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The Impact of 3D Dynamic Structural Framework and Subsurface Mapping Technology on Complex Reservoirs in Saudi Arabia

Abdul Mohsin A. Al-Maskeen [1], Sadaqat S. Ali [1], and Roger R. Sung [1]

[1]Saudi Aramco

Abstract

Mature reservoirs tend to have a large number of well and subsurface data as well as valuable interpretations. While extremely accurate, tying all these information together and correlating with real time data streaming in from new wells being drilled can be very complex and time consuming. The industry has also recognized that hydrocarbon reservoirs occur in complex geometries and this creates large challenges when it comes to model the structural framework. The current 2D subsurface mapping techniques could be tedious, particularly around fault and unconformity. The problem arises due to the lack of technology that can integrate large volumes of geoscience data and provide accurate quality maps in a timely fashion. Also, with current surface-based mapping process, surfaces and fault blocks are modeled independently which cause inconsistencies. Large number of horizontal wells, cost of drilling, well placement, and complex reservoir settings further compound the challenges of updating operation maps.

A new 3D dynamic structural framework application and workflow technology has been developed to make multi-surface mapping accurate and efficient. This new approach uses well surface picks to tie the geological surfaces vertically at wells and uses seismic horizons to guide the surfaces laterally between wells. This paper presents a case study of this new subsurface mapping workflow that utilizes 3D topology engine to dynamically update multiple subsurface layers with geological and geophysical data. The workflow of building dynamic framework model begins with incorporating seismic horizons, well picks, faults and other data. The framework model parameters are then defined by setting the gridding parameters to control the well top's surface geometries guided by seismically defined surfaces. The conformance rules are established to manage structural surfaces and fault relationships. Faults intersections and polygons can be automatically generated. This workflow combines traditional mapping, fault networking, conformance mapping, unconformity trimming, and interval modeling into one integrated process.

The benefits of this methodology are a sealed 3D framework model that can be shared among geologists, geophysicists, and geological modelers. 3D topology engine-based modelling ensures that updates to any one or more data object are propagated to all other related surfaces and faults.

Combined with horizontal well correlation, the framework can be updated with real time data thus helping efficient steering of the wellbore into the most productive portions of the reservoir. This 3D structural framework can also be used as input for the velocity, lithofacies, and 3D property models. This technology has been successfully applied on complex reservoirs in Saudi Arabia. Not only reservoir contact has been increased but also the integrated 3D structural framework update cycle time has been reduced from days previously to hours. Accuracy and efficiency in characterizing and developing mature reservoirs has been significantly enhanced through this innovative workflow technology.