10.10: Contribution of mean and shear to pressure generation in thrust belt

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ABSTRACT

We study the loading components that lead to overpressure generation in an evolving thrust belt (Fig. 1). We quantify the mean- and shear- induced components of overpressure using principles from critical state soil mechanics (Fig. 2). We find 2 distinct regions of overpressure generation as sediment gets incorporated into the wedge: a transition zone near the trench and the critical wedge (Fig. 1c). Near the trench, all overpressure components increase at a higher rate than in the critical wedge (Fig. 1c). We show that this correlates with the transition of the sediment stress state from uniaxial to critical state (Fig. 1e). We also show that within the transition zone, shear-induced overpressure is twice as high as the mean-induced overpressure (Fig.2d). Overall, our study highlights the importance of both mean and shear stress in pressure generation.

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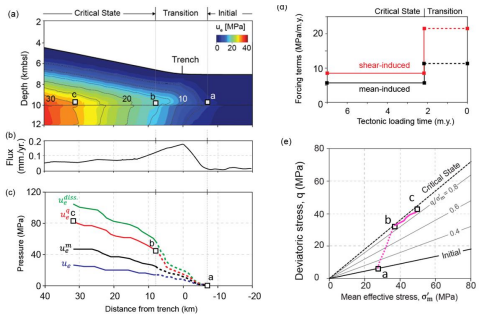


Fig 1: (a) Contours of overpressure ($\boldsymbol{u_e}$). (b) Flux normal to the seafloor. (c) Pore pressure components of tracked element "a" in hanging wall: dissipated overpressure ($\boldsymbol{u_e^{diss.}}$, green); shear-induced overpressure ($\boldsymbol{u_e^q}$, red); mean-induced overpressure ($\boldsymbol{u_e^m}$, black); resultant overpressure ($\boldsymbol{u_e}$, blue). (d) Mean- and shear-induced forcing terms in transition zone and critical wedge. (e) Stress paths of sediment "a" in hanging-wall (magenta) as it gets incorporated into the thrust belt.

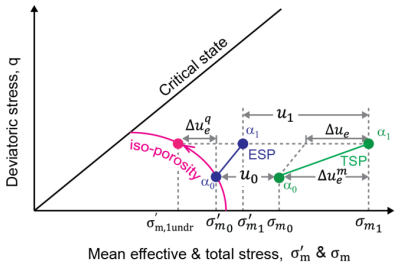
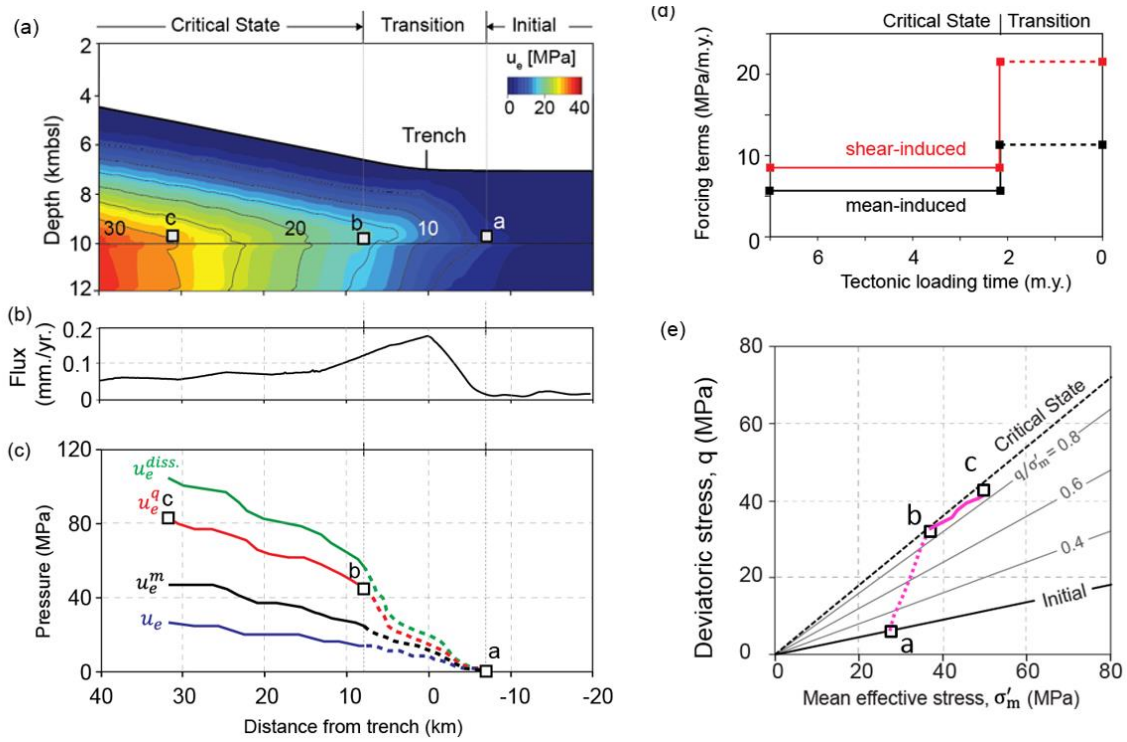


Fig 2: Schematic illustration of pore pressure decomposition workflow during loading increment $\boldsymbol{\alpha_0}$ to $\boldsymbol{\alpha_1}$ (total stress path, green line): $\boldsymbol{u_0}$ and $\boldsymbol{u_1}$ are the initial and final pressures, $\Delta\boldsymbol{u_e^q}$, $\Delta\boldsymbol{u_e^m}$, the shear- and mean-induced overpressure, and $\Delta\boldsymbol{u_e}$ the overpressure change. Blue line depicts the effective stress path; and magenta curve the iso-porosity curve.



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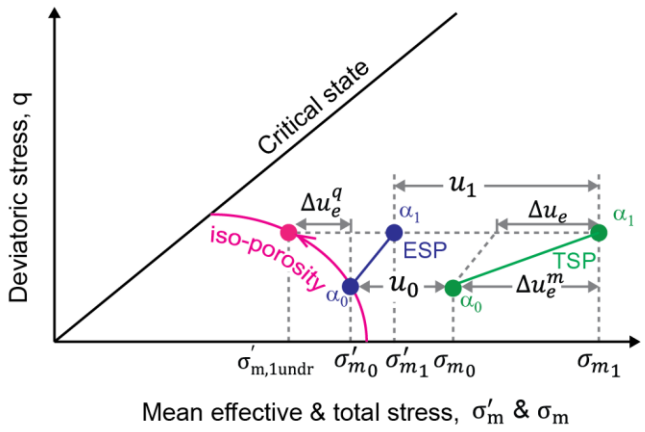

Fig.2 : Schematic illustration of pore pressure decomposition workflow during loading increment α_0 to α_1 (total stress path, green line): $\boldsymbol{u_0}$ and $\boldsymbol{u_1}$ are the initial and final pressures, $\Delta \boldsymbol{u_e^q}$, $\Delta \boldsymbol{u_e^m}$, the shear- and mean-induced overpressure, and $\Delta \boldsymbol{u_e}$ the overpressure change. Blue line depicts the effective stress path; and magenta curve the iso-porosity curve.

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