Evolutionary vs. static modeling of stresses around a salt dome

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ABSTRACT

We compare an evolutionary vs. a static approach for modeling stresses and deformations around a salt dome and we show that the two approaches predict different stress paths and very different strains within the wall rocks. Specifically, we show that significantly higher shear stresses develop during the evolutionary analysis at the lower parts of a rising salt dome (Figure 1).

Underestimating shear stresses at this region may result in underestimating shear-induced pore pressures, and wellbore stability. Indeed, we illustrate that the evolutionary model yields a narrower safe-mud window near a salt dome structure.

Furthermore, the evolutionary model predicts strains an order of magnitude higher than the strains within the static model (Figure 2). More importantly, it shows a significant horizontal shortening accompanied by an almost equal hoop extension. Therefore, the evolutionary model can improve predictions regarding material properties (porosity, anisotropy in velocities measurements), as well as pore pressures and shear/tensile strength. We perform the evolutionary model with Elfen, and after 2 Ma of sedimentation we export the final salt geometry to Abaqus, for the static analysis. We model the sediments using a poro-elastoplastic model (Modified Cam Clay, or its equivalent SR3 in Elfen).

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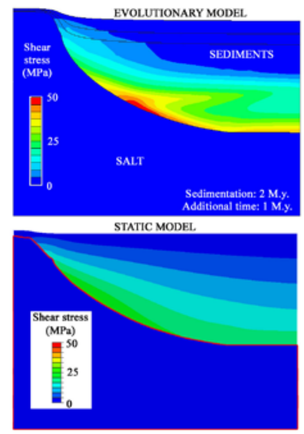


Figure 1: Shear stresses close to the rising salt dome, as predicted by the evolutionary (top) and the static (bottom) analysis. The evolutionary analysis predicts much higher shear stresses. As a result, the static model overestimates the least principal stress close to the dome, and hence underestimates wellbore stability.

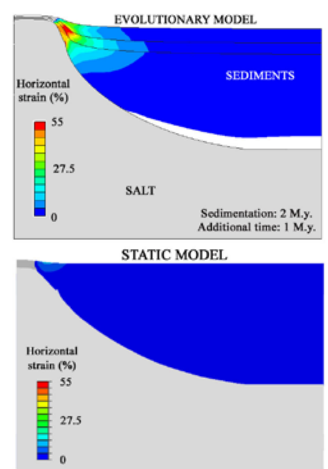
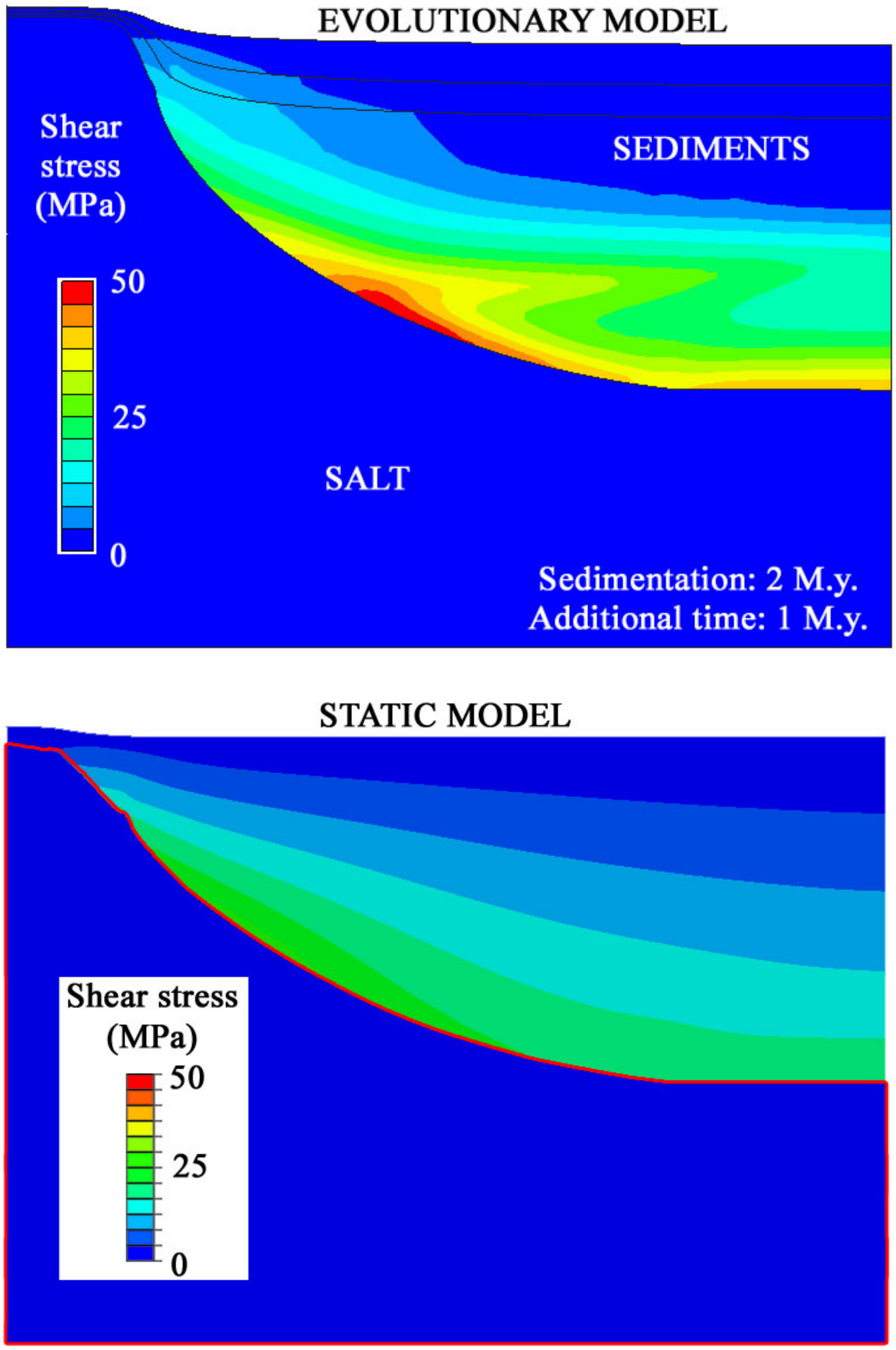


Figure 2: Horizontal strains close to the rising salt dome, as predicted by the evolutionary (top) and the static (bottom) analysis.



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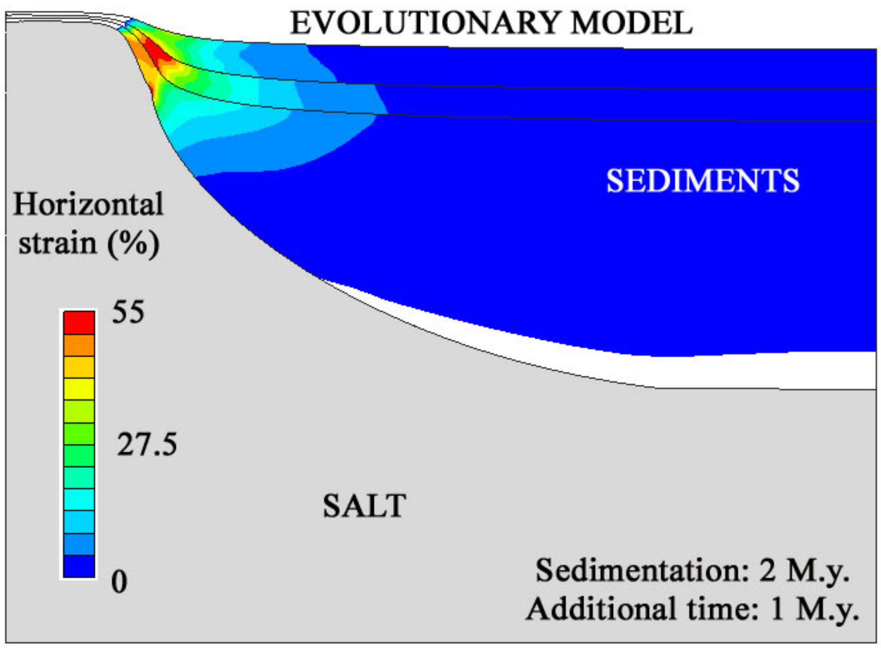

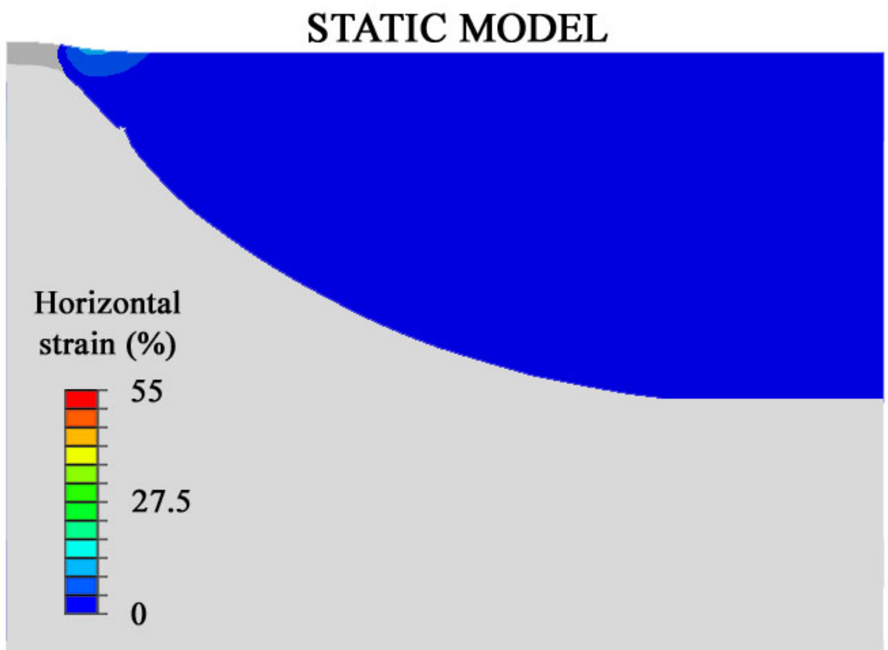

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