Seismic Geomechanics Around a Mud Volcano in the Offshore Nile Delta

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ABSTRACT

Mud volcanoes are large surface manifestations of hydrocarbon fluids escaping deeper prospective petroleum structures. Their occurrence is generally associated with the active tectonic setting, rapid sedimentation and high rate of gas generation. Over 6500 mud volcanoes have been recorded worldwide and are primarily developed where mudstone sequences are overlain by thick and rapidly deposited sediments from modern and Tertiary deltas. This study investigates the geomechanics and mud volcano intrusion and growth mechanisms within the Nile Delta slope, offshore Egypt. Integrating research into the geomechanical importance of mud volcanoes requires addressing mechanics of their formation. We are utilizing high quality 3D seismic reflection and velocity data and petrophysical data from two wells to investigate the spatial and temporal evolution of a mud volcano and mechanics of mud volcano development, which has so far received limited attention using this type of analysis within the offshore Nile Delta. The study area is characterized by high post-Miocene sedimentation rates leading to extensive mud volcanism sourced by overpressured sediments. Primarily caused by a disequilibrium compaction, the overpressure is analysed through the available petrophysical dataset combined with the velocity data, and is characterized by a transition zone at a depth interval of 2050-2150mbsl. Pore fluid pressure variations around a mud volcano shows lateral as well as vertical pressure gradients and these are perceived driving mechanisms for mud volcano formation. Understanding contemporary stress state and structural evolution of the area and how the fault patterns may affect drilling, in particular deviated and horizontal wells, is addressed through fault/fracture quantification and is further constrained using borehole breakout information from the World Stress Map. Regional observations are then incorporated into analysing variations in wellbore stress concentrations. Overall, this paper will showcase how integrating seismic and wellbore datasets in such mechanically complex settings helps in furthering understanding of mud volcano geomechanics, as well as some engineering practicalities.