## Challenge
Dynamically model complex flow path within fault and fracture networks at full field level to support development strategies without loss of geological detail.

## Solution
Develop domain-driven workflow for fracture network representation to replicate initial sector model results and move on to full-field model that matches well test data by using the Petrel® E&P software platform and INTERSECT® high-resolution reservoir simulator for development planning.

## Results
Enabled Hurricane Energy to assess the impact of uncertainties on overall reservoir performance by efficiently delivering reservoir simulation of full-field, high-resolution fracture network model on workstations that led to improved field development decisions within project deadlines.

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### Complex Fractured Basement Reservoir
Hurricane Energy plc, is a leading oil and gas company focused on fractured basement discovery and development in the UK. It holds six licenses within UK Continental Shelf (UKCS) basement plays and, while having other exploration and appraisal opportunities, the company is focused on bringing its UKCS Lancaster field into development.

Lancaster field, located in 160-m water depth in the West of Shetlands area of the UK Atlantic Margin, was the first basement prospect drilled by Hurricane and the first exploration well in the UKCS to specifically target the basement. It proved to be a significant discovery, with well tests flowing light (38 API) oil. An independent report in 2013 assigned 207 million bbl of oil equivalent at 2C best-estimate of contingent resources.

The field comprises a highly fractured granitic basement reservoir, primarily tonalite, featuring fractures at a number of scales. As a Type 1 naturally fractured reservoir, fluid distribution and flow characteristics are entirely dominated by the fracture network—there is no intergranular matrix. Fracturing within the reservoir is related to a combination of the original cooling joints inherent to all igneous rocks and numerous episodes of tectonic activity throughout the rocks’ 2.4 billion year history, which has led to reactivation of the joints as well as the introduction of seismic-scale faults and associated damage zones. Extended periods of subaerial exposure and fluid flow through the reservoir have further enhanced the fracture network.

### High-Resolution Dynamic Modeling
The geological complexity of Lancaster field demands high-resolution modeling to capture the main geological features and consider their impact on dynamic behavior. Traditional reservoir simulators have difficulty solving the challenges presented by the field’s strong contrasts in permeability and the extensive presence of faults and fractures. Previous simulation models exhibited poor performance, required coarsening to complete in a reasonable time frame, and did not allow investigation of key uncertainty parameters such as aquifer presence and strength, depth of the free-water level (FWL), and their impact on production forecasting profiles.

“I am delighted with the results we obtained using the INTERSECT simulator. Now we can run forecasting scenarios of the fractured basement reservoir at the right level of geological detail in just a few hours.”

Dr. Robert Trice  
Chief Executive Officer  
Hurricane Energy plc

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Software
A joint work plan involving resources from Hurricane and Schlumberger was established to produce an operational full-field reservoir simulation model at the required geological resolution. A domain-driven workflow was established using the Petrel E&P software platform to set up the model and leverage the power of the INTERSECT high-resolution reservoir simulator for field development planning. The main technical requirement was to match the latest geological and dynamic data acquired in a recent horizontal drilling campaign. The ultimate goal was to enable Hurricane’s staff to reliably and accurately model and simulate the subsurface complexity of the field within practical simulation runtimes using the company’s in-house workstations.

Multiple simulation runs would be required to perform sensitivity analysis and increase confidence in the results. The results of the simulation would enable better field development decisions, such as future well placement, through an improved understanding of reservoir behavior — specifically the potential for water breakthrough, pressure support over time, and permeability anisotropy.

CASE STUDY: Hurricane Energy efficiently forecasts fractured basement production, UKCS

Production forecasting at the right level of geological detail

Hurricane’s large Lancaster greenfield was modeled initially using a traditional reservoir simulation approach with a sector model of the field.

Hurricane was satisfied with the initial simulation results, but the complexity of the model restricted its ability to efficiently examine multiple scenarios, much less enable a full-field model, because run times were too high. Hurricane was therefore interested in the high-resolution capabilities of the INTERSECT simulator.

Hurricane first ran the sector model in the INTERSECT simulator to compare its results with its previous simulator. This comparison showed good agreement of the results and validated the physics of the INTERSECT simulator — the INTERSECT simulator also had a significantly faster run time.

Hurricane proceeded to test the ability of the INTERSECT simulator to model the full field. This larger model incorporated a more connected fault network obtained using ant tracking in the Petrel platform. This model was also able to take into account additional test data including the 205/21a-6 well test, which previously could not be accurately honored because the radius of investigation exceeded the boundaries of the sector model. The full-field model ran in reasonable time and Hurricane was able to history match to the available test data, which increased its confidence in the accuracy of the predictions. Hurricane’s experts then used the model to run several forecasting scenarios.

The results from this first phase enabled Hurricane to improve its technical understanding of some uncertainties, allowing it to refine development plans for an early production system. The results were then presented to Hurricane shareholders.

Hurricane is now continuing to phase 2 and has engaged Schlumberger to work on further investigation of other key uncertainties, which will help improve development plan forecasting for Lancaster field.

With the ability to maintain fidelity to geological complexity combined with robust speed that takes advantage of modern computing, the INTERSECT simulator is enabling Hurricane to model its reservoir with an unprecedented degree of accuracy.

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