Trends and Architecture of the Bluestone Formation Turbidites in Point Pleasant Park, Halifax, Nova Scotia

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Abstract

In the Meguma Supergroup, a series of sandy and shaly intervals formed in a range of depositional environments from deltaic to deepwater. The Lower Ordovician Bluestone Fm. in Point Pleasant Park on the Halifax Peninsula is part of the Halifax Group. Prior studies examined the regional geology, micropaleontology, and metamorphism but paid little attention to the sedimentology of these outcrops, in part due to the metamorphic overprint that can obscure primary physical sedimentary structures. The goal of this project was to interpret the depositional environment of these sediments and understand their distribution and architecture. Data were collected at outcrops along the Northwest Arm, Black Rock Beach, the Battery, and Sailors' Memorial Road to investigate the geometry and architecture of the studied sections. Data collection included measuring and logging sections, paleocurrent measurements from such features as tool marks and current ripples, petrographic analysis, scintillometer measurements to create synthetic gamma logs, LiDAR to develop 3D geological models in Polyworks and Petrel. The strata comprise mainly quartz, mica, zircon and tourmaline, and shows five lithofacies. These lithofacies make up a cyclic lithofacies association which is separated by sharp or scoured contacts. Scintillometer analysis showed no apparent relationship to lithology, likely due to the moderate metamorphism throughout the Meguma Supergroup. Interpretation suggested that the lithofacies association is characteristic of the Bouma sequence T_{a-e} and represents low density turbidites. Current ripples on bedding planes indicate the paleocurrent was towards the northwest. The beds fine and become thinner towards the top of the outcrop and lithofacies like meta sandy-siltstone ripples, and structureless silty slate to slate become more dominant, due to the reduction of sediment supply. Lithofacies and sedimentary structures seen in the outcrop, suggest these sediments were deposited from hypopycnal flows associated with low density turbidite, on the distal overbank and levees of channels.

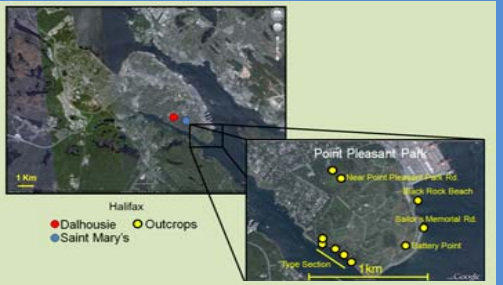

Figure 1: Study area, (maps retrieved from Google Maps, March 2010).

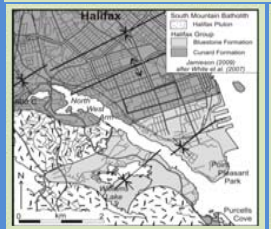

Figure 2: Bedrock geology map of study area (modified from Jamieson, 2008).

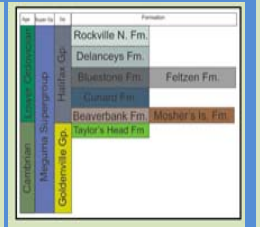

Figure 3: Stratigraphic column of Meguma Supergroup (modified from Schenk, 1997).

Figure 4: Fine grained turbidite model.

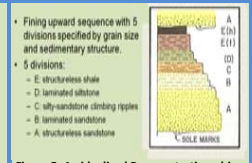

Figure 5: An idealized Bouma stratigraphic column (modified from Bouma, 1962)

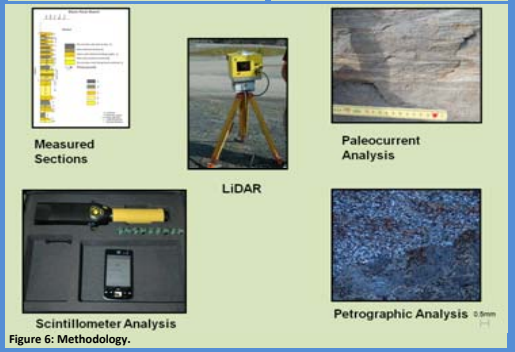

Figure 6: Methodology.

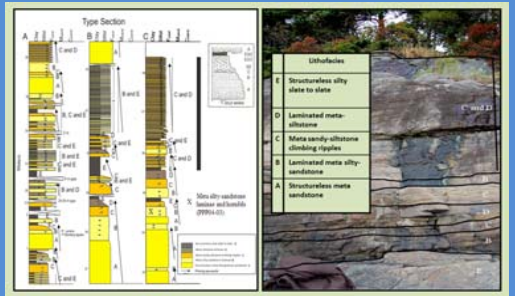

Figure 7: Sedimentological type section along the NW arm.

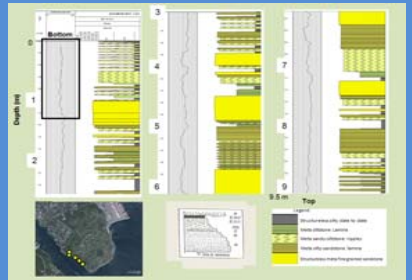

Figure 8: Scintillometer/ Gamma Ray analysis.

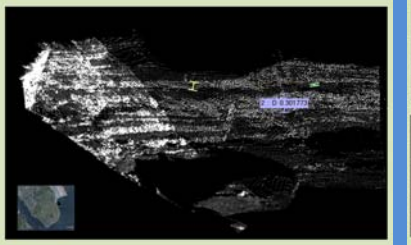

Figure 9: Lidar (Light Detection and Ranging) image of Black Rock Beach outcrop.

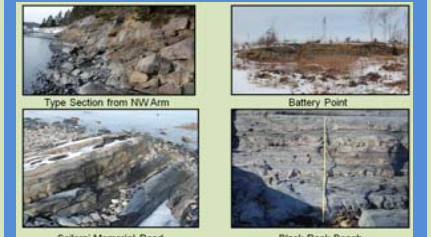

Figure 10: Outcrops in Point Pleasant Park

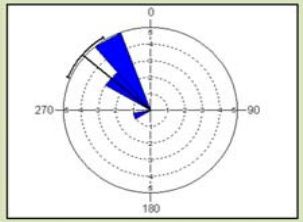

Figure 11: Paleocurrent orientation as determined from the evaluation of current ripples (310° NW +/- 22°).

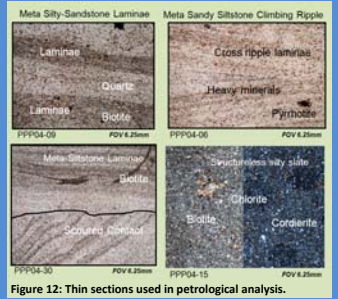

Figure 12: Thin sections used in petrological analysis.

Figure 13: The Meguma terrane deposition.

Conclusions

Analysis of the Bluestone Formation outcrops at Point Pleasant Park demonstrate these outcrops contain lithofacies that are characteristic of the divisions of the Bouma sequence and suggest these sediments were deposited as overbank low density turbidites. Petrographic analysis of the lithofacies show the growth of cordierite and indicate the protolith was mud rich. Metamorphism enhanced sedimentary structures but conversely limited accurate grain size identification.

The location of the Bluestone Formation was associated with the Acadian Orogeny in the Devonian and Jurassic (Piper et al., 2010; Schenk, 1975). Paleocurrents show turbiditic flow was northwest, confirmed by earlier regional studies (Waldron 1987; Schenk 1975).

If we conclude that these outcrops were deposited as overbank deposits, where are the associated channel sands? These sands are not seen within or near the park so more work needs to be done to locate the channel sands that came from the same turbiditic flows that these finer grained sediments originated; or are the sediments from distal flows down dip or lateral to channelized inner for deposition.

The study shows that application of new techniques (e.g. LiDAR) helps to define the architectural elements, however standard methods including measured sections, sedimentologic and petrographic analysis provide the ground data for calibration of LiDAR and scintillometer analysis. Recommendations for future study include a similar study on the Cunard Formation and the Taylors' Head Formation of the Goldenville Group to compare the sedimentological characteristics of the low density turbidities between the Bluestone and the Cunard with high density turbidites of Taylors' Head Formation. This could help 1) refine the Paleozoic depositional model for the Meguma Supergroup and 2) develop a broader depositional analogue for the offshore Nova Scotia Mesozoic strata

References

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Acknowledgements

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