

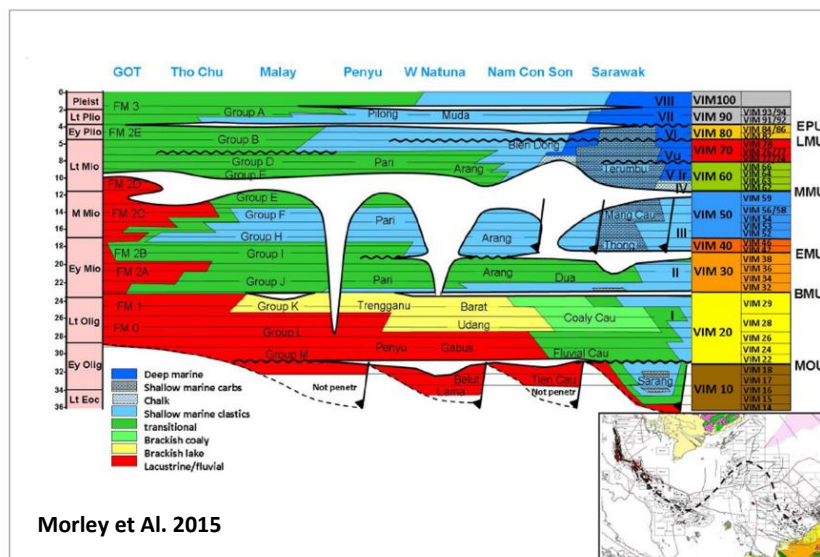
LACUSTRINE DERIVED OIL, NEW AND UNIQUE EVIDENCES FROM THE NAM CON SON BASIN VIETNAM

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The Vietnam, Indonesia, Malaysia (VIM) depositional cycles, can be interpreted from proximal to distal from the Gulf of Thailand to Sarawak, highlighting the way VIM cycles help to clarify stratigraphic relationships and the nature of unconformities across the region (Morley 2015, Figure 1). The stratigraphic model proposed by Morley suggests that during Late Eocene-Early Oligocene a Lacustrine-Fluvial depositional environment represented by the Tien Cau/Early Cau Formation is present in the depocenter of the Nam Con Son Basin. However, this oldest section has been only partially penetrated and there is a substantial amount of sediment above the basement that has never been reached by any well.

Figure 1



Murphy Vietnam, during the drilling campaign 2016-2017, drilled three wells in the Nam Con Son Basin Block 11-2-11, respectively: 11-2/11-CC-1X, 11-2/11-CT-1X and 11-2/11-CM-1X.

The first well drilled, 11-2/11-CC-1X, targeted the Early Miocene Dua and Late Oligocene Cau Formation and reached TD in the upper part of the Cau Formation. The sediments in the Dua and upper Cau intervals were deposited in a fluvial-brackish, coal rich environment as indicated by the abundance of coals penetrated over this interval. The well didn't find oil or gas pays but oil shows were found in the sandstone reservoirs in the shallow part of the Dua and in the Cau Formations. Geochemical analyses of the extracted hydrocarbon from the oil shows suggest that the origin of the oil is from the coals themselves due to mainly in-situ generation with limited gas migration. The whole extract gas chromatograms from coal extracts show a suite of normal alkanes in the range nC11 to nC30+ with a maximum at nC13. The predominance of light-end members, together with very high pristane/phytane ratios (7-14), is consistent with generation from a source rock facies deposited in an oxic environment. The biomarker profiles show Tricyclic Terpanes in low amounts and dominated by C19 tricyclic terpanes, suggesting contribution from terrestrial organic matter. Extended Homohopanes exist

in significant amounts (up to C33) which are often associated with oxic conditions. Steranes C27, C28, C29 show a dominance of C29 over C27, pointing to a terrestrial organic matter type.

The second well drilled, 11-2/11-CT-1X, also targeted the Dua and Cau Formations and reached TD in the upper part of the Cau Formation. The stratigraphy penetrated by the wellbore is very similar to the CC-1X well with coals present in the Dua and Cau Formations. However, several stacked oils pay sands were found in the shallow Middle Miocene Thong Mang Cau Formation (TMC). Only minor amount of gas pay was intersected in the main Dua reservoir target interval.

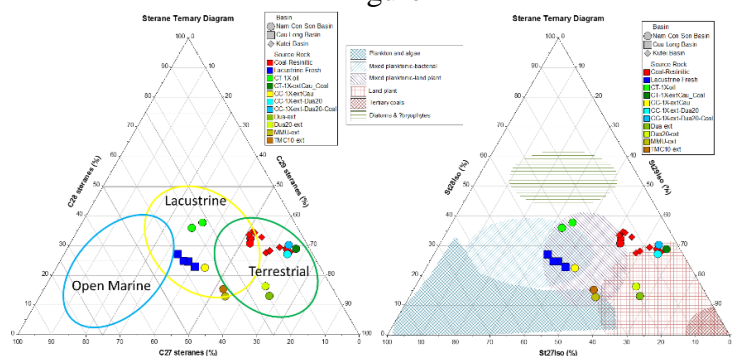
Geochemical analyses indicate that the CT-1X oils are refreshed with light compounds C5 to C13 indicating a present-day active migration. Carbon isotope data from oils and extracts indicate, in general, a non-marine depositional environment and a good correlation with lacustrine-derived oils from the Cuu Long Basin. Oil maturities are around 0.78-0.84 Ro% eq., while the extracts from the coals are less mature at 0.7 Ro% eq. suggesting that the oil is a migrated product. Biomarker analysis based on Steranes C27-C28-C29 suggests that the CT-1X oils correlate with the Cuu Long oils from a lacustrine depositional environment (Figure 2). C30 Steranes (4-Methyl sterane) are commonly abundant in oils derived from freshwater lacustrine source rocks. These compounds are abundant in all the CT-1X oil samples but are absent from the CC-1X extracts. The high C26/C25 Tricyclic Terpanes ratio >1 and the low C29/C30 Hopane ratio <1 are typical of lacustrine environments and correlate positively with the Cuu Long Basin lacustrine source oil-derived analog.

Geochemical analyses from oil extracts obtained in the third well (11-2/11-CM-1X), which targeted the equivalent TMC oil bearing sands encountered at CT-1X well, also suggest a lacustrine source rock origin for the oil pay interval penetrated in the well.

Provided that fluvial to coastal plain facies are the predominant depositional environments for the Dua and upper part of the Cau Formations, it is postulated that the Tien Cau/Early Cau interval as the most likely candidate for the lacustrine source rock for the oils found at CT-1X and CM-1X wells

A full 3D Basin Modeling project is in progress with the goal to better understand and characterize the Tien Cau/Early Cau lacustrine source potential as a possible charging model for the CT-1X and CM-1X oil pay sands.

Figure 2



References

R. Morley¹, T. Swiecicki², P. Restrepo Pace: Correlation across the South China Sea Using VIM Transgressive-Regressive Cycles; Search and Discovery Article #51109 (2015) Posted June 30, 2015.