Geophysical Research Abstracts
Vol. 19, EGU2017-15569, 2017
EGU General Assembly 2017

Mechanics of gravity instability in offshore deltas, with reappraisal of fluid overpressures in the Niger Delta

Bertrand Maillot (1), Yves Leroy (2,3), and Xiaoping Yuan (4)

(1) Laboratoire Géosciences et Environnement Cergy, Univ. de Cergy-Pontoise, France (bertrand.maillot@u-cergy.fr), (2) Laboratoire de Géologie, CNRS, Ecole Normale Supérieure, Paris, France, (3) Now at Total SA, CSTJF, Pau, France, (4) Helmholtz Centre Potsdam, German Research Center for Geosciences (GFZ), Germany

Gravity instabilities in offshore deltas often involve three structural domains in interaction by the weak detachment plane: an upslope extensional region, a transitional domain sliding seaward, and a downslope compressive region. We provide the fluid pressure conditions for the occurrence of gravity instabilities due to the interaction of these three domains. For that purpose, we apply the kinematic approach of Limit Analysis which relies on the mechanical equilibrium and on the assumption that the onset of the instability is indeed triggered by the motion of the three domains if the Coulomb criterion is met on all slipping faults. For any given topographic profile, the Limit Analysis predicts the normal fault position and dip, marking the extensional domain, the activation length of the detachment defining the transitional sliding domain, and the thrust fault position and dip delimiting the compressive domain.

The frontal thrusting occuring on the downslope compressive region works against gravity and therefore stabilizes the upslope gravity collapse. As a consequence, the critical topographic slope at the onset of the instability is found to be several degrees larger than predicted with the Critical Coulomb Wedge (CCW) theory, which can account for either the upslope extensional region, or the downslope compressive region, but does not account for the interaction of the three domains. The difference in predictions between the two theoretical approaches is important when the downslope sediment thickness above the detachment is more than a hundredth of the detachment activated length.

The above length ratio is in the range 1/30 to 1/70 in the offshore Niger Delta. Neglecting cohesion, we found that, for the gravity instability to occur, the effective friction coefficient μ'_B is less than 0.27 within the bulk material and μ'_D is less than 0.017 in the detachment. These values are lower than those previously determined ($\mu'_B = 0.5 - 0.9$, $\mu'_D = 0. - 0.2$) by applying the CCW theory to the compressive domain only [*Bilotti and Shaw*, 2005]. These new values correspond to a pore-fluid pressure in the range of 80 to 90% of the lithostatic pressure within the bulk material (Hubbert-Rubey fluid-pressure ratio $0.8 - 0.9$), and in the range of 97 to 99% of the lithostatic pressure within the detachment.