10.06: Geomechanical simulation of pressure and stress in an evolving thrust belt

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ABSTRACT

We use transient evolutionary geomechanical models to study the coupled mechanical and fluid-flow behavior in an evolving thrust belt. We find that overpressure in the hanging wall increases rapidly as sediment is incorporated into the wedge (Fig. 1b). We show that this results from an increase in both mean and shear stress in the trench area (Fig. 1e-f). As a result, overpressure in the hanging wall is higher than in the footwall (Fig. 1c) and fluid flow is established both towards the seafloor and the footwall. In addition to pore pressure increase, we find significant strain rotations in the trench area (Fig. 2). Hence, the trench marks a transition zone from the initial uniaxial state in front of the wedge to critical state inside the wedge. Beyond this transition zone (>30km from the trench, Fig. 1b), overpressure increases monotonically with depth (Fig. 1d). We further investigate the effect of permeability and convergence rate on the evolution of stress and pressure.

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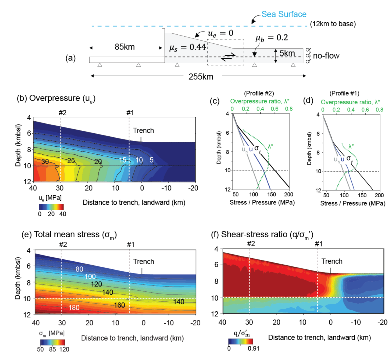


Fig.1: (a) Model set-up and boundary conditions: (a) An initial 5 km-thick sediment package includes a proto-décollement located 3km beneath the seafloor and defined as a discrete slip surface with a friction coefficient μ_b =0.2. Sediment above the décollement is displaced 85 km to the right at 5 mm/yr.; (b) Overpressure (u_e) in transition zone and 40km into the wedge (dashed box in (a)). (c) Pore pressure (u), overburden stress (σ_y), and overpressure ratio ($\lambda^* = (\frac{u_e}{\sigma_v - u_h})$) along profile #2; hydrostatic pressure (u_h) shown for reference; d) Profile #1; (e) Total mean stress (σ_m). (f) Shear-stress ratio (q/σ'_m).

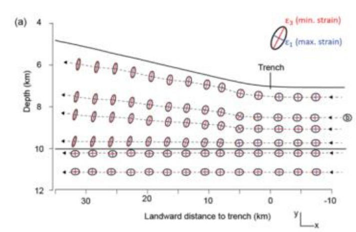
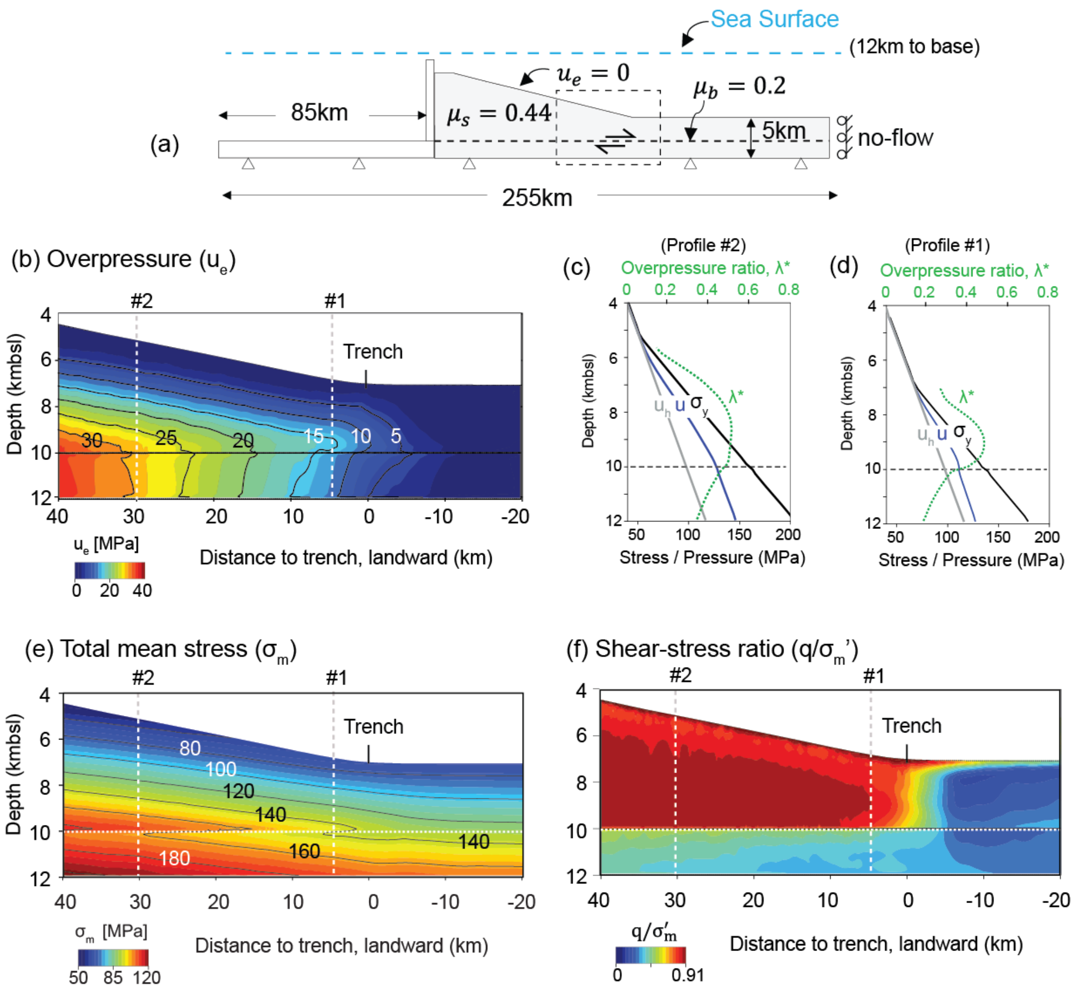


Fig 2: Evolution of strain of sediment elements that pass into the accretionary wedge (transient model, base case). The dark blue and red axes show the maximum (ε_1) and minimum (ε_3) strain orientations, respectively.



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Back

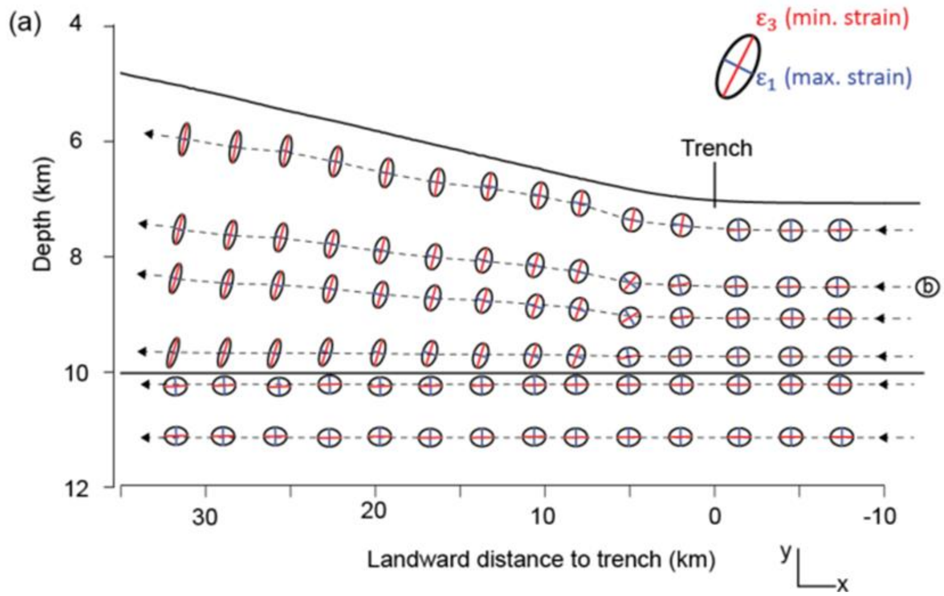

Fig.2: Evolution of strain of sediment elements that pass into the accretionary wedge (transient model, base case). The dark blue and red axes show the maximum (ε_1) and minimum (ε_3) strain orientations, respectively.

Back