Introduction

Offshore Sabah comprises two contrasting basin systems, the inboard Kinabalu Basin and the outboard Layang Layang Basin (Figure 1), each defined by distinct tectonostratigraphic histories and petroleum systems. The Kinabalu Basin hosts a post–Mid Miocene Unconformity (MMU) clastic play associated with a syn-kinematic fold and thrust belt, whereas the Layang Layang Basin contains a pre-MMU Oligocene system recently revitalized by major oil discoveries.

These results have triggered renewed exploration interest in underexplored Oligocene syn-rift settings and highlight the broader implications for the Dangerous Grounds region.

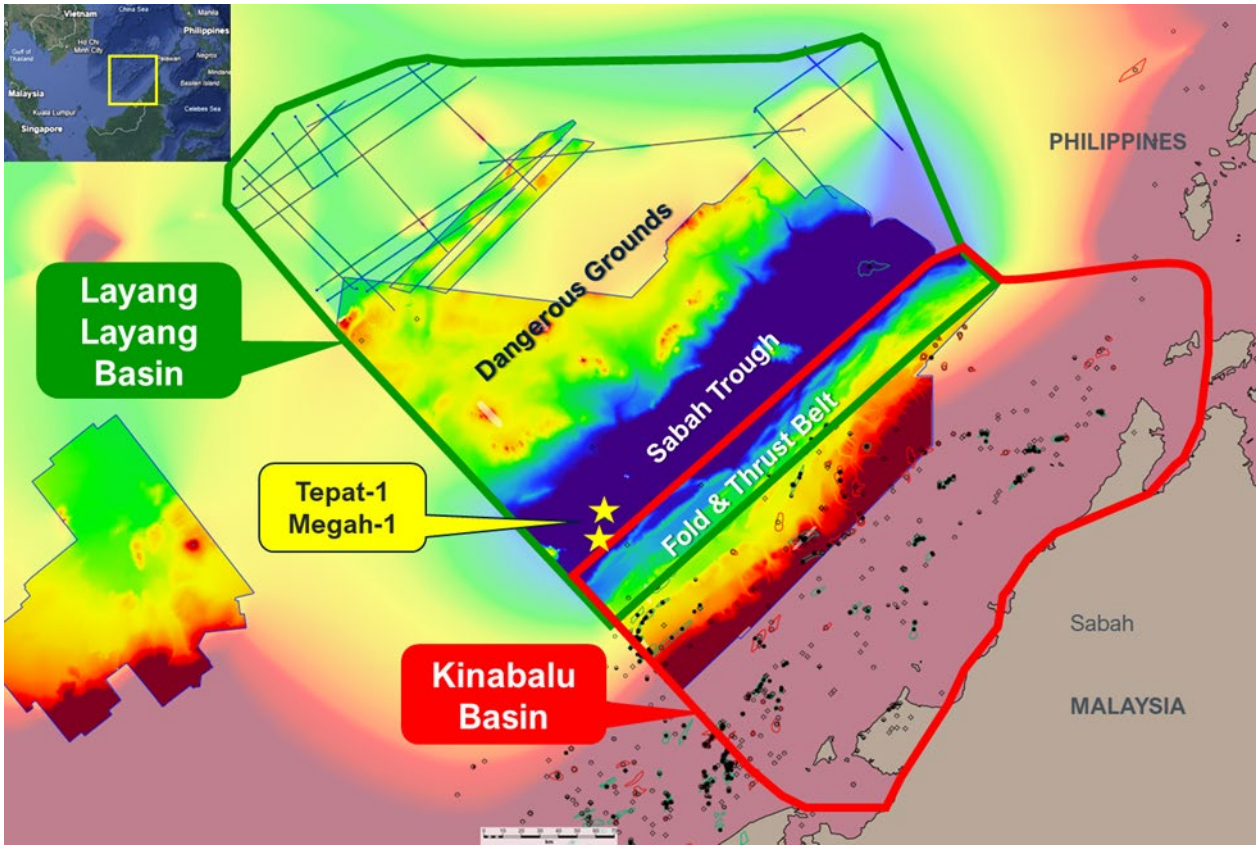

Figure 1 *Seafloor TWT of the study area showing the outline of the Layang Layang and Kinabalu basins and location of the Oligocene Carbonate discoveries.*

Geological Setting

The Kinabalu Basin is characterized by thick (>8 km) marine Tertiary strata deposited within an active fold-and-thrust belt sourced from the Baram, Champion, and Meligan delta systems (Madon, 1999). These sediment inputs have historically supported prolific turbidite reservoirs within anticlinal traps (Figure 2).

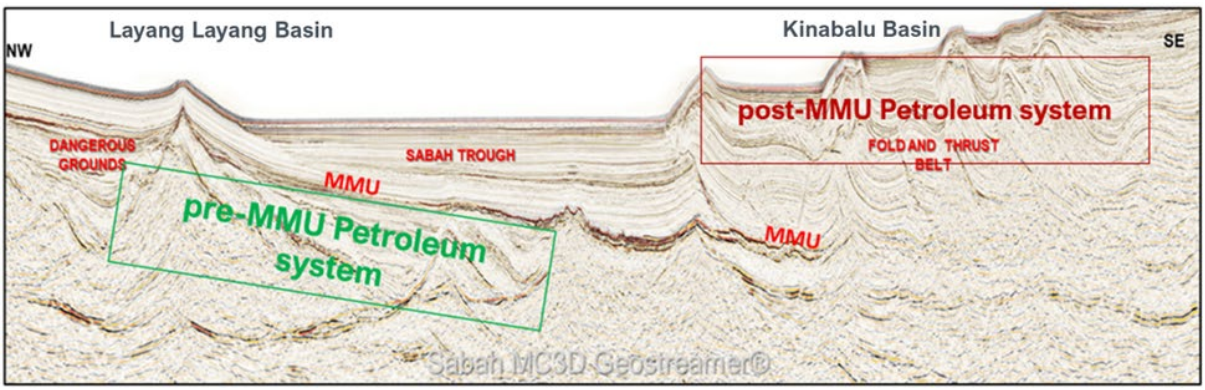

Figure 2 *NW-SE seismic section illustrating the Layang Layang and Kinabalu basins.*

Conversely, the Layang Layang Basin comprises rifted continental fault blocks formed during the opening of the South China Sea. Pre to early syn-rift Paleocene–Oligocene sedimentation potentially provided both organic rich source rocks and reservoir facies (Meng, L. 1999). The basin's petroleum prospectivity was confirmed through the Tepat-1 and Megah-1 discoveries, the latter ranking among Malaysia's largest oil finds.

Data & Methods

This study integrates a suite of regional geological and geophysical datasets to evaluate the working petroleum system in the Layang Layang Basin:

1. 3D Seismic Interpretation
High-resolution multi-client 3D seismic data (e.g., Sabah MC3D) were used to map basin architecture, structural styles, and stratigraphic relationships. Key seismic markers such as the MMU and syn-rift horizons were interpreted to delineate reservoir intervals and migration pathways. Seismic lines illustrate the contrasting structural regimes between the Kinabalu fold-belt and the extensional Layang Layang domain.

2. Well Data Integration
Where possible, well data were utilized to constrain reservoir age, lithology, and fluid presence, providing direct calibration for seismic facies and petroleum system elements. These wells validate the presence of Oligocene source and reservoir rocks, confirming active charge within the basin.

3. Regional Basin Analysis
Tectonic reconstructions and regional stratigraphic frameworks were evaluated to assess the distribution of syn-rift plays and their potential extension into the wider Dangerous Grounds and toward southwest Palawan.

Results

Seismic interpretation reveals a series of well-developed syn-rift half-graben systems containing thick Oligocene sediment packages. These units demonstrate good structural closure potential and effective juxtaposition of reservoir and seal. The validated petroleum system indicates active charge, efficient migration pathways, and multiple untested structural and stratigraphic traps across the basin.

Megah-1, in particular, confirms a significant oil column within Oligocene carbonates, substantially upgrading the play and regional prospectivity.

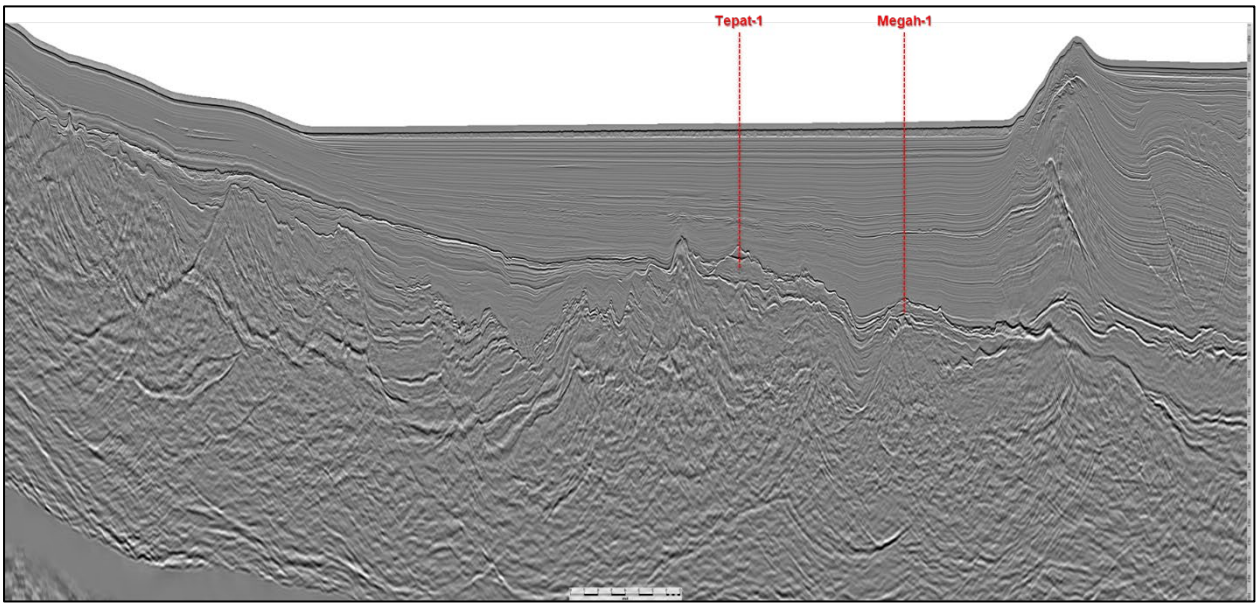

Figure 3 *The Tepat-1 and Megah-1 discoveries on the Sabah MC3D.*

Discussion

The shift from traditional exploration targets in the Kinabalu Basin toward the Layang Layang Basin marks a major paradigm change. Historically, efforts focused on post-MMU turbidite systems within structural traps of the fold and thrust belt. The new discoveries emphasize the importance of underexplored extensional tectonic settings. Syn-rift basins such as Layang Layang, long overshadowed by inboard plays, possess rich petroleum system components and significant structural complexity conducive to hydrocarbon accumulation.

This realization encourages re-evaluation of similar rifted blocks throughout the Dangerous Grounds.

Conclusions

Recent Oligocene discoveries in the Layang Layang Basin confirm a robust petroleum system with major implications for future exploration. Key conclusions include:

- A working Oligocene source to reservoir system is now established.
- Extensional syn-rift basins remain underexplored yet highly prospective.
- Regional prospectivity extends beyond Sabah into the broader Dangerous Grounds and potentially as far as southwest Palawan.
- These findings provide a compelling basis for continued seismic acquisition, basin modeling, and prospect maturation across the region.

References

Madon, M.B. [1999]. Basin Types, Tectono-Stratigraphic Provinces, and Structural Styles. In: The Petroleum Geology and Resources of Malaysia. PETRONAS, Kuala Lumpur, 78-111

Meng, L.K. [1999]. Geological Setting of Sabah. In: The Petroleum Geology and Resources of Malaysia. PETRONAS, Kuala Lumpur, 474-497