Dynamics of shear slope failure: a case study on dilation slope failure

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ABSTRACT

Breaching is a style of retrogressive subaqueous slope failure controlled by dilation and consequent pore pressure drop; it has the potential to generate turbidity currents that build thick successions of turbidites. We present pore pressure measurements made during breaching failure with two types of sediment, as well as a physical model that shows how the pore pressure field within the failing deposit is connected to the erosion rate associated with the failure surface. We find breaching occurs in granular material that has strong dilation strength. A dynamic equilibrium exists between the slope failure and the pore pressure dissipation during breaching. This equilibrium leads to a way to estimate the rate of sediment release from breaching using a simple material property, the coefficient of consolidation. The equilibrium between the erosion and pore pressure dissipation decouples the steady-state pore pressure field from the permeability of the deposit; this is the first time this behavior has been recognized in sediment failures.

CLICK ON IMAGE FOR LARGER VIEW

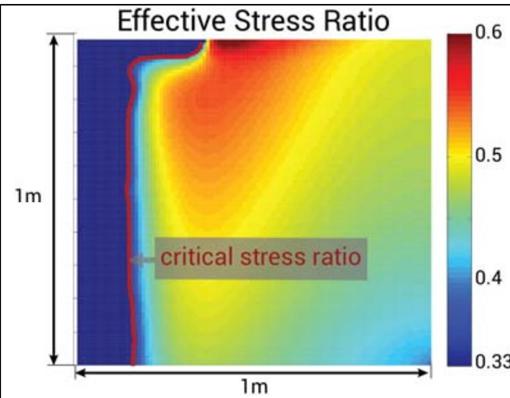


Fig. 1: Effective stress ratio (σ_3'/σ_1') field of the deposit during dilative slope failure. Any stress ratio larger than the critical value (red line) means stable. The critical stress ratio line is right on the surface of the slope failure.

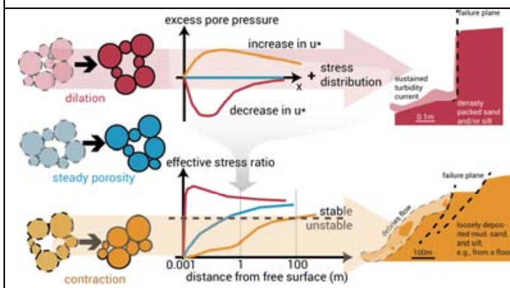
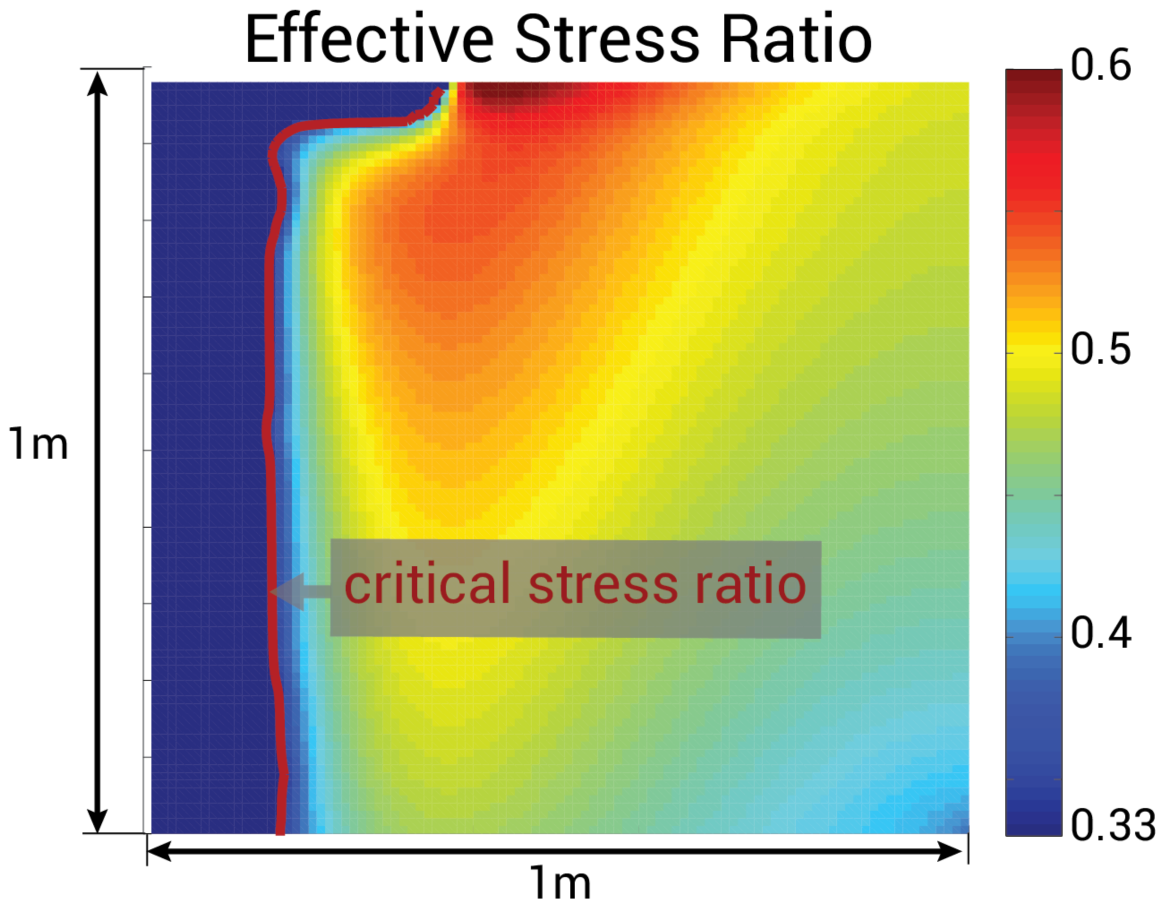


Fig. 2: Conceptual model for linking the style of slope failure and density currents (right column) to the poro-mechanics of the deposit (left column). The link is the pore pressure (center column). Dilative material (red) generates negative excess pore pressure. As a result, it produces slow grain scale slope failure and sustained turbidity currents. Contractive material (yellow) generates positive excess pore pressure. As a result, it produces fast and large scale landslides that generate debris flow.



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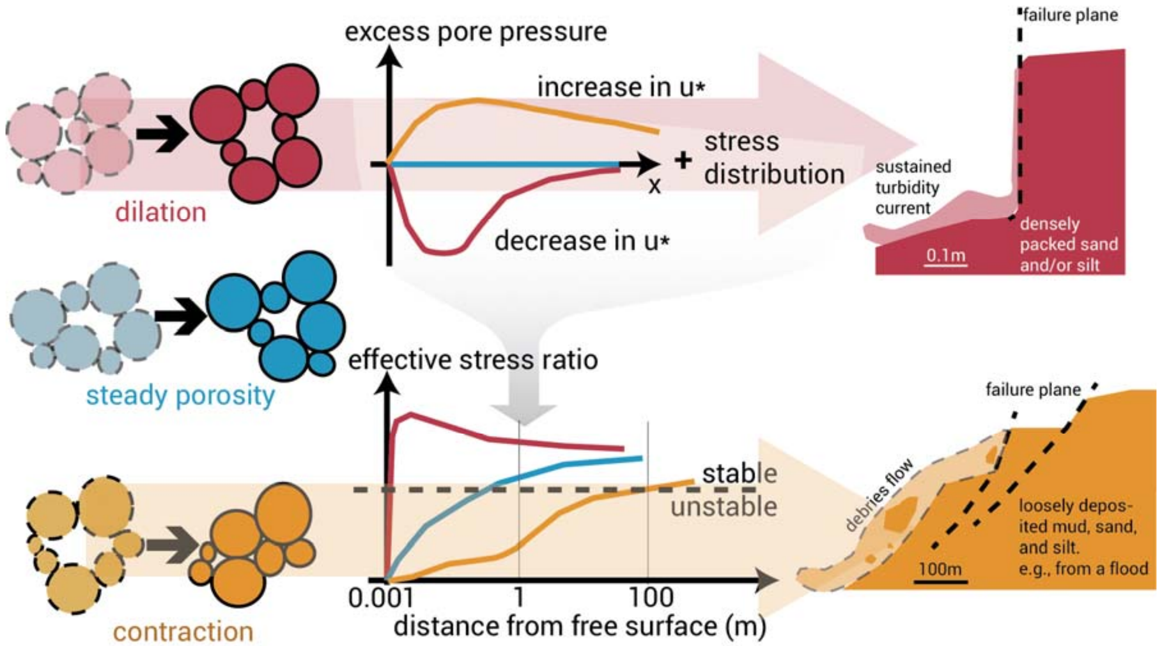

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