14.02: 3D geomechanical models and field development: Mad Dog field, deepwater GoM

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ABSTRACT

We discuss a 3D case study in the Mad Dog field, deepwater GoM to demonstrate that 3D geomechanical models using the FES workflow provide both insights on the stress state ahead of the drill bit and quantitative predictions for field development. We show that steeply inclined salt faces increase the stress ratio in wall rocks and rotate the least principal stress (Fig 1). We further show that below salt overhangs, the stress state remains practically uniaxial (Fig. 1). We show examples where it is impossible to fully understand the stress field without considering the 3D salt geometry. We extract pressure and stress along existing well paths and show that the geomechanical pore pressure prediction is higher that than log-based uniaxial estimate due to salt loading. The geomechanical prediction of least principal stress is systematically lower than the uniaxial estimate but comparable to field measurements (Fig. 2) because the 3D model is able to capture the extensional effect of the anticline structure. Finally, we show that the 3D anticline geometry plays a key role for the least principal stress orientation. Overall, we demonstrate that the 3D FES models incorporate the complexity of salt loading (Fig. 1) not captured by any VES approach and can provide pressure and stress predictions along any existing or planned well path.

CLICK ON IMAGE FOR LARGER VIEW

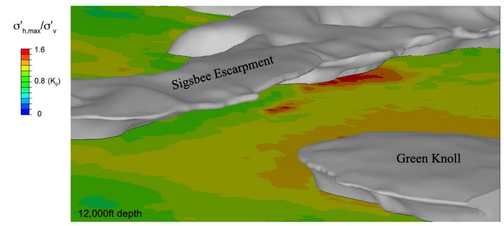


Figure 1: Ratio of maximum horizontal to vertical effective stress in sediments in front of the Sigsbee Escarpment, on a plan section at 12,000 ft depth. Stress ratio is higher than 1 in front of steeply inclined salt faces but remains near uniaxial below overhangs.

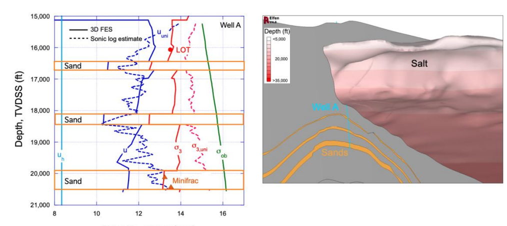
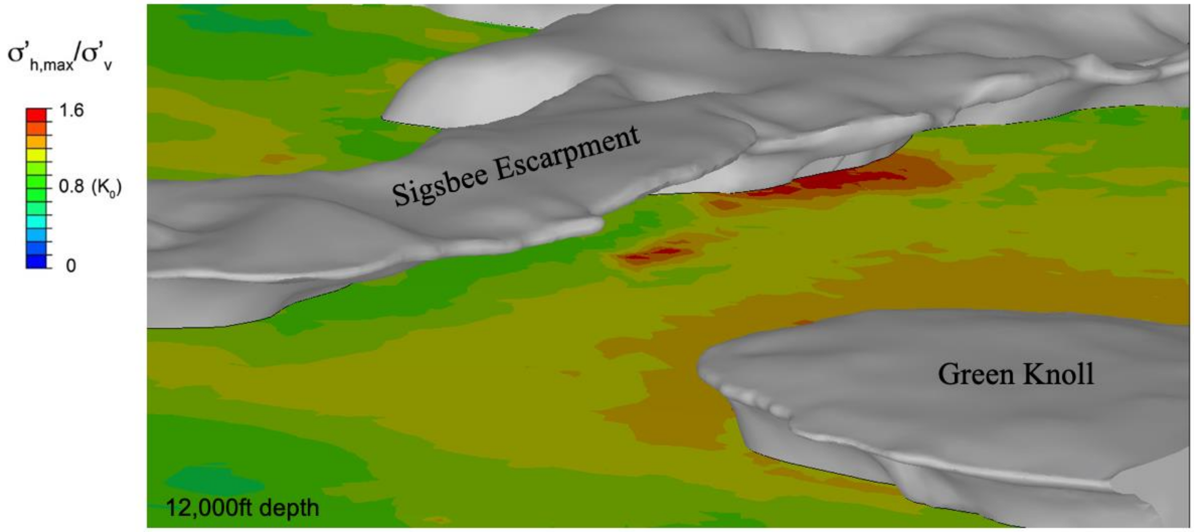


Figure 2: Pore pressure (blue) and least principal stress (red) along well A. The 3D FES geomechanical model (solid lines) systematically predicts lower least principal stress (solid red line) than the uniaxial estimate based on sonic logs (dashed red line). Geomechanical predictions agree well with field measurements (LOT (red circle) and minifracs (orange triangles)).



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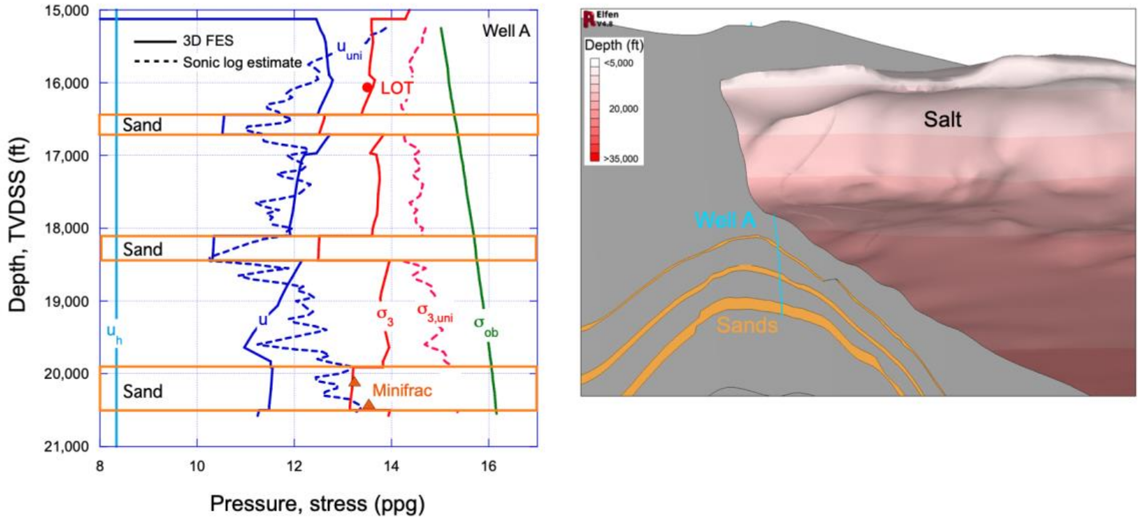

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