Using light detection and ranging (LiDAR) to validate the use of ground penetrating radar (GPR) in the reconstruction of internal rock from braided channel deposits - an example from the Lower Wolfville Formation, Minas Subbasin, Nova Scotia

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Braided channel deposits of the lower Wolfville Formation display well-developed and cyclic channel sandstone and overbank mudstone deposits along multiple kilometres of seaside cliffs. Juts along the cliff face, into the intertidal zone, have presented researchers the opportunity to study the architectural elements of braided channel siliciclastic deposits in varying profiles, in essence giving three-dimensional characterization. Researchers have proposed the use of GPR to provide insight on the internal and subsurface makeup of rock, allowing for the true three- dimensional geometry and distribution of rock units to be characterized. However, no comparison has been made between GPR subsurface profiles and actual cross sections in paleo siliciclastic fluvial deposits. This research intends to check the validity of GPR in demonstrating the true stratigraphy of paleo-fluvial units using LiDAR. Additionally, the data gathered can be combined with properties from the outcrop (permeability and porosity) to form a realistic geocellular hydrocarbon reservoir or aquifer model.

The 20 m-high seaside cliffs along the Minas Subbasin, Nova Scotia, provide a true representation of the stratigraphy of the braided channel complex of the lower Wolfville Formation. A georeferenced GPR study was conducted on an open grass field above at the top of the cliff using 25, 50, and 100 MHz antennas to detect the varying dielectric properties of the fluvial and interfluve rock units. A georeferenced LiDAR study was performed on the exposed cliff face, capturing an exact stratigraphic representation of the braided channels as a digital "point-cloud". The true stratigraphy of the cliff face was then extrapolated from the point-cloud and into the subsurface, ground trothing the GPR profiles.

This work provides a measure of validity showing that GPR can be used in visualizing the internal and subsurface stratigraphy of paleo-fluvial siliciclastic successions. The 50 and 25 MHz antennas clearly show the geometry and distribution of large continuous subsurface geobodies which can be correlated to the stratigraphy of the cliff face. The 100 MHz antennas show small scale reflections, possibly caused by singular clasts, but fail to reach a depth suitable for this study (20+ m).

Understanding the exact architecture of sand bodies (reservoirs) and mudstone deposits (barriers) is essential to understanding maximum hydrocarbon recovery in clastic reservoirs. This work provides a realistic model, populated with permeability and porosity data, to be used as an analogue for similar global fluvial systems.

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