A New Perspective of Structural and Property Modelling: A Case Study of Baram Oil Field, Offshore Sarawak, Malaysia.

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Introduction

Baram is a giant mature oil and gas field located in the Baram Delta area of offshore Sarawak Malaysia. Reservoirs are Late Miocene to Early Pliocene deltaic to shoreface sands with an approximate thickness of 7000 feet and comprise of over 200 sand-shale zones. The field is outlined in a very complex structural setting of Sarawak Basin where early growth faulting, followed by compressional phase has created numerous unconventional fault geometries.

The field complexity, poses a real challenge to effectively manage and optimize the reservoir. An integrated reservoir model will be a prudent solution for interdisciplines communication platform and database, and also effective tool to support optimum reservoir management process. This is especially true, considering huge amount of data available in the field, in combination with over 40 years of production history.

An attempt has been made in 2006 to construct static model of Baram Field. However, due to technology limitation to address complexity of fault geometries, the model has to be segmented into 10 pieces. It restricts establishment of vertical reservoir communication (trough wellbore or faults) and also lateral inter fault blocks interaction. Unfortunately, both event clearly observed and reflected in well production performance.

An innovative approach has been put in place in 2011, taking advantage of "state of the art" structural modelling technology and parallel property modelling technique. This has made construction of Baram Field integrated static model possible within a very effective timeframe. A static model which incorporate over 150 zones, 150 wells and 6000 compartments, been established in six months time. The model has set a new level of technology utilization in mature and complex field reservoir management.

Methodology

There are two important aspects, as described below, which contribute to the project success.

- **Automated fault geometry modelling.**
  A modern algorithm for modelling the complex fault geometries in the Baram field (Figure 1 to 4) was used. This algorithm is fully automated and data driven and can model complex growth faulting and antithetic/synthetic conjugate structures. This would not have been possible using more conventional pillar gridding based fault modelling approaches.

- **Parallel property modelling.**
  The geological grid were split into separate key stratigraphic intervals to allow parallel property modelling work. When completed the results were simply re-combined by upscaling into a single simulation grid to enable integrated reservoir simulation. This parallel approach to property modelling was one of the key measures which allowed the static model to be built within an effective timeframe.

In addition to the above, all the work processes from structural modelling up to volumetric uncertainty analysis were included in an automated (batch) workflow. This optimized the time used in modelling iterations and also provides the foundation for model updates as new well are drilled on the field.
Examples

To illustrate geometrical complexity of faults in Baram field, several examples are provided below. These examples have been chosen to represent most geometries exist in Baram field and posturing a real challenge to be modelled. It could be used as reference to tackle similar problem which may occur in other fields.

**Figure 1** Example of interpenetrating complexes of faults in Baram field. This is the most complex geometry to be modelled as fault shapes are irregular, and only partly penetrating one into another, both laterally and vertically.

**Figure 2** Interpenetrating Y faults, in which faults change from synthetic to the antithetic side laterally.
Figure 3 Example of slotted faults where faults are partly penetrate and intersect each other.

Figure 4 Example of faulted faults where faults are displaced by younger ones.
Conclusions

The construction of full field static model of a giant oilfield with a complex structural setting is non-trivial, but not an impossible task. A full focus on the importance of the timeline and early investment, plus the adoption a variety of strategic project management measures and use "state of the art" modelling technology can allow fit-for-purpose static models to be delivered within effective timeframe.

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