

Case History

Wellbore Management

Geomechanical Analysis of Casing Failure in Deepwater GOM Well Facilitates Effective Completion Design and Trouble Free Drilling

Location: Deepwater Gulf of Mexico

OPERATOR'S CHALLENGE – Following a 13 3/8 in. casing collapse in a subsalt well, partners of the deepwater Knotty Head #1 discovery well were looking to better understand the field geomechanics, especially the casing requirements imposed by the salt overhang. The drilling engineers needed to understand the conditions that created the initial casing collapse, and then simulate several new designs (including 13 5/8 in.) to help ensure they would survive the same loading conditions.

HALLIBURTON'S SOLUTION – A basin scale geomechanical Earth model was developed to characterize the pore fluid pressure (Pp), in-situ stress (Sv, σ_H , σ_h) and mechanical rock properties. Subsequently, higher resolution models of each wellbore and tubular were constructed by linking the field scale analytical models to the more detailed numerical simulations. The integrated models were then utilized to hypothesis test various scenarios of wellbore geometry, trajectory and tubular specifications. Halliburton predicted and recommended for subsequent well designs: casing point set depths, drilling fluid densities, optimal wellbore trajectories and tubular specifications. In addition to formal recommendations, Halliburton was also engaged in key operations discussions surrounding drilling and reaming practices, cementing and pipe running speeds. The combination of formal recommendations with informal discussions addressing critical operator issues was essential to the success of the project and helped ensure each wellbore would provide service for formation evaluation, casing,

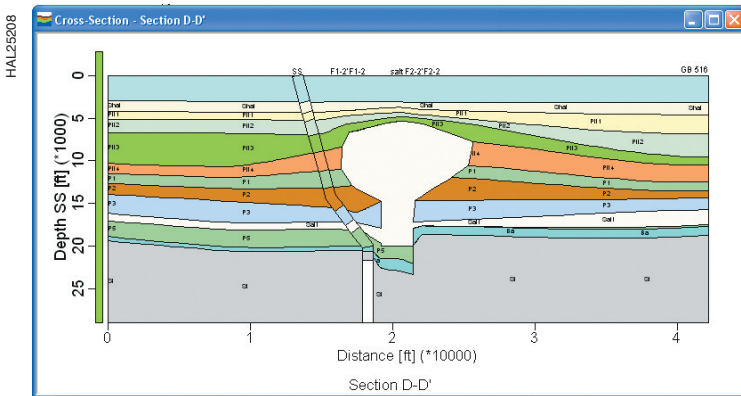


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initial salt-loading, and the additional loads that would be created under petroleum production over several years.

In addition to the salt related challenges, the geomechanical Earth model also revealed a field scale pressure regression beneath the salt. This pore fluid pressure regression creates the unique challenge of a collapsing operating window between the pore fluid pressure and fracture pressure. Anisotropic stresses around the wellbore brought on by deviation also required additional fluid pressure to maintain wellbore stability. The result was a rapidly collapsing subsalt pressure window within to operate safely. Failure to correctly navigate this window would lead to formation fluid influx, drilling fluid loss or wellbore instability; all major sources of non-productive time and well failure in deep water.

The geomechanical Earth modeling project recommendations were successfully deployed resulting in a record setting measured depth of 34,189 ft.



ECONOMIC VALUE CREATED – The geomechanics modeling demonstrated that heavy-wall pipe would be highly effective in resisting large loads, and should be incorporated into the drilling programs in future wells. As recommended, the partners switched to 13 5/8 in. casing and also used our subsalt geomechanics predictions to reduce non-productive time and drill the wells more efficiently.

PREVENTING FAILURES – Typically, high resolution 3D geomechanical models are not run in support of well design, particularly early in the life of a project; failure to run high resolution geomechanics models for salt creep and equipment survivability in the computer environments is unfortunate, and often costly. Customers often cite the lack of available data during the exploration phase; however, these sophisticated models can be run with only seismic information and further refined as the field enters the appraisal phase. While a more conservative approach, this early modeling will help ensure that the well is designed to survive and is of similar value, optimized to reduce the expenses related to its construction.

By investing in subsurface modeling early in the life of a prospect, operators can avoid problems such as stuck pipe, wellbore collapse, hydraulic fractures, and kicks. Stable wellbores are also easier to log

for reservoir analysis, and they are less prone to cementing failures.

Finally, long-term benefits include larger diameter production wellbores and greater longevity of all wellbores in the production system. The key to all these gains is to develop well-constrained models for hole sizes, casing, cementing, and fluid densities that are appropriate for the life of the wellbore.

TECHNOLOGIES USED – Halliburton’s Salt Creep Analysis Service couples geomechanics expertise in analytical modeling with finite element analysis to generate a well plan that minimizes the risk of salt-induced shear stress on the casing. Our Salt Creep Service provides key inputs to the drilling plan, including casing grade selection; mud weight requirements; hole size implications; and cementing requirements.

The Drillworks® family of software provided understanding and manageability in this complex pore fluid pressure and geomechanical environment. Drillworks® software can help to accurately forecast and address pore fluid pressure, fracture gradient and overburden gradient at single or multi-well locations; plan optimum well paths, casing programs and mud programs; improve drilling efficiency; help to increase safety and avoid costly problems such as kicks, stuck pipe, lost circulation and blowouts; help to reduce casing-related costs and contingency casing design; and optimize hole sizes for maximum protection and production.

Based on methodologies derived from DEA-sponsored Joint Industry Projects and field-proven—by customers and through our own service operations—Drillworks software provides critical data that can significantly help to improve your exploration and drilling performance.