

11.23: Stresses in an accretionary prism with fault generation

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ABSTRACT

We study how the development of faults in an accretionary prism affects stress and topography. We find that the initiation and growth of faults that have lower frictional strength than the intact sediments lead to a system-wide decrease in differential stress inside the prism. As a result, the shear stress is lower than the intact sediment shear strength, and the stress state is more uniform compared to a critical wedge without faults (Fig. 1). We show that principal stresses re-orient near the faults and that the minimum principal stress changes abruptly across faults. We also find that in locations where faults form, the system equilibrates by thickening the topography (Fig. 2). We built this evolutionary simulation with Elfen, and model sediments as a poro-elastoplastic material. Faults develop when the deviatoric plastic strain exceeds 25% over a distance of 3 km. Compression and strength properties are calibrated using experimental observations on Resedimented Gulf of Mexico Eugene Island material.

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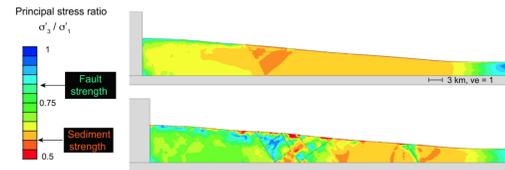


Figure 1: Ratio of minimum to maximum principal stress illustrating the amount of differential stress in the wedge. Before faults form, the ratio is the lowest sediments can support (orange colors). Fault development increases the ratio in nearby sediments (cooler colors), leading to a more uniform stress state.

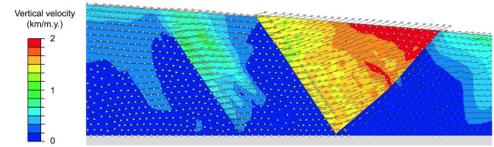


Figure 2: Vertical upwards velocity (contours) and overall velocity (arrows) of the sediments near the toe, following fault formation. Faults introduce a surface of lower resistance to sliding, enabling the system to equilibrate by thickening the topography.

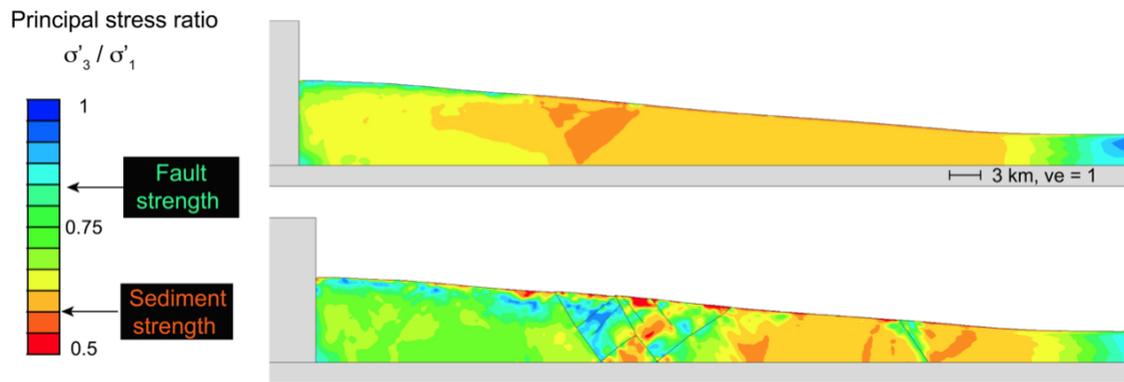


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[Back](#)

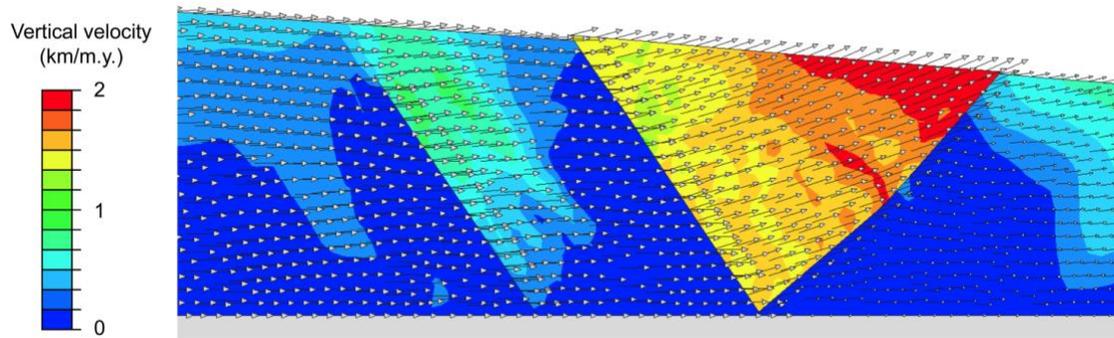


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[Back](#)