Stress, Strain, and Compression in Fold-and-Thrust Belt Systems

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ABSTRACT

I simulate the large-scale deformation of an evolving thrust belt using ELFEN, a large-strain poro-elasto-plastic geomechanical model. The overlying thrusting layer is subjected to horizontal loading and reaches about 2.5km displacement. The right hand side of the model is a zero displacement boundary. The decollement is simulated as a frictional interface with a friction coefficient of 0.4. The porosity is reduced in the hanging wall relative to the underlying footwall (Fig.1). The enhanced porosity loss within the hanging-wall sediments is the result of elevated lateral stress, which increases both the mean effective stress (σ'_m) and the deviatoric stress (q). In addition, I show that there is a broad zone within the hanging wall where the sediments are at critical state (Fig. 2). This failure zone dips approximately 28 degrees toward the backstop, and is characterized by a high value of the relative shear stress (q/ σ'_m) (orange region, q/ σ'_m =0.91, Fig. 2b). Along a hypothetical well within the hanging wall (well A), sediments are at or near the critical state (i.e. following the red line in Fig. 2a), whereas along a second hypothetical well far from the thrust belt (well C), sediments follow a K_0 (uniaxial) compression path (green triangles, Fig. 2a).

CLICK ON IMAGE FOR LARGER VIEW

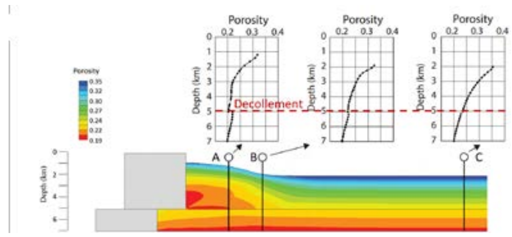


Figure 1: Porosity distribution within an evolving thrust belt. Porosity is reduced within the hanging wall due to lateral compression. There is an abrupt jump in porosity beneath the decollement.

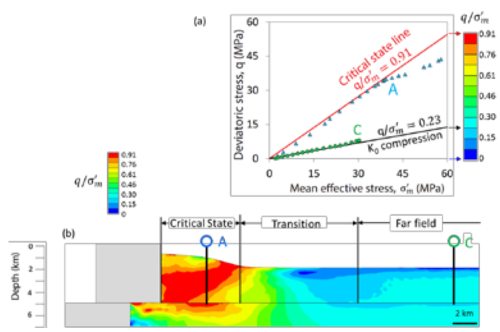
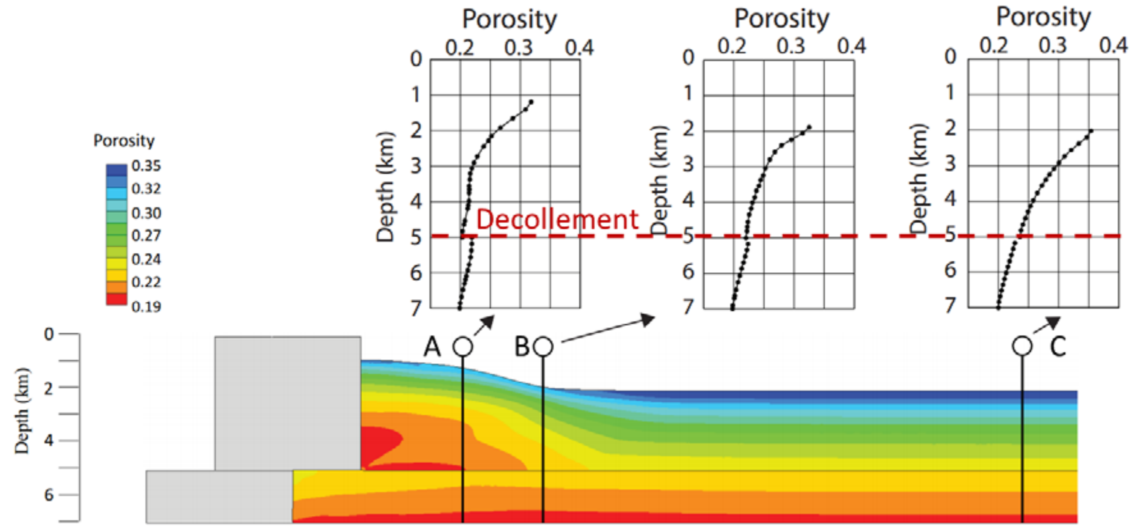


Figure 2: (a) Mean effective stress, σ'_m plotted against deviatoric stress, q, along a well path within the hanging wall (well A, blue triangles) compared with the far-field (well C, green circles).

(b) Relative shear stress ratio q/ σ'_m . Within the thrust belt, sediments are on or close to critical state condition. At the far-field, sediments follow the K_0 (uniaxial) compression line.



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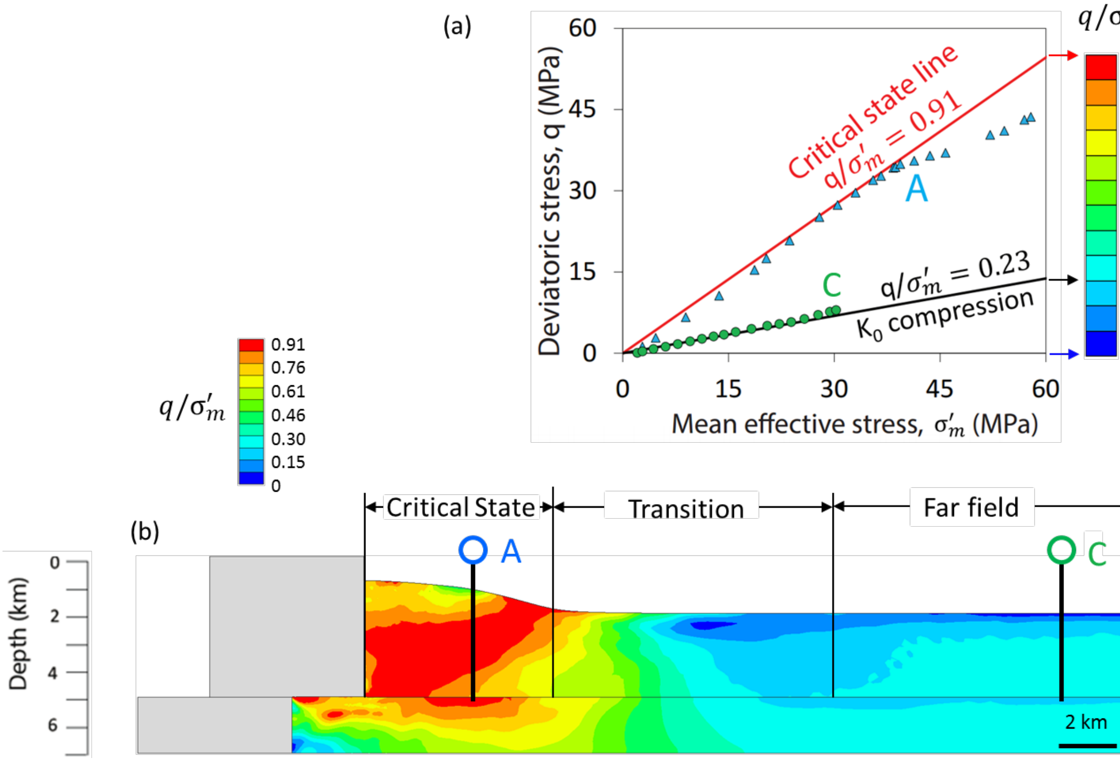

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