

# Stratigraphy and Architecture of the late Silurian Bass Islands Formation, Southwestern Ontario

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## Introduction and Approach

The Bass Islands Fm consists of grey-buff, variably laminated, argillaceous dolostones, with minor shales and evaporites (Armstrong and Carter 2010). Paleokarstic features are present and fossils are rare. The karstic features contribute to its high porosity as major groundwater flow zone in SW Ontario. Basal microbialites and shaly dolomites of the Bass Islands Formation overly the Salina G grey shale with anhydrite nodules. The Bass Islands Formation is overlain by either Devonian Bois Blanc cherty carbonates or Oriskany siliciclastic sandstones. The contact represents an irregular unconformity surface that delineates the Silurian-Devonian hiatus of a few million years (Johnson et al. 1992).

The objective of this study is to describe the depositional environments and paleokarstic features related to bedrock aquifer systems and to establish a 3D subsurface architecture of Bass Islands Fm based upon outcrops and regional cores.

The approach comprises the logging and sampling of 39 continuous cores across southwestern Ontario integrated with downhole geophysics data. Lithofacies characterization has been carried out within a sequence stratigraphic framework across the cratonic forebulge region with emphasis on depositional breaks related to bedrock aquifers.

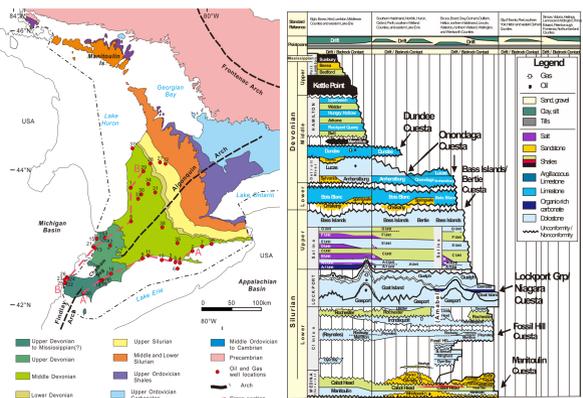


Figure 1: Stratigraphy distribution map and well locations in the study area (Modified from Armstrong and Carter 2010).

## Lithology and Stratigraphy

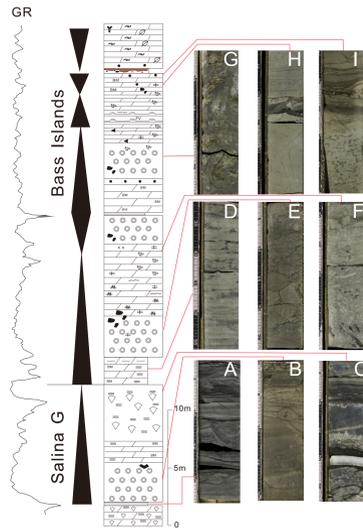


Figure 3: Lithofacies of core 16 (OGS 82-2).

The Bass Islands Fm is dominated by sabkha facies - comprising microbialites, argillaceous dolostone, anhydrite nodules and subaerial sedimentary structures. Shallowing upward cycles (3-5m thick) comprise subtidal massive dolostones through intertidal to supratidal microbialites possessing evaporite laths and anhydrite nodules. **A.** Salina G shaly dolostone with common collapse structures - bedding is distorted due to sulfate dissolution. **B.** Argillaceous dolostone. Note the dolostone nodule in the middle. **C.** Anhydrite nodules encrusted by crinkly laminated algal laminites. **D.** Microbialites with blue fenestrae mottles at base of Bass Islands Fm. **E.** Brecciated dolostone. **F.** Caliche deposits representing subaerial exposure. **G.** Recrystallized dolostone, matrix is partially recrystallized. **H.** Karstic conduit infilled by Devonian siliciclastic sands - 1.4m beneath the S-D contact. **I.** S-D erosional surface overlain by subround dolostone clasts - sinkhole infills.

## Cross-Sections

Along the Lake Erie shoreline the thickness of Bass Islands Fm. varies from 18m to 25m. It thickens to 32m towards Lake Huron area. The Bass Islands overlies Salina G Unit by a basal shale or shaly dolostone, which can be recognized as a positive excursion in gamma ray logs. In the middle Bass Islands, thin interbeds of shaly laminites are present and can be correlated regionally. The "False G" unit in the lower Bass Islands is corrected as the top of "Salina G" unit, which has a similar lithology and GR response to the Salina G in Ohio. Where the Bass Islands is thinner, the overlying Devonian sandstones can reach 30m thick (e.g. in core U.S. Steel No.1), suggesting the windblown Devonian siliciclastic sandstone is probably present as infills in paleo-topographic lows in the karstic paleotopographic surface of top Bass Islands.

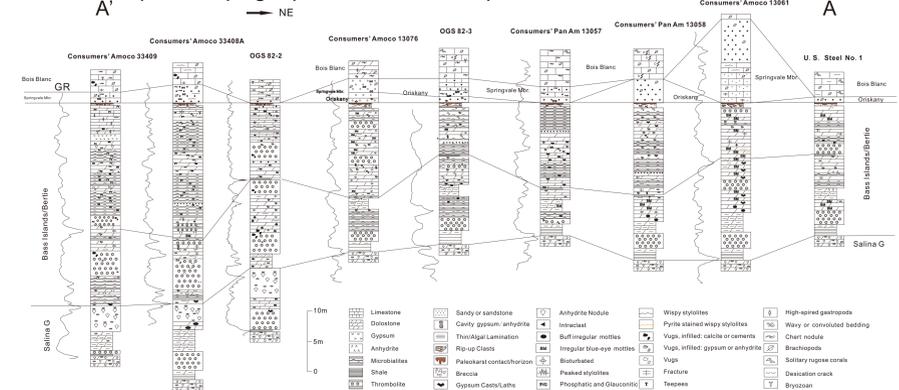


Figure 6: Stratigraphic cross section A-A' showing the lithofacies distribution at the S/D contact from Niagara through along the western Lake Erie to Essex County.

## Paleokarstic Features

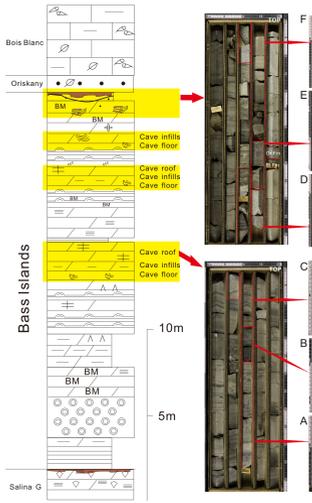


Figure 4: Lithologic logging of Core 1 (U.S. Steel No.1) along Lake Erie, Bass Islands.

Karstic features are readily visible in core No.1 (U.S. Steel No.1). Lower cave system comprises: **A. Cave floor.** Irregular, subangular microbialite clasts are cemented by recrystallized dolostone. Replacement of pre-existing evaporites and laminite breccias. **B. Cave infills.** Dark grey shales and a caliche unit overlie the cave floor breccias sharply. Shaly contents may be the undissolved residues in cave. **C. Cave roof.** Mosaic dolostones and crackle fractures are present, formed by gravity and pore water dissolution. Upper interval directly beneath the S/D contact shows a succession of epikarst features. **D. Burrowing trace fossil.** *Thalassinoides* burrowed dolostones form a caprock facies of the Bass Islands. **E. Oriskany siliciclastic sandstone clasts.** Subangular Devonian siliciclastic sands cemented in Silurian dolomites. A karstic conduit enables the sand grains to infiltrate downward into the Silurian strata. **F. Bleached dolostone.** Massive, very porous, light buff dolostone. Porosity is highlighted by meteoric dissolution.

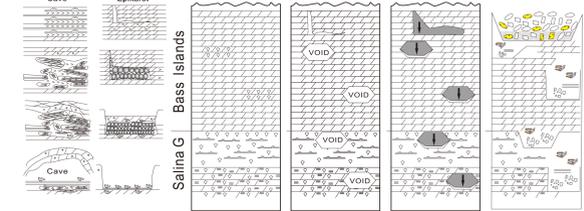


Figure 5: Karstification model of Bass Islands Formation

The karstic features may have been formed by the dissolution of evaporites and host dolomites both during and after the deposition of Bass Islands. Crinkly laminated microbialites act as aquitards for underlying water flow to dissolve the anhydrite/gypsum nodules. The fluctuation of water table may also dissolve the underlying evaporites in the Salina Group strata and form the collapse structures and caves in Bass Islands. Devonian siliciclastic clasts can be found both at the S-D contact and in karstic conduits, suggesting an extended post-Oriskany karstification phase. The later Acadian Orogeny uplift and modern glacial-deglacial events may have influenced karstification of paleokarst rock units.

## Summary and Future Work

1. Bass Islands is interpreted as being deposited in a coastal environment.
2. Two paleokarstic intervals can be recognized: the lower one was mainly controlled by the dissolution of evaporites and the upper one was formed by epikarst process and erosional events during S-D hiatus - spanning a few million years.
3. The varied thickness of the Bass Islands Fm. regionally may have been influenced by the dissolution of both Salina and Bass Islands evaporites.
4. Future work includes the regional correlation using stable isotope.

## Acknowledgement

Jordan Clark and the staff in OGSR Library are thanked for the help with core handling, photography and geochemistry sampling. Derek Armstrong is acknowledged for guidance in field trips. S. Sun acknowledges the China Scholarship Council, NSERC, the Ontario Geological Survey and University of Western Ontario for financial support.

## Reference

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