Litho-Tectonic Features of the Early Mesozoic Grand Manan Basin, New Brunswick and Maine

J. Gregory McHone

1. ABSTRACT

LITHO-TECTONIC FEATURES OF THE EARLY MESOZOIC GRAND MANAN BASIN, NEW BRUNSWICK AND MAINE

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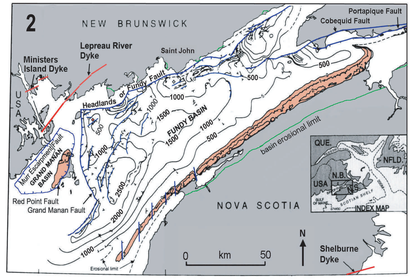
The island of Grand Manan in the southwestern Bay of Fundy exposes strata and basalt of the Grand Manan Basin, an Early Mesozoic rift basin about 30 km wide by 70 km long that is mostly submerged along the border of New Brunswick and Maine. On the eastern side of Grand Manan and its archipelago, the fault-bounded White Head Horst exposes Ediacaran to Cambrian basement rocks between the small basin and the much larger Fundy Basin, which has a similar Triassic stratigraphy. End-Triassic (201.3 Ma) Dark Harbour Basalt covers western Grand Manan with a thickness around 240 m, but it is probably missing from erosion in most of the submerged basin. Up to 12 m of sub-horizontal lacustrine grey mudstone and red sandstone of the Late Triassic Dwellys Cove Formation are exposed along the western shoreline beneath the basalt, and the sediment probably forms most of the seafloor bedrock of the basin. These uppermost formation strata and overlying basalt represent the top of tectono-stratigraphic unit TS-III and lower part of TS-IV. A few metres of conglomeratic fluvial red sandstone (Late Permian? TS-I) at Miller Pond Road rest on a basement of Cambrian argillite immediately east of the basin.

Several unusual features of the Grand Manan Basin set it apart from most Early Mesozoic rift basins in eastern North America. The basin is bounded on opposite sides by normal faults with similar vertical displacements, so strata at Grand Manan are not tilted as in a half-graben. The Miller Pond Road arkose is probably a remnant of the base of basin strata now perched on the horst, and juxtaposed by the border fault to nearly the same level as the top of Dwellys Cove mudstone to the west. Thus by amazing coincidence, the vertical offset of the border fault must nearly match the thickness of Permian/Triassic sub-basalt basin formations, estimated at 3 km.

2. THE GRAND MANAN BASIN HAS A TECTONIC HISTORY THAT SEPARATES IT FROM THE FUNDY BASIN

Basalt and strata of the Fundy Basin thicken toward the southwest-central area, tilting down to the NW in Nova Scotia, and with border faults only on the northern and western sides. There is no indication of strata tilt at Grand Manan, and its basin has border faults on both sides. Border faults in both basins truncate basalt and strata, but with much less down-drop in the Grand Manan Basin.

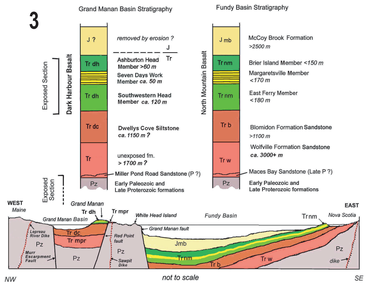


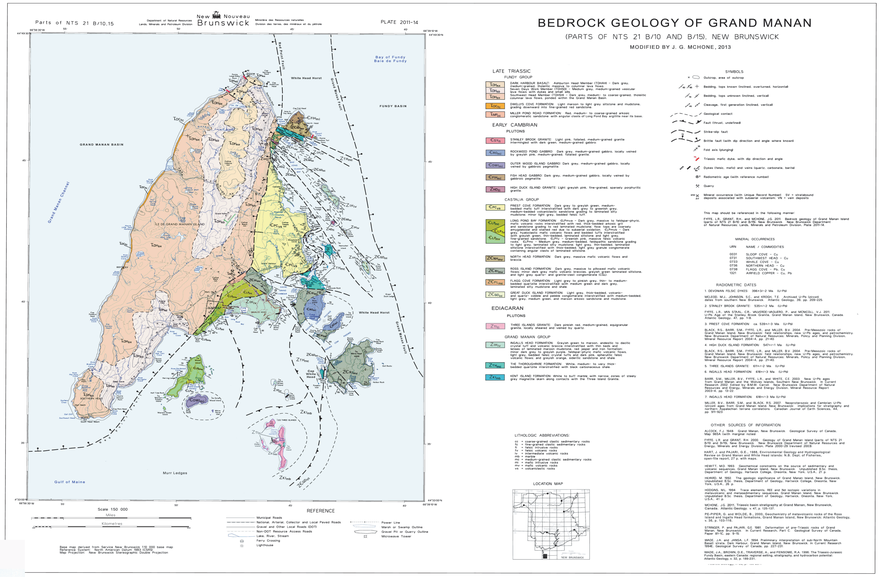
Structure contours (depth to top) of the North Mountain Basalt. After Fig. 15 of Wade et al 1996.

3. THE GRAND MANAN BASIN HAS A LITHO-STRATIGRAPHIC HISTORY THAT CONNECTS IT TO THE FUNDY BASIN

Basalt and strata beneath the basalt are similar in both the Grand Manan and Fundy basins, where they can be observed. Thicknesses vary but are probably greater in the Fundy Basin. A lack of any seismic profile in the Grand Manan Basin makes it hard to compare their strata, but it appears to lack the sag and tilt of Fundy Basin formations.

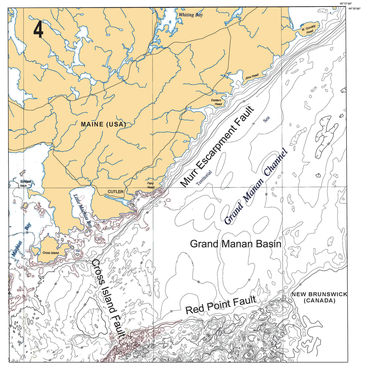
Mesozoic Stratigraphy and Cross Section, Southwestern Bay of Fundy





4. SEA FLOOR FAULT TOPOGRAPHY OUTLINES THE WESTERN BASIN

Bathymetry shows a relatively flat sea floor for the basin, around 80 m deep. Steep and abrupt fault scarps mark the northwestern, southwestern, and southeastern basin borders. Modified from Dickson et al. 1994.

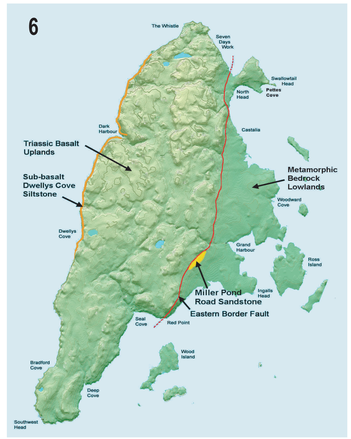


5. THE EASTERN BASIN BORDER FAULT IS WELL EXPOSED

At Red Point the border fault is exposed in a wave-cut shoreline bank, with drag-folded Triassic Dark Harbour Basalt (left side) down against Cambrian ? Long Pond Bay argillite. The top of strata beneath this level of the basalt is about 90 meters below the beach. The view is to the NW.

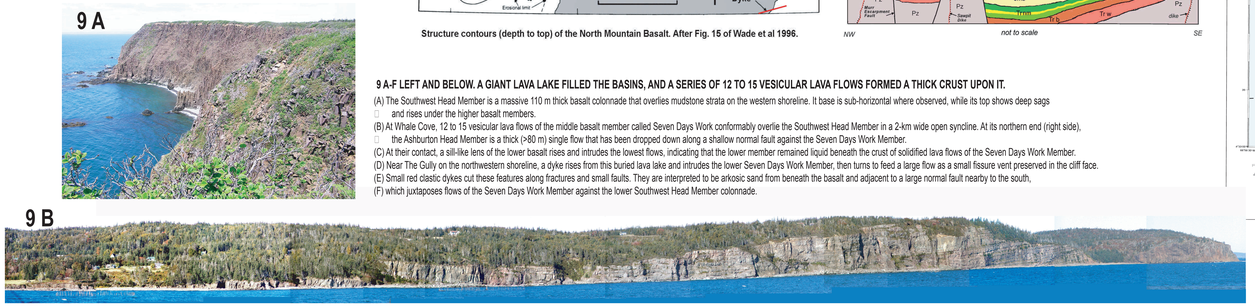
6. BASIN ROCKS ON GRAND MANAN OVERLIE ADJACENT BASEMENT ROCKS

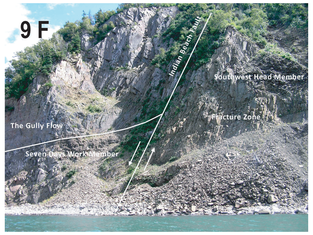
The Red Point Fault on Grand Manan divides a western hilly upland made by late Tr Dark Harbour Basalt from a low and level eastern peneplain of Ediacaran to Cambrian meta-volcaniclastics, argillite, phyllite, quartzite, and meta-basalt. Could this be a relict Triassic surface only recently exhumed?



9 A-F LEFT AND BELOW. A GIANT LAVA LAKE FILLED THE BASINS, AND A SERIES OF 12 TO 15 VESICULAR LAVA FLOWS FORMED A THICK CRUST UPON IT.

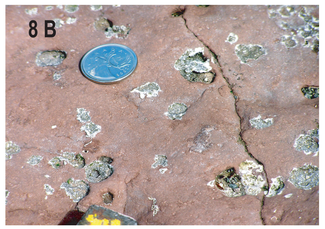
(A) The Southwest Head Member is a massive 110 m thick basalt colonnade that overlies mudstone strata on the western shoreline. It base is sub-horizontal where observed, while its top shows deep sags and rises under the higher basalt members.
(B) At Whale Cove, 12 to 15 vesicular lava flows of the middle basalt member called Seven Days Work conformably overlie the Southwest Head Member in a 2-km wide open syncline. At its northern end (right side), the Ashburton Head Member is a thick (>80 m) single flow that has been dropped down along a shallow normal fault against the Seven Days Work Member.
(C) At their contact, a sill-like lens of the lower basalt rises and intrudes the lowest flows, indicating that the lower member remained liquid beneath the crust of solidified lava flows of the Seven Days Work Member.
(D) Near The Gully on the northwestern shoreline, a dyke rises from this buried lava lake and intrudes the lower Seven Days Work Member, then turns to feed a large flow as a small fissure vent preserved in the cliff face.
(E) Small red clastic dykes cut these features along fractures and small faults. They are interpreted to be arkosic sand from beneath the basalt and adjacent to a large normal fault nearby to the south,
(F) which juxtaposes flows of the Seven Days Work Member against the lower Southwest Head Member colonnade.

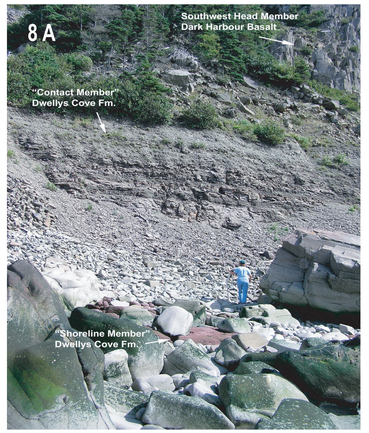




8 A-C BELOW. DWELLYS COVE SILTSTONE AND SANDSTONE ARE IN CONTACT WITH DARK HARBOUR BASALT ON THE WESTERN SHORELINE

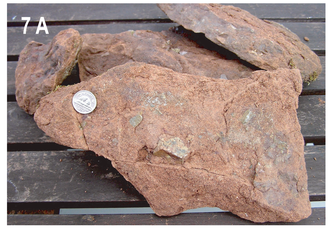
The Dwellys Cove Formation is equivalent to the Blomidon Formation of the Fundy Basin to the northeast. The "contact member" of shale and siltstone is about 7 to 12 m thick (A) and bounds abruptly below with red sandstone ("shoreline member"), which is pock marked with evaporite minerals (B) as exposed at one place along the shoreline. The contact member shows light and dark layering or Milankovich Cycles (C). Bedding and the contact are sub-horizontal, with dips up a few degrees that vary in direction.

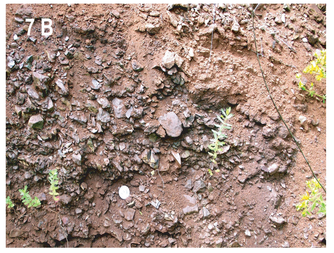




7 A-B. BASAL ARKOSE MERGES WITH BASEMENT ROCKS

Poorly cemented medium grained arkosic red sandstone with sharpstone clasts (A) has a single exposure near Miller Pond Road. It is east of the Red Point Fault and grades downward into a substrate of angular clasts of Early Cambrian (?) Long Pong Bay argillite (B).





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