GEOPHYSICS PAPER 19

SEISMIC IMAGING NEAR AND WITHIN THE BASEMENT OFFSHORE MALAYSIA; INCLUDING COMPARISONS OF IMAGING ALGORITHMS

Nabil El Kady[1], M. Shah Sulaiman[1], Zabidi M Dom[1], Tang Wai Hoong[1], Lee Mei Lu1, Pavel Vasilyev[2] & Martin Bayly[2]

[1]PETRONAS Carigali Sdn Bhd, Tower 2, Petronas Twin Towers, Kuala Lumpur City Centre, 50088 Kuala Lumpur, Malaysia.
[2]WesternGeco, 8th floor, East Wing, Rohas Perkasa, No. 8 Jalan Perak, 50450 Kuala Lumpur, Malaysia.

Better 3D acquisition and better imaging have made it possible to explore complex basement plays in Vietnam, Indonesia, and the Malay Basin with some success. It is postulated that oil from adjacent formations may get trapped (under favourable conditions) in vughs and fractures within the basement. Imaging the basement architecture is a key issue (Deva Ghosh et al., TLE, April 2010, also; Areshev, 1992, Reservoirs in Fractured Basement on the continental shelf of Southern Vietnam, Journal of Petroleum Geology, Vol 15, Issue 3, pp 451–464).

In this paper we describe the data preparation; velocity model building and migration methods applied to successfully image the data. The basement fractures are present at a variety of scales but to aid interpretation the larger, seismic scale fractures and faults need to be clearly imaged. In addition to imaging the basement, the seismic data processing flow also was designed to resolve and image shallower clastic horizons. Pre-processing of this data followed a generally industry standard marine data processing flow, however, particular attention was paid to the deep basement events and to the application of multiple attenuation type processes.

This data exhibits a strong vertical compressional acoustic velocity change between the younger clastics and the harder, older basement, with the possibility of intermediate velocity metasediments. Due to the extreme spatial changes in depth of the basement and regional scale faulting there are strong and rapid lateral velocity changes within the dataset. This necessitates the application of pre stack depth migration techniques that can comprehend the lateral changes.

Initially in 2004 a time Migration was run to provide a structural interpretation and asses the gross velocity variability. The subsequent depth migration used a derivation of depth and space varying interval velocities in a "hybrid" model building approach. The shallow clastic overburden model was built using a series of iterative loops of multi parameter reflection based tomography (Woodward et al, 2008, A decade of tomography, Geophysics Vol73, No 5). Shallow sediment velocity updates were based on the residual curvature calculations. In order to overcome the limitation of residual curvature tomography as it becomes less sensitive to velocity perturbation at deeper depth, deeper layers velocity in the metasediments and basement zone were built using a combination of interpretation and Multi-velocity scans.

The progressive model building and checking of the results was performed with intermediate Kirchhoff pre stack depth Migrations. Following the completion of the depth model building the data was fully depth migrated with both Kirchhoff and Adaptive Beam Migration methods. Adaptive Beam Migration (ABM) is an implementation of Pre-stack Depth Migration as described by Ross Hill (N. Ross Hill, 2001, Pre-stack Gaussian-Beam Migration, Geophysics, vol 66, No.4, p1240-1250) and utilises an oversampled range of tapered beams propagated through the subsurface. Upon completion, the two results were compared, The Beam Migration method showed improved focussing and definition of the faults close to the basement.

In an area of the data close to a graben feature, a "curious event" was observed on the stacked depth migrated images. The position of this event was certainly not geologically plausible. Upon inspection of the Common Image Point (CIP) gathers, this data was observed to be poorly moved out, of apparent low frequency, and also appeared only on mid to far offsets. After some analysis and discussion, it was proposed that this data is possibly "duplex wave" or "prismatic wave "energy. That is, a double subsurface reflection. To further investigate this possibility a simple 2D Finite Difference model was constructed with similar reflector geometry and velocities. This model produced a similar event on the raw model gathers as observed in the real data. This implied that it may be possible for this energy to be a" double bounce". To focus such wave phenomena requires an imaging algorithm that comprehends both down going and up going wave propagation, namely a two-way wave equation implementation. Such an implementation is the Reverse Time Migration (RTM) method (Fowler et al, 2010). Consequently, a small subset of the data was run using this depth imaging algorithm to see if the "curious event" energy migrates to a geologically plausible place.

Overall, this case study demonstrated that careful selection of suitable pre-processing processes, depth - velocity model building, and an appropriate prestack depth migration algorithm can assist greatly in improving the image of the top basement and clarify the delineation of fractured basement plays.

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