Poster 8

Challenges of developing a stacked clastic gas field

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The Laila gas condensate field, offshore Sarawak, comprises a thick (~2,000 ft) Upper Miocene succession of shallow marine sediments associated with major growth fault systems and deposited as part of the paleo-Baram delta. It is a marginal gas field (<300 Bscf UR) awaiting development to supply gas to MLNG-DUA. The structure is a NE-SW 3 way dip closure roll-over associated with a gravity induced tectonic regime and a later compressional phase (Upper Miocene). Laila is bounded to the east by a long NE-SW bounding fault and is dissected by a NW-SE splay fault in the middle of the structure; thus dividing the field into 2 major fault blocks: Main Block (footwall) and Block 1 (hanging wall in relation to Main Block). Minor fault splays are also observed in various intervals, but these faults were considered not to have a big impact on reservoir fluid dynamics.

The gas bearing intervals occur in 15 separate sands in the P, Q, R and S zones, which are then subdivided to parasequences. No core is available. Sidewall samples from the shallowest sand interval (P1) display fine–very fine grained sand with a silty matrix. Cleaning-upward signature on gamma ray, as well as prograding stacking patterns observed on seismic suggest that the bulk of the sequences correspond to a stack of prograding shoreface and/or deltaic sands. The field has high CGR, low permeabilities (3–7 mD from R1 DST) and is overpressured from R1 downwards. 3D seismic (pre-stack time) was recently acquired and AVO analysis was conducted along with this study.

In early 2003, a field study was initiated to characterize the stacked reservoirs of the Laila field for volumes (GIIP & UR), uncertainty identification for appraisal well drilling optimization and for flow unit definition. An appraisal well is planned for 2004.

For the purpose of this study only the Q5 sands of Block 1 and the R1 sands (which represent 50% of the GIIP) were modeled. The interval of interest is approximately 550 ft thick with 5 flooding surfaces: Q5A, Q5C, Q5D, Q5E and R1. Individual sands of the Q sequence are 20–70 ft thick, whereas the R1 sand, which represents the thickest sand, is 120–150 ft thick.

A 15 x 1.5 km 3D static model was built using Petrel v2003 using the PSC boundary as AOI limits. The model incorporates 2 mapped seismic horizons that were used to constrain zonal intervals. Zones were made conformable with high vertical resolution layering (mean = 1.15 ft). Listric faults were made linear for simplicity in the pillar gridding process, which uses a 300 x 150 grid increment.

Key uncertainties (i.e. sand continuity, porosity) that might have an impact on field development and GIIP were tested. The volumetric assessment of the various static models showed that the structural trapping mechanism uncertainty in Block 1 has the biggest impact on GIIP. Amplitudes, Vp/Vs and seismic facies maps suggest a drastic change to the NE of Laila-2. Reflectors in this area are chaotic and dim, suggesting either lateral shale-out, sub-seismic faulting, or slump scars. Lateral shale-out is assumed to be the most likely case, but the possibility of pay in this area cannot be ruled out. Seismic facies mapping in various intervals indicate a large lobate body terminating to the east. Severe dip shale-outs are considered unlikely given the size of the accumulation (edge of model is 1.5 km downdip of main bounding fault), nevertheless drastic dip shale-out realizations were modeled for sensitivity analysis. The downside impact of dip shale-outs is the order of 25–35 percent, which is significant given the small size of the field.

Since no clear GWC's were encountered, the high side potential of deeper contacts is another big uncertainty to GIIP. Contacts were postulated based on spillpoints, AVO, logs and pressure plots. Porosity distribution (i.e. kriging vs Gaussian simulation) does not have a big impact on volumes. The base case porosity model was co-kriged using S-impedance as a secondary control to well logs. No clear reduction of porosity with depth is seen A decrease in reservoir quality is seen north-eastwards towards Laila-2.

An XRD study conducted on Laila-2 cuttings showed total clay content of approximately 7–16%. However, a significantly high proportion of that is illite (36–58%) and mixed layer illite-smectite (19–28%). Pore bridging illite may very well be the culprit of the low permeabilities seen in the well tests, however, only a proper study on future core will give us a clue to the low flow potential of these rocks. Cuttings are not considered to be reliable and will always be questioned.