Paper 13

Quantitative fault seal analysis in Muglad Basin, Sudan

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The hydrocarbon structural traps in concession areas of Petronas in the Muglad Basin, Sudan are mostly fault-bounded in nature. With the geologic risk associated with hydrocarbon source, reservoir and top seal rocks being well understood, the remaining critical factor that influences the success of finding commercial quantities of hydrocarbon is the lateral fault seal efficiency. Hence the ability to predict the effectiveness of lateral fault seal is crucial in assessing, risking and ranking of prospects.

Traditionally fault seal analysis was carried out in a qualitative manner. This was done normally on paper by constructing a 2-D cross-section of the prospect and analysing the lithological juxtaposition across the fault surface. This qualitative method is quite useful in providing a "quick" prediction of the effectiveness of the fault seal. The result however is difficult to quantify, and thus limiting its uses to single prospect analysis rather than a risking and ranking tool for all the available prospects.

The advancement in computer technology has enabled quantitative fault seal analysis to be performed on workstations. ***FAPS***, developed by Badley Earth Science Ltd., is one of the available software in the market that specialises in fault seal analysis.

The first-order fault seal analysis involves identifying lithological juxtaposition across fault surfaces. Detailed seismic mapping and well analysis provide the input required to build the structural and lithological model. 3-D visualisation techniques over fault surfaces reveals areas where sand/shale contacts are occurring.

Consequently after defining areas of sand/sand contacts along fault surfaces, a second-order fault seal analysis can be carried out to determine whether high entry pressure due to shale smearing may arised at fault surfaces to provide lateral seal. The proportion of shale entrained into the fault gouge, termed as *Shale Gouge Ratio*, is an attribute that can be computed by ***FAPS*** using a specific algorithm. The *Shale Gouge Ratio* can then be used to derive another fault attribute known as *Fault Zone Permeability* using an empirical relationship developed by Badley Earth Science Ltd. A calibration process is important to determine *Fault Zone Permeability* cut-off value to make a fault sealing or leaking.

Warta Geologi (Newsletter of the Geological Society of Malaysia), Vol. 26, No. 6, November-December 2000

The study area is covered with 3D seismic and comprises 4 separate geological structures. These structures have been drilled resulting in two discoveries and two dry holes. The area was selected as a pilot area to devise a technique for systematic workstation-based analysis of fault sealing capabilities to be implemented in prospect ranking.