Pore Pressure and Fracture Gradients Prediction Challenges in Salt-encased Carbonate Stringer Reservoirs in South Oman Salt Basin

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Abstract

Objectives/Scope: Cambrian Ara Group intra-salt carbonate reservoirs of the South Oman are discovered in late 90s, most of them are currently in production phase, providing significant part of an overall PDO daily output. Objective of the paper is to provide an overview of the reservoir pressure regimes of the Ara salt basin, their relation to fracture gradients and unique challenges and solutions developed to reduce field development and well delivery risks related to pressure and fracture gradient prognosis. **Methods, Procedures, Process:** Understanding the overall process of forming reservoir pressures in the salt basins as well as detailed analyses of drilling events (losses/kicks) in addition to LOT (Leak-off test), FIT (Formation integrity test) and pressure measurements data are important ingredients for successful reservoir and fracture pressure prognoses needed for well delivery and field development needs. Estimating lithostatic pressure based on density logs provides upper limits for reservoir pressure prediction and lower limit for fracture gradient when drilling outstep or exploration wells. **Results, Observations, Conclusions:** Ara Group consists of Evaporate deposits with a number of multi-layered carbonate stringers “floating” inside it. Two pressure regimes are observed in the stringers: hydrostatic and lithostatic. Lithostatic pressure regime is a result of the reservoir losing any communication to the regional aquifer - burial of encased stringer and subsequent HC’s generation bring the reservoir pressure to the values close to true lithostatic pressures. All the present-day hydrostatic reservoirs have been over pressured in the past. Grounding of the stringer onto the pre-salt carbonates that may happen in a course of post-deposition halokinesis process, does lead to reservoir pressure deflation, forming hydrostatically pressurised reservoirs. Besides that, on-going depletion and gas injection in some of the reservoirs add to overall complexity of the pressure distribution and forming a “pressure sandwich” within the basin. Such situation creates unique challenges for well planning and field development. Extra measures such as improved pressure prediction techniques as well as using special mud additives and improved casing design had to be developed. **Novel/Additive Information**: Presence of the hydrostatic and overpressure reservoirs in Ara carbonates in combination with an on-going depletion in some of them does present significant development and well delivery challenges. Unique set of information was collected, appropriate methods and best practices were developed allowing to reduce drilling risks and to overcome challenges caused by “pressure sandwich” of the Ara Salt basin.