9.07: Pore Pressure and Stress in an Evolving Thrust Belt

Baiyuan Gao, The University of Texas at Austin

ABSTRACT

We apply a transient geomechanical model and critical state soil mechanics to study the evolution of pore pressure, stress, and porosity in fold-and-thrust belts. We find that tectonic loading generates significant overpressure both in the hanging wall and footwall (Fig. 1a). In the hanging wall, the overpressure increases rapidly near the trench (Fig. 1b). This keeps the effective stresses low (Fig. 1c) and the hanging wall sediment at failure. In addition, because of the low vertical effective stress, σ'_y, the slip-threshold ($\mu_b * \sigma'_y$) remains low (Fig. 1d), resulting in a very weak décollement. We also show that high overpressures at the trench cause unloading and dilation in the footwall sediment (Figure 2). Overall, we demonstrate that high thrusting rates and low mudrock permeabilities increase overpressure and delay sediment compaction in the hanging wall.

CLICK ON IMAGE FOR LARGER VIEW

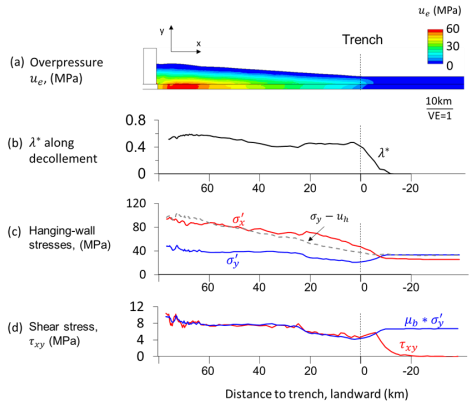

Figure 1: Pressure and stress prediction for an evolving thrust belt using transient geomechanical model. (a) Contours of overpressure in hanging wall and footwall; (b) Overpressure ratio, λ^*, along décollement; (c) Horizontal (σ'_x, red) and vertical (σ'_y, blue) effective stresses at base of hanging wall, and reduced vertical stress (σ_y - u_h, gray dashed line); (d) shear stress (τ_{xy}, red) and slip-threshold ($\mu_b\sigma'_y$, blue) at base of hanging wall.

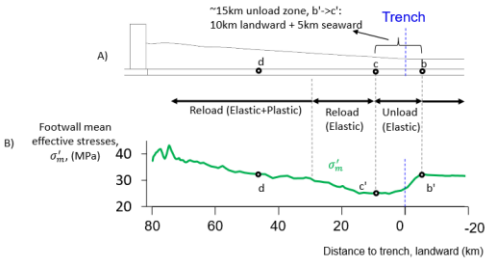

Figure 2: Mean effective stress at footwall. Rapid increase in overpressure along the trench causes unloading in the footwall sediments. This leads to unloading (elastic behavior) and dilation of the footwall sediments.

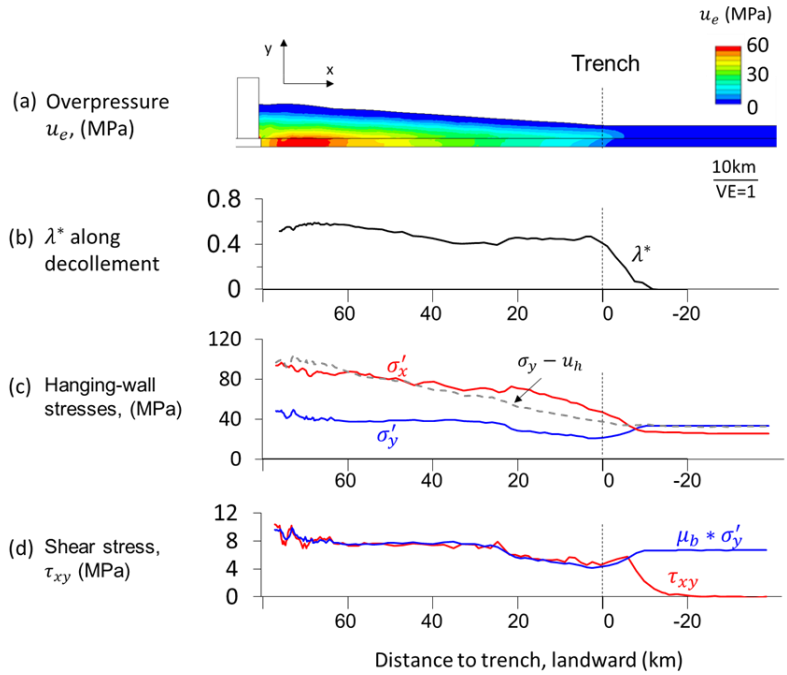

Figure 1: Pressure and stress prediction for an evolving thrust belt using transient geomechanical model. (a) Contours of overpressure in hanging wall and footwall; (b) Overpressure ratio, λ^*, along décollement; (c) Horizontal (σ'_x, red) and vertical (σ'_y, blue) effective stresses at base of hanging wall, and reduced vertical stress ($\sigma_y - u_h$, gray dashed line); (d) shear stress (τ_{xy}, red) and sliding threshold ($\mu_b\sigma'_y$, blue) at base of hanging wall.

Back

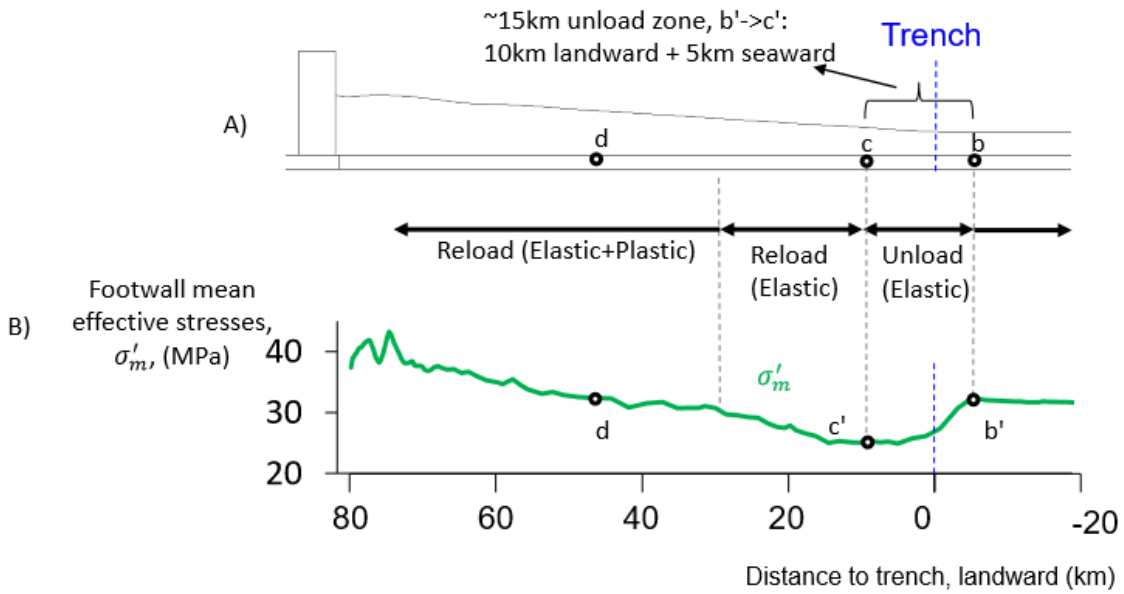

Figure 2: Mean effective stress at footwall. Rapid increase in overpressure along the trench causes unloading in the footwall sediments. This leads to unloading (elastic behavior) and dilation of the footwall sediments.

Back