**Challenge**
Obtain drilling and completion parameters for horizontal development wellbores in hazardous formation overlain with weak shales and coal layers.

**Solution**
Build a wellbore stability model, validate it with high-resolution, time-lapsed LWD data, and provide drilling and completion recommendations.

**Results**
Successfully validated wellbore geometry and stability for two horizontal wells and calibrated key parameters for future development plans.

“...the expertise of Schlumberger petrotechnical services for geomechanics and wellbore-stability forecasting enabled us to obtain essential parameters required to plan field-development drilling and completion operations.”

Allan Ritchie
Senior Drilling Engineer
BG Norge

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**Determine wellbore stability in challenging formation**
As the operator of PL 407 in the Norwegian sector of the North Sea, BG Norge AS needed to establish parameters for a three-year drilling program in the Bream oil discovery. The company had drilled its first three appraisal wells to delineate the find, determine oil and reservoir properties, fluid contacts, and sand connectivity, and estimate recoverable reserves. The formation’s sands were interbedded with silt and coal layers and overlain by weak shales, which could present significant drilling and completion hazards in horizontal sections as a result of variations in rock strength.

**Build reliable mechanical earth model**
For this project, BG Norge selected Schlumberger to provide openhole logging, LWD, and directional drilling services and to perform a detailed wellbore stability study.

Geomechanics consultants built a predrill mechanical earth model (MEM) of the Bream structure using the Petrel® E&P software platform plug-in based on all relevant geological, petrophysical, drilling, and geomechanical data from offset wells in the field. Projecting rock properties onto a proposed well trajectory, they identified potential zones of drilling risk while creating the wellbore stability model. The well path, drilling design, and operational parameters were optimized to ensure safe operations.

Upon openhole logging of the first vertical well, Schlumberger provided inputs for the MEM from the data, updating the predrill wellbore stability model and making mud weight recommendations for the two planned horizontal sidetracks to avoid the main drilling hazards in the weak overburden shales.

While drilling both boreholes, Schlumberger acquired time-lapse EcoScope® multifunction logging-while-drilling service data to provide hole-shape analysis through these weak shales. Real-time indications of hole enlargement during reaming enabled decisions to be made regarding drilling practices and increasing mud weight for successfully pulling out of hole without collapse. Schlumberger experts then updated the wellbore stability model with measurements from the LWD density caliper data to confirm predictions from the geomechanical model about the stress regime.

**Calibrated reservoir parameters and estimated reserves**
Both appraisal wells were drilled successfully. Based on high-resolution LWD data used to refine the Bream geomechanical model and the availability of solid wellbore stability predictions, Schlumberger calibrated a number of critical reservoir properties and parameters required for BG Norge to begin planning future field development drilling and completion operations.

The first sidetrack established reservoir properties and sand connectivity in the western part of the structure; the second sidetrack did the same for the eastern sector. All three wells proved that there was oil in the formation, providing the data necessary to estimate reserves.
CASE STUDY: Critical wellbore-stability analysis optimizes drilling and completion plans, the North Sea

Wellbore stability model showing breakout orientation (left) and the stress distribution around the borehole (right) using the 3D wellbore stability viewer in the Petrel plug-in.

Wellbore stability model through the weak overburden shale, calibrated using LWD measurements from the EcoScope service.

Changes in borehole shape with variations in equivalent circulating density based on LWD EcoScope multifunction logging-while-drilling service images, available in real time.

Wellbore stability model through the weak overburden shale, calibrated using LWD measurements from the EcoScope service.