Integrated 3D and 4D Characterization and Modeling of Fractured Reservoirs*

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Abstract

A significant proportion of the world future hydrocarbon production resides in fractured reservoirs. The success of the recovery methods relies on a good understanding and appropriate modeling of the fracture network.

Introduction

In order to support field development strategies, numerous fracture characterization and modeling studies have been and will continue to be carried out. In Shell E&P, one key enabler for these studies is a new integrated software technology, SVS Fracture Solutions, developed by the Carbonate Expertise and Research Teams, thanks to a collaboration of experts from all subsurface disciplines.

Discussion

The key pillar of the SVS Fracture Solutions workflow is detailed fracture characterization, captured in a series of conceptual models, which reflect the range of the subsurface uncertainties to be expected. SVS Fracture Solutions integrates data from various sources (wells, seismic, petrophysics, geomechanics, 3D stress tensors, outcrop analyses, dynamic data etc.), in combination with field kinematic structural evolution, analogue fields and the regional understanding. Once the conceptual models have been developed, they can be transformed into discrete fracture models, and upscaled into cellular property arrays (e.g. permeability anisotropy, fracture spacing etc) for reservoir simulation.

Summary

This paper illustrates the benefit of a consistent fracture characterization approach to assess the development strategy at regional scale. We place particular emphasis on demonstrating the impact of 3D data integration, 3D borehole image (BHI) analysis, geometrical and dynamic (Figure 1) to help constrain the structural understanding of the fields and build subsurface realizations.
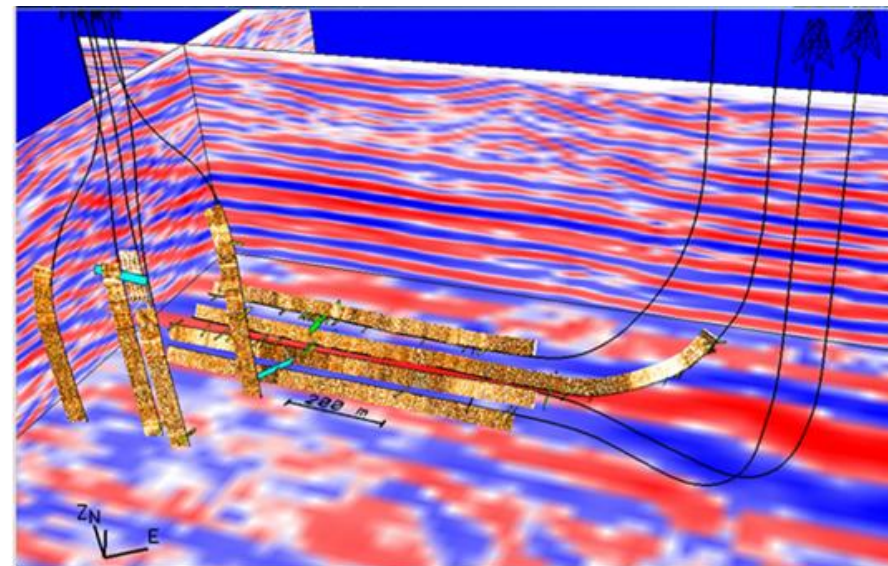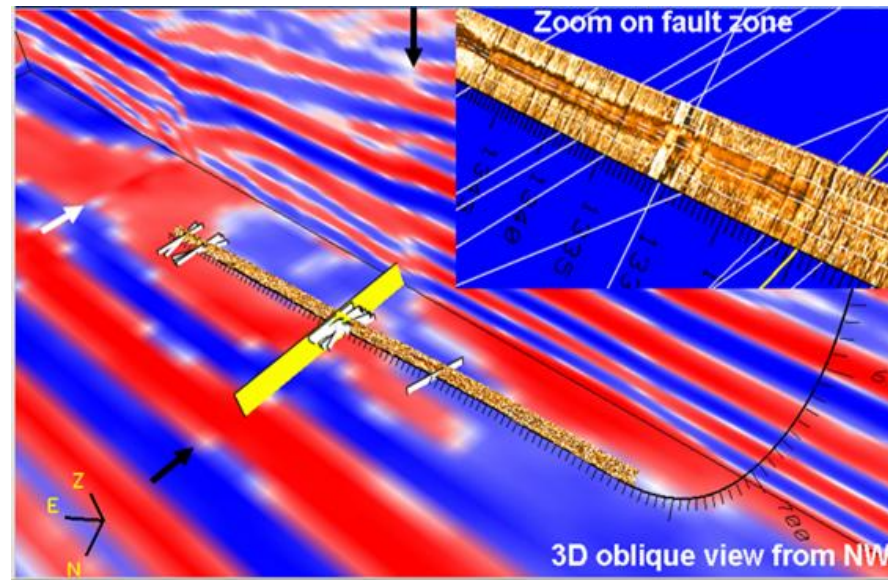
Figure 1. Combination of seismic data with BHI on chair displays illustrating the understanding gained by integrating both scales of data. A) The presence of a fault (indicated by the black arrows) is highlighted by the fracture cluster (white and yellow rectangles) interpreted on the BHI. B) The rectangles correspond to electrically conductive fractures picked on the BHI. Loading multiple wells enables the interpreter to assess possible connections between nearby wells.