13.16: Geomechanical analysis of a shale anticline using a finite-element model

Mahdi Heidari, Research Associate

ABSTRACT

We use a 2D plane-strain forward finite-element model to investigate the mechanics of shale mobilization in a region with no shortening or extension. The model includes a 3km-thick horizontal layer of low-permeability shale that lies on a frictionless detachment and underlies layers of regular-permeability shales that are deposited sequentially at a dipping of two degrees and a rate of 1 km/myr (Fig. 1). We show that the dipping overburden (Fig. 1) induces shortening in the base shales at the overburden downdip and extension at the overburden updip. This mobilizes the base shales in these areas by bringing them to shear failure (critical state), giving rise to a shale anticline at the overburden downdip (Fig. 2). Mobile shales at the top of the anticline have very small effective confining stress and are thus near fluidization. Regional shortening is added to the model, and it is shown that shortening helps the anticline rise higher. When regular permeability is assigned to the base shales, overpressure drops in the shales and no anticline forms.

CLICK ON IMAGE FOR LARGER VIEW

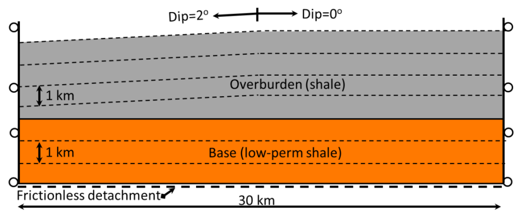


Figure 1: Set up of forward finite-element model used to investigate shale mobilization.

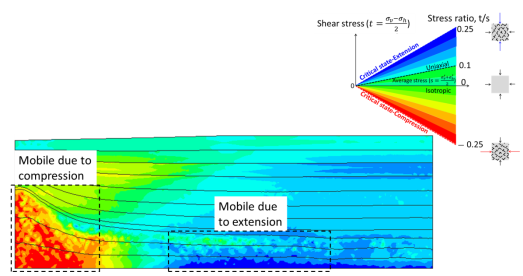
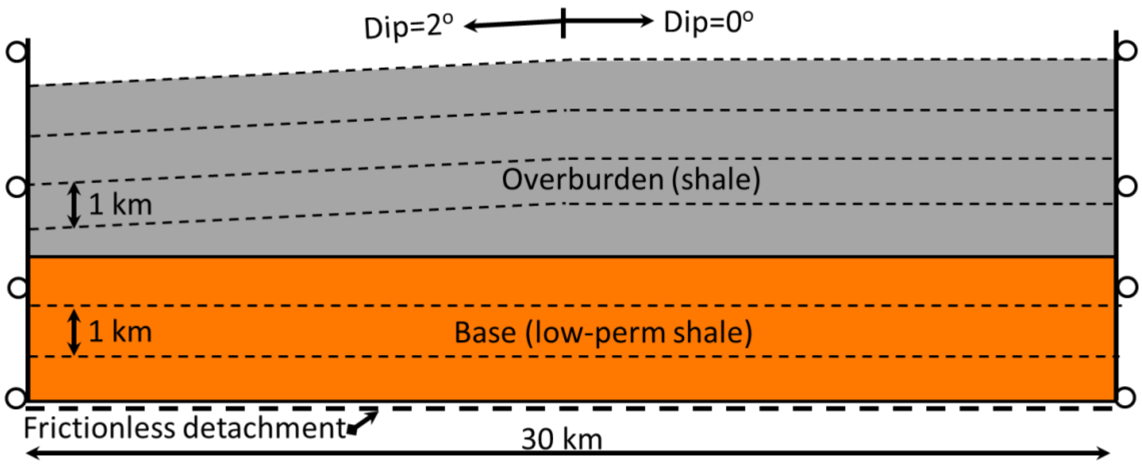


Figure 2: Ratio of shear to effective mean stress. Red color represents critical state due to lateral compression, and blue color represents critical state due to lateral extension.



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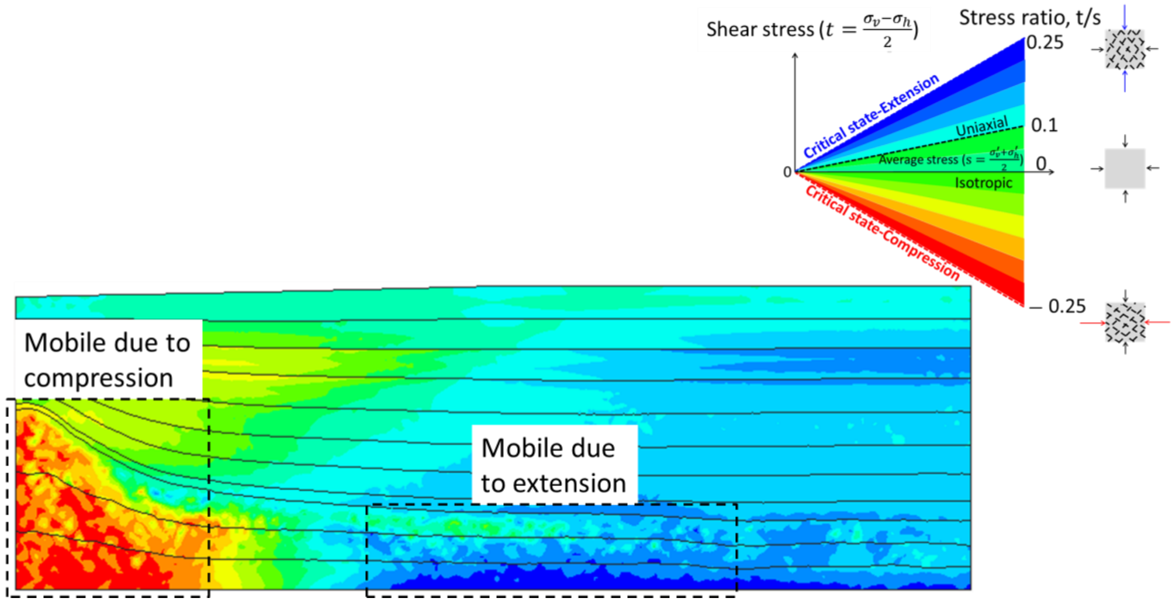

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