Seismic inversion and source rock evaluation on Jurassic organic-rich intervals in the Scotian Basin, Nova Scotia, Canada

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Source rocks are a key element of a petroleum system and are identified as a risk in the exploration of the Scotian Margin, offshore Nova Scotia Canada. There have been 24 significant hydrocarbon discoveries, including eight commercial discoveries since 1967 in the Sable Sub-Basin of the Scotian Basin. Although there are proven hydrocarbon accumulations in both Jurassic and Cretaceous reservoirs, identification of their source is problematic. This is due to the low organic matter content of the studied sedimentary section, 'turbo' drilling practices, and extensive drilling mud contamination. This project investigated the extent and geochemical properties of (presumed) Middle to (known) Upper Jurassic source rocks in the Scotian Basin. It tests the hypothesis that source rocks, (if present in a 2120 km^2 area surrounding Sable Island), can be identified using petrophysical techniques and then mapped using seismic inversion.

Investigation of Middle and Upper Jurassic successions and their potential as source rock was completed using a combination of petrophysical and seismic techniques. Wireline log estimation of total organic carbon (TOC) was completed using the Passey method. Seismic inversion was achieved via a 3D constrained sparse spike inversion, based on the presence of low impedance source rocks investigated using the Løseth *et al.* "Source Rock from Seismic" method. The study area was selected based on well control (with 19 Jurassic penetrations) and the availability of 3D seismic data.

The petrophysical methods did not identify intervals of source rock in the studied wells. This is consistent with the publicly available geochemical data, showing measured TOC values of generally <2%. Seismic inversion was effective in mapping low acoustic impedance intervals, especially in calcareous shales. However, without unequivocal evidence of high TOC content (>2%), low acoustic impedance cannot be interpreted as source rock, i.e. a relationship between AI and TOC was not found. A correlation was found between low impedance calcareous shales and overpressured zones with overpressure known to lower seismic velocity. It is suggested that late hydrocarbon generation and migration in the Scotian Basin are responsible for overpressure. Hence, low acoustic impedance may provide indirect evidence of source rock presence and active or late stage hydrocarbon generation from below present well penetrations or from outside the study area.

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