

# **Regional Depositional Environment Model of Muara Enim Formation and Its Significant Implication for CBM Prospectivity in South Sumatra Basin, Indonesia\***

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## **Abstract**

Two main coal horizons exist within the South Sumatra basin, the Oligocene Talang Akar (TAF) and the Miocene Muara Enim (MEF) formations. Typically, coals are recognized to thin toward the east as they pinch out against the Sunda landmass. The Main Coal Bed Methane (CBM) targets are the MEF coals, which are known to have good coal thickness and favorable depth for CBM production. Important elements of the CBM play are coal presence and coal lateral distribution. The objective of this study is to indentify coal prone areas by using a depositional environment model.

This study is based on analyses of 2D seismic and well data. Sequence stratigraphic and sedimentological observations have been applied to generate well-to-well correlation based on sediment packages, log character and cuttings description. MEF can be divided into two depositional packages: Lower and Upper MEF. The Lower part of MEF interval appears uniform in thickness except around local structure while the upper part of MEF interval thickens in the synclinal area.

The study area is dominated by faulted anticlinal features trending NW-SE. Pre-existing structure seems to influence the deposition of the lower Muara Enim interval, while the syn-orogenic structure, post depositional structure, and present day erosion controlled the present day distribution of the upper Muara Enim interval. Plio-Pleistocene tectonic events have locally exposed the Muara Enim formation at surface.

MEF were predominantly deposited on tide dominated coastal plain during an overall regressive cycle. South Sumatra present day depositional environment probably serve as a good analog for MEF coal deposition. A depositional environment model was proposed for two MEF packages with three identified subenvironments, there are tidal mud flat, tidal mixed flat and tidal sand flat. Generally, coals developed in tidal mud flat and tidal mixed flat subenvironment.

## **Introduction**

Coal Bed Methane (CBM) is a natural gas containing close to 100% methane (CH<sub>4</sub>) produced from coal seam reservoir. CBM is often produced at shallow depths and is often associated with large volumes of produced water. CBM is natural gas that is sourced and reservoired in a coal seam.

CBM is one of potential type of unconventional energy in Indonesia. Indonesia has 453 TCF of estimated prospective CBM resources within several basins ([Figure 1](#)), based on preliminary assessment conducted by Advance Resource International Inc. (Stevens, 2004). This regional evaluation indicates South Sumatera Basin as the most prospective CBM basin in Indonesia that has 183 TCF estimated prospective resources.

Sufficient coal quantity and quality is one of key technical requirement for CBM to be economic. A good understanding of coal distribution is needed for identifying high potential areas for CBM project development in the early stages of exploration. One method to predict coal distribution is to develop a model for the depositional environment. The main objective of this evaluation is to assess regional depositional environment based on subsurface data. 645 2D seismic lines and more than 40 wells across the basin have been used as guidance on interpretation.

## **Regional Geology**

The South Sumatra Basin is an asymmetric basin located to the east of Barisan Mountains, to the north and west of the Lampung High, and to the south of Tigapuluh Mountains (de Coster, 1974). The South Sumatra Basin systems were initiated during Eocene Period (Daly, 1987). Transgressive-regressive cycles of Tertiary sediments are deposited on a pre-Tertiary surface of eroded igneous and metamorphic rocks.

The tectonic history of Sumatra was profoundly influenced by the movement and collisions of the Indian Ocean and Southeast Asia plates. The structural features in South Sumatra Basin are the result of orogenic activity that occurred in at least three separate episodes, the mid-Mesozoic orogeny, Late Cretaceous-Early Tertiary tectonism and the Plio-Pleistocene orogeny (de Coster 1974). The structural setting of South Sumatra Basin is dominated by northwest-southeast trending fault and fold, north-south trending fault, and northeast-southwest trending fault (Figure 2).

There are two coal bearing formation that potentially prospective for CBM development. The older Oligocene Talang Akar coals are known to be more mature than the Miocene MEF coals but are known to be thinner and buried deeper and are considered less prospective for CBM generation. The main CBM targets in South Sumatra Basin are Late Miocene coal bearing formation (MEF). MEF form part of the overall regressive cycle (Boyd, 1986), overlying shales with glauconitic sandstones and occasional limestones of Air Benakat Formation (Figure 3). MEF coals are known have a good coal thickness and favorable depth for CBM development, though the coals typically thin towards the Sunda landmass. Therefore, detailed study about regional depositional environment is critical.

### **Depositional Environment Model**

Depositional environment model was built based on a detail analysis from well and seismic data. Two depositional packages in MEF are identified with guidance from well data evaluation across South Sumatra Basin: Lower and Upper MEF. Considering detail sediment package observation and cuttings description, these two intervals are proposed as tide dominated coastal plain deposits with three identified subenvironments. There are tidal mud flat, tidal mixed flat and tidal sand flat environment. Well correlation indicates that the MEF landward position is at the southwestern edge of South Sumatra Basin with potential dominant sediment provenance coming from Lampung High.

There are no significant differences between Lower and Upper MEF for depositional environment interpretation. The facies belts are seen to step basinwards due to the regressive nature of the sequence (Figure 4 and Figure 5). However, seismic interpretation indicates Upper MEF potentially was influenced by initiation of latest tectonic event along South Sumatra Basin. The syn-orogenic structure can be captured from the Upper MEF that has thinning sediment thickness towards the Lematang High.

Tidal mud flat environment was determined as organic rich material. Tidal mud flat environment is a restricted environment with limited influence from fluvial and tidal wave, which have high potential for peat development. Based on proposed depositional environment model for Upper and Lower MEF, this environment has widespread distribution across the South Sumatra Basin, which

leads to potential coal preservation in the subsurface. Considering this is one of key technical requirement for CBM to work, South Sumatra Basin has high CBM prospective since it has significant coal presence with good lateral distribution.

### **Conclusion**

Late Miocene sediment in South Sumatra Basin deposited on tide dominated coastal plain, which can be subdivided into two intervals: Lower and Upper MEF with three subenvironments: tidal mud flat, tidal mixed flat and tidal sand flat. Regional depositional environment model suggests thick coals may be present over significant areas of the South Sumatra Basin. South Sumatra Basin can potentially hold large volume of CBM resource because coal is preserved in the subsurface within favorable CBM depth window.

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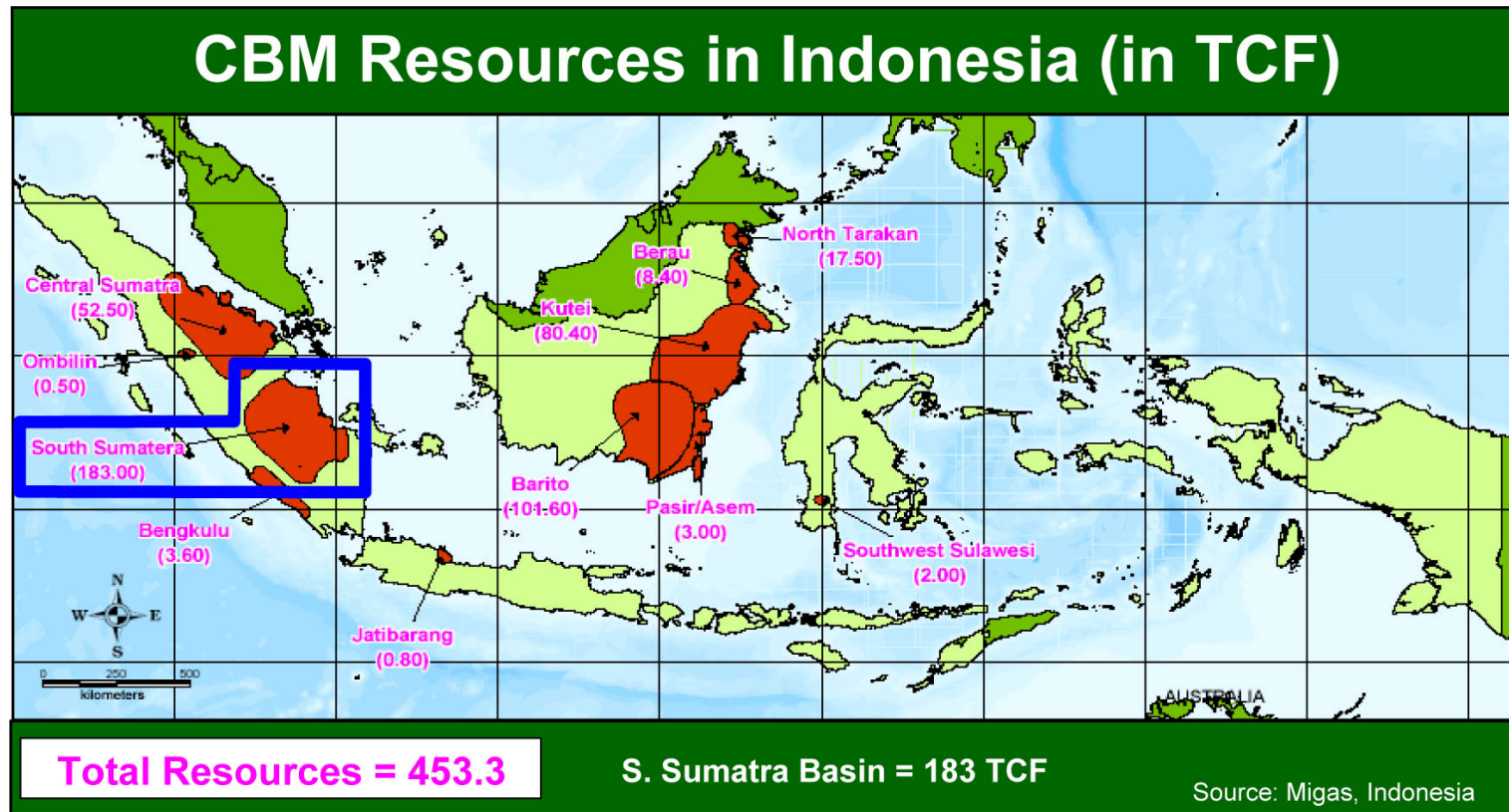


Figure 1. CBM potential location in Indonesia with estimated prospective resources (after Stevens, 2004)

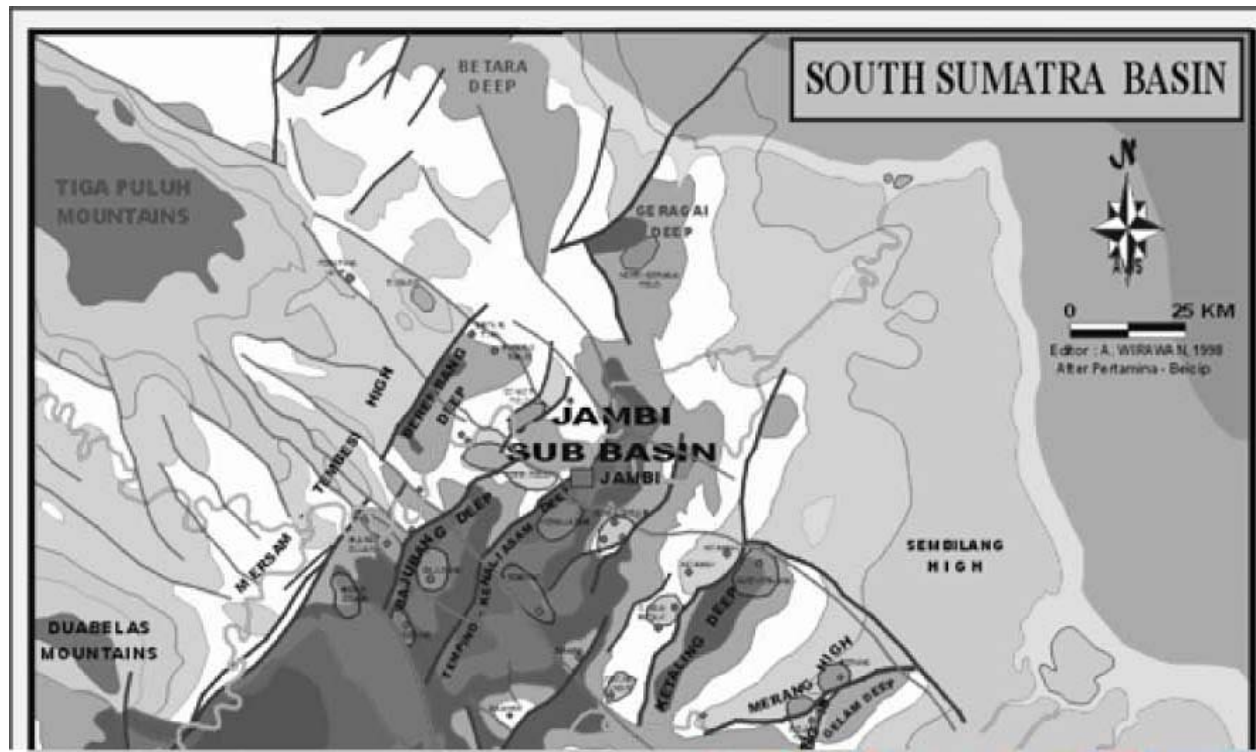


Figure 2. Map of South Sumatra Basin showing regional structural setting (after Pertamina and Beicip, 1992)

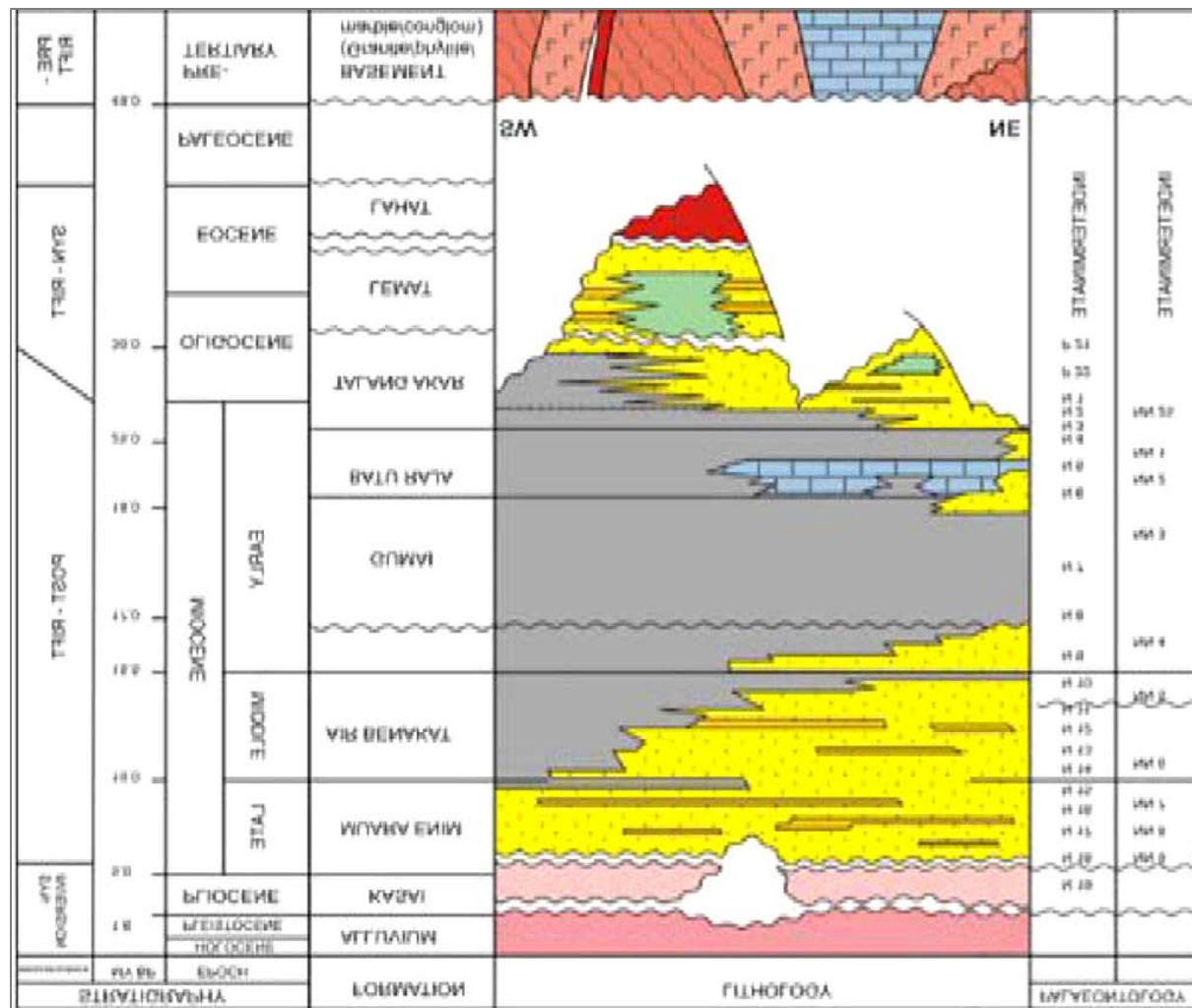


Figure 3. Simplified chronostratigraphic scheme for the South Sumatra Basin (Ginger, 2005)

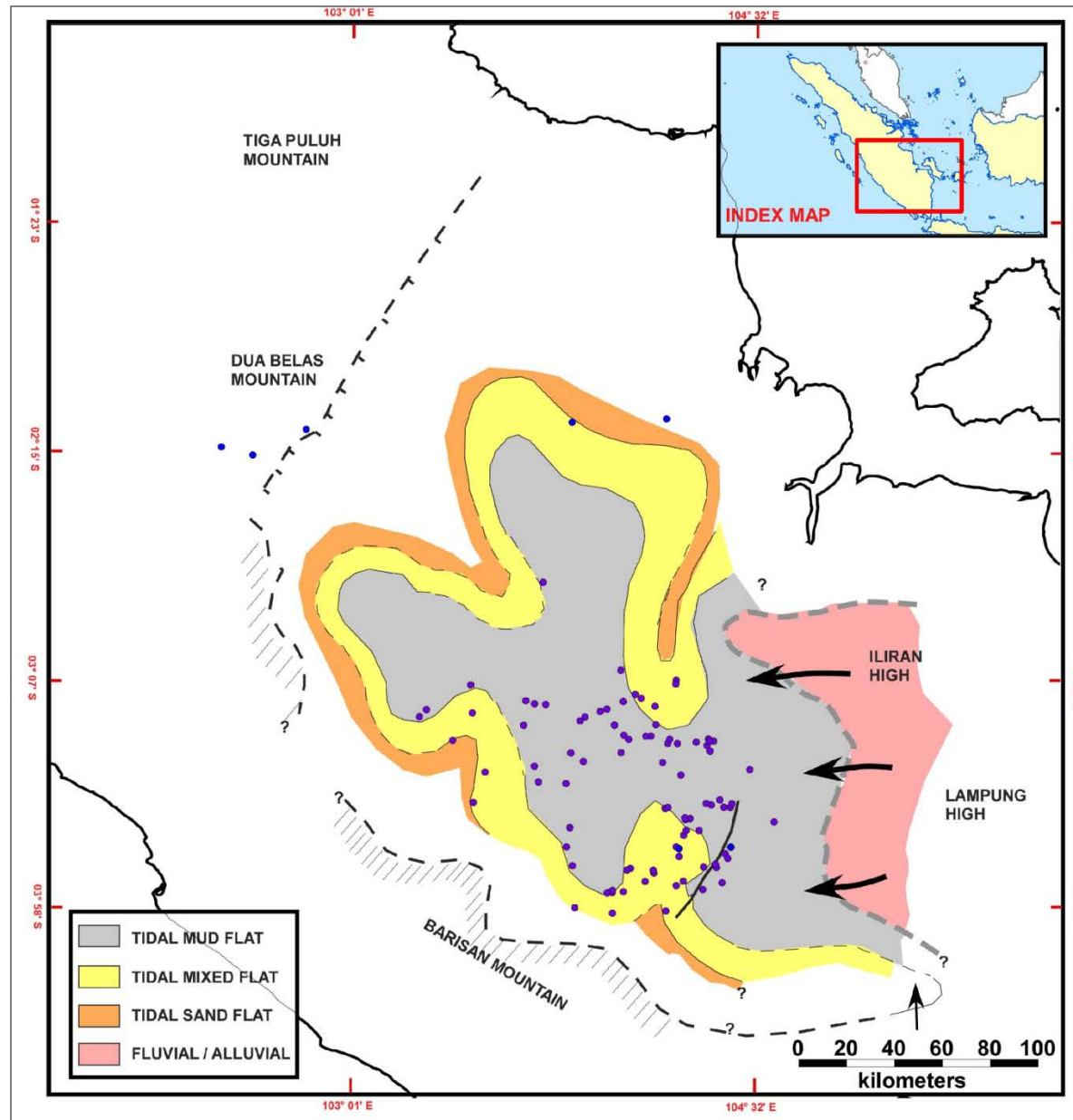


Figure 4. Depositional environment model of lower MEF.

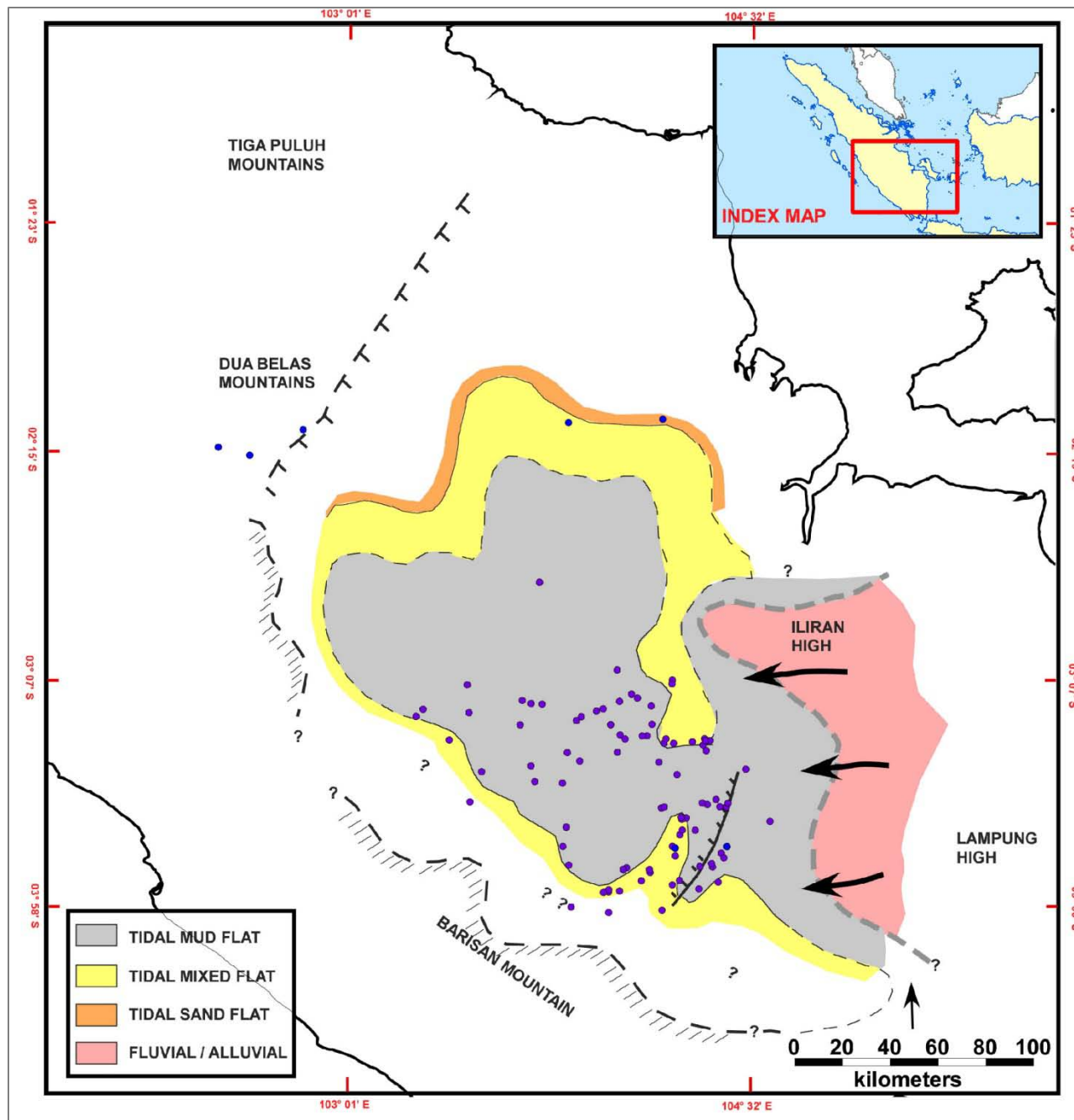


Figure 5. Depositional environment model of upper MEF.