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Case Study of 3D Geomechanical Model of Salt Dome in North German Basin

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The energy crisis in Europe has stimulated the re-evaluation of historically uneconomic hydrocarbon resources. This case study focuses on the North German basin, where a lot of exploration wells have previously been drilled, but only a few fields developed successfully in what is a geologically challenging structural region, due to the formation of salt domes within the Zechstein group. The stress field around and below these domes is highly influenced by the structure of the salt diapirs and requires a full 3D analysis of in-situ conditions to optimize drilling both close to the flanks and when exiting at the base of the salt dome.

In this case study a workflow of setting up and applying a 3D geomechanical model to establish a base for well trajectory planning, is presented. Three existing wells are used to evaluate the numerical model, based on breakout observations and drilling events. The 3D geomechanical model then provides a guideline for finding the most optimal well trajectory and avoiding high-risk areas. Mud losses are typical challenges near the top of salt dome structures, while wellbore collapse and shear failures can be experienced along the flanks. Balancing risks when exiting salt is a well-known challenge, with potential problems including mud losses, salt creep, washouts, stuck pipe, and even borehole collapse. Based on stress changes around the salt dome optimised drilling directions can be identified. Due to the limited availability of high-quality model calibration data, a sensitivity study was performed to evaluate the uncertainties in critical parameters such as in-situ stresses and rock mechanical properties.
The short-term study shows that a good baseline 3D study can be utilised for practical field applications within a reasonable time frame.