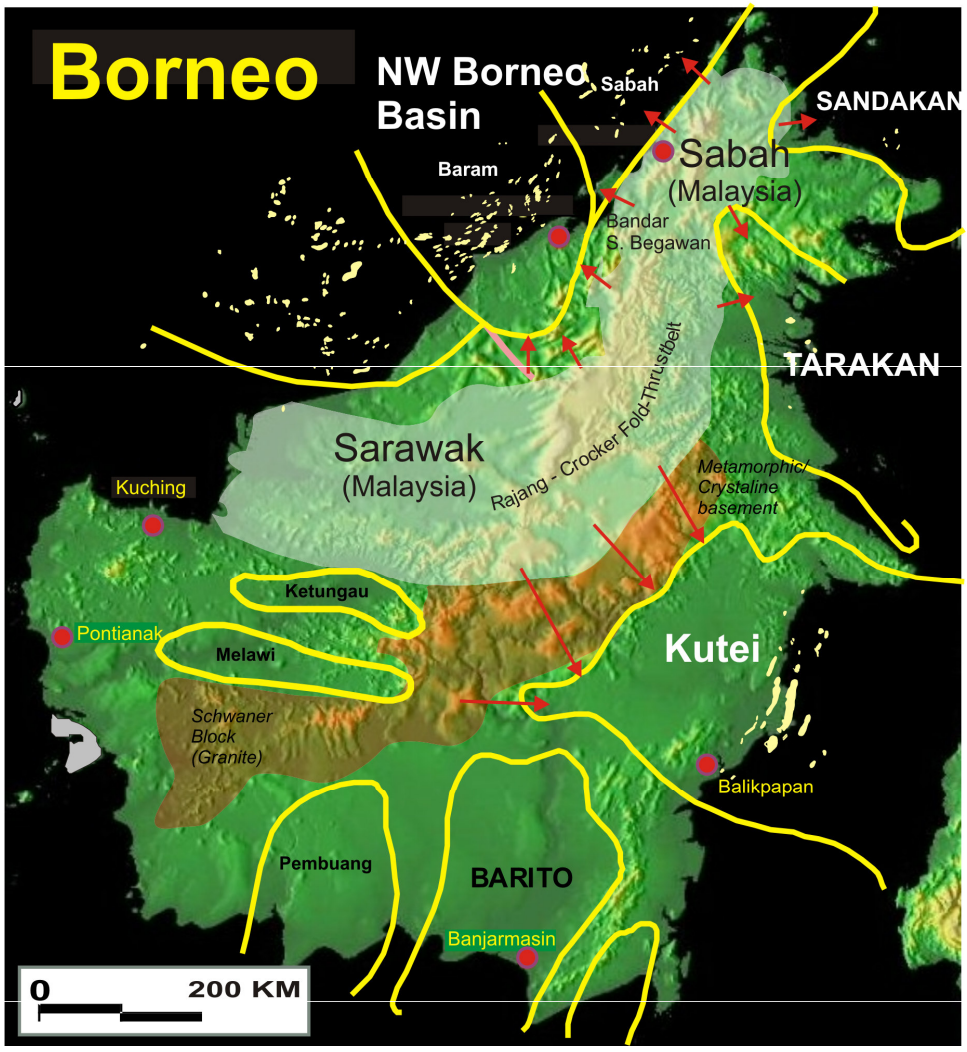


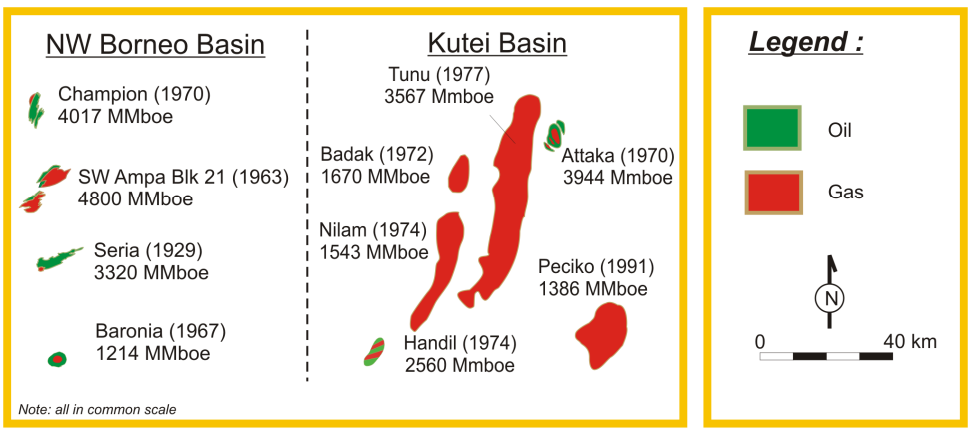
Mahakam Delta

- **Historically not much avulsion**
- **Generally point sourced**
- **Sands are deposited within the distributary channel, perpendicular to the coast outline.**



9. Conclusion





	Field Name	Disc Date Year	Oil In Place MMbbl	Gas In Place Pp MMscf	Gas In Place in Mmboe	Total HC in place in Mmboe	Tot Remain. Mmboe	Cumul Tot Prod Mmboe	Basin
1	Southwest Ampa	1963	2235.0	14250000.0	2565.0	4800.0	1477.9	1684.4	Baram
2	Champion	1970	3295.0	4011000.0	722.0	4017.0	783.2	535.5	Baram
3	Attaka	1970	2186.5	9765900.0	1757.9	3944.4	379.9	881.5	Kutei
4	Tunu	1977		19819000.0	3567.4	3567.4	2444.8	553.6	Kutei
5	Seria	1929	2996.0	1803000.0	324.5	3320.5	316.0	1274.5	Baram
6	Handil	1974	1975.3	3248900.0	584.8	2560.1	248.0	1068.7	Kutei
7	Badak	1972	294.9	7639300.0	1375.1	1670.0	349.2	1003.8	Kutei
8	Nilam	1974	197.4	7477300.0	1345.9	1543.3	451.2	607.9	Kutei
9	Peciko	1991		7702100.0	1386.4	1386.4	1042.6	52.5	Kutei
10	Baronia	1967	840.0	2080000.0	374.4	1214.4	137.7	685.2	Baram

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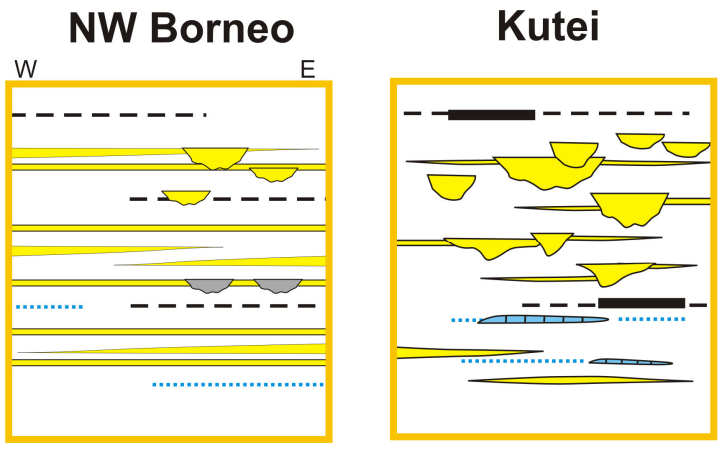
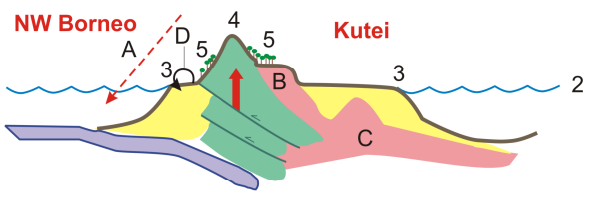


Comparison of Kutei and NW Borneo hydrocarbon objective intervals:

		Baram	Kutei
	Channel sands	Tidal channels	Distributary channels
	Sheet sands	Tidal channel and shoreface wide lateral extension	Distributary mouth bar limited lateral extension
	Clay filled Channel	Some clay filled channels act as lateral seal	
	Coal seams	Relatively thin and rare	Thick coal seams, occasio-nally used as correlationlamina
	Carbonaceous layer	marker	
	Limestone reefs	Rare and thin	Common and relatively thick
	Calcareous Layer		

Common

1. Climate
2. Sea level changes
3. Topset reservoirs
4. Crocker range as provenance
5. Abundance of land plant material (rich in Type III source rocks)



Differences

A. NW Borneo has a steeper slope. Kutei as gentle slope which trap sands, (e.g. Kutei Lakes).
B. Kutei has a granitic / metamorphic provenance
C. Kutei's basement is granitic & relatively more stable (gentle anticline, less structuration)
NW Borneo basement is a plate margin & unstable. (Larger subsidence, more structuration)
D. More sedimentary recycling processes in NW Borneo
E. NW Borneo reservoirs has more tidal influence, Kutei reservoirs has more fluvial influence
F. More avulsion in NW Borneo.

- **Kutei basin has larger structures but less sandstone reservoir content compare to NW Borneo basin**

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