Paleogene Clastics, Mangkalihat, Borneo: Implications for Petroleum Systems*

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Abstract

Paleogene clastics are widely reported to have source and reservoir potential in SE Asian Tertiary marine rift-related basins. However, with limited outcrop or subsurface data the sedimentology, diagenesis and petroleum systems development are poorly studied. In order to address questions of: i) controls on petroleum systems variability, ii) influences on reservoir quality, and iii) issues of petroleum systems volumetrics and quality, coastal and deep marine Paleogene siliciclastic successions were investigated at outcrop from the Mangkalihat Peninsula, Borneo. Succession characteristics are:

• **NW Mangkalihat** – Deep-water Maliu Mudstone - The Maliu Mudstone consists mainly of dark grey, low-energy, bathyal mudstones of Eocene age. Fine sand- to siltstone greywacke interbeds are interpreted as distal turbidites. Calcite cements are common in the sandstones and intergranular porosities are ~2-4%. The provenance, poor sorting and diagenesis of the sandstones results in poor reservoir quality, although source and reservoir potential are known from nearby subsurface proximal turbidites.

• **NE Mangkalihat** – Coastal Sembakung Formation - Paleogene interbedded coals, sandstones, claystones, and arenaceous carbonates are poorly exposed as fault bounded inliers. Deposition occurred in a range of protected swampy to brackish settings, tidal flat and channel environments with an up sequence change to a shallow marine mixed carbonate-clastic shelf influenced by faulting. The coals and organic-rich clays may have source potential, whereas the sandstones are possible reservoir units (10-15% porosity). Clays may reduce permeability or compartmentalize the system.

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Provenance, Regional Context and Summary

Provenance studies show clastics in the west were derived from a volcanic and low grade metamorphic terrain, whereas those in the east came from a higher grade metamorphic source with some cherts. The different source terrains and depositional settings (bathyal and a mixture of coastal, shallow marine and fault-bounded deeper grabens) is consistent with early Paleogene block and basin development influencing environments and sediment pathways. Highly localized environments associated with this tectonically complex setting may limit the volumes and quality of potential source and reservoir rocks. Provenance, diagenesis, basin evolution as well as depositional environments all strongly influenced the potential for a working petroleum system.

Selected References

Camp, W.K., E.E. Guritno, D. Drajat, and M.E.J. Wilson, 2009, Middle-Lower Eocene turbidites: A new deepwater play concept, Kutei basin, east Kalimantan, Indonesia: Proceedings Indonesia Petroleum Association, Thirty-third Annual Convention and Exhibition, Jakarta, Indonesia, 5 May 2009, p. 1-15.

Dickinson, W.R. and C.A. Suczek, 1979, Plate tectonics and sandstone compositions: AAPG Bulletin, v. 63/12, p. 2164-2182.

Dott, R.H., Jr., 1964, Wacke, greywacke and matrix: what approach to immature sandstone classification?: Journal of Sedimentary Petrology, v. 34/3, p. 625-632.

Doust, H. and R.A. Noble, 2008, Petroleum systems of Indonesia: Marine and Petroleum Geology, v. 25, p. 103-129.

Moss, S.J. and J.L.C. Chambers, 1999, Tertiary facies architecture in the Kutai Basin, Kalimantan, Indonesia: Journal of Asian Earth Sciences, v. 17/1-2, p. 157-181.

Saller, A., K. Werner, F. Sugiaman, A. Cebastiant, R. May, D. Glenn, and C. Barker, 2008, Characteristics of Pleistocene deep-water fan lobes and their application to an upper Miocene reservoir model, offshore East Kalimantan, Indonesia: AAPG Bulletin, v. 92/7, p. 919-949.

Saller, A., J. Dunham, and R. Lin, 2008, Leaves in turbidite sands; the main source of oil and gas in the deep-water Kutei Basin, Indonesia; reply: AAPG Bulletin, v. 92/1, p. 139-141.

Saller, A., R. Lin, and J. Dunham, 2006, Leaves in turbidite sands: the main source of oil and gas in the deep-water Kutei Basin, Indonesia: AAPG Bulletin, v. 90/10, p. 1585-1608.

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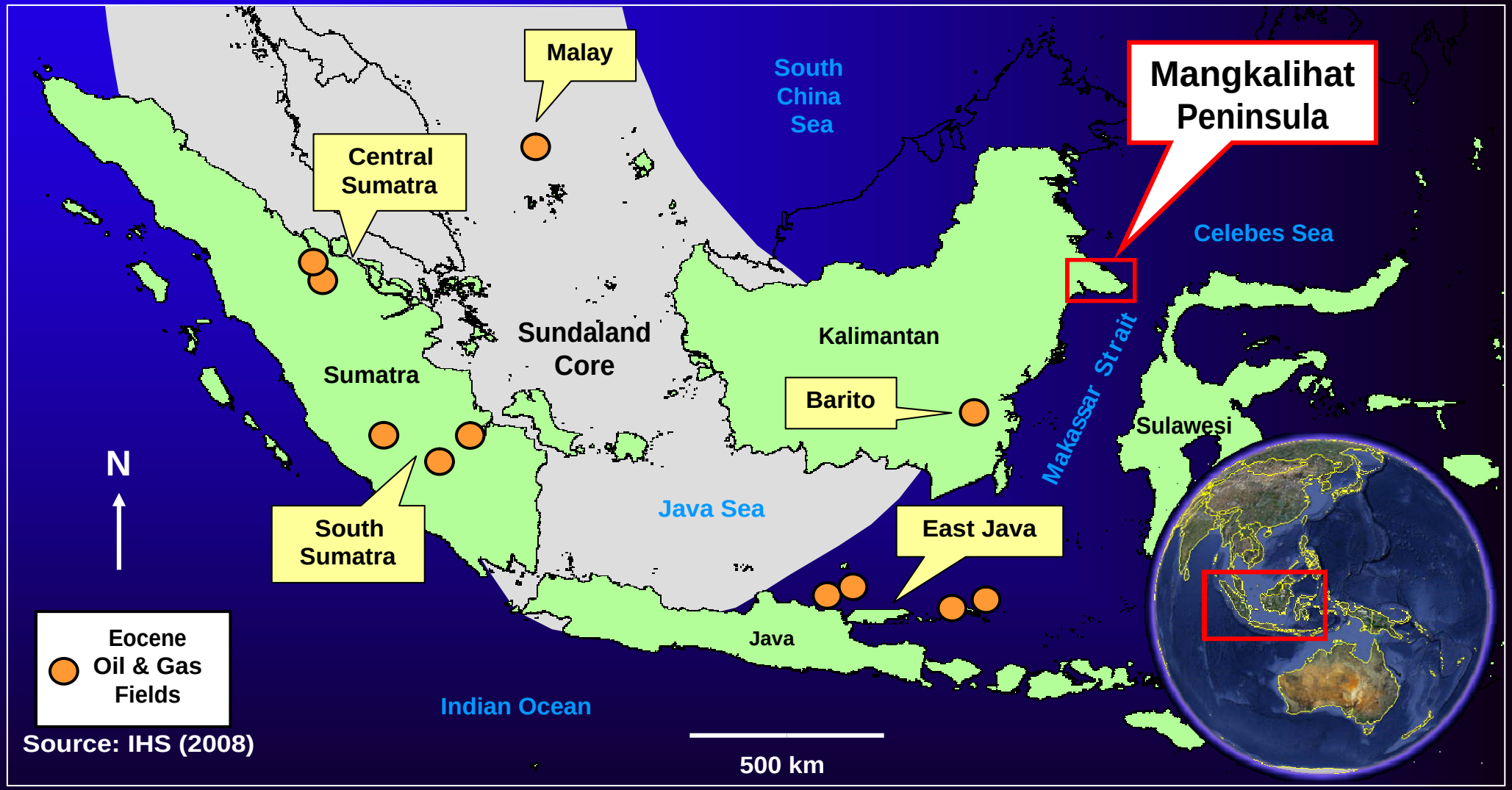
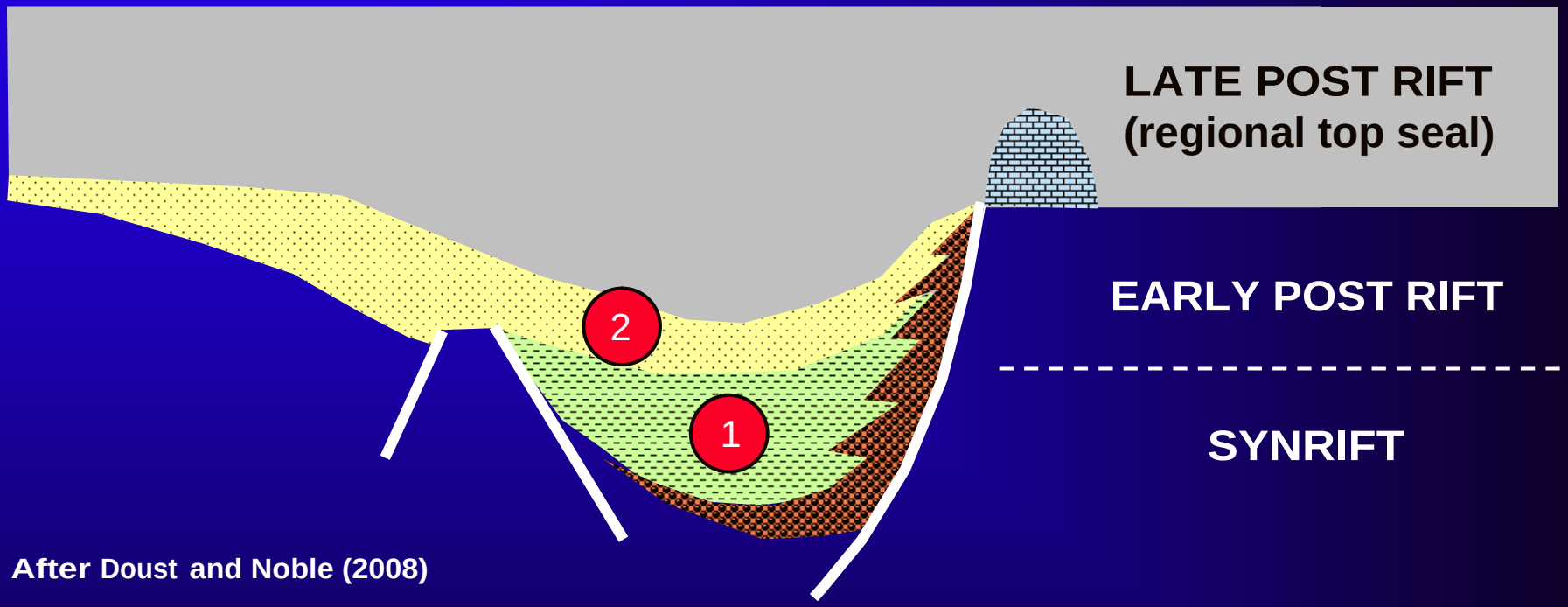
Eocene Oil & Gas Fields



Source: IHS (2008)

Camp et al. (2009)

Paleogene Rift Model



1. Early Synrift Lacustrine (Oil Prone)
2. Late Synrift Deltaic (Oil & Gas Prone)

Study Objectives

- Describe reservoir and source rock potential of Paleogene marine synrift clastics around Sundaland based on available limited outcrop and subsurface data
- Evaluate regional (tectonic & climatic) vs. local geological influence (provenance & depositional setting) on reservoir & source rock quality
- Basin history modelling and petroleum system study

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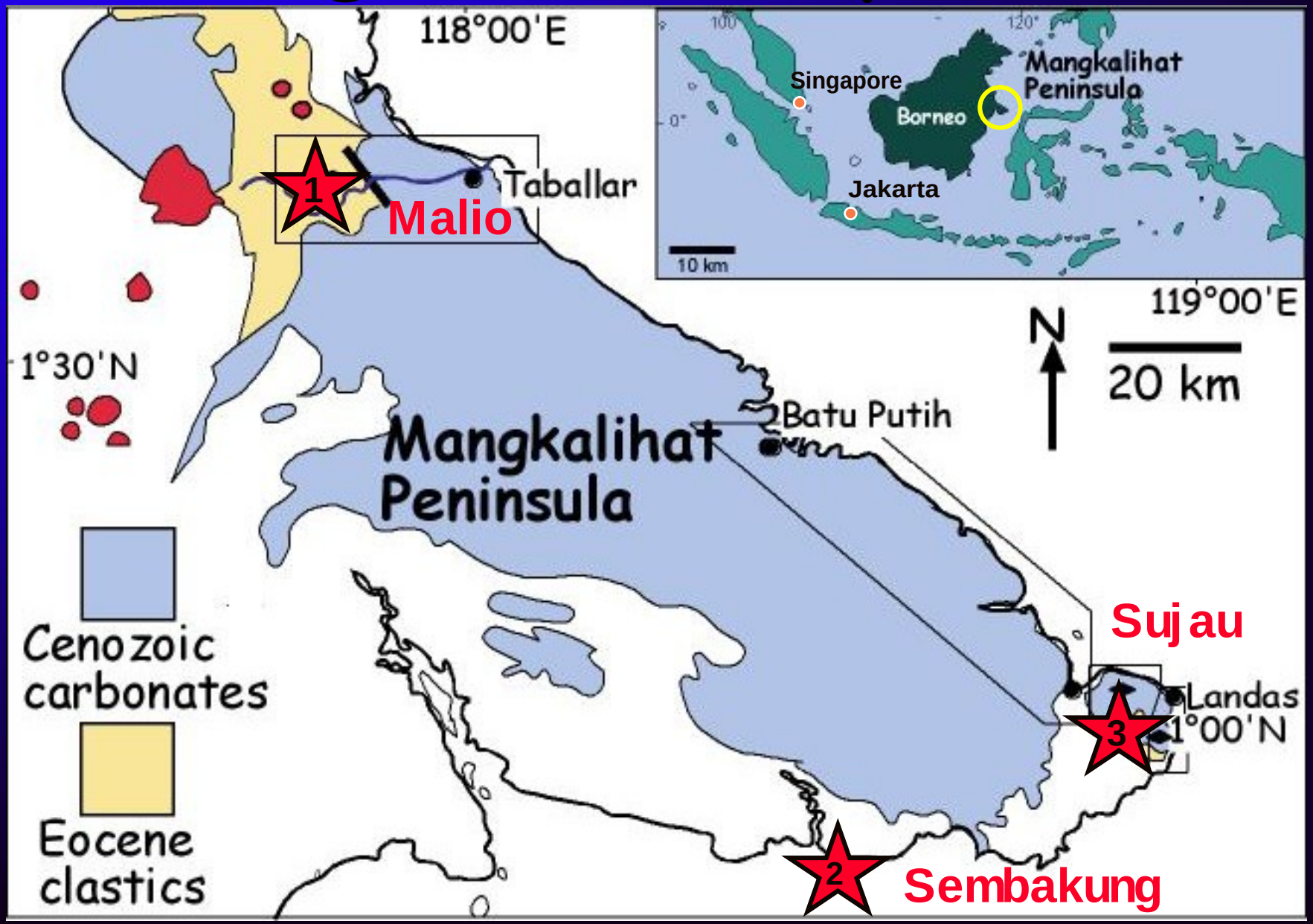
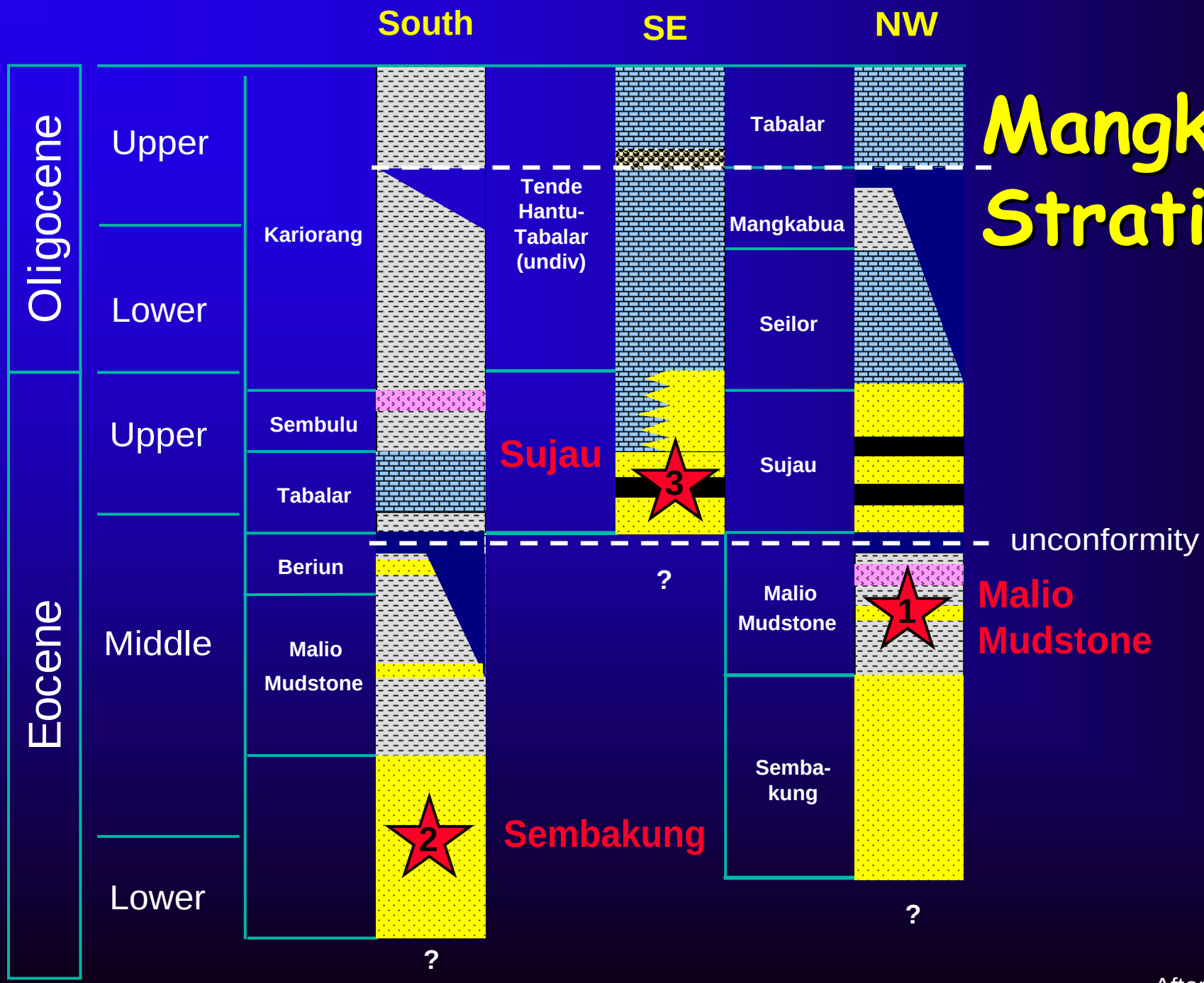
Mangkalihat Study Areas



MEJW, 2009

Mangkalihat Stratigraphy



After Camp et al. (2009)

MEJW, 2009

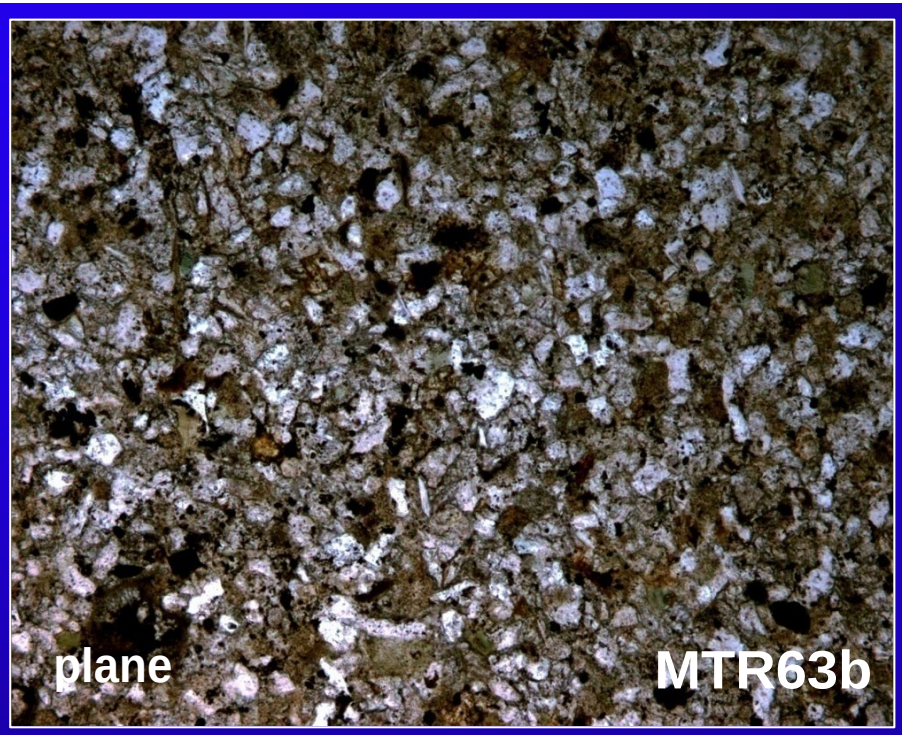
Malio Mudstone (NW)

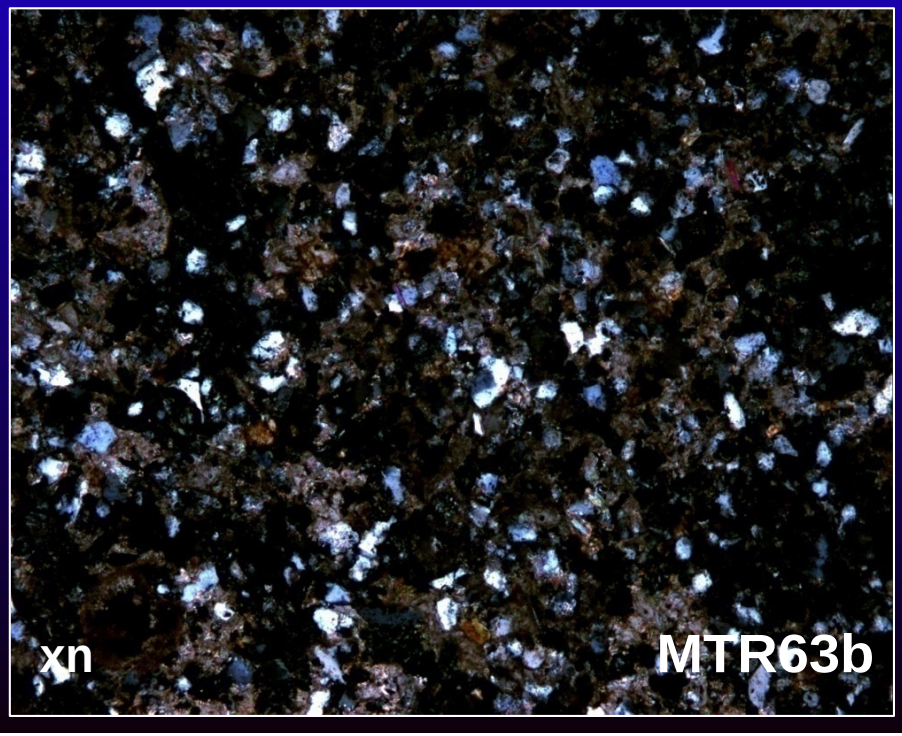
- Shale, mudstone & thin sandstone
- Interbeded w/ basaltic flows
- Large burrows
- Planktonic forams
- Mid Eocene P14
- Upper Bathyal
- <2% TOC, poor source

Malio Mudstone (NW)

- Siltstone, fine-grained sandstone
- Horz lam, graded & rippled
- Carbonaceous lam
- Cm to dm/m scale

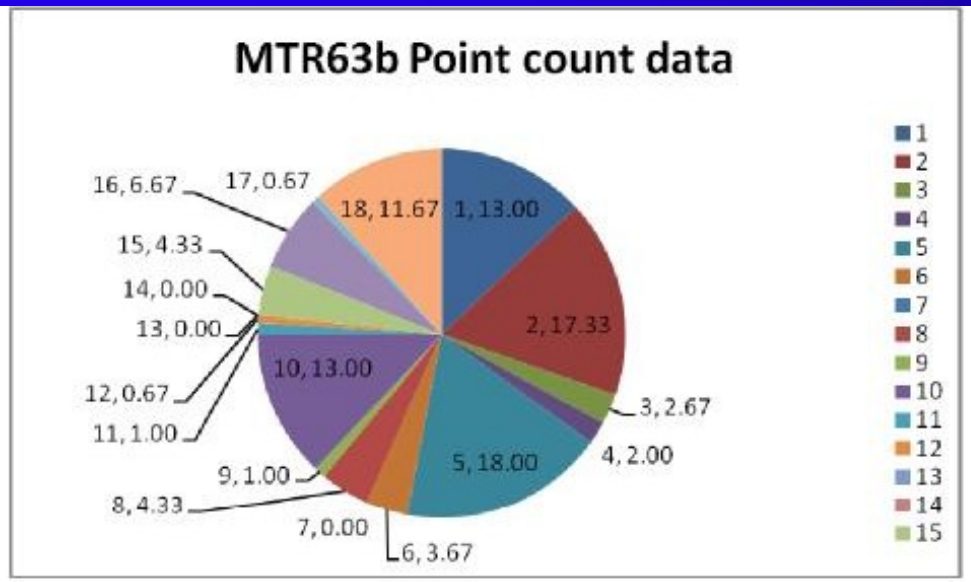
Malio Mudstone (NW)

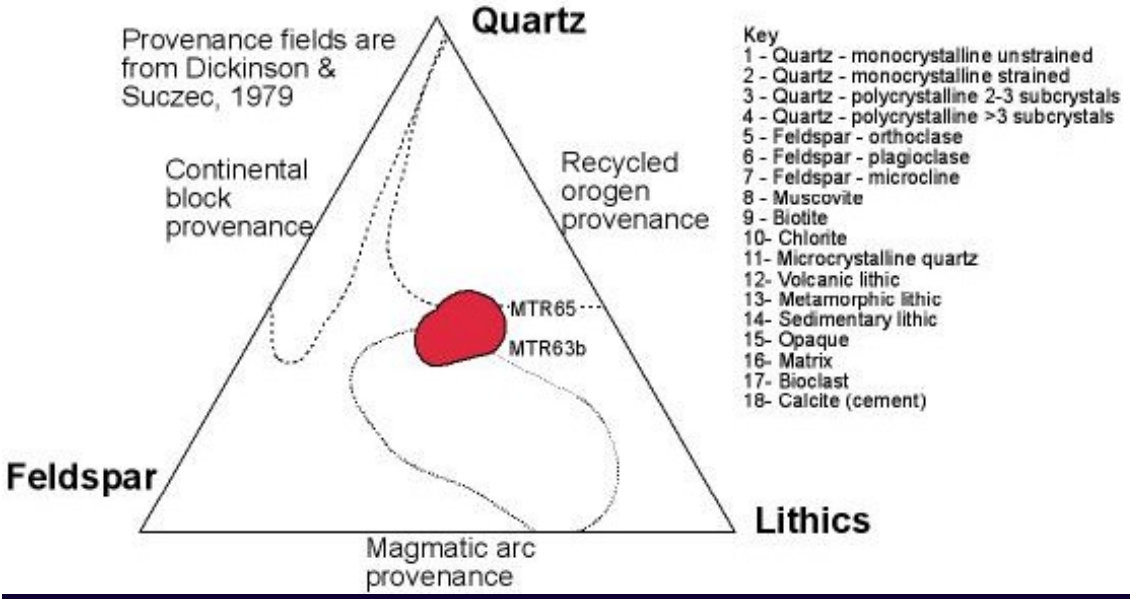




- Siltstone, fine-grained sandstone
- Poorly sorted
- Angular – sub rounded
- Greywackes
- Distal turbidites
- Porosity 2-4%

Malio Mudstone (NW)

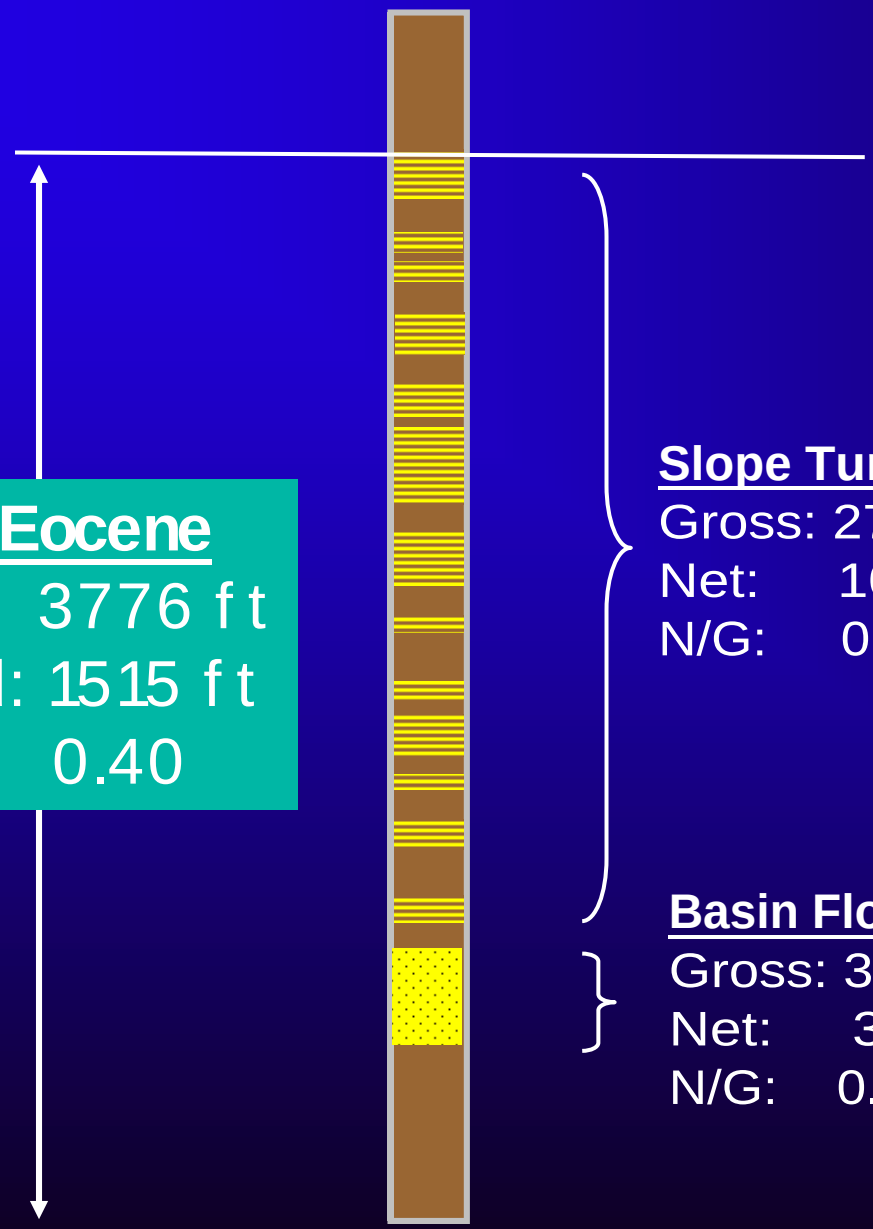




- Quartz, feldspar & lithic (includes chert)
- Distal turbidites – poor reservoir
- Poor source rock
- Intraformational seal

Sembakung (South)

Makassar - A1



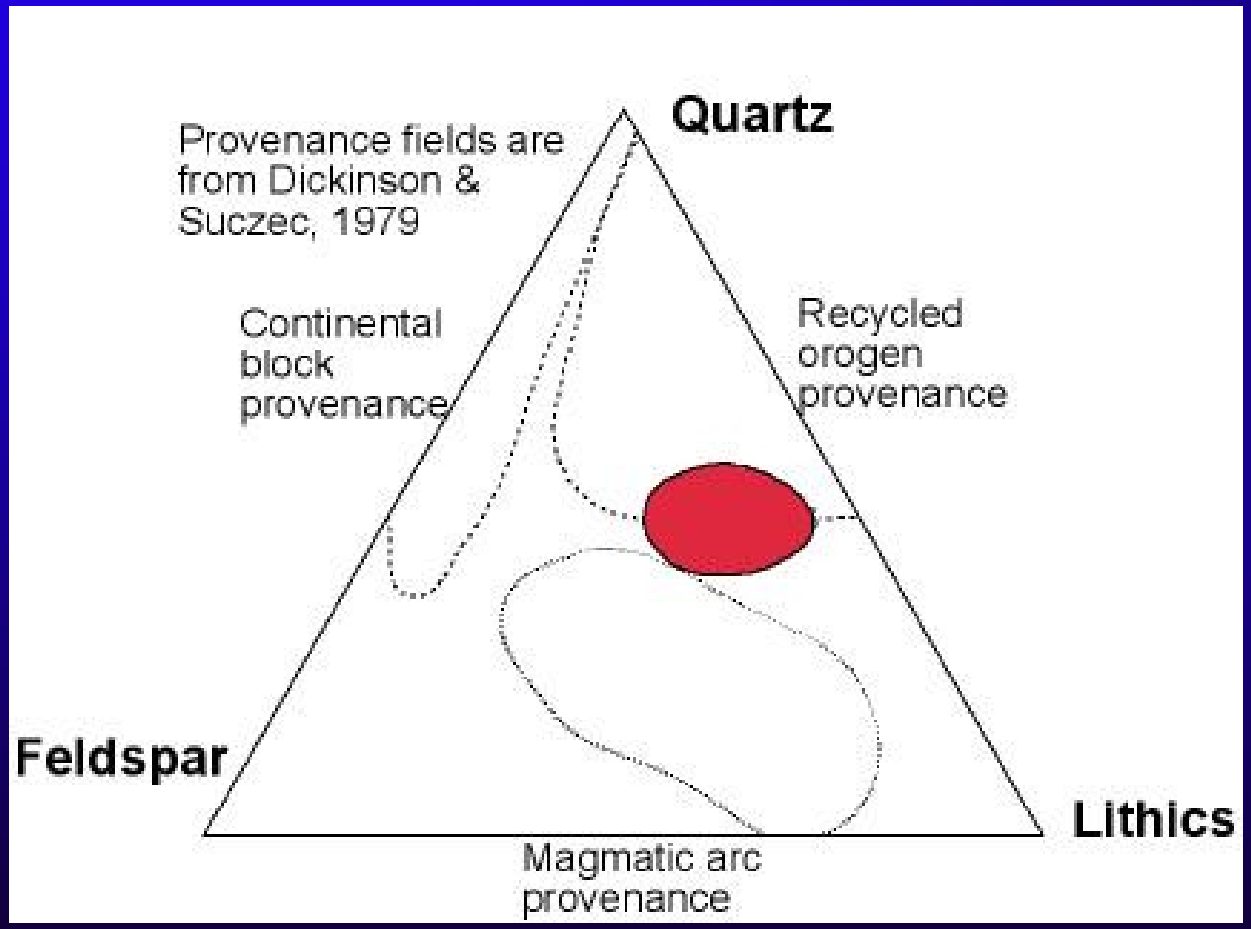
Lower Eocene
Gross: 3776 ft
Net Sd: 1515 ft
N/G: 0.40

Slope Turbidites
Gross: 2795 ft
Net: 1094 ft
N/G: 0.39

Basin Floor Fan
Gross: 330 ft
Net: 308 ft
N/G: 0.93

Camp et al. (2009)

Sembakung (South)



- Quartz, feldspar & lithic (includes chert)
- Upper-mid bathyal
- Early Eocene
- Proximal Turbidites
- Ø - 10-25%
- Organic lean shales
- Carbonaceous sands-potential source (Camp et al., 2009)

Deepwater Kutei Basin Turbidite Source Rocks

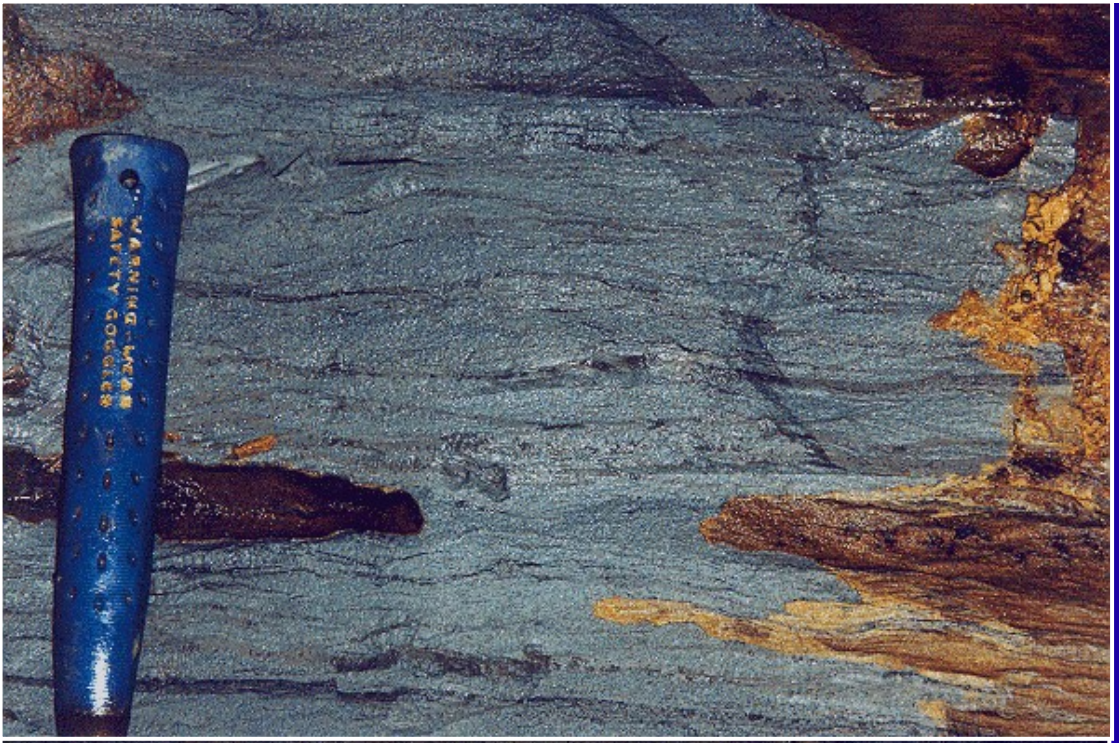
- Miocene organic-rich turbidites
- Laminated beds (Tb facies)
- TOC: 2-50 (avg 7.5) wt%
- HI: 25-430 mg/g TOC
- Cuticle rich-waxy oil
- Vitrinite rich-gas

Saller et al. (2006, 2008)

MEJW, 2009

Sujau Fm. (SE)

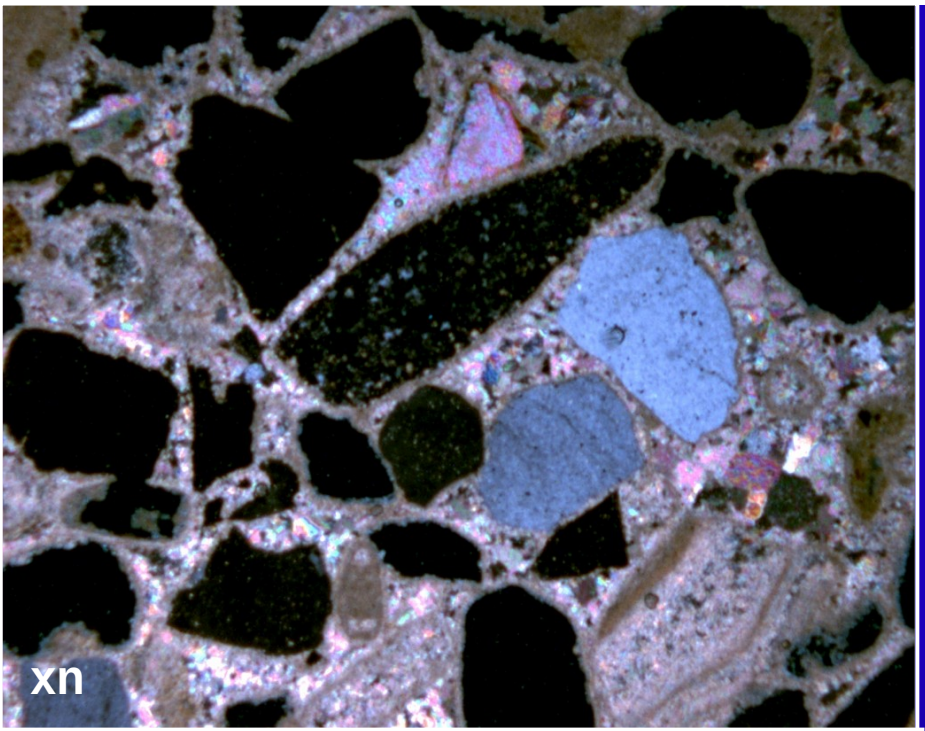
- Carbonaceous clay & lignite
- 1- 10 m thick
- Late Eocene (pollen)
- Potential source rock

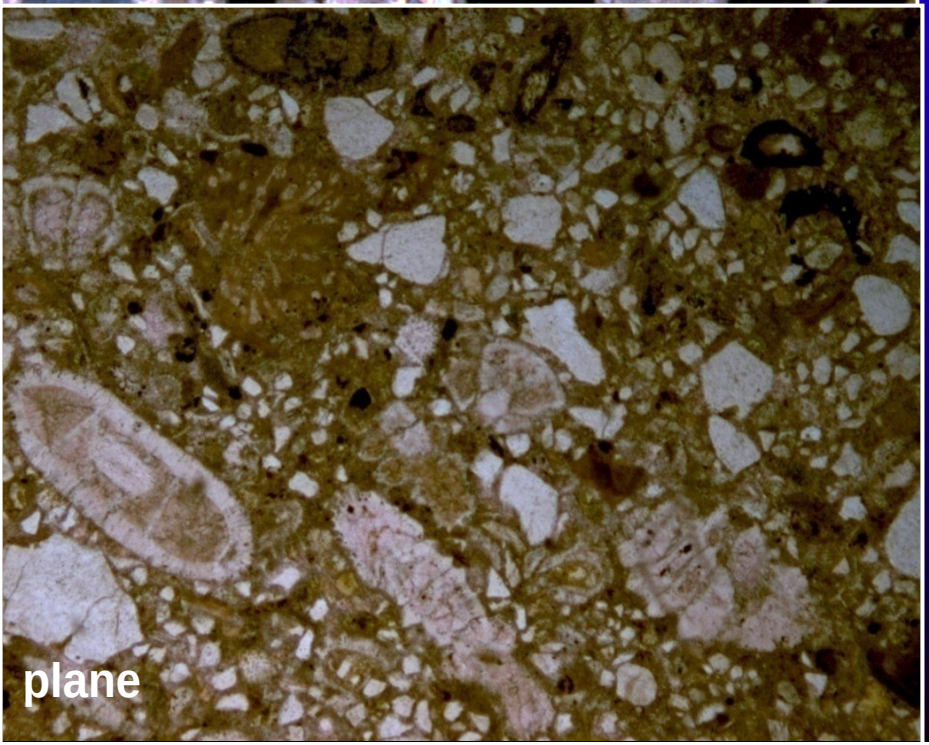


Sujau Fm. (SE)

- Quartz arenites
- Rippled sands, clay/ carbon drapes, trough X- bedding,
- Tidal flat/ bar & channel
- Localised/ faulted
- Porosity 10- 15%

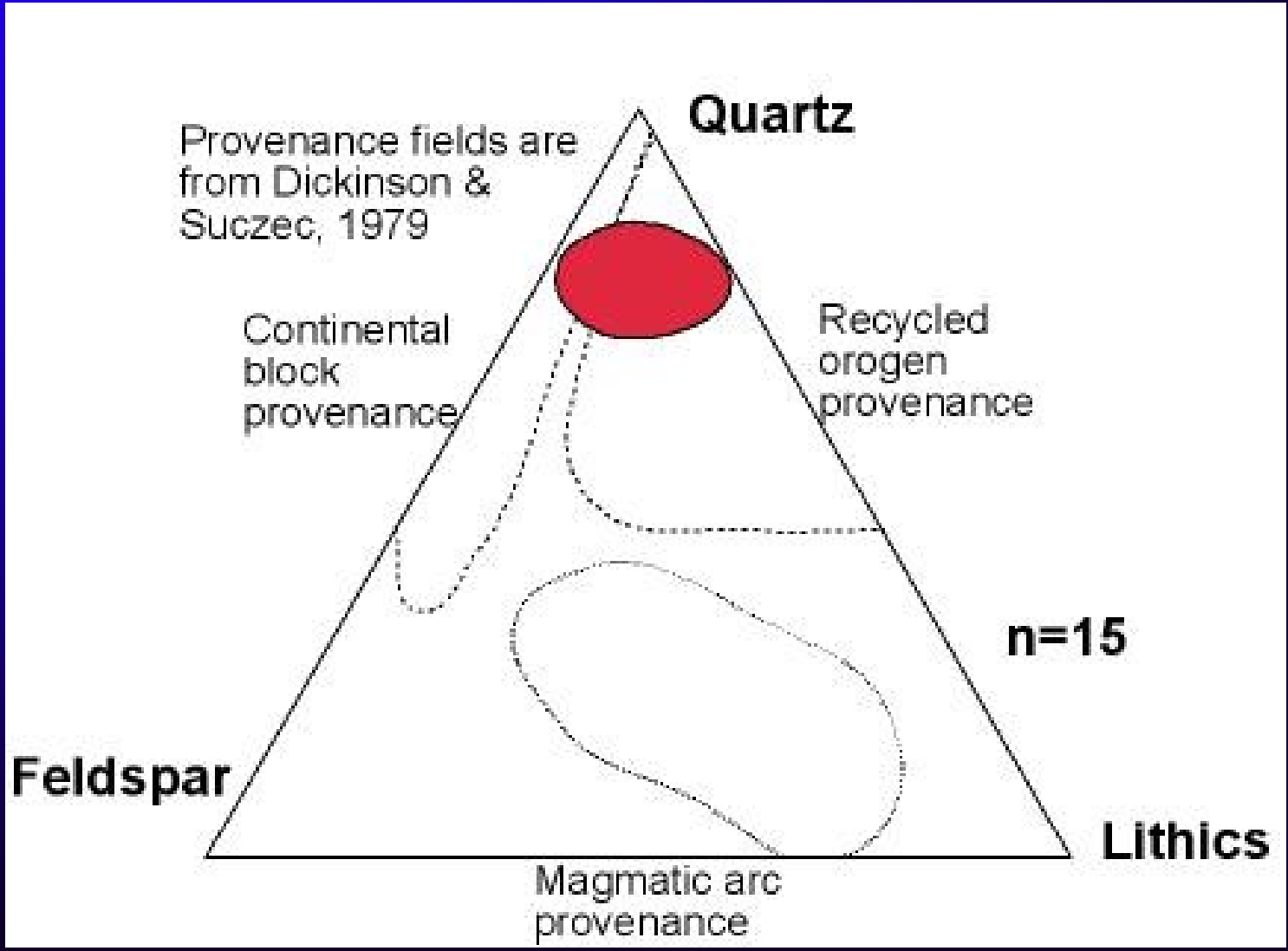
Sujau Fm. (SE)



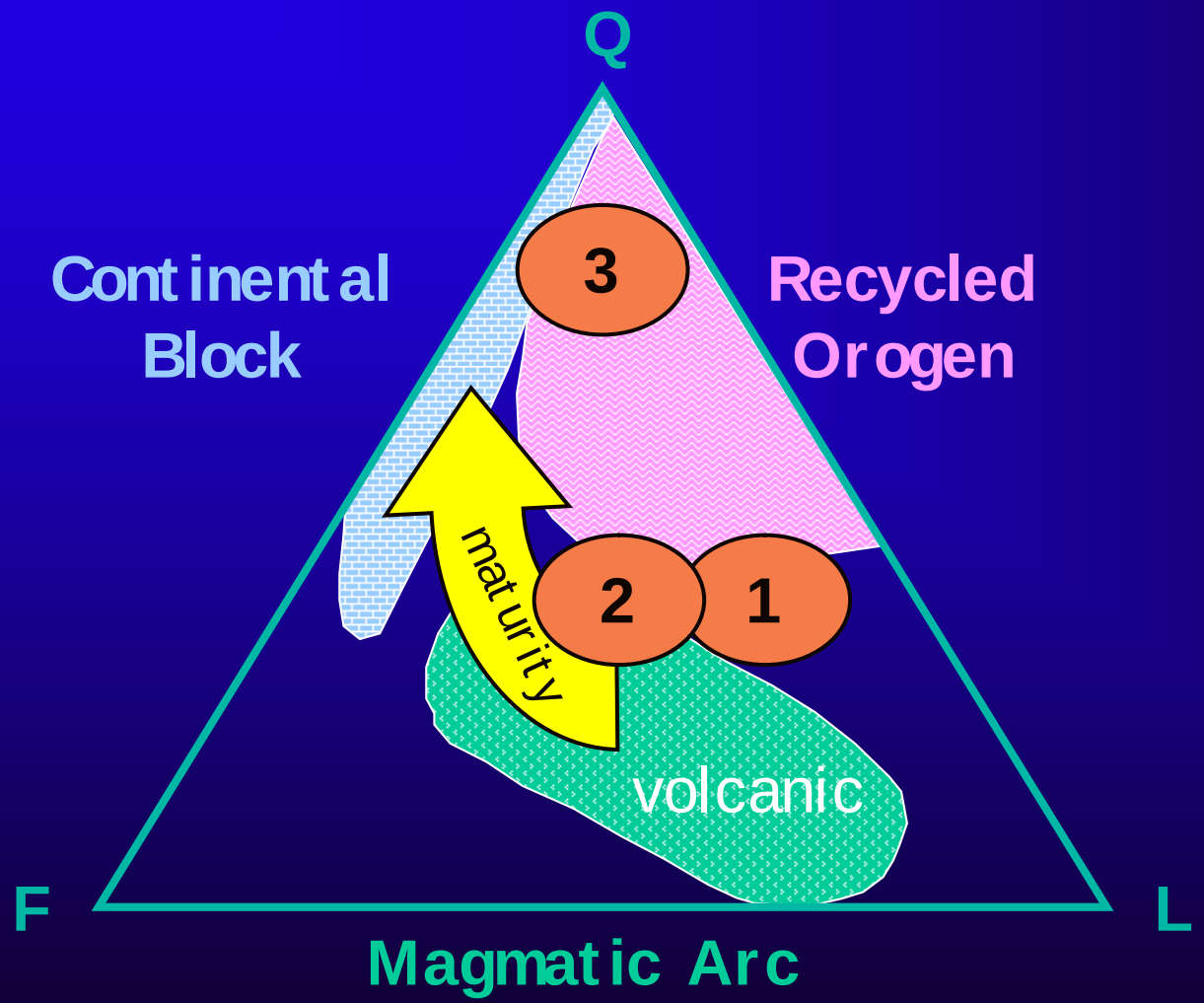


- Quartz rich (lith & chert)
- Grade into arenacous limestone – trangression
- Faulted highs ?
- Late Eocene
- Thick x-bedded, massive & fining-upward sands, clays & lignite
- Deltaics & coastal

Sujau Provenance



Provenance vs Time



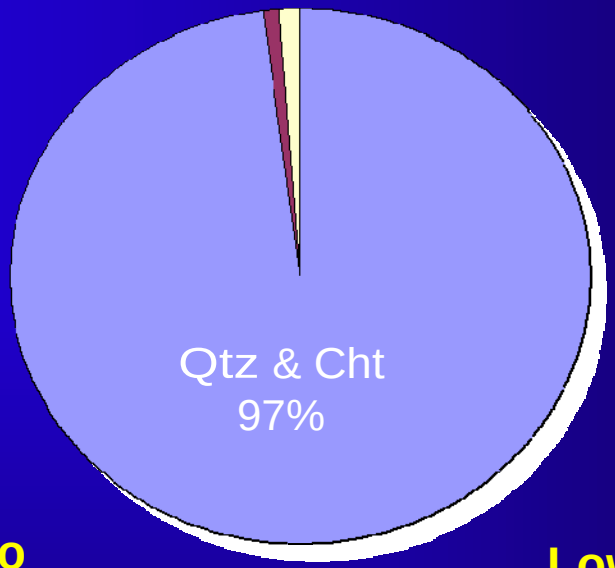
- Increasing maturity-
- Shift in source area
- Composition change due to unroofing

After Dickinson and Suczek (1979)

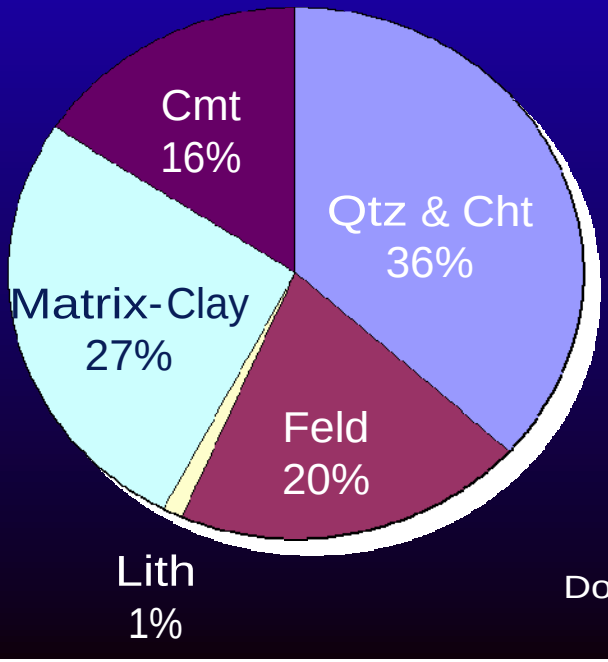
- Climate
- Environment
- Proximal distal

- Provenance
- Increasing maturity
- Tropical weathering

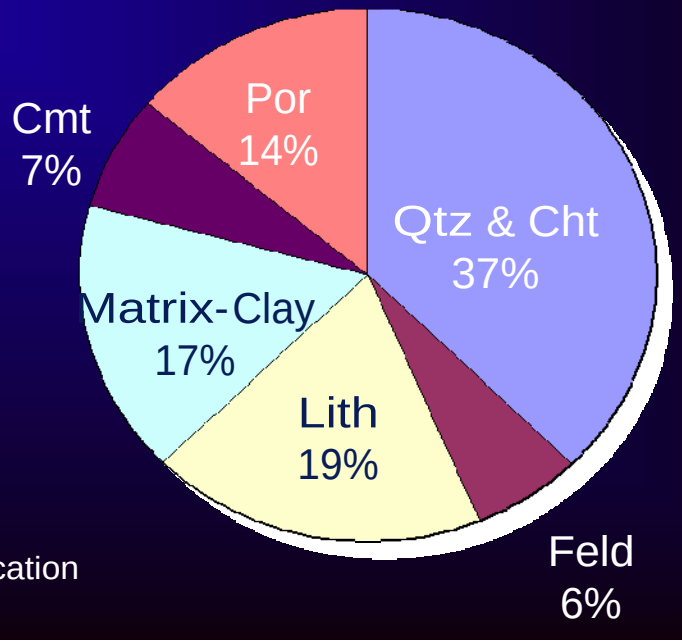
Upper Eocene - Sujau



Middle Eocene - Malio

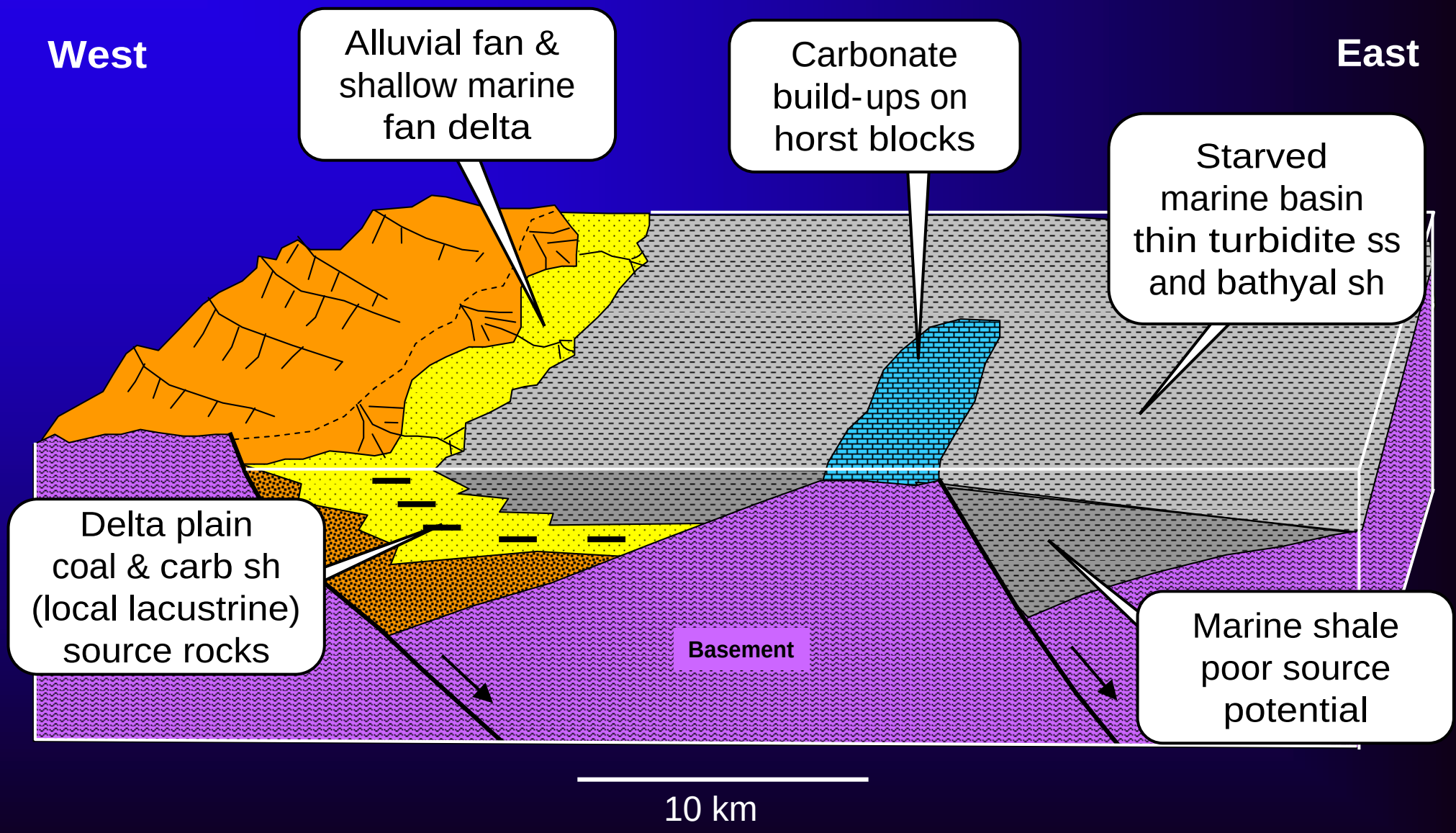


Lower Eocene - Sembakung



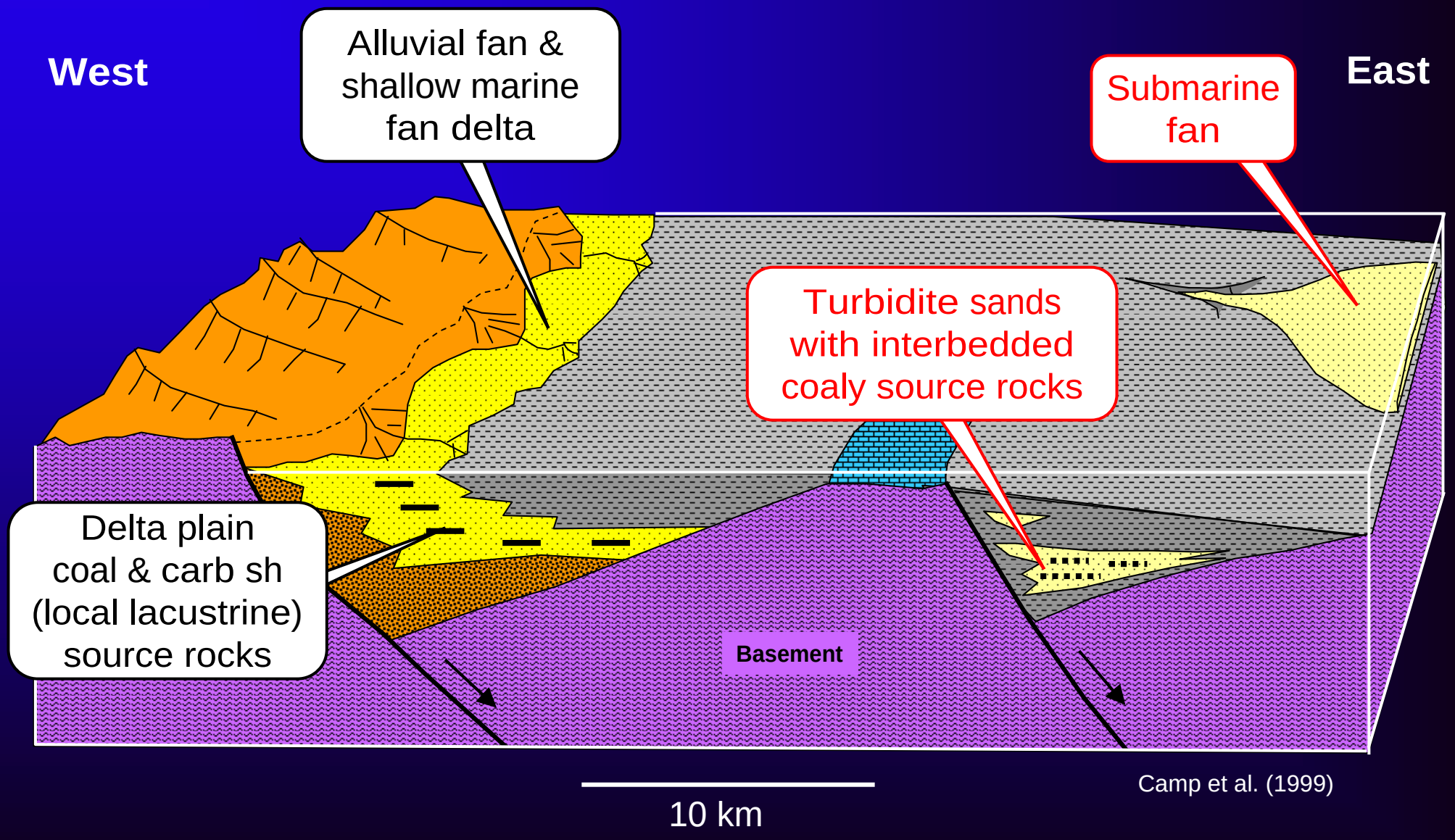
Dott (1964) Sandstone Classification

Kutei Basin Mid Eocene Model



After Moss and Chambers (1999)

Kutei Basin Eocene Turbidite Model



Camp et al. (1999)

Conclusions

- Add Eocene marine early synrift to continental rift model
- Working petroleum system – Mangkalihat oil & gas seeps
- Source – carbonaceous mudstone & coal, and carbonaceous turbidite sandstone (?)
- Reservoir – proximal turbidites, deltaics & channel/tidal sandstones
  - Primary reservoir quality controls: provenance & depositional environment
- Economic volumes ?