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High Pressure Situations: Understanding Reservoir Compartmentalization in the Sable Subbasin

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Introduction

The Scotian Margin pressure systems have been extensively studied to understand the mechanisms and timing of excess pressure generation and dissipation, with a strong focus on the Sable Subbasin. Fluid pressures have been observed in Jurassic and Early Cretaceous reservoirs, where they increase with depth in unpredicted increments from hydrostatic to immense excess pressure. This study examined whether the excess pressure distribution is controlled by the reservoir connectivity, which is ultimately a function of permeability.

Workflow

The pressure distribution was investigated with a sub-regional 3D static reservoir model for five gas fields: South Venture, Venture, Arcadia, Citnalta, and Uniacke. The model was built by interpretation of a 3D seismic volume that was integrated and calibrated with data from 27 wells. The model was populated with excess pressure data and upscaled lithologies interpreted from wireline logs and well tests.

Results and Conclusions

Excess pressured sections are lithified with thin intraformational seals and high net-to-gross ratios of porous to tight sandstones, shales, and low permeability limestones. It is difficult to justify current excess pressure without late hydrocarbon generation (or another late pressure source) within the region given micro-nano Darcy flow across thin imperfect seals that should allow for pressure equilibration over at most several million years. Hydrocarbon generation during the Cretaceous was cited as a pressure source, supported by basin modelling results. Pressure and fluids are interpreted to be currently entering the system by ongoing generation of hydrocarbons based on recent thermal modelling of the South Venture O-59 well (Wong et al. 2016).

A similar arrangement of reservoir connectivity and pressure distribution are observed in all the fields, although the ages of the units evolve due to progradational advance of the shelf and progressive formation of expansion trends. Expansion trends are isolated, high accommodation space depocentres formed in the hanging walls of down-to-basin listric faults. These faults created low-relief, hanging wall, fault-bend folds - the main hydrocarbon traps of the Subbasin.

In the deep section, where reservoirs are stratigraphically and structurally isolated, the fluids and pressures are interpreted to be actively dissipating by mechanical leak. In the intermediate section, pressure equilibration within pressure cells occurs where the displacement of minor crestal faulting exceeds the thickness of minor intra-formational seals allowing for “stair stepping” up juxtaposed permeable units. In

the shallow section, which is above the listric fault system, the reservoirs are contiguous and hydrostatically pressured. The model supports that reservoir connectivity, therefore permeability, is the primary control on the excess pressure distribution, and is supported by late to ongoing hydrocarbon generation.

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References

Wong, J.C., Skinner, C.H., Richards, F.W., Silva, R.L., Morrison, N., and Wach, G. 2016. 1D thermal model of South Venture O-59, Sable Subbasin (Scotian Basin, Nova Scotia). In The Atlantic Geoscience Society 42nd Colloquium and Annual Meeting. Edited by T. Fedak and B. Grantham and R. Raeside and C. White. Atlantic Geoscience Society, Truro NS. p. 68.