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The role of heterogeneous fluid pressures in the shape of critical-taper submarine wedges, with application to Barbados

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Some classic accretionary wedges such as Nankai trough and Barbados are mechanically heterogeneous based on their spatial variation in taper, showing inward decrease in surface slope α without covariation in detachment dip β. Possible sources of regional heterogeniety include variation in fluid pressure, density, cohesion and fault strength, which can be constrained by the seismic or borehole observable parameter, fluid-retention depth Z_FRD, below which compaction is strongly diminished. In particular the Hubbert-Rubey fluid-pressure weakening can be addressed as (1-lambda)$\sim$0.6Z_FRD/Z. We recast the heterogeneous critical-taper wedge theory of Dahlen (1990) in terms of the observable Z_FRD/H, where H is the detachment depth, which allows for real world applications. For example, seismic velocity and borehole data from the Barbados shows that the fluid-retention depth Z_FRD is approximately constant and Z_FRD/H decreases inward. This leads to a factor of four inward decreases in wedge strength, dominated by fluid pressure, with only a second-order role for density and cohesion. An inward decrease in wedge strength should by itself produce an increase in taper, therefore the observed decreasing taper must be dominated by decreasing fault strength mu_b* from 0.03 to 0.01. Static fluid-pressures along the detachment in equilibrium with the overlying wedge predict the observed wedge geometry well, given a constant intrinsic friction coefficient mu_b=0.15.