WHY BETTER GEOMECHANICAL MODELS MEAN LONGER-LASTING WELLS

As oil and gas reservoirs are depleted they and the rock around them change shape, and this can threaten ongoing production. Maersk Oil's Geophysical Technology team is using field measurements to improve computer models of these changes – so we can predict dangerous movements and take action before they occur.

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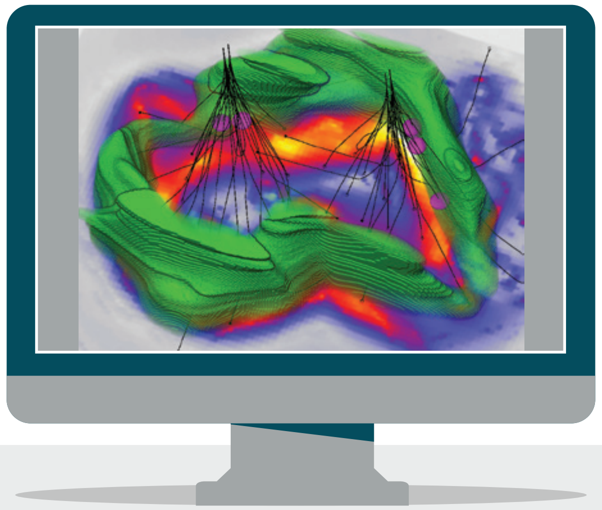
Figure 1



The recent announcement of the Tyra redevelopment has raised awareness that hydrocarbon production can lead to reservoir compaction, changes in the overlying rock (the overburden) and seafloor subsidence. These effects can threaten the integrity of wells and thus jeopardise production, while changes to the overburden can affect drilling conditions for infill wells and could even eventually damage the overburden's ability to seal the field.

Given the significance of these impacts, it's essential our models are as accurate as possible: we need to be able to predict confidently what changes will occur before they do.

Maersk Oil's Geophysical Technology (GT) team has been working to enhance classical geomechanical models of stresses and strains in the overburden by testing them against real world measurements – both geophysical data (seismic measurements of the subsurface) and geodetic data (sonic measurements of the depth of the seabed). This pioneering work is a direct result of the team working more closely with Maersk Oil's business units and understanding their challenges.

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Figure 1 shows a ring of maximum overburden deformation (in green) derived from 4D seismic measurements in the Tyra field. This ring agrees well with the prediction of a geomechanical model, shown in the background; it also matches places where deformed well casings have been observed in producing wells (pink markers).

The success of these groundbreaking predictions means they can be used to help ensure new wells avoid drilling through high-risk areas such as these. But the team hasn't stopped there. In an attempt to make its predictions even more robust, it has developed a novel geomechanical modelling approach that can predict changes in the reservoir using measurements of seafloor subsidence (using repeated bathymetry surveys) and changes in the overburden (using 4D seismic).

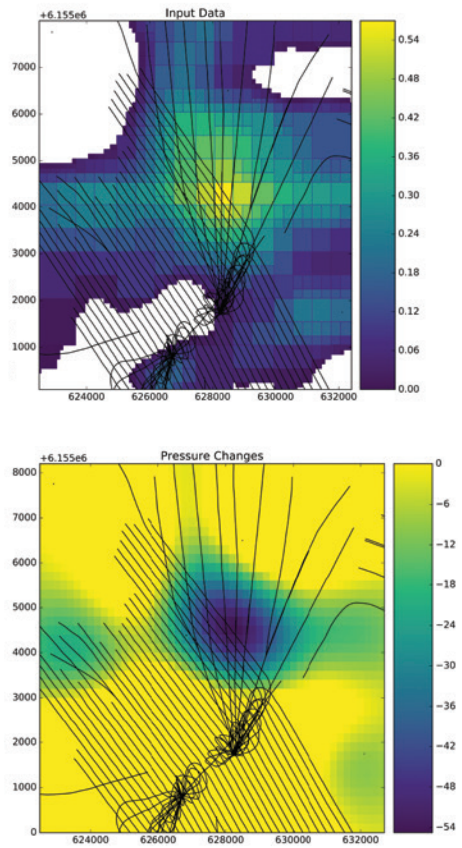

Figure 2

Figure 2 shows an example of measured seafloor subsidence (top) and the associated predicted changes in the reservoir (bottom). This information provides an additional, independent way of quantifying the impact of overburden changes on pressures surrounding wells and on wellbore stability. Not only can it can help us design and drill safer wells, it could also help us understand changes within reservoirs during hydrocarbon production, allowing us to manage the field better.

These new methodologies have already been tested in several fields in the Danish North Sea. However, they will be valuable in other areas, such as Culzean, where high initial pressures in the reservoir make it likely that we will see large changes in the overburden during production. ■

At a glance

Purpose:
Improve geomechanical models with time-lapse seismic and bathymetric data

Technology:
Geomechanics, geomatics and geophysics

Impact:
Safety, well integrity, hydrocarbon recovery, Investment decisions