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Geology Paper 25**PRE-TERTIARY CARBONATE PLAY, OFFSHORE PENINSULA MALAYSIA, A REVIVAL OF FORGOTTEN PLAY**OGAIL A. SALAM¹, SAHALAN A. AZIZ¹, M. YAMIN ALI²¹PETRONAS Carigali Sdn. Bhd., Exploration Division, Level-10, Tower-2, Twin Towers, KLCC- 50088 Kuala Lumpur, Malaysia²Group Research, Research & Technology Division, PETRONAS Kawasan Institusi Bangi, 43000 Kajang, Selangor, MALAYSIA

The exploration activities in offshore Peninsular Malaysia have started as early as 1960's. The first well was drilled in 1969 and the oil discovery had made the area as a new petroleum province in Malaysia beside those in the Sarawak and Sabah Basins. It was then followed by several exploration cycles in 1970's and 1980's with many significant discoveries.

Several Tertiary play types were drilled and proved to contain hydrocarbons. The plays include compressional anticline, extensional structural faults, Tenggol Arch basement drape, NE ramp margin, and so on (Figure 1). In early 1970's, the Pre-Tertiary carbonate play was tested at three localities on Sotong and Bunga Raya structures (Figure 2). These wells penetrated between 8 to 492m of limestone formation. However, the three wells proved to be dry. These disappointing results put the exploration of deeper carbonate reservoirs into complete halt as compared to a high success ratio (1 in 4.5 wells) in other overlying Tertiary plays. To date, the only new play type that proved to be successful was the fractured basement play after the discovery of Anding Utara in 2005.

This paper aims to reflect results and findings of most recent geological evaluation and modeling conducted by PETRONAS Carigali in trying to investigate the potential of the Pre-Tertiary carbonate play. Based on onshore regional data, the shallow marine sequences (Lower Carboniferous to the Upper Triassic) cover most of the Sunda shelf area in Peninsula Malaysia, Thailand, and Indochina. Some Pre-Tertiary Formations are outcropping in Peninsula Malaysia as documented by Tija (1985, 1986). The Triassic and older sedimentary formations are mainly marine, while those younger than Triassic are mostly non-marine. The Permian sediments are dominantly calcareous (often reefal) and often associated with volcanic tuffs. Detailed studies in Gua Musang area and the Biostratigraphic study of Sotong-B1 (H. Fontaine et al., 1989) have identified Triassic age fauna in several limestone occurrences.

Recent efforts on identifying new potential plays by PCSB in South Malay Basin indicated the potential of this Pre-Tertiary carbonate play near to Sotong and Tenggol Arch areas (Figure-3). A thorough review of Pari-1 well Penyu Basin, which reached final T.D. in the calcareous siltstone and meta-sediment basement, has indicated the possibility of calcareous shale/carbonate as evident from sample description and seismic data.

Despite the poor quality and old 2D seismic vintages in Tenggol arch and Penyu Basin, some still indicate possible carbonate or reefal build-up reflection patterns. New 3D seismic sections recently acquired in Blocks PM307 and PM308 have clearly indicated 45 deg. dipping beds patterns with circular reefal buildup geometries as seen in time slices (Figure-4). Special seismic attributes e.g. Sweetness, provided further support of possible Pre-Tertiary reefal carbonates overlying the granitic basement at horsts and paleo-highs structures.

The geological model for this play type indicates the source rock is made up of the matured lacustrine facies of Lower-Upper Oligocene often present at deeper grabens and charging updip and vertically along faults. The Pre-Tertiary carbonates (potential reservoir) are present at the paleo-basement highs and horst structures. The cap rock is provided by the massive regional shales that were deposited during the sagging phase and later interformational shales. Deep burial diagenesis of the reservoirs and its proximity to basement mass is believed to enhance the reservoir secondary porosity through dolomitization and dissolution processes.

This Pre-Tertiary play has proved to be successful in southern Thailand when the Nang Nuan oil field was discovered in Permian carbonate by Shell in 1987. This field is located in Chumphon Basin in Southern Thailand where the carbonates extended further south in the central and east coast of the Malay Peninsular. The reservoirs have been strongly affected by karstic features, deep-burial diagenesis and dolomitization by hydrothermal fluids. Good quality 3D seismic and other data will be significantly helpful for better imaging and identifying potential exploration targets in Pre-Tertiary Carbonates. Successful testing and drilling of the play will considerably contribute towards reserve addition.

References

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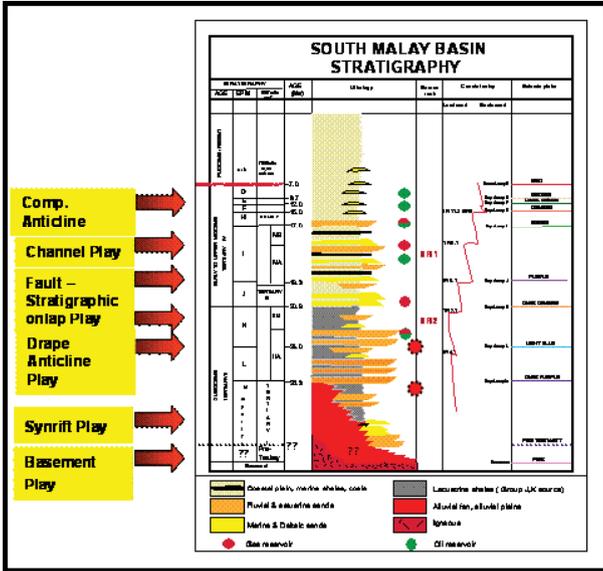


Figure 1: Block PM307 Stratigraphic Column and Play Types.

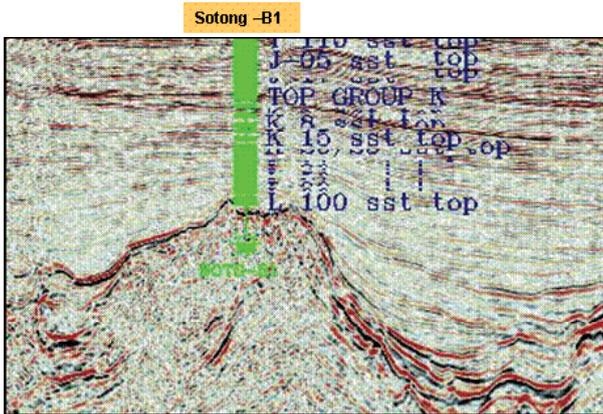


Figure 2: Sotong-B1 Well, drilled about 292 meter of Reefal Limestone (slightly metamorphosed).

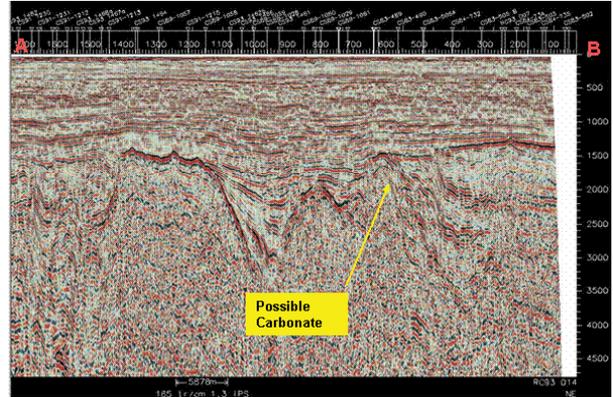


Figure 3: Block PM307- Possible Carbonate Buildup in Tenggol Arch Area.

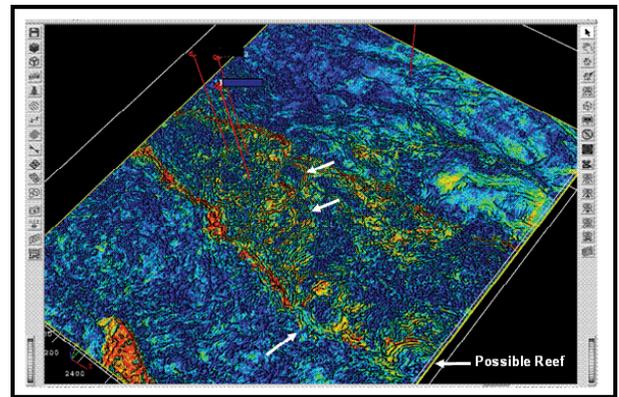


Figure 4: Time Slice 2478 ms, Combo-Mambo Seismic Attribute indicating a possible Reefal Buildup.

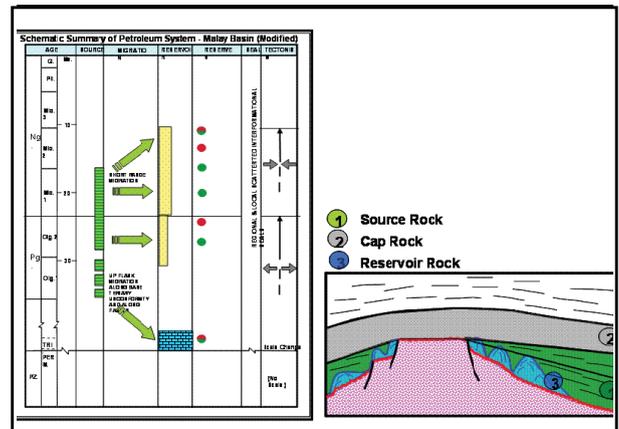


Figure 5: Schematic Summary of Petroleum System, Pre-Tertiary Carbonate Play – Offshore Peninsula Malaysia.