Unravelling New Prospectivity in the Clastic and Carbonate Reservoirs using Differential Compaction Concept and 3D Seismic Attributes: Case Study from Malaysia Basins

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ABSTRACT

Malaysia offshore Tertiary basins have yielded billions of barrel of oil and gas over almost a century with first oil produced from Miri-1 in the initial part of 1900s and peak production in the 70's.With hundreds of wells drilled by various operators and numerous world class discoveries Malaysian offshore is considered as matured basin. Exploration in a mature basin is challenging and hence required out of the box thinking, State-of-the-art technology and customized workflow. This paper discusses an innovative seismic interpretation approach to delineate, characterize and mature Stratigraphic plays which pose challenges because of the thin beds (beyond seismic resolution) as well as subtle structural elements, which are difficult to interpret with conventional methods.

'Differential Compaction' features have been reported from various basins around the world and are found to gives notable seismic expression. These features form as the different sediments (shale or sand or limestone) are compacted differently as per their mineralogical constituents and therefore produce a subtle irregular topography. Differential compaction on seismic can be used to define features of interest, such as identifying subtle carbonate buildups in a shale matrix and also to define channel fill , point bars sand in complex channel belt surrounded by shale matrix flooding plain. The constituent of shale is mainly clay minerals (i.e kaolinite, illite) known as phyllosilicates meanwhile sand constitute of silicate. These sheeted phyllosilicate minerals have a tendency to be compacted more that silica by overburden stress thus will give the seismic expression of differential in compaction. In this paper we will discuss some of the striking differential compaction features from two examples of (1) negative relief, shale-filled channel features with excellent positive relief of sandy point bar build up with a shale matrix (flood plain) in the Malay Basin, and also (2) carbonate reefal buildups in a shale matrix in the Central Luconia Carbonate Province.

On the eastern hinge of Malay Basin channel complex, five new fluvial channel point bars prospects has been identified. The best analog on the channel play is Y Field, located on the western hinge of Malay Basin. The Y Field is a dome structural trap configuration at multiple level with channel fill and point bar sand reservoirs. This setting comprise of stratigraphic element limiting the net oil pay as the reservoir is confined by the channel belt point bar sand. This idea of 'lateral limit' of net oil sand has been used to look for channel belt on the other part of the basin. Positive relief mounded feature with subtle structure seismic expression over the channel belt complex indicate that these pointbars are filled with a lithology that is less compactable than the surrounding matrix, indicating the presence of sand. Calibrated Rock physics studies also in agreement with the lithology description from the geological model. In 2015, one of these five pointbars has been chosen to be a drilling candidate. The result is oil and gas discovery and the well testing rate is 2,500 barrel of oil per day. Thus, this become a play opener of the

eastern hinge of Malay Basin as the channel play is relatively under-explored compared to the western hinge. This prospect is easily monetized as it is located only 2km from a depleting producing field.

In Central Luconia Carbonate Province, Cycle IV and older Cycle II Carbonates are the main exploration target with many world class discoveries made till date. Reefal type Cycle III carbonates is relatively underexplored in the region. Cycle III Carbonate buildups buried in shale will appear as subtle structural high, giving rise to a positive curvature anomaly. In 1974, an exploration well that targeting older Cycle II carbonates accidently drilled through this Cycle III reef carbonates. The well electric logs shows convincing 50m of gas column with good porosity and permeability. However, this Cycle III interval was not tested and ignored because of the geobodies cannot be defined as the prospect was mapped using 2D seismic data. By utilizing this invaluable well data, a thorough evaluation was conducted on the Cycle III Carbonates prospectivity and potential. The results of the evaluation is very encouraging with eleven new prospects has been identified with the biggest identified carbonate is around 32km² and with Prospective Resources of 1.5 TCF.

Using this thorough and “creative” approaches of seismic interpretation together with detailed analysis of various seismic attributes and different color blendings, the ‘unseen’ potential that was left behind can be opened up. Besides from reefal carbonate and channel belt complex, this method also can be applied at other geological setting with differential of elements such a distal sand of turbidite and slope deposit.