Crestal faulting as a cause of trap integrity loss and gas migration in the Migrant structure, Sable Delta, offshore Nova Scotia, Canada

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Shelf margin deltas like the Mississippi, Amazon, Niger and the ancient Sable Delta host some of the world's largest gas accumulations. They are localized by the interaction of gravity-driven extension, syntectonic sedimentation, and salt mobilization processes. These processes impact the evolution of faults and the formation of complex structures that may in turn control the accumulation and distribution of reservoirs and hydrocarbons. Since 1959, hydrocarbons have been explored for in Nova Scotia's offshore region. Results of this exploration show that fault-controlled rollover anticlines contain significant/commercial volumes of hydrocarbons (mainly gas), with 75% of the discoveries in the Sable Sub-basin on the shallow water Scotian Shelf in these structures.

Located in the Sable Sub-basin, the Migrant structure is a fault-controlled, four-way dip anticlinal closure that formed as one of a series of related structures during salt mobilization in the Cretaceous. The Migrant N-20 well (1978) was drilled to test for hydrocarbons trapped in Late Jurassic to Early Cretaceous deltaic and fluvial-deltaic reservoirs in the Mic Mac and Missisauga formations, respectively. A drill stem test in the Mic Mac Formation flow-tested to the surface gas from a deep sand reservoir with a reported flow rate of 10 million SCF/D with associated decline over the duration of the test. The well's inability to demonstrate a sustained flow rate indicated that the discovery was non-commercial. Further geologic analysis showed diminishing net porous sand with little evidence of extensional crestal faulting deep in the core of the Migrant rollover anticline.

Integration of 3D seismic with well data allows us to investigate the attributes of the Migrant structure as a potential hydrocarbon trap. Through a combination of pressure data at Migrant and 3D geocellular models populated with input parameters such as shale volume, porosity, water saturation and permeability calculated in Petrel from key wireline logs, we relate fault distribution and seal versus reservoir properties offset in an Allan diagram. From our models, we examine the inferred mechanism for leakage at Migrant (the crestal fault), and further, model leakage volumes with varying fault displacements, seal thicknesses/net to gross ratios and permeabilities. The new interpretations and results from this study will be useful for de-risking future exploration and development of ancient deltaic systems along the Atlantic margin including the undrilled Shelburne Delta in southwest Scotia Basin, potential deltas off Labrador, and the Iberian and Moroccan conjugate margins.

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