Fault Seal Analysis through Geologic Time Using an Integrated Petroleum Systems Approach

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Abstract

A workflow is presented to improve the understanding of fault seal behavior through geologic time at basin scale.

The dataset used in this workflow was compiled from Geoscience Australia and covers the Gippsland Basin. Five major faults have been interpreted from seismic and modelled including the major normal faults that form the Northern and Southern terraces.

The first part of the workflow describes the present-day geometry definition and detailed structural interpretation based on an existing earth model and interpretations. The second part covers the petroleum systems simulation to generate a full 3D pressure-temperature controlled, back stripped model through geologic time. In the third part, using fault interpretation and basin geometries at selected time steps, a fault seal analysis is performed on the geometries in the geologic past. In the final step, the results of the fault seal analysis are used in the petroleum systems model to control fault related hydrocarbon migration and pressure compartmentalization.

Using the described workflow, it is possible to reproduce the observed distribution of hydrocarbons and pressure in the Gippsland Basin more accurately. The iterative approach of basin analysis, restoration, and fault seal analysis directly leads to a better understanding of fault activity through geologic time. The results of the back stripped models are used to analyze the fault seal behavior related to the period of activity and affected lithology at a particular age. The combination of fault seal analysis and petroleum systems modeling improves the understanding of fault dominated extensional basins. It needs to be considered that this workflow requires regional data with significant offset along faults to work on a basin scale.

The workflow demonstrates that the combination of back stripping and fault seal analysis in petroleum systems modeling can be used to achieve a better analysis of basin scale pressure and hydrocarbon distribution through geologic time. This workflow can be applied in frontier areas where no structural restoration was done before and only regional data is available. The demonstrated workflow can be performed on one single platform without the need of data transfer between software.

We thank Geoscience Australia for the permission to use the data and Schlumberger to publish this workflow.