

*Paper 10*

## **Seismic facies analysis of the synrift sediments in the northeast Malay Basin**

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A study of the synrift sediments has been carried out in the northeastern part of the Malay Basin. Two main east-west orientated half-graben systems are located here. The Abu-Lukut Subbasin is the smaller one and it contains partially tested Upper Synrift Basement Drape and the untested stratigraphic trap of Lower Synrift Ponged Facies. The larger Peta Subbasin located southeast of Abu-Lukut Subbasin contains the

untested Lower Synrift Faulted Play. The source rock for both subbasins is envisaged from the Middle Synrift facies comprising the mainly lacustrine shales.

The seismic data of 1988, 1989 and 1990 vintages are mainly utilised for this study as they contain many regional lines useful for correlation purposes. Not many exploration wells penetrated the synrift sediments and when they did, it was not the main target. Out of the 17 wells that had reached the synrift sediments, many of them were bottomed at the upper synrift facies only. Hence, the importance of seismic facies analysis must be emphasized in order to carry out the study of the hydrocarbon potential of the graben plays.

The seismic interpretation is focused more on identifying the play-types using seismic facies analysis.

The Oligocene synrift sediments known as Group M, are divided into lower, middle and upper synrift segments based on their distinct depositional environment which correspond to specific seismic character.

The Lower Synrift sand-prone fluvial/alluvial facies correspond to the high-amplitude, continuous reflectors and also displays a prograding pattern indicating a high sand content. The Middle Synrift shale-prone lacustrine facies is represented by transparent to weak seismic events and can be very thick, providing a good seal for the lower synrift sands. In addition, the Middle Synrift facies constitutes the main source rocks for the synrift plays. The Upper Synrift sand-prone fluvial facies relates to another series of the high-amplitude, continuous reflectors. On the basement highs, they either overlie the Lower Synrift facies/basement or they onlap the rising basement rock as indicated.

So far, only wells drilled in the Abu-Lukut Subbasin did penetrate down to the Lower Synrift facies. A well correlation was constructed tying the Well-1, Well-2, Well-3, Well-4 and Well-5. The Lower Synrift facies is shown to be blocky to coarsening upward sand-prone which is consistent with the seismic facies interpretation. Hardly any sands are deposited in the Middle Synrift facies, again tied to the transparent to weak seismic reflectors. More sands appear in the Upper Synrift facies equivalent to the high-amplitude reflections on seismic data.

Wells in the Peta Subbasin managed to reach the Middle Synrift facies only. Hence, no well correlation was generated for this area. By analogy, the similar seismic facies of the Lower Synrift sediments would yield blocky to coarsening upward sands, suitable for reservoir target. Based on the seismic data, a thicker Middle Synrift lacustrine facies is deposited here which leads to better source and seal potential. The Upper Synrift facies is similar in thickness and character to the other subbasin.

Two play-types in the Abu-Lukut Subbasin emerged from this study. The structural trap of Upper Synrift Drape Over Basement has been partially tested in the Abu oil field. The stratigraphic trap of the Lower Synrift Pondered Facies remains to be tested. The Lower Synrift Pondered facies exhibit a high amplitude, continuous to slightly chaotic events indicating that poor to fair quality reservoir which may not be interconnected and may possess poor to fair sorting. Sealing depends on lateral seals of basement rock and vertical seal of Middle Synrift lacustrine shales. No well has penetrated this facies.

Only one play type could be possible in the Peta Subbasin. The Lower Synrift Faulted Play is still untested. The seismic events shown here are high amplitude, parallel, continuous indicating good quality reservoir of fluvial sheet sands. These sands are sealed laterally and vertically by the Middle Synrift lacustrine facies. Hence, sealing should not be a problem here.

AVO analysis were carried out for the Lower Synrift Pondered Play and also the Lower Synrift Faulted Play to upgrade their prospectivity. The work was carried out by PRSS. A variety of AVO products were analysed including P\*G, P+G, P-G and AVO crossplots. Line 1 AVO response is for the Lower Synrift Faulted Play is positive and points to a Class 2 AVO of oil sands indicating that the Lower Synrift Faulted Play is better ranked than the Lower Synrift Pondered Play.