

## Abstract

The Wolfville Formation crops out along the shoreline of the Minas Basin of the Bay of Fundy, Nova Scotia. Cambridge Cove contains an exceptionally well preserved outcrop of the that presents 2D and 3D exposures of the braided channel paleo-depositional environment of the Wolfville Formation.

This study aims to: 1) investigate the heterogeneity of a braided channel complex including interconnectivity between channel bodies, as well as baffles and barriers to fluid flow within stratigraphic packages, 2) determine the structural controls on reservoir compartmentalization, including sealing and transmissive faults, 3) discern the potential of these outcrops as an analogue for other early Mesozoic syn-rift and post-rift reservoirs in the subsurface, and 4) provide data that allows the evaluation of reservoir compartments that allows identification of which best suited for potential hydrocarbon development and CO<sub>2</sub> sequestration.



Figure 1: Cambridge Cove Study Area, Minas basin, Nova Scotia

## Regional Geology

Cambridge Cove is located at the southern coast of Minas Basin and Cobequid Bay which is part of the Bay of Fundy (Fig.1) Pre-Mesozoic rocks are exposed on both sides of the Bay of Fundy. The Mesozoic rocks are mostly continental clastics, basalts and mafic dykes (Greenough, 1995). These Mesozoic rocks were formed during early rifting of Pangaea and the opening of the Atlantic Ocean, were deposited on Paleozoic rocks related to the Appalachian Orogeny. The Horton Group formed during early Carboniferous age which was overlain unconformably by the Triassic rocks of the Fundy Group. In the Cambridge Cove and the surrounding areas along the coast, Horton Group and Fundy Group rocks are exposed as vertical cliffs up to ~20 m in height.

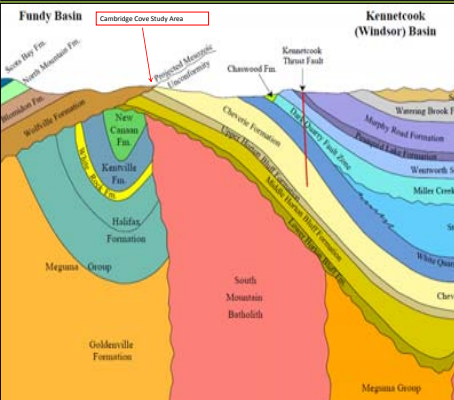


Figure 2: Cross-sectional profile of regional bedrock, scale 1: 750 000 (Source: Nova Scotia Department of Natural Resources)

# Architecture and Geometry of Braided Channel Complex in the Triassic Wolfville Formation

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## Work Flow / Methodology

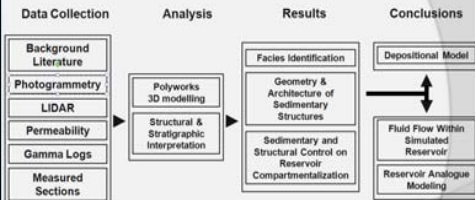


Figure 3: Work Flow Box Diagram displaying Methodology used in Cambridge Cove Study



Figure 4: Optech ILIRIS-3D Intelligent Laser Imaging System



Figure 5: Lidar grid projection, scanning point selection and X-Y axes geometry

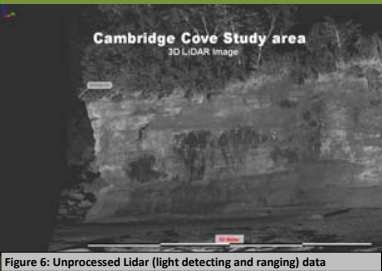


Figure 6: Unprocessed Lidar (light detecting and ranging) data

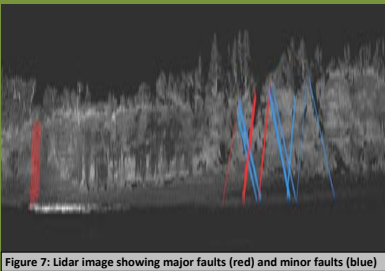


Figure 7: Lidar image showing major faults (red) and minor faults (blue)



Figure 8: Stratigraphic section measured across the outcrop

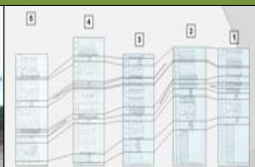


Figure 9: Identification of principle lithofacies: clast-supported conglomerate, matrix-supported conglomerate, coarse-medium grained sandstone and a paleosol.



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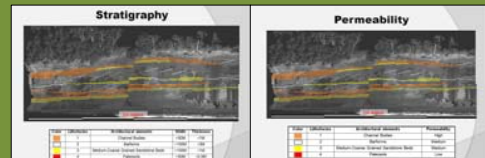


Figure 10: Architectural element dimensions and associated lithofacies

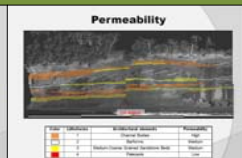


Figure 11: Lidar image showing architectural elements and associated permeability

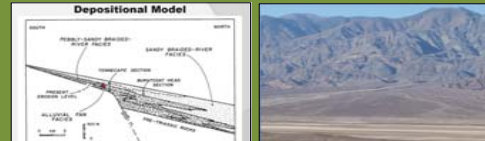


Figure 12: Red star indicates hypothesized paleo-location of study area



Figure 13: Modern analogue of Cambridge Cove depositional environment (Death Valley, California). Source: <http://static.earthtimes.com>

## Reservoir Compartmentalization

- Stratigraphy
  - Permeability Results of Lithofacies
  - Baffles and Barriers
- Structural
  - Faults & Joints
  - Sealing Faults
  - Transmissive Faults
- Simulated Fluid Flow
  - Stratigraphic & Structural Compartmentalization



Figure 14: Structural compartmentalization



Figure 15: Structural and Stratigraphic compartmentalization



Figure 17: Simulated fluid flow during extraction

## Conclusions

- Four principle lithofacies have been identified in the Wolfville Formation at Cambridge Cove
- Architectural elements and structural features of the outcrop were identified, and a braided channel depositional model was constructed
- Two types of faults were identified:
  1. sealing faults that act as baffles or barriers to flow
  2. transmissive faults that can allow lateral and vertical migration flow
- Structural features within the study play a role in fluid migration by:
  1. increasing reservoir compartmentalization through the development of bedform offsets which cause noncommunication between the thick barforms and channel bodies
  2. enhancing vertical fluid flow within the reservoir by creating vertical migration pathways along the fault surfaces
- This study demonstrated how bedrock outcrop analysis can be used to characterize a basin's geologic structure and provide data for the strategic planning of potential hydrocarbon development and CO<sub>2</sub> sequestration.

References  
 Greenborough, J.D. 1995. Mesozoic rocks. In *Geology of the Appalachian-Caledonian Orogen in Canada and Greenland*. Edited by H. Williams. Geological Survey of Canada, Geology of Canada, no. 6, pp. 567 - 600.  
 Kettani, Mohamed. 2007. Reservoir Quality, Diagenetic History and Provenance of the Late Triassic sandstones of the Wolfville Formation, Cambridge Cove, Bay of Fundy, Nova Scotia. Co-op Summer Work Terms I Report, Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia, Canada.

