IPTC 12544

Can One Size Fit All? A Comprehensive Solution for Fault Modeling

Karen S. Hoffman, SPE; John W. Neave; and Erik H. Nilsen; Roxar, Inc.

This paper was prepared for presentation at the International Petroleum Technology Conference held in Kuala Lumpur, Malaysia, 3–5 December 2008.

Abstract

Petroleum exploration and production is increasingly moving into challenging areas, which requires reducing risk as much as possible. Often, however, the structural complexity is simplified due to the lack of robust modeling techniques. Common configurations such as a Y intersection formed by a synthetic/antithetic fault pair can be difficult to model due to the limitations of the framework-building technique. Truly difficult situations, such as listric faults, low angle faults, or crossing conjugate faults, are often not even attempted – which means that the resulting reservoir models do not correctly represent the subsurface.

Our technique for building a fault framework provides a comprehensive solution for modeling any type of fault shape or fault intersection. Complex shapes such as listric faults, low angle faults, and undulating faults, which are treated as special cases in other methods, can now be modeled with no additional work. Y, lambda, and low angle intersections are also modeled correctly. Even crossing conjugate faults with half-Y or half-lambda intersections are not treated as special cases.

When the fault framework is correctly modeled, the subsequent steps of building the complete structural framework, creating a reservoir grid, and populating that grid with rock attributes can be done with greater confidence and thus less risk. A structural framework that correctly represents the interpretation provides a better basis for understanding compartmentalization, calculating reserves, and overall making better reservoir management decisions.

The advances in fault modeling shown here provide a comprehensive solution to handle all type of faults and fault intersections without any of the compromises previously necessary. The flexibility of the technique reduces cycle time for building the framework and allows for more in-depth investigation of reservoir properties. Including the full structural complexity in the reservoir model improves the overall management of the asset.

Introduction

The structural and stratigraphic complexity of the areas in which much exploration and production is done today requires reducing risk as much as possible – which in turn often means building a three-dimensional computer model of the field, as the two-dimensional techniques of the past are no longer sufficient. These models may have many purposes: basic understanding of the structural framework, examining the distribution of facies, distributing petrophysical properties in order to calculate volumetrics or perform flow simulation, or serving as a basis for target selection and well planning. No matter what the final purpose of the model is, the first and common step is to build a structural framework. Without this, no further calculations would be possible. Unfortunately, too often the structural framework is simplified from the actual interpretation due to limitations in the model-building software – and when the model does not represent the current interpretation, any subsequent calculations or decisions have increased uncertainty and risk.

Three-dimensional geologic modeling is not a new science – a great deal of development was done in the 1980s and 1990s – but some of the techniques used today are still based on original assumptions or techniques. For example, some techniques were developed primarily for extensional structures, and therefore compressional structures have to be treated as special cases. Other techniques assume that faults are often planar, so that listric faults or thrust faults are special cases. Forcing complex geometries into these modeling systems often means that the structures must be simplified; faults are left out of the model or modified to fit the constraints of the modeling system. Obviously, a change to the basic structural framework has consequences for the remainder of the workflow: wells may not be placed correctly with respect to faults, flow simulation may not take into account the true compartmentalization of the structure, and volume calculations may have a high degree of uncertainty.

Creating a comprehensive solution for fault modeling means that no fault geometry should be a special case. We have developed a new technique [1] of fault modeling that uses a unique method of defining fault/fault intersections. Because this