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Geopressure characterization: Preliminary results on 1D/2D modeling associated with gravity tectonics in the Amazon Fan (southeast compartment), Foz do Amazonas Basin

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The dynamics of pore fluid pressure within marine sediments plays a key role in the stability of continental margins and is an issue of major concern on hydrocarbon exploitation. Burial or tectonic stress can be a major overpressure-generating mechanism, and thermal and diagenetic changes can also generate overpressure in-situ when thermal and chemical conditions allow. Due to the low permeability of fine-grained marine sediments, pore fluid pressures may not able to dissipate. This would end up developing zones developing zones of overpressure and inducing gravity tectonics – décollements and detachments surfaces - and instability zones (wellbore failures and loss of fault integrity, landslides and tsunamis), implying great hazards for drilling operations.
This study aims to better understand the mechanisms of overpressure generation in stratigraphic sequences and to determine their relationship with gravity tectonics. This study investigates the post-rift sedimentary record (Upper-Cretaceous to Recent) in the Amazon Fan, Foz do Amazonas Basin, Brazilian Equatorial Margin. Foz do Amazonas Basin is one of the preeminent basins in the world to study pore pressure evolution as clastic fluxes sedimentation associated with fast burial can control large-scale extensional and compressional structures recording gravitational tectonics.
In order to understand the mechanisms that could lead pore fluid overpressure and their effects on the basin, this study proposes an innovative integration of methodologies involving both 2D seismic interpretation, geophysical well logs, direct pressure measures to build of a 1D geomechanical model along offset wells and 2D pore pressure evolution of the studied basin using analytical and Finite Element Models. A structural restoration allowed us to build a 2D geological model. The 1D pore pressure, rock's strength and stress field modeling were built using available geophysical borehole data from 1 offset well, including: density data, resistivity and compressional transit time and calibrated with drilling events, leak off tests (LOT's) and direct pressure measurements.
This 1D geomechanical model calibration together with the 2D restoration allowed us to use a 2D geomechanical model to reproduce the full deformation of the basin and understand the pore pressure and stresses evolution.
The results obtained from this geomechanical study predicted the pore pressure with greater reliability. The deformation through the faults and their evolution according to mechanical parameters and fluid pressure have been reproduced. We identified possible causes of décollements. Besides, 2D petroleum systems modeling was performed to integrate the results of geomechanical models, and thus it was possible to calculate the pore pressure evolution through time, including the hydrocarbons generation.