“Deltaic” Reservoir Characteristics of Giant Fields of the Kutei and Baram Basins, Borneo*

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Search and Discovery Article #20191 (2013)**
Posted May 20, 2013

*Adapted from poster presentation given at AAPG 2006 International Conference and Exhibition, Perth, Australia, November 5-8, 2006
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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.
1. Introduction

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

2. Exploration History and Discoveries

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

3. Regional Overview

3.1 Oligocene - Mid Miocene

3.2 Mid Miocene - Present

- 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 compared to the Kutei Basin
4. Geological setting

5. Reservoir Geometry

NW Borneo Field 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

- Discovered in 1970, 3844 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

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

Champion Field

- Discovered in 1972, 4017 MMboe HCIP
- Combination of shoreface, tidal, and shelf sandstone reservoirs.
- Multiple reservoirs, high net/gross, faulted blocks

Tunu Field

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

Kutei Basin Examples

This part is not shown on the map

NW Borneo

- Dominated by shoreface and tidal ‘sheet’ sandstone reservoirs

Kutei

- Dominated by distributary channel sandstone reservoirs

Note

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

NW BORNEO BASIN

- 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 BASIN

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

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.

After Lambiase et al, 2004
7. Outcrop Analogs

**NW Borneo Facies**
- Herring bone Cross lamination
- Tidal channel cross-bedded sandstone
- Upper Shoreface, massive sandstone

**Kutei Basin Facies**
- Distributary channel
- Fluvial channel
- Delta front

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

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Photo courtesy: PT Eksindo Pratama
9. Conclusion


References


Acknowledgement

The author would like to thank the following for their input and suggestions on this paper.

- Henry Maulana (Chevron)
- Art Trevena (Chevron)
- Joe Lambiase (University of Brunei Darussalam)
- Abdul Razak Damit (Brunei Shell Petroleum)
- IHS Energy in providing field volume data

NW Borneo

Kutei

Comparison of Kutei and NW Borneo hydrocarbon objective intervals.

- Baram Basin
- Kutei Basin
- NW Borneo

Legend:

- Oil
- Core

---|---|---|---|---|---|---|---
Southward Ampa | 1969 | 2225 | 1420000 | 2955 | 4800 | 1072 | Baram
-2C Area | 1970 | 1210 | 4010000 | 722 | 1017 | 203 | 1050 (Baram)

Common

1. Climate
2. Sea level changes
3. Thrust 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, i.e. 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 subduction, 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