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Hurricane Energy Enhances Fracture Modeling with the Petrel E&P Software Platform

Natural fracture prediction process improves well placement decisions

CHALLENGE

- Improve discrete fracture modeling for use in highly fractured basement reservoirs
- Closely represent regions of high-fracture density and preferred fracture orientation

SOLUTION

Introduce geomechanical forward modeling process using the Petrel* platform to achieve the following:

- Identify likely fracture orientation and density
- Provide fracture probability properties for more accurate distribution
- Calculate dominant structural regime for each tectonic event
- Create independent discrete fracture sets for simulation

RESULTS

- Process findings consistent with Hurricane's independent investigations
- Tectonic event properties used to create independent discrete fracture sets for simulation
- Discrete fracture modeling workflows optimized for multiple reservoir types, improving well placement decisions

UK-based Hurricane Energy was working on a fracture modeling project to inform future well placement decisions for its operations in the West of Shetland. The company specializes in exploring and appraising fractured basement reservoirs.

The area's complex tectonic history, and the logistical difficulties in imaging faults within the basement, meant that traditional fracture-prediction methods proved too challenging to apply. In addition many fault trends are present, and with little well control these are difficult to relate to the known fracture orientations.

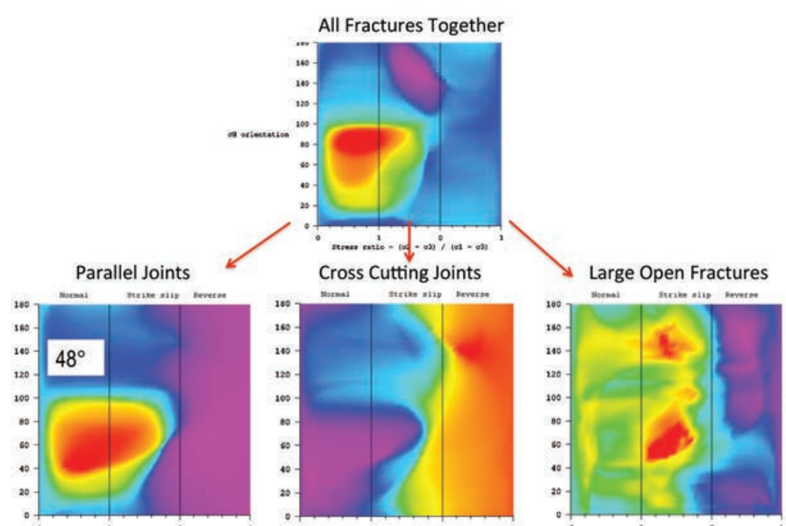
Hurricane Energy's exploration team was keen to optimize its 3D model and better understand reservoir faults to deliver the level of structural detail required for accurate fracture prediction. The model needed to closely represent regions of high-fracture density and preferred fracture orientation.

Natural fracture prediction

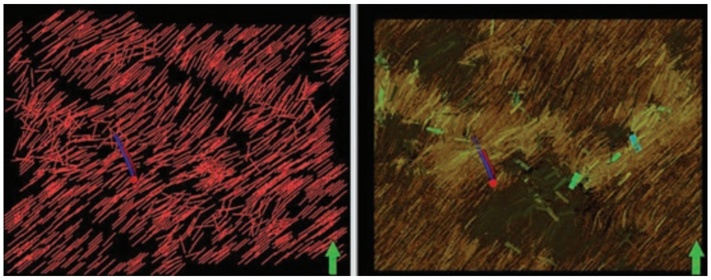
After meeting with Schlumberger, Hurricane Energy decided to use the Fracture Network Modeling module in the Petrel E&P software platform as a geomechanical solution for advanced fracture prediction.

The natural fractures prediction (NFP) process is a form of advanced geomechanical forward modeling, incorporating the 3D iterative boundary element method to identify likely fracture orientation and density, based on well fracture data and the fault model.

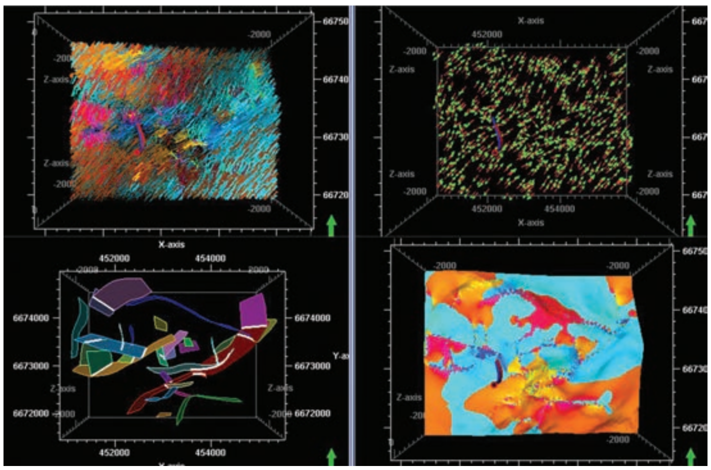
In stochastic modeling, properties are often used as spatial probability distributions for the placement of geological features, including channels, porosity distributions, and discrete fracture planes. Using the Fracture Network Modeling module, the major outputs from the NFP forward modeling are input as fracture probability properties for more accurate distribution. This geomechanical approach increases confidence for future well placement decisions in highly fractured locations.



The NFP process identifies likely fracture orientations and densities, from well fracture data and fault models.



Vector plot (left), with distribution and geometry properties generated by the NFP process, used as input to fracture network models (right).



Clockwise from top left: resultant discrete fracture network; vector plot with predicted orientations before input into the network; dip azimuth property used in dip azimuth creation; and structural framework fault model input.

Optimized well placement

The NFP process calculated a dominant structural regime for each tectonic event, with an orientation of maximum horizontal stress. When the previously determined fracture sets were run separately, three different structural regimes were identified: normal, strike-slip, and reverse. The most dominant of these was the normal regime, with a corresponding maximum stress orientation of north east. These findings were also consistent with Hurricane Energy's independent investigations.

Such a range of results, covering the full tectonic regime spectrum, confirmed the complexity of the reservoir. The NFP process allowed tectonic event properties to be used to create three independent discrete fracture sets that could be upscaled separately for simulation, each one incorporating the fracture apertures to enable fracture network permeability calculations.

Hurricane Energy has also been using the NFP process to investigate how discrete fracture modeling workflows can be used in a complicated basement setting to inform optimized well placement decisions.

"The NFP process allows us to construct reservoir-scale discrete fracture models whilst accommodating the effects of seismic scale faults on the geometry of the fracture network. Its applications are particularly relevant to layer-bound fracture sets in reservoir volumes where faults have been constrained by 3D seismic and where there is a clear relationship between tectonic stress, faulting, and fracture distribution."

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