LAVA STRUCTURES AND EMPLACEMENT OF NORTH MOUNTAIN BASALT AT GRAND MANAN ISLAND, BAY OF FUNDY, NEW BRUNSWICK

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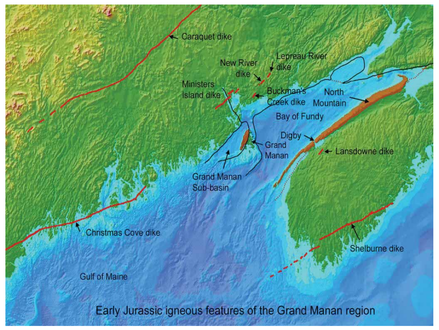
ABSTRACT

The North Mountain Basalt of the Early Mesozoic Fundy basin between New Brunswick and Nova Scotia is one of the world's largest lava flows at 6,600 km3, but only a small part of the enormous circa-200 Ma Central Atlantic Magmatic Province. The lava was ponded into the wide basin valley, with thicknesses of 300 to 400 m along the eroded margins and up to 1,000 m in the south-central area of the basin. The original flow probably extended beyond the present basin.

Three distinct basalt members, displayed along the western shore of Nova Scotia and also on Grand Manan Island in the southwestern end of the basin, consist of a lower unit of massive, dense, columnar basalt up to 190 m thick, overlain by a middle member of 9 or 10 amygduloidal flows and sills, each about 3 to 7 m thick and totaling about 50 m. Some middle member strata show distinct flow tops and basal contacts with pipe vesicles. Above them is about 90 m of coarse to porphyritic columnar basalt, which forms the third or upper member.

Rather than forming independently in a sequence of fissure eruptions, the basalt members and strata are co-magmatic expressions of the same gigantic ponded flow, as shown in spectacular outcrops on Grand Manan Island. The massive lower flow unit produced the initial middle member flow as a gas bubble-rich crust, and additional amygduloidal layers overran this crust as gas-rich extrusive surges from the upper levels of the lower member. Intrusions from the lower member also crosscut the middle flows, including a large dike that bends to be a sill within the amygduloidal flows. The entire middle-flow package was later breached and overflowed by a massive extrusion of magma from the lower member, which produced the third or upper member.

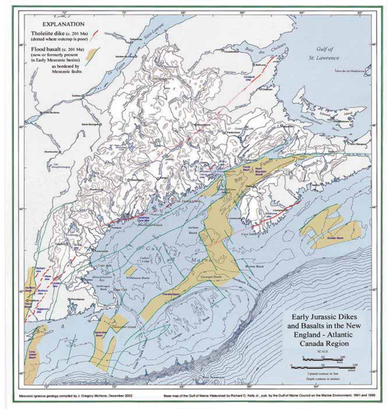
The North Mountain Basalt members and structures may reflect eruptive surges from one or more volcanic fissures beneath the western side of this immense lava flow. The surges were events of magmatic inflation of the liquid interior of the lower flow, each of which fed syn-magmatic flows into and over its amygduloidal surface layers



Early Jurassic igneous features of the Grand Manan region

The lower member is well exposed in cliffs of 60 to 120 meters in height along the western shoreline. Here at Southwest Head, it is apparent that this flow forms a single colonnade without entablature, with an appearance similar to large sills such as the Palisades Sill of New Jersey. Even so, it is a flow, not a sill.

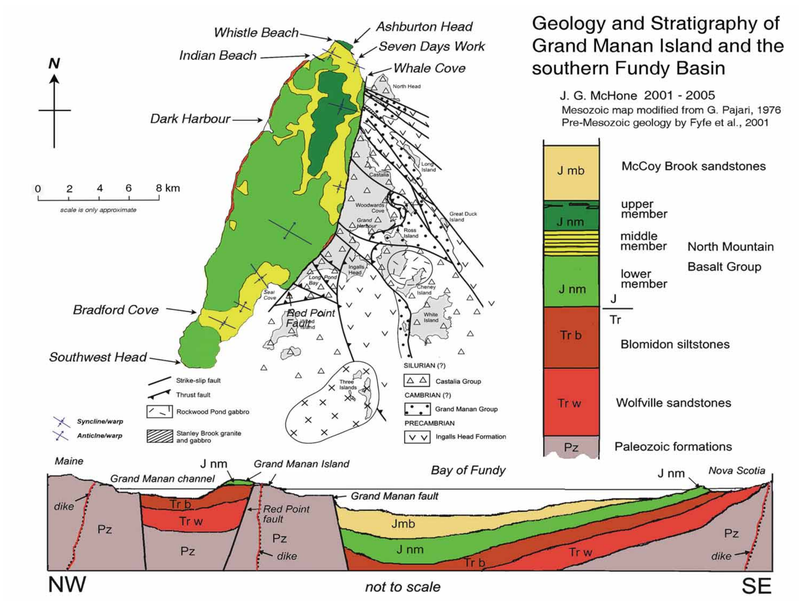
The base of the lower member is exposed in long stretches of the shoreline NE and SW of Dark Harbour. The Blomidon siltstone beneath the basalt is fine grained and gray to brick-red in color, except in a thin bleached zone directly beneath the basalt (lower center of photo).



The Fundy Basin is one of several on- and off-shore Early Mesozic continental basins in the region. The basins contain Late Triassic to Early Jurassic clastic fluvial and lacustrine sediments, and one to three thick tholeiite lave flows a few meters above the Tr-J boundary horizons. As shown by Philpotts and Martello (1986), the basalt flows are each derived from giant fissure dike systems the stretch from Connecticut toward Atlantic Canada. The earliest of the basalt flows is represented in all of the basins, and it appears to be derived from the Higganum-Christmas Cove dike system. In the Findy basin, this is the North Mountain basalt..

Pahoehoe flow lobes (above) attest to the fluid nature of some of the middle member flows at Seven Days Work. A large arch (below) at Bradford Cove is probably a tumulus, which is caused by inflation pressure of a lava tube or fluid interior of a middle-member flow.

Dikes and sills cut upward into and along the middle member flows at Seven Days Work. The intrusions are interpreted to be from the still-molten interior of the lower member beneath the middle member flows. One of the dikes has expanded to form a lava tube, now eroded into a small cave (below). The dike continues up the cliff above the tube.



Geology and Stratigraphy of Grand Manan Island and the southern Fundy Basin

J. G. McHone 2001 - 2005
Mesozoic map modified from G. Pajari, 1976
Pre-Mesozoic geology by Fyfe et al., 2001

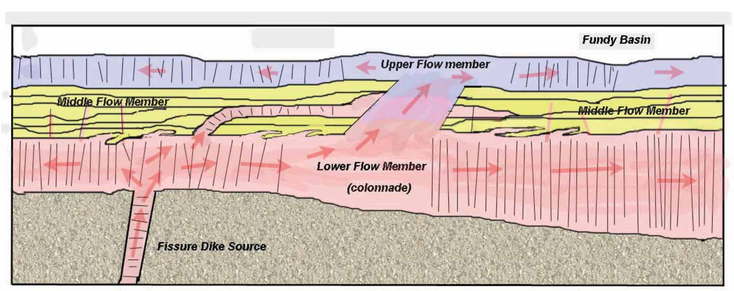
J mb	McCoy Brook sandstones	
J nm	upper member	North Mountain Basalt Group
J nm	middle member	
J nm	lower member	
J Tr		
Tr b	Blomidon siltstones	
Tr w	Wolfville sandstones	
Pz	Paleozoic formations	

A large-displacement fault at Red Point separates the North Mountain basalts from metamorphic basement rocks that underlie the entire Fundy basin strata (right). A least several hundred meters of displacement is indicated. The fault is the eastern border of the Grand Manan sub-basin or graben, and the basement rocks to its east form a horst.

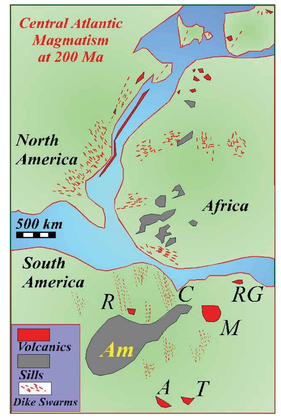
Columns of the lower member colonnade are bent in a drag fold, from near-vertical to about 20 degrees of tilt within 20 m of the fault, which also indicates normal faulting.

The upper member is a flow over the middle member in the photo above, at a site near Indian Beach. The entire cliff has slid down a fault to the right of the photo, causing the bent layers or drag fold visible toward the right side. The rocks to the right of the fault are apparently of the lower member.

The contact between the lower and middle members at Whale Cove (above) is conformable but interfingered. The lowest "flow" of the middle member is the vesicular or bubble-rich top of the massive lower member. Most of the other flows of the middle member are identical to this lowest flow, and as is evident at Seven Days Work, were extruded as dikes, sills, and flows emitted from the lower unit.



We welcome visitors to our summer cottage at 9 Dexters Lane, North Head. Let us know if you are in the area.



The North Mountain basalt is a member of the vast Central Atlantic Magmatic Province or CAMP (Marzoil et al, 1999). The CAMP extends across 11 million km2 with dikes, sills, and flows, all within a few million years of 200 Ma in age.

The upper basalt member at Ashburton Head (right) overlies the middle member at Seven Days Work (left).

Dear Whistle Beach, what was thought to be a fault bnetween the middle (above, lower right) and upper (above left) members) is actually an igneous contact, as shown by the pipe vesicles in the upper member (closeup below). The new interpretation is that the upper member flowed up the "fault" surface in an intrusive, cross-cutting relationship. This magma also must have come from the liquid interior of the lower member, but after the middle member had formed as a composite of thin flows and sills.

In this cartoon (left), surges from the dike fissure have produced a series of thin vesicular (bubble-rich) flow tops that form the middle member. The fissure dike injected additional magma to inflate the lower flow, until it eventually cut across the middle flow member to produce the upper member, as well as additional smaller dikes and sills within the mddle member.

A large dike (above) cuts the flows of the middle member near Indian Beach. The dike bends to the left (NE) to become one of the "flows," actually a sill, within the middle member of the cliff in the photo below. The SW contact of the dike has a chill zone being examined by Tony Philotts (bottom photo).