Submission code: 0XMLMG978D

See this and other abstracts on our website: https://home.sbgf.org.br/Pages/resumos.php

Data-driven pore pressure prediction updates using Bayesian Networks guided by basin modeling

Josué Fonseca (Petrobras)

Data-driven pore pressure prediction updates using Bayesian Networks guided by basin modeling

Introduction

Accurate pore pressure prediction is essential for safe and cost-effective drilling operations when accessing subsurface reservoirs. Traditional methods either struggle to dynamically incorporate new data during drilling for computational reasons or are empirically based. This study presents an innovative approach that combines Bayesian Networks (BN) with basin modeling to create a dynamic pore pressure prediction system that updates "on-the-fly" as new drilling data becomes available. The methodology leverages the strength of basin models that simulate the physical processes occurred in the area of interest while providing computational efficiency through BN use, needed for nearly real-time applications during drilling operations.

Method

The methodology consists of a two-stage approach. First, it is developed a comprehensive Bayesian Geophysical Basin Modeling (BGBM) workflow that generates Monte Carlo simulated models of the subsurface. These models integrate physical and geological processes and are conditioned with pre-drill offset well data and seismic information to ensure geological consistency.

In the second stage, the drilling section is partitioned into discrete geological compartments based on stratigraphic boundaries, which are represented by nodes in the BN. Therefore, for the whole geological section, a complete BN is constructed while capturing the relationships between relevant geological parameters affecting pore pressure. The conditional probability distributions within the BN are informed by the calibrated posterior basin models from the BGBM workflow.

The key innovation is how a BN rapidly updates pore pressure predictions when new drilling data becomes available without requiring additional computationally intensive simulations. The network recognizes patterns between observable drilling parameters and simulated pore pressure gradients, creating a probabilistic framework accounting for uncertainties.

Results and Conclusions

The approach is validated using Gulf of Mexico dataset, demonstrating significant uncertainty reduction when predicting pore pressure. The BGBM-informed Bayesian Networks delivers more geologically consistent predictions than purely data-driven approaches and successfully updates pore pressure predictions in near real-time, providing valuable information to drilling teams.

Key advantages of this method include: (1) incorporation of calibrated geological process models; (2) quantification of prediction uncertainty; (3) rapid updates without new basin model simulations; and (4) maintenance of geological consistency across compartments.

This methodology can be extended to other drilling-related parameters and has potential for integration into drilling automation systems, providing nearly real-time guidance. Future work will focus on expanding the framework to incorporate additional data types and testing the methodology in diverse geological settings.