Day: Wednesday 26 April **Session: 2**
Time: 11.10am

Insights in the Development of the Central Tertiary Basins Onshore & Offshore Myanmar

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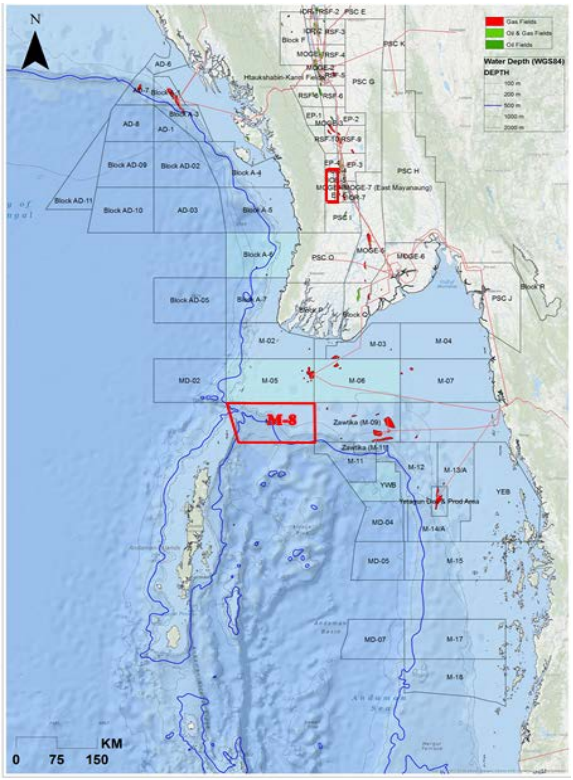
Introduction

The Onshore MOGE4 block, operated by CAOG and Offshore M8 block, operated by Berlanga Myanmar (both part of the Berlanga Group) were awarded by MOGE in 2014. MOGE4 is situated on the western flank of the fore-arc Tertiary Pyay (Prome) Embayment (part of the Central Basin), bordering the Rakhine (Arakan) Yoma mountain range (Figs 1, 2 & 3). It is a transition zone with a total sediment thickness of approximately 4km at the eastern edge of the block. The formations gradually outcrop to the west, down to the Eocene and possibly older formations. Directly to the east of the block lies the suspended gas and condensate field of Htantabin and slightly further east can be found the Shwepyitha, Myanaung and Pyay gassy oil fields (Fig. 3). There is a clear indication that hydrocarbons are charged and are likely still charging from the east from the Pyay Embayment Basin kitchen. Reservoirs for the above fields are mostly late Miocene Kyaukkok and Obogon sandstones, within structural traps sealed by intraformational shales. The Htantabin Field is a notable exception with hydrocarbons found in the early Lower Miocene Pyawbwe limestone lenses/shoals, within combination stratigraphic-structural traps, encased in Pyawbwe marine shales which likely also constitute the source rocks.

The Offshore M8 block is situated to the south of the Total operated Yadana Field and is situated to the west of the Moattama back-arc basin and to the east of the fore-arc Coco Basin (Figs 4 & 7). The eastern half of the block is dominated by the M8 High which is part of the Myaungmya High, a volcanic ridge of hotspot origin ("Kerguelen Plume") formed 110-80 Ma in the Indian Ocean (Fig. 8). This High extends northwards from M8 to 3CA and into the present onshore and had a significant impact on carbonate deposition throughout the Upper Oligocene and Lower Miocene. potential counter parties.

Onshore in MOGE4 the main structures in the area are asymmetrical anticlines associated with transpressional strike-slip caused by the ongoing northern translation and clockwise rotation of the Burma platelet, following the highly oblique collision with the India plate, subducting beneath the Eurasia and Sunda plates. In M8 structural styles are dominantly influenced by right-lateral translation on the Sagaing/Shan Fault System (Fig. 3) throughout the Tertiary and later pull-apart zones associated with the Andaman Sea opening (Fig. 2).

Acquisition of 2D seismic data in early 2016 in MOGE4 and 3D in M8 have provided for the renewed evaluation of the prospectivity of the blocks, the introduction of a new Oligocene play in MOGE4 not present in the adjacent blocks to the east and are shedding light on the tectonic and depositional history in the area. In M8 the 3D data has elucidated the geometric complexity of the carbonate architecture, the uniqueness of the Yadana Field in terms of Platform Carbonate development and karsts and the dominance and influence of the M8-3CA High on Miocene sedimentation in this part of the offshore.



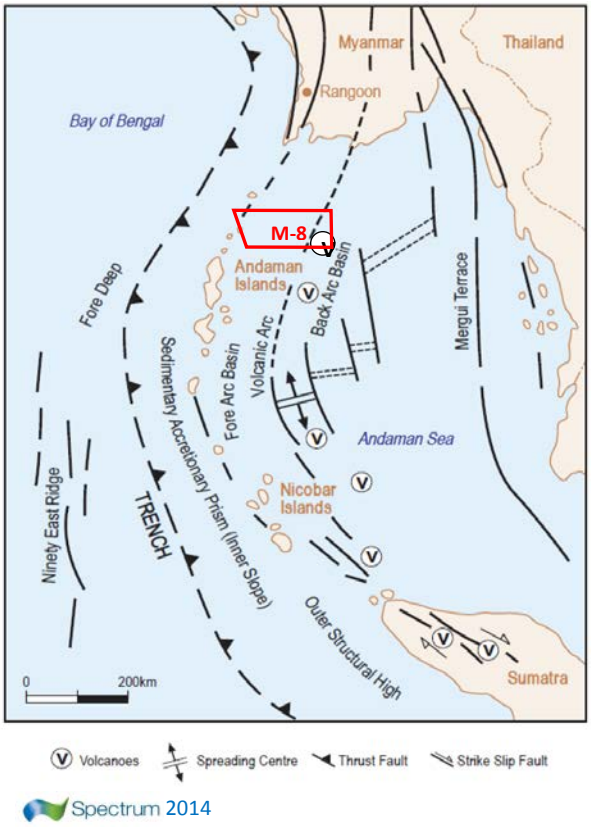


Figure 1 & 2: Location of the MOGE4 & M8 Blocks and main structural elements.

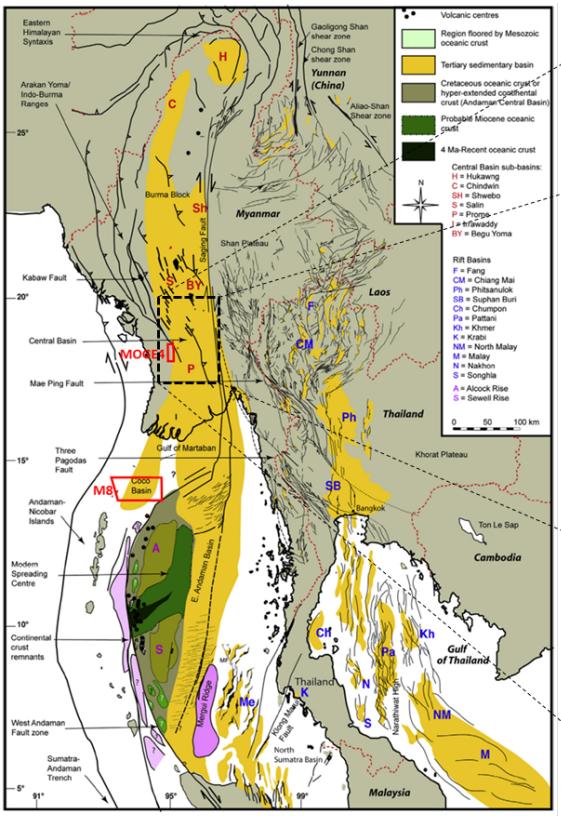


Figure 8. Structural map of the major basins and ridges of the Mergui/Andaman and Thailand basins.

Modified from Pubellier-Morley, 2014

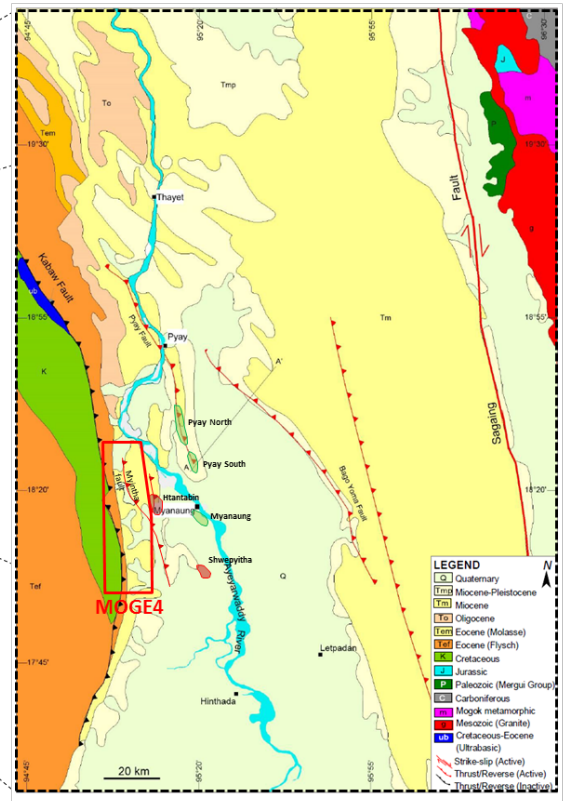


Fig. 2.2 Regional geological map of the Pyay oil field, modified form Bender (1981), Soe Thura Tun and MGS (2014).

Modified by Berlanga Myanmar, May 2016

Figure 3: Geology of the MOGE4 block

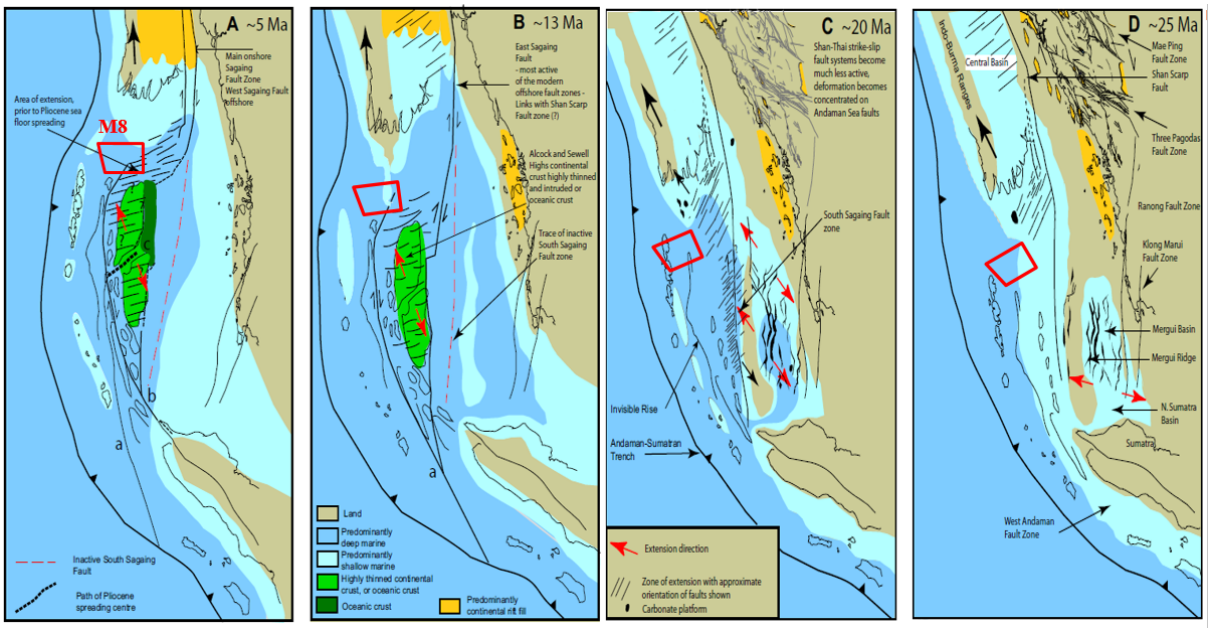


Figure 4: Evolution of the region Miocene to present.

New seismic acquisition

The MOGE4 block initially offered only a very sparse and irregularly distributed seismic coverage. Berlanga planned to acquire a 2x3km regular 2D grid for a total of 463 LKM. Restricted access to certain areas limited the survey to 390 LKM with two notable gaps in the southern and northern halves of the block. The new data were processed to high quality, particularly 159km in the central part of the block that were processed through dedicated PSDM. Interpretation was made easier by the presence of clear unconformities and the very distinct character of the truncated highly-deformed pre-Oligocene sequence, transparent Pyawbwe shales, strongly reflective Miogypsina Pyawbwe limestones of early Lower Miocene age and more sandy intervals of the Kyaukkok and Obogon Formations (Figs 5 & 6).

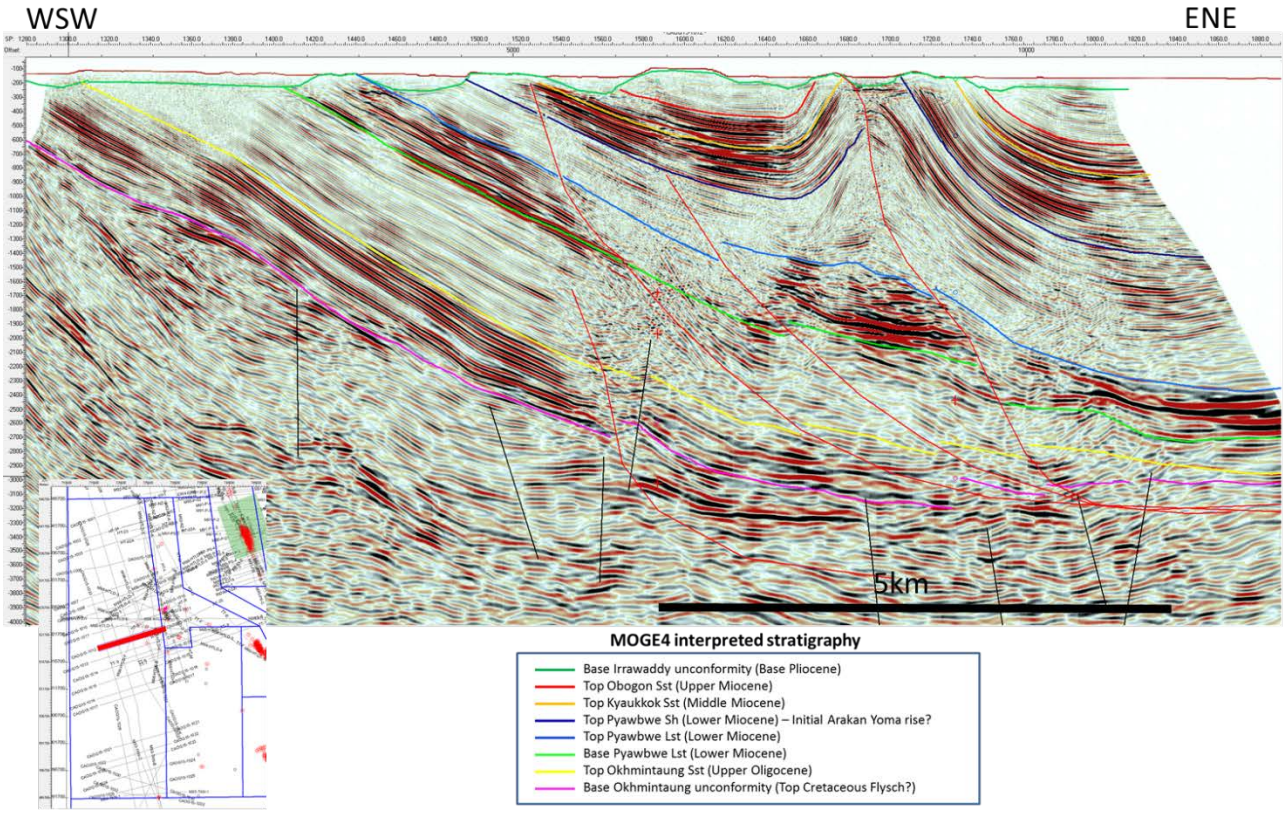


Figure 5: Typical MOGE4 new seismic line (PSDM) illustrating tectonostratigraphy and prospectivity (i.e. Pyawbwe limestone play).

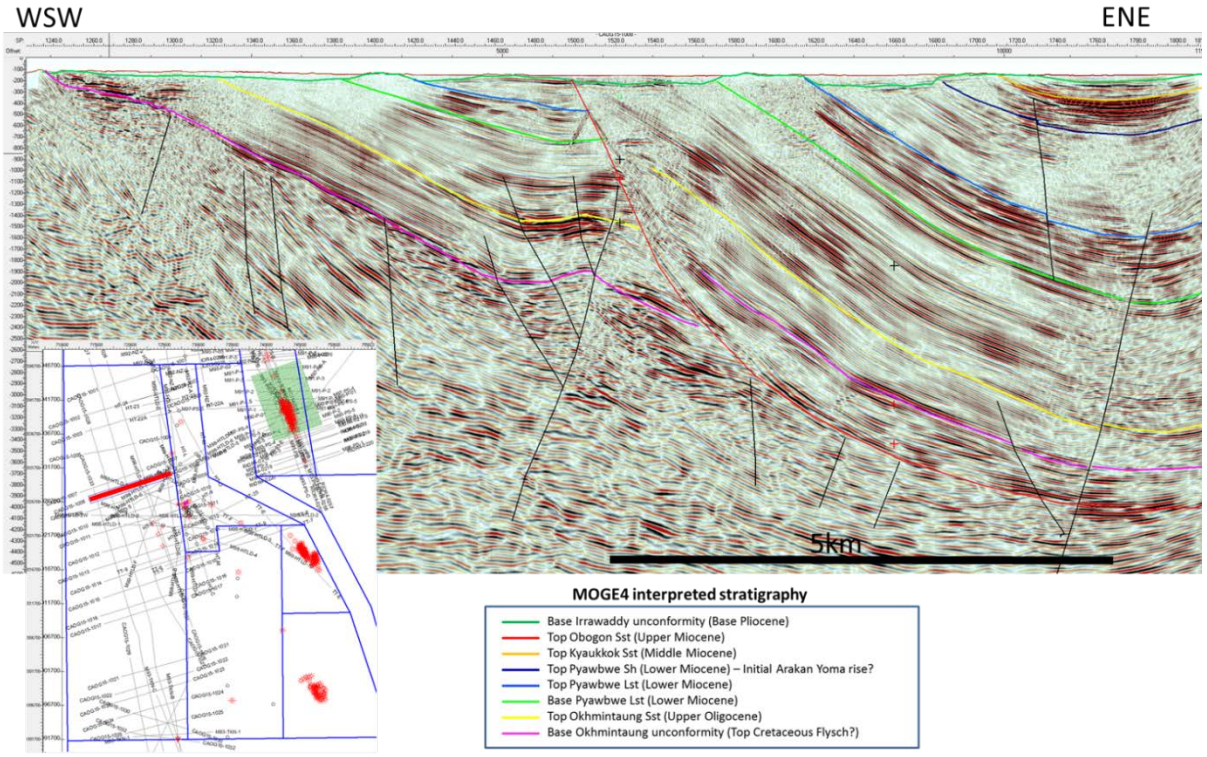


Figure 6: Typical MOGE4 new seismic line (PSDM) illustrating tectonostratigraphy and prospectivity (i.e. Okhmintaung sandstone play).

Regional tectonic and depositional perspective

The new seismic data is of sufficient quality to allow clear identification of the two main unconformities, as well as distinguishing depositional facies and basin-ward trends, hence reposition the block within the published regional tectono-stratigraphic framework.

The Oligocene Okhmintaung corresponds to a quiet phase of deposition, in a near-shore to outer-shelf marine environment, where the basin was clearly opening to the west towards the Bay of Bengal open ocean. The Rakhine (Arakan) Yoma was not yet present as a positive feature or barrier to sedimentation.

The Pyawbwe sequence is thickest in the MOGE4 area due to a phase of northwest-southeast extension in the Lower Miocene (Fig. 9). The Lower Pyawbwe shales were deposited in a deeper marine environment corresponding to a major flooding phase. A gradual lowering of the sea level brought an environment suitable for fringing carbonate shoals, concomitant with the major carbonate platform growth further south in the Andaman sea in M8. Eventually the sea level rose again, drowning the shoals and bringing back an environment favourable to the deposition of deep marine shales. However, in the upper part of the Pyawbwe the direction of thickening is clearly to the east indicating that the basin depocenter is shifting from west to east, likely indicating the early rise of the Rakhine Yoma range.

Subsequent sequences of the Middle and Upper Miocene exhibit the characteristics of a shallowing marine environment, with clear thickening to the east confirming that the basin is now confined by a prominent Rakhine Yoma ridge that is funnelling sediments sourced from the eastern Himalayas in a north-south direction, in what would later become the Irrawaddy depositional system.
In the Offshore in M8, Carbonate Platform development started in the Late Oligocene (Chattian) and was terminated some 25Ma by uplift at the end of the Oligocene and clastic deposition associated with the uplift of the Rakhine Yoma (Figs 8 & 10). Sea level rise in early Miocene (Aquitanian) resulted in renewed Carbonate Platform development.

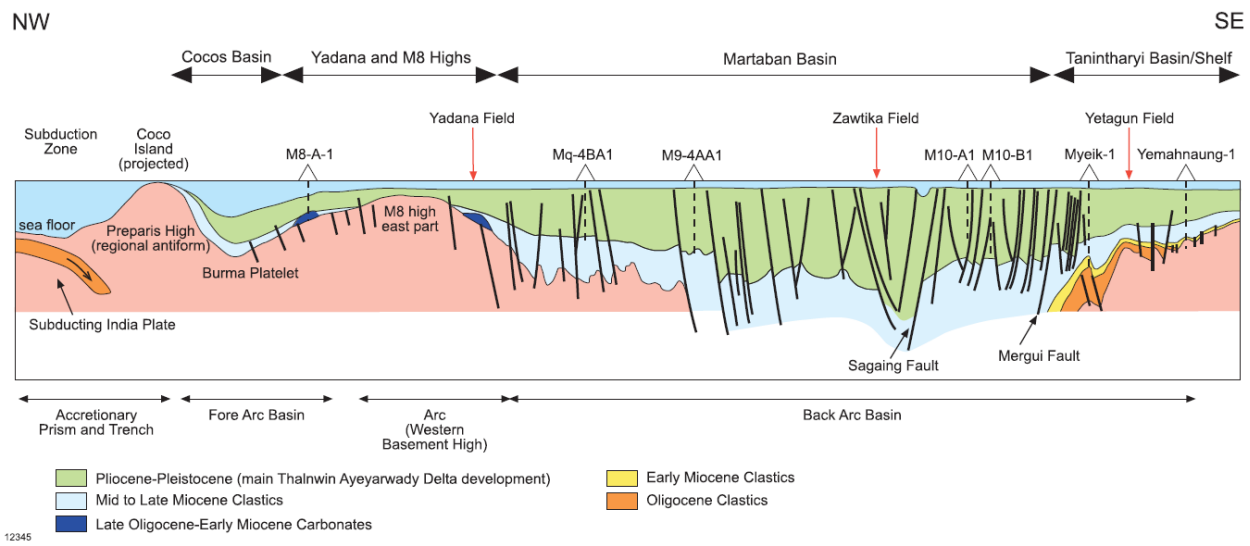


Figure 7: Transect from COCO Basin through Block M-8 to Martaban (Moattama) Basin, Offshore Myanmar.

Relative rise in SL in Aquitanian- 3DE Reef Drowned. Arakan Yoma Uplifted in Burdigalian c. 20mya confined space in Moattama area and relative SL rise with drowning of the 3DF and YADANA Platforms. M8 High likely remained exposed

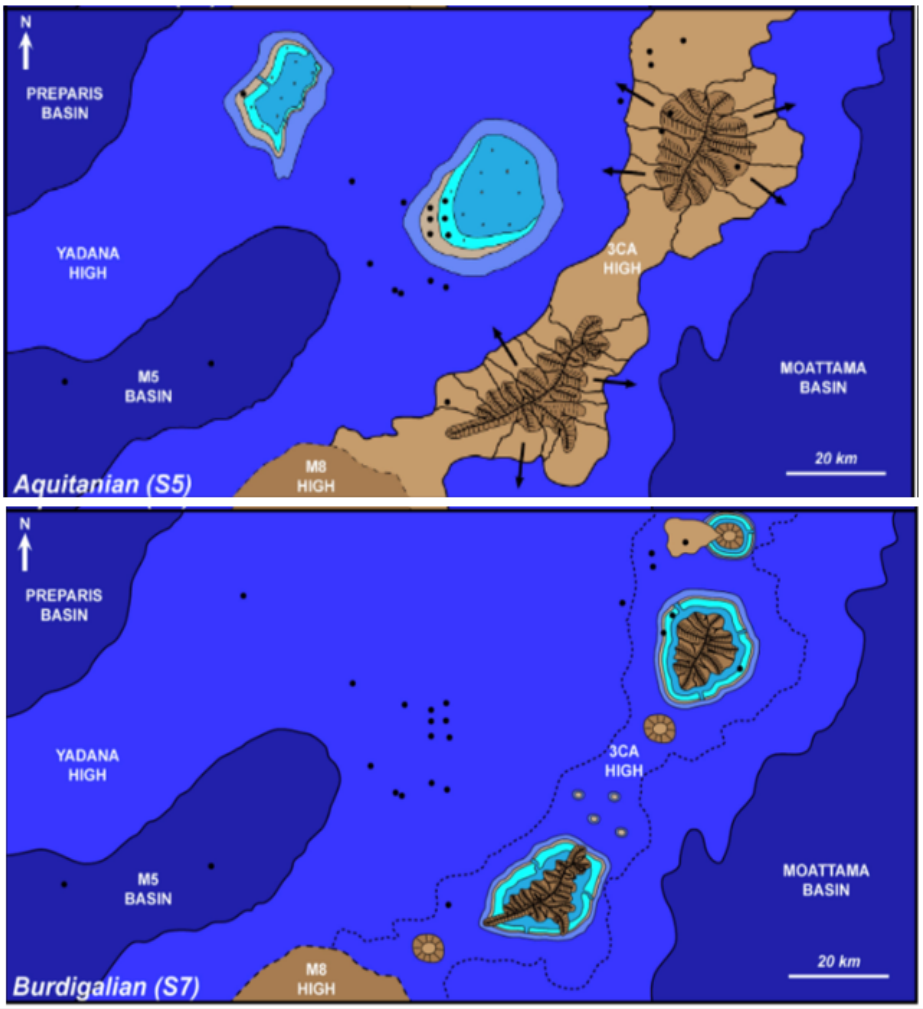


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Figure 8: Moattama Basin, Sea Level Rise approx. 20 Ma and drowning of the Carbonate Platform.

Sea level rise increased with the uplift of the Rakhine Yoma and the Carbonate Platforms were "drowned". These early Lower Miocene Carbonates correspond with those Carbonate shoals in MOGE4.

Following the drowning of the platforms there was renewed uplift associated with the Andaman Sea opening in late Miocene /Pliocene times associated with right lateral movements on the Sagaing Fault and uplift of the Bago Yoma (Fig 3).

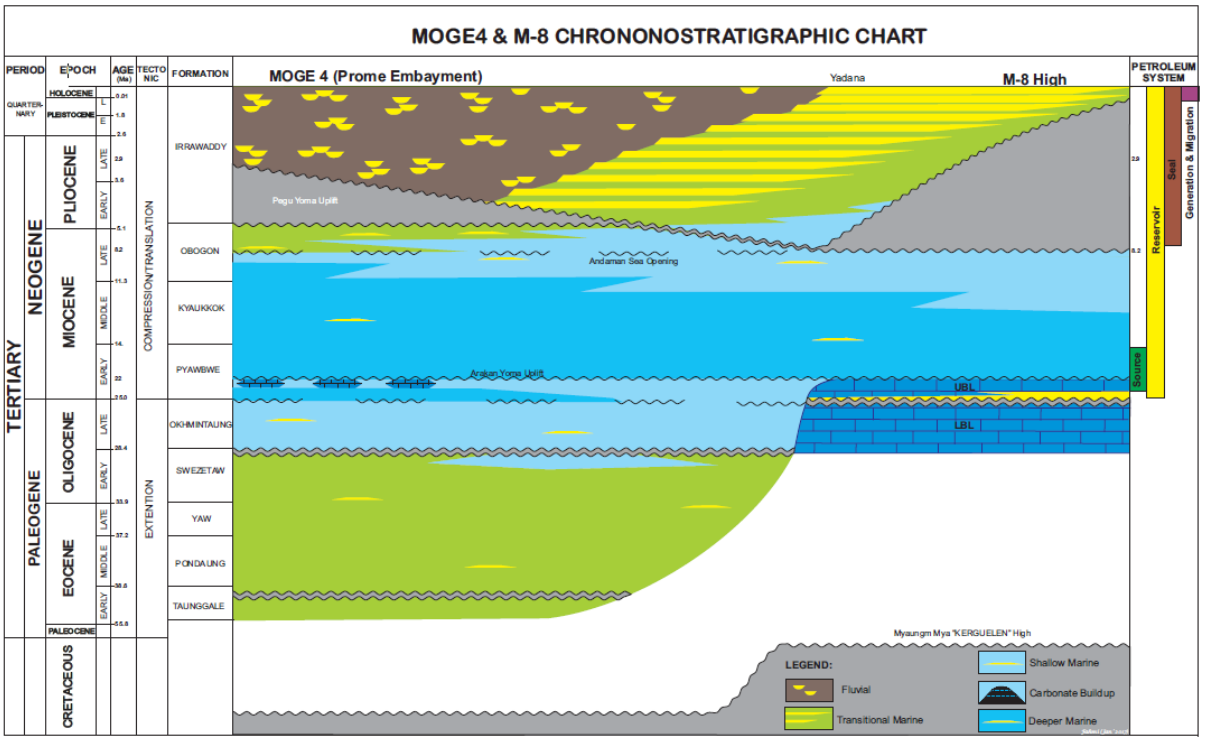

Figure 9: Chronostratigraphic Chart Onshore MOGE4 & Offshore M-8 Blocks, Myanmar.

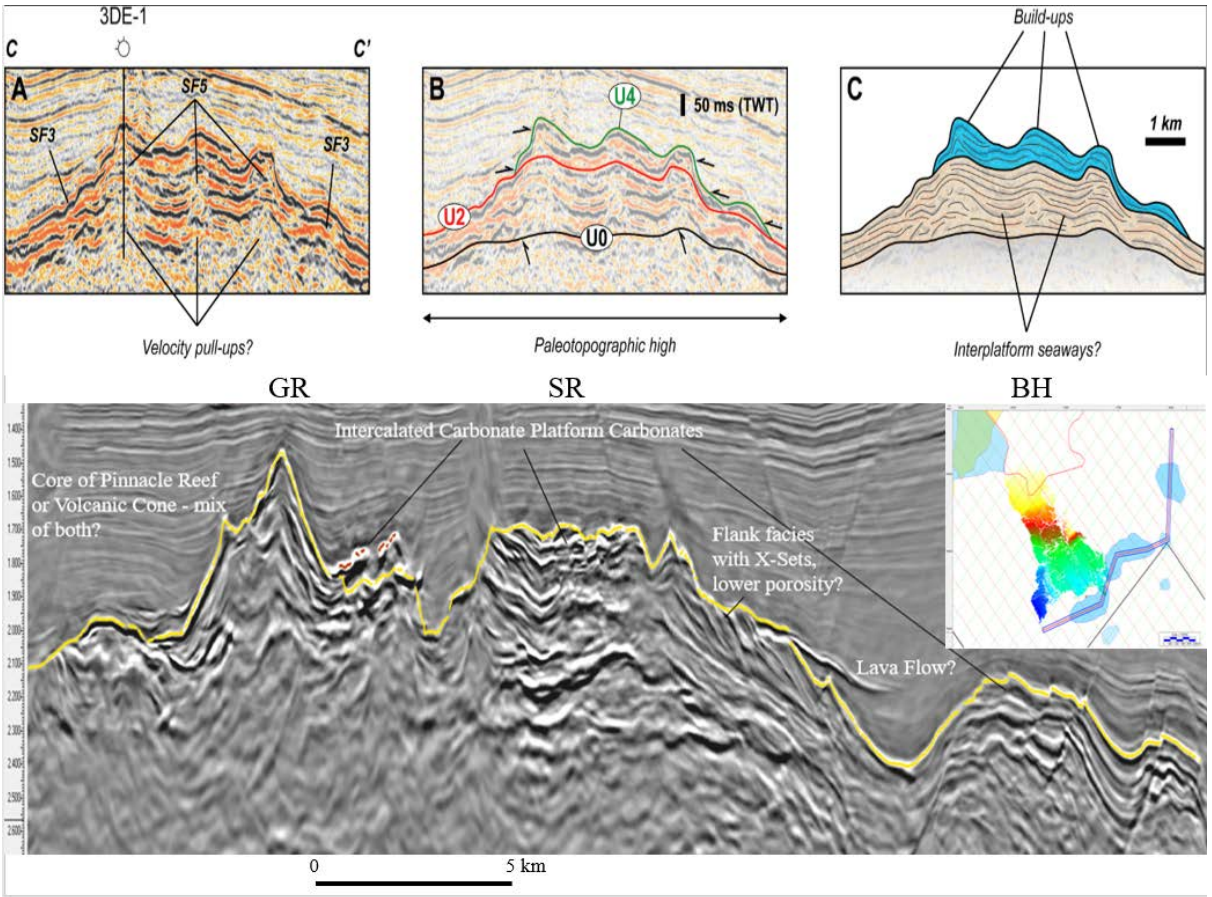

Figure 10: Carbonate Architecture analogues M-8.

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