9.09. Coupling geomechanical modeling with seismic pore pressure prediction

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ABSTRACT

We couple geomechanical modeling with seismic pore pressure prediction to enhance the prediction of pressure and stresses in complex geologic settings, where stress and strain are far from those in purely vertical, uniaxial strain conditions. In these settings, pressure is controlled by mean and shear stresses rather than by only the vertical (overburden) stress. We estimate total mean and shear stresses from a geomechanical model. Effective mean and shear stresses are calculated from velocity using a relationship that we develop between velocity and these stresses. The predicted pressure field is input to the geomechanical model, and the pressure prediction is iterated to attain convergence between the predicted and the input pressure fields. In addition to pore pressure, our method explicitly predicts the full stress tensor. We compare our method to the standard vertical method in predicting pressure and stresses in a salt basin in the Mad Dog Field, Gulf of Mexico. We show that salt and basin bathymetry substantially perturb the stress field (Fig. 1). Compared to the vertical method, our method predicts narrower mud-weight margin for drilling wellbores beneath salt (Fig. 2) and higher pressure in front of salt, where shear stress is high due to large lateral push from salt.

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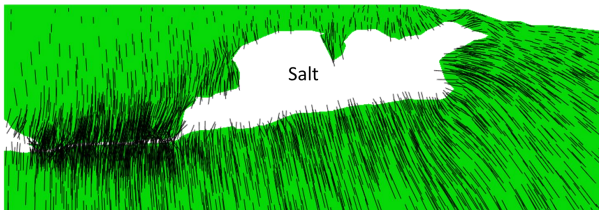


Fig. 1: Orientation of maximum principal stress predicted by geomechanical model in a salt basin, Mad Dog field, Gulf of Mexico. Stresses are strongly perturbed particularly in front of salt due to large lateral push from salt and sediments to the left of the surface slope.

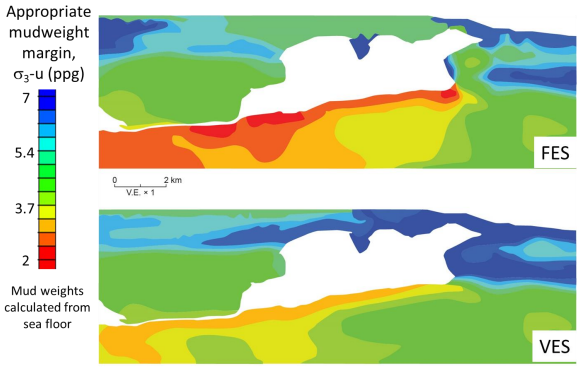
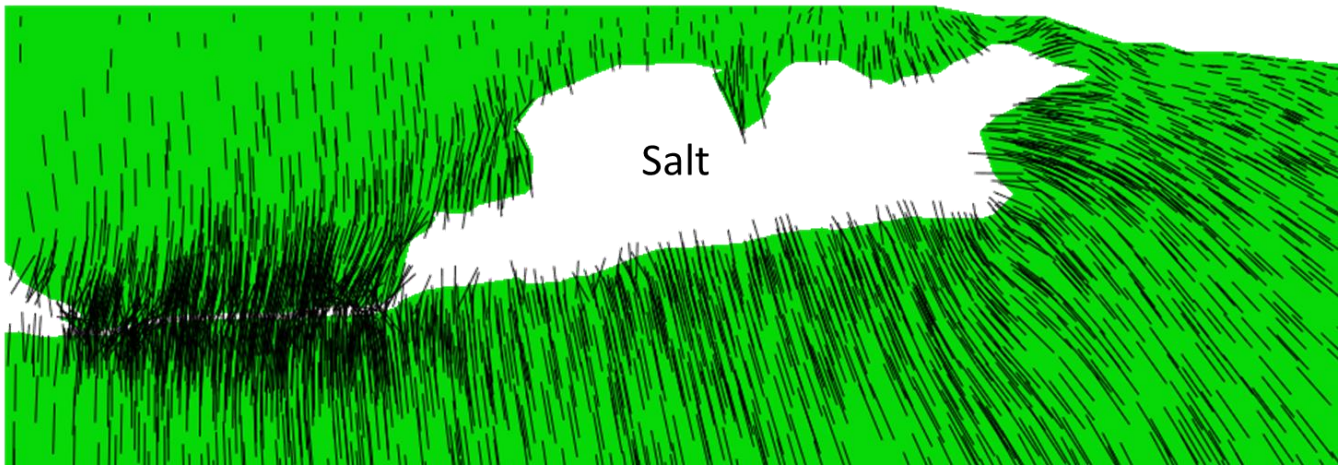


Fig. 2: Appropriate mudweight margin for drilling wellbores as predicted by our method (top) and by vertical method (bottom). Our method predicts that this margin is substantially narrower than predicted by the vertical method subsalt and in front of salt.



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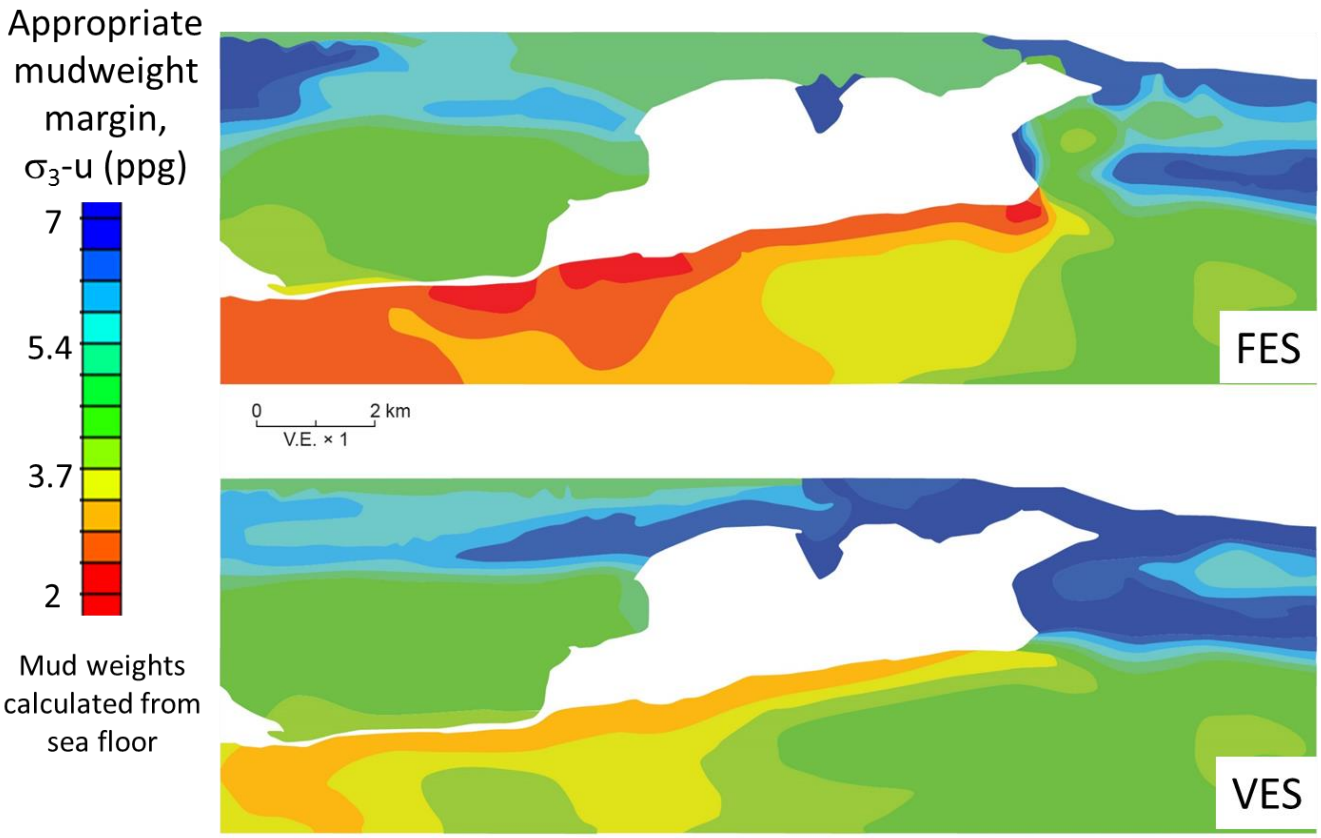

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