The Use of Structural Modelling in the Simulation of Naturally fractured Reservoirs

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A Introduction

Naturally fractured reservoirs are increasingly forming a significant proportion of operators' portfolios. The flow simulation of such reservoirs requires an understanding of the spatial distribution of reservoir units and their associated petrophysical properties; porosity, permeability, water saturation, relative permeability and capillary pressure. Such information is difficult to obtain away from wells.

Models of fractured reservoirs additionally require information on the likely recovery processes occurring between the unfractured material (matrix) and the fractures. These processes are a function of the matrix and fracture petrophysical parameters, which are in turn related to the fracture density, connectivity, orientation and distribution.

Since fracturing in natural systems forms as a result of geological processes, we believe that structural modelling can be used to provide information on the spatial and temporal evolution of strain paths and stress history. This information can be used to build geologically realistic models of fracture networks.

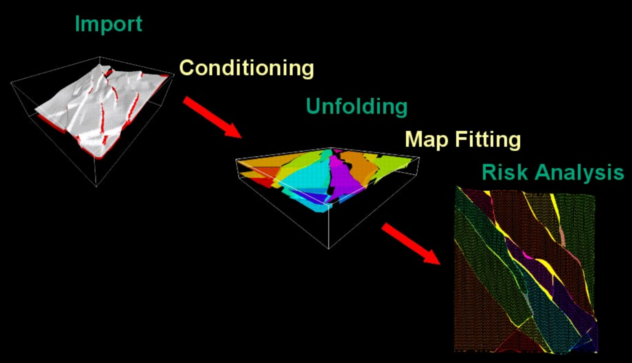
B Structural Workflow

The first stage in the structural modelling workflow is to build a 3D structural model (1). This can be constructed from all the available data, e.g. 3D seismic surfaces, 2D fault lines (polygons or sticks), 3D fault planes and 2D seismic interpretations. The resultant model is then tested to determine if it is geologically valid. If the model is wrong then any calculations made with this model will be incorrect.

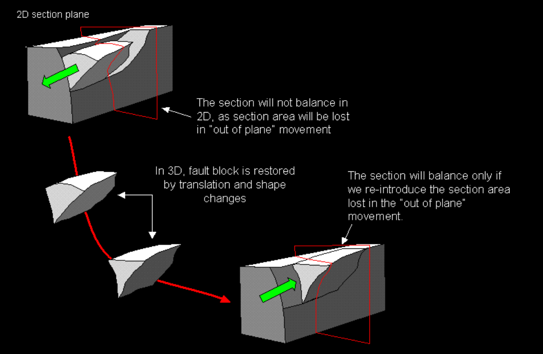
The next step is to condition the model by splitting the 3D surfaces into fault blocks (constrained by fault data). Then, if required the structural model is decompacted back to the time of the deposition of the horizon of interest. Once the horizon to be tested is in its temporally correct 3D position the appropriate restoration algorithm is utilised to flatten the surface to a selected datum.

The algorithm used is dependent upon the tectonic setting envisaged for the model, e.g. bed parallel slip (associatiated with compressional regimes) can be accommodated by using flexural slip unfolding. The surface can be unfolded to a pre−selected depth or a palaeosurface (e.g. a palaeobathymetry).

Map restoration of the flattened surface is then used to determine if the structural interpretation is geologically valid. If the interpretation is wrong then iteration is required to improve the seismic interpretation. Movement vectors from the map restoration provide information for the kinematic restoration of fault blocks along the fault plane surfaces (2).



1 Workflow for construction of structurally valid 3D geological model



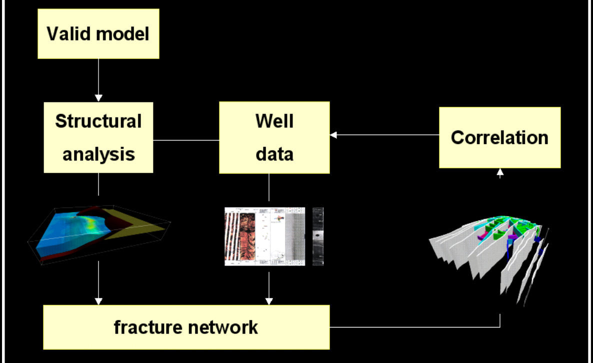
2 3D restoration of fault blocks can account for out−of−plane movement that would be missed in 2D

C Analysis Workflow

Once a geologically valid model is produced structural analysis of the model is undertaken (3). Static geometric attributes (e.g. dip, curvature) and dynamic geometric attributes, such as the evolution of strain can be output for direct use in calculation of permeability enhancement factors for reservoir simulation.

Alternatively, geologically realistic fracture networks, constrained against well information, can be generated and exported for further analysis and use in reservoir simulators.

The generation of geometric attributes and geologically realistic fracture networks is dealt with later in this poster



3 Workflow for integration of structural analysis results into reservoir model

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