Shale Gas Opportunities in Southern Ontario – an Update

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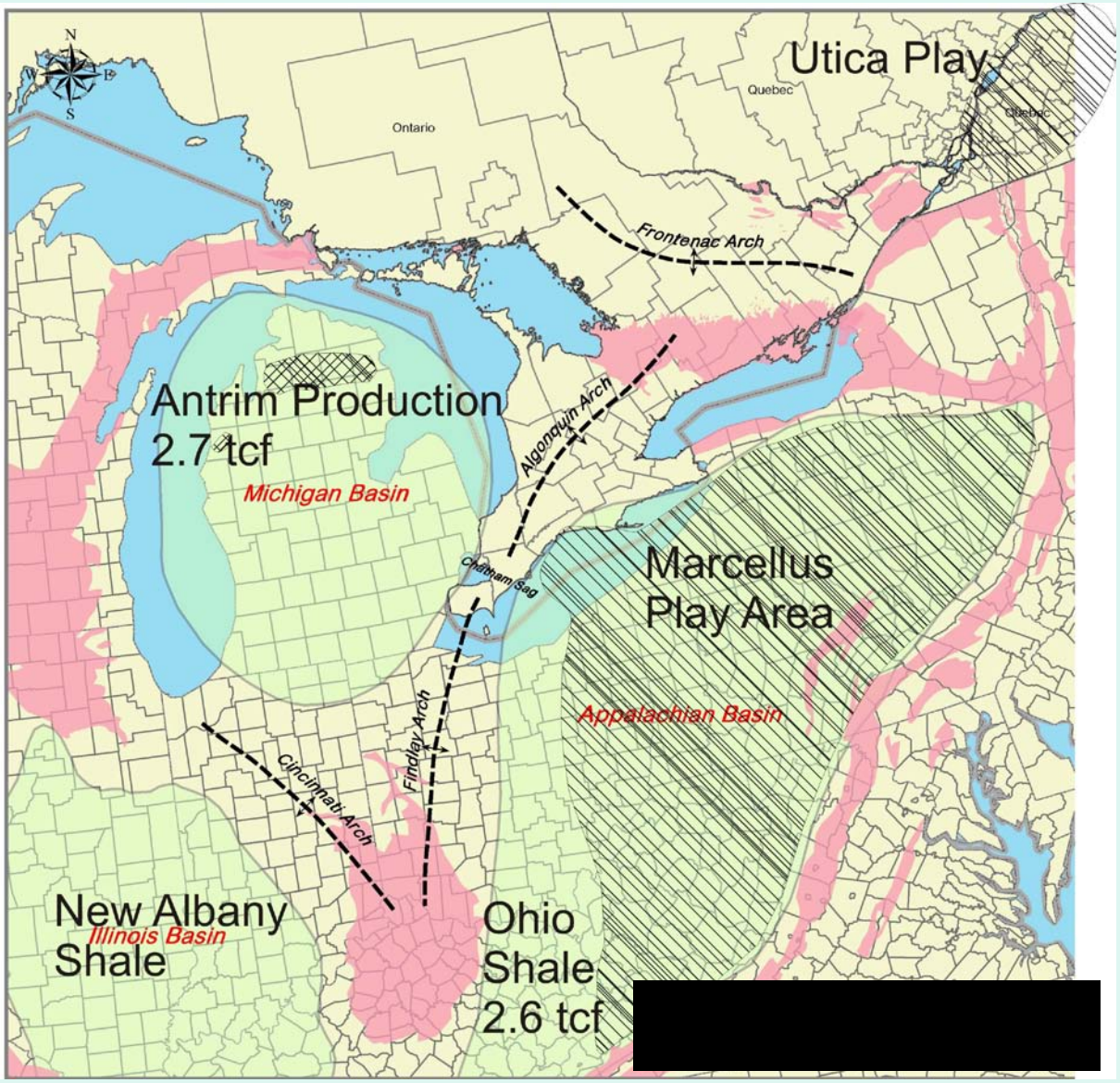
Regional Geological Setting and Shale Gas Plays



Potential gas shales in Ontario

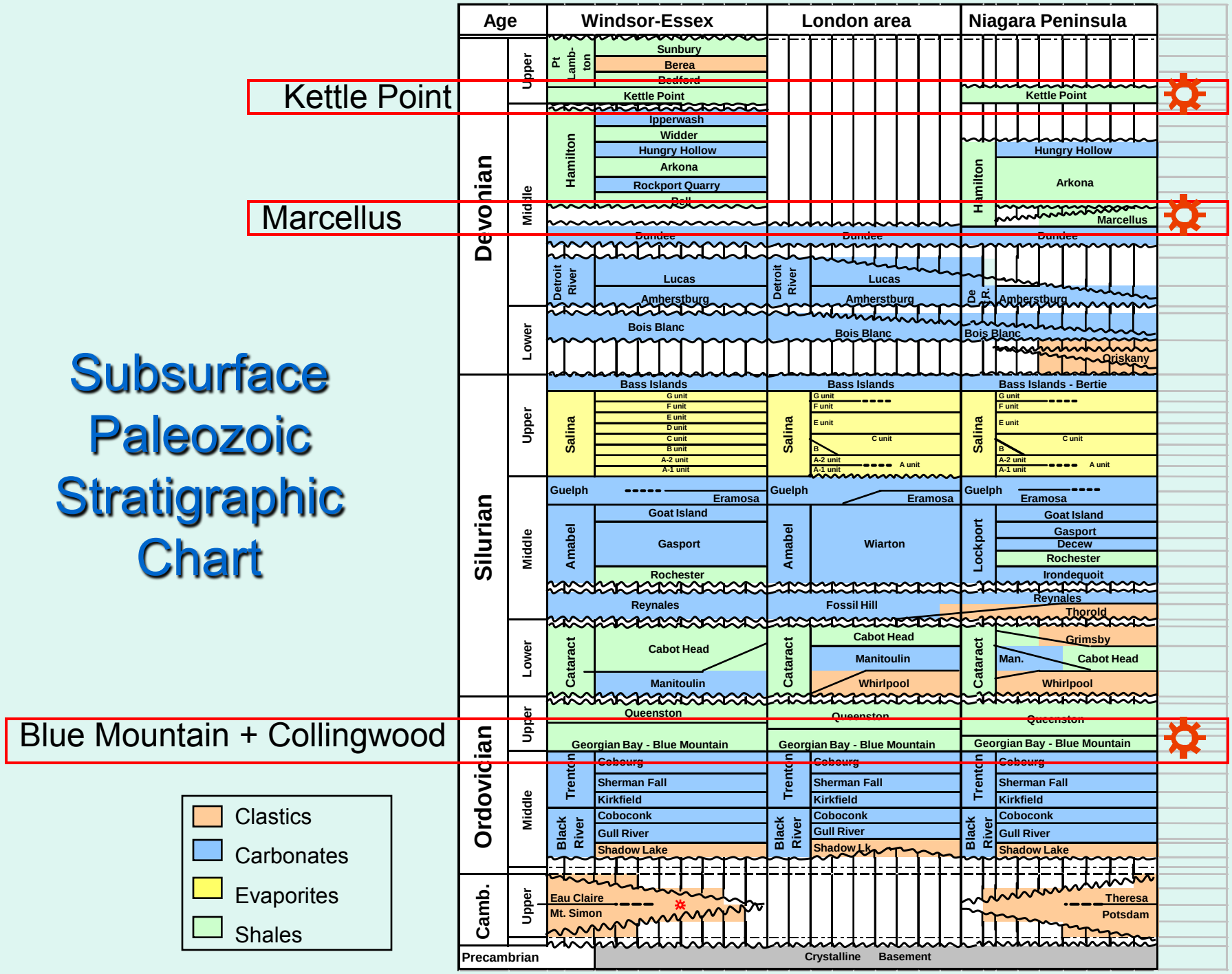
Same plays as in NE U.S. and Quebec

Best potential in:

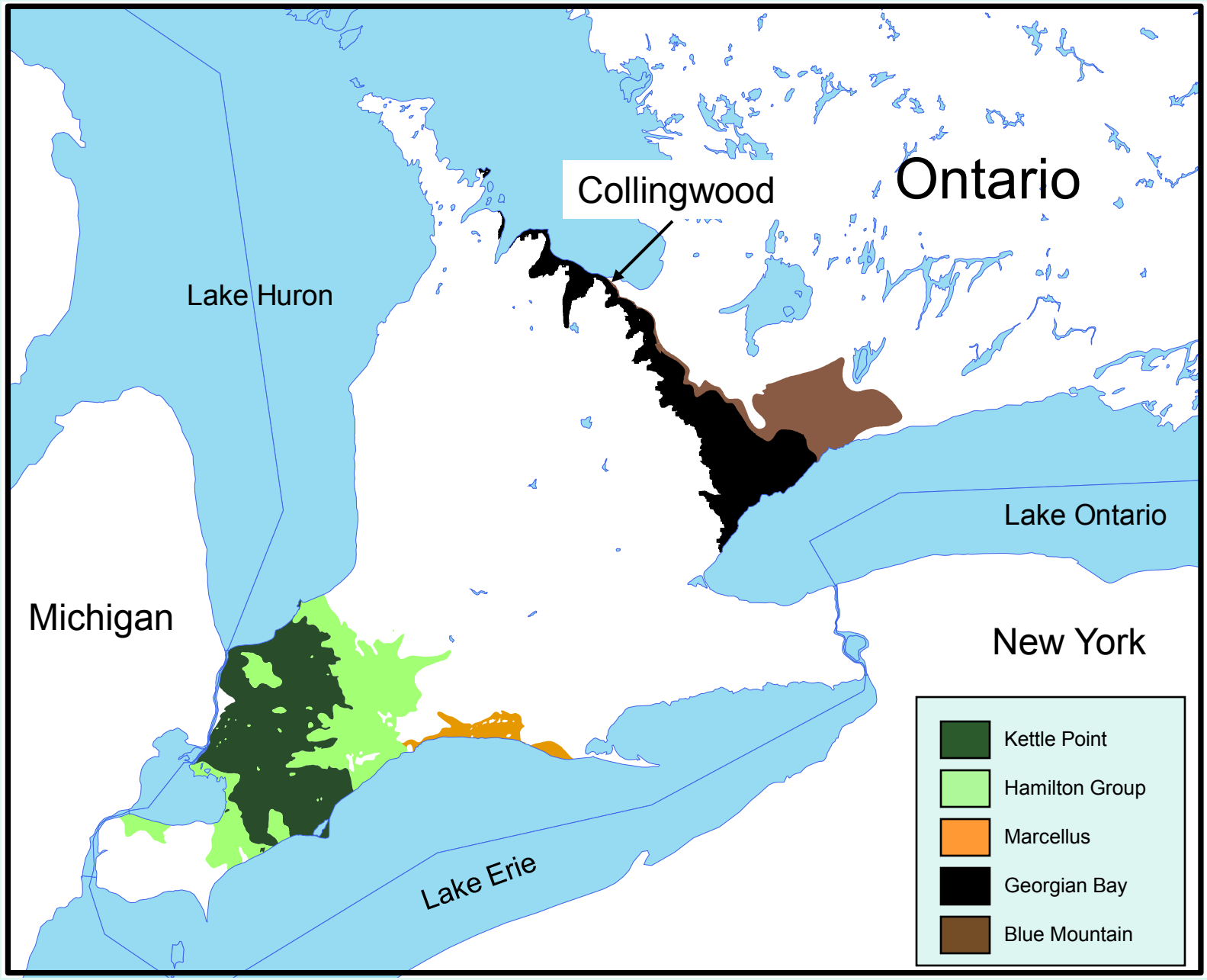
- U. Devonian Kettle Point Fm (Antrim shale equivalent)
- M. Devonian Marcellus Formation
- U. Ordovician Blue Mountain Formation and Collingwood shale (Utica equivalents)

- Gas shows, no current production
- Unexplored (only one shale gas exploratory well)
- Large prospective areas

Subsurface Paleozoic Stratigraphic Chart



Potential Gas Shales in Southern Ontario - outcrop



Georgian Bay-Blue Mountain / Collingwood outcrop

Blue Mountain / Collingwood (Utica)

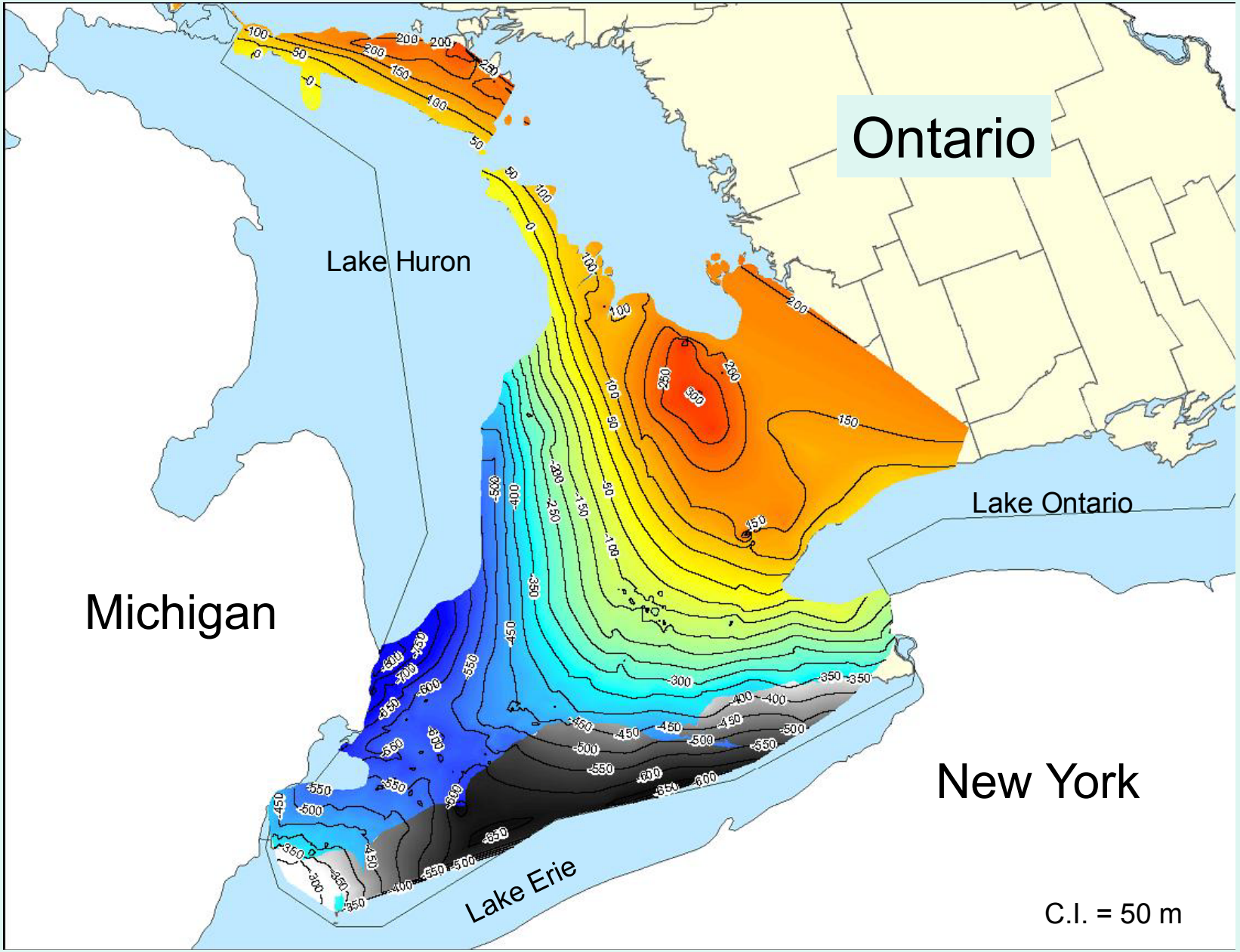
- **Collingwood**
  - Calcareous shale; average thickness 4 to 6 m, max 12 m
  - TOC: 1 to 11%, marginally mature to mature
  - Depth to top: outcrop - 175 m
  - 25,000 km^2
  - Attempts to extract oil in 1860's
- **Blue Mountain Formation**
  - Unsubdivided Georgian Bay-Blue Mountain Formation in subsurface
  - Non-calcareous shale approximately 75 m thick
  - Lowermost 2 to 50 m is black organic-rich with up to 3 % TOC
  - Depth to top: outcrop - 1000 m
  - 70,000 km^2

Blue Mountain / Collingwood

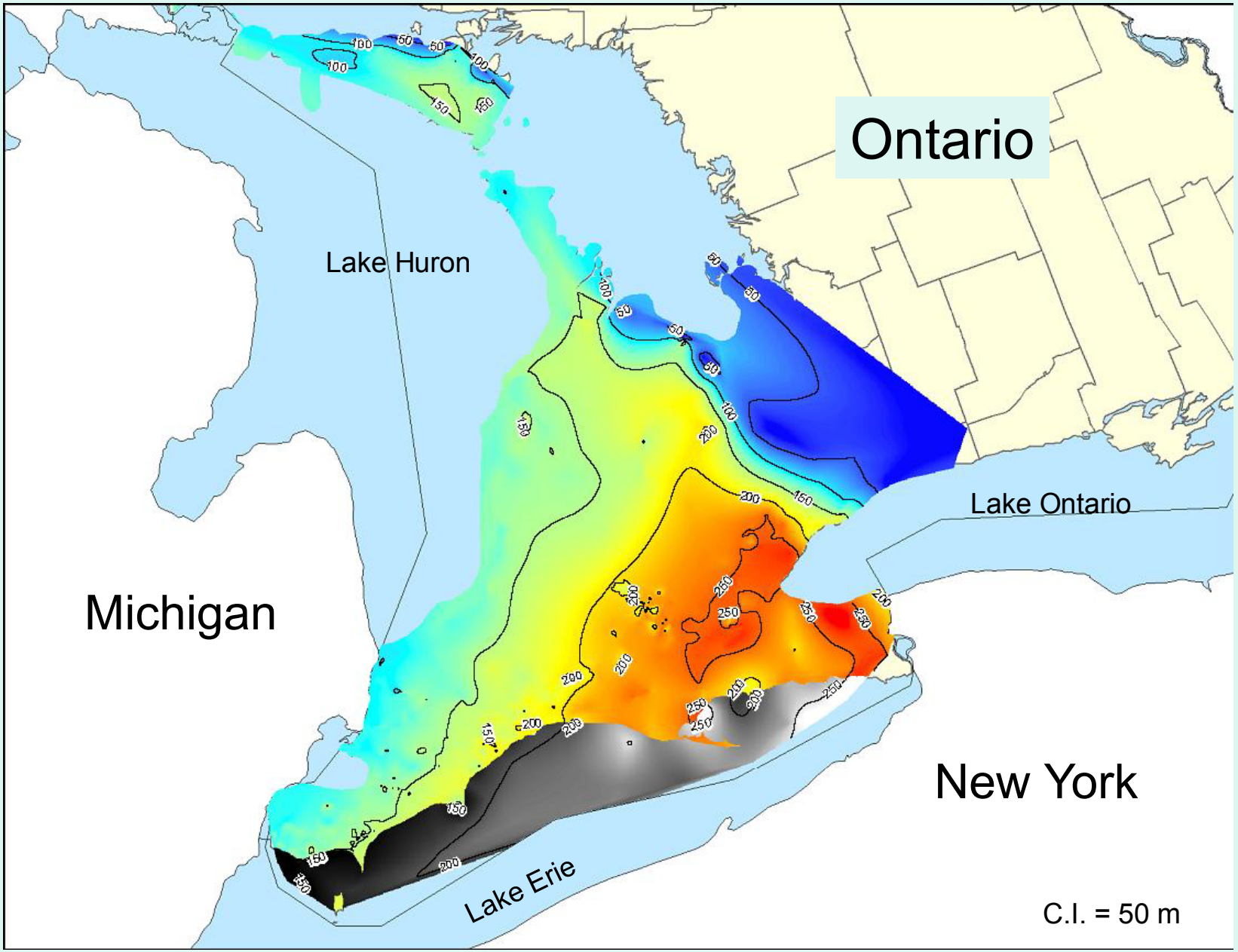
Collingwood subcrop / outcrop

Churcher et al, 1991
OFR 5817

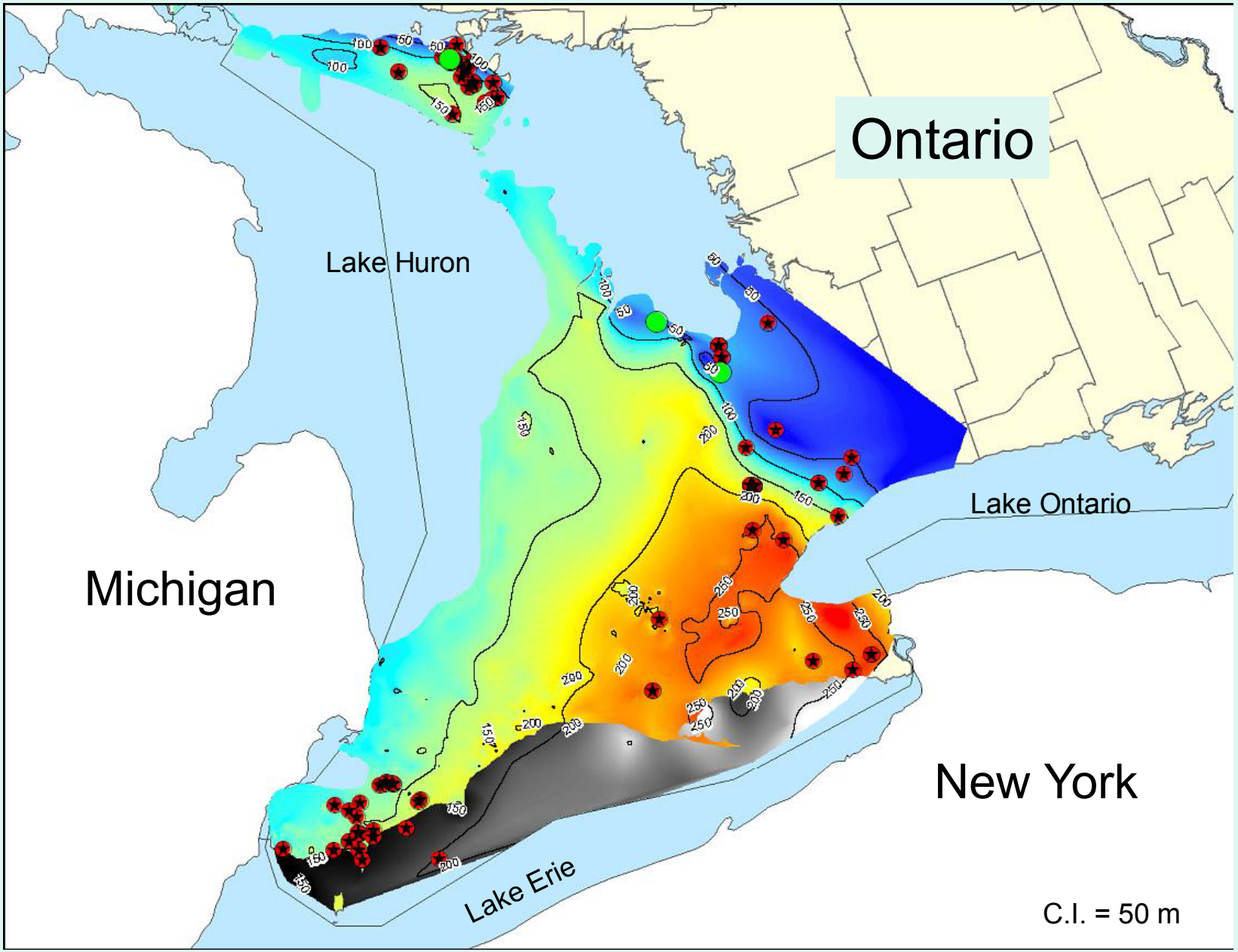
Georgian Bay-Blue Mountain Structure



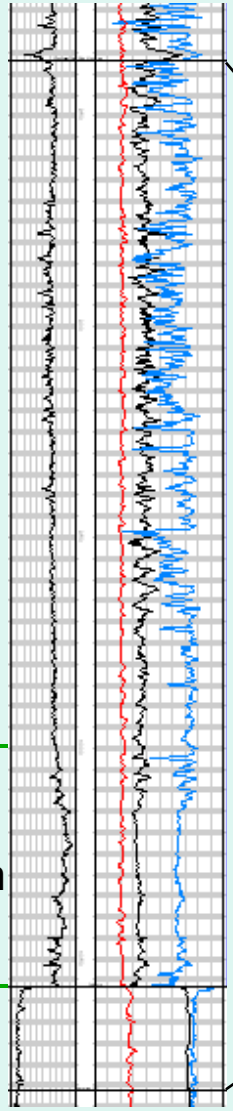
Georgian Bay-Blue Mountain Isopach



Georgian Bay-Blue Mountain Gas Shows

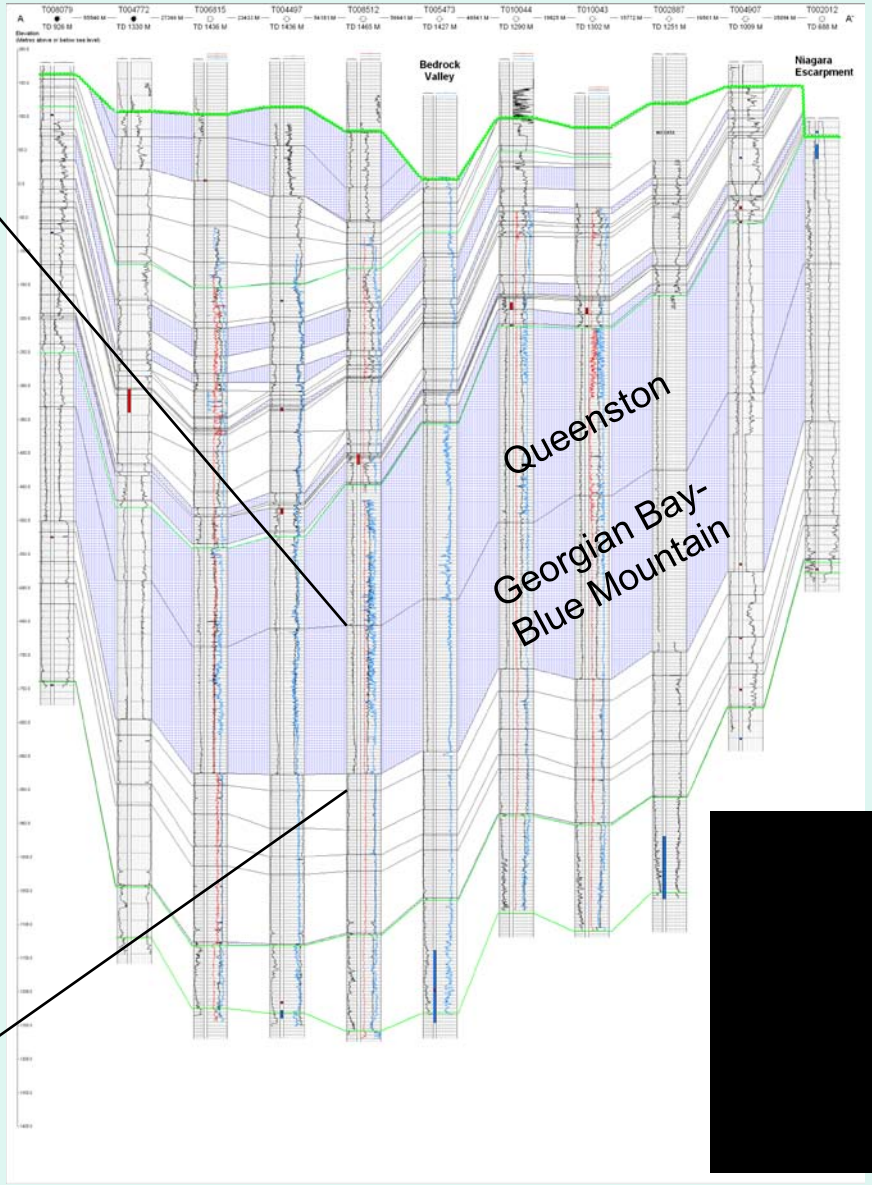


Blue Mountain black shales



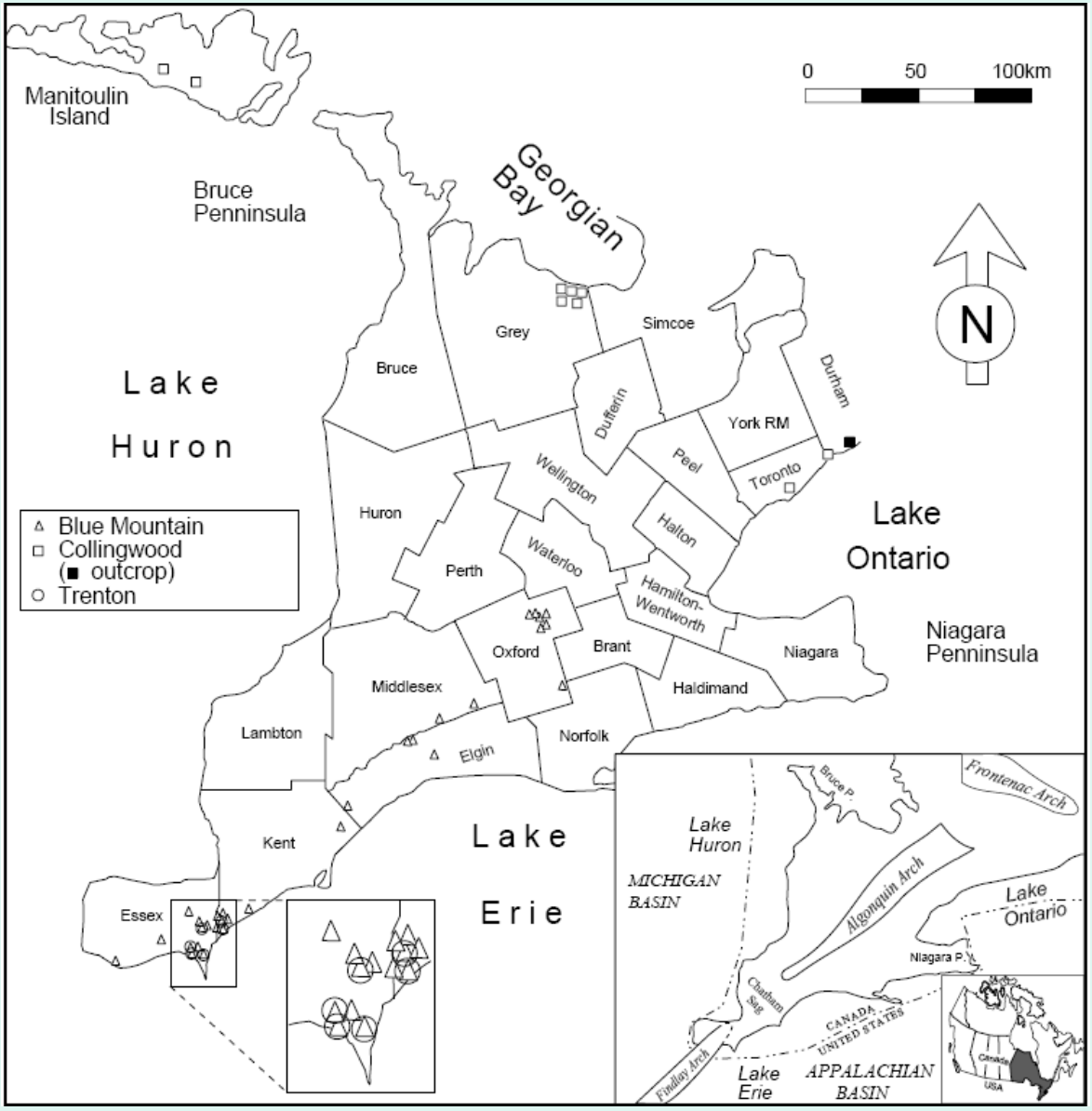
black shale

1000-1055 m



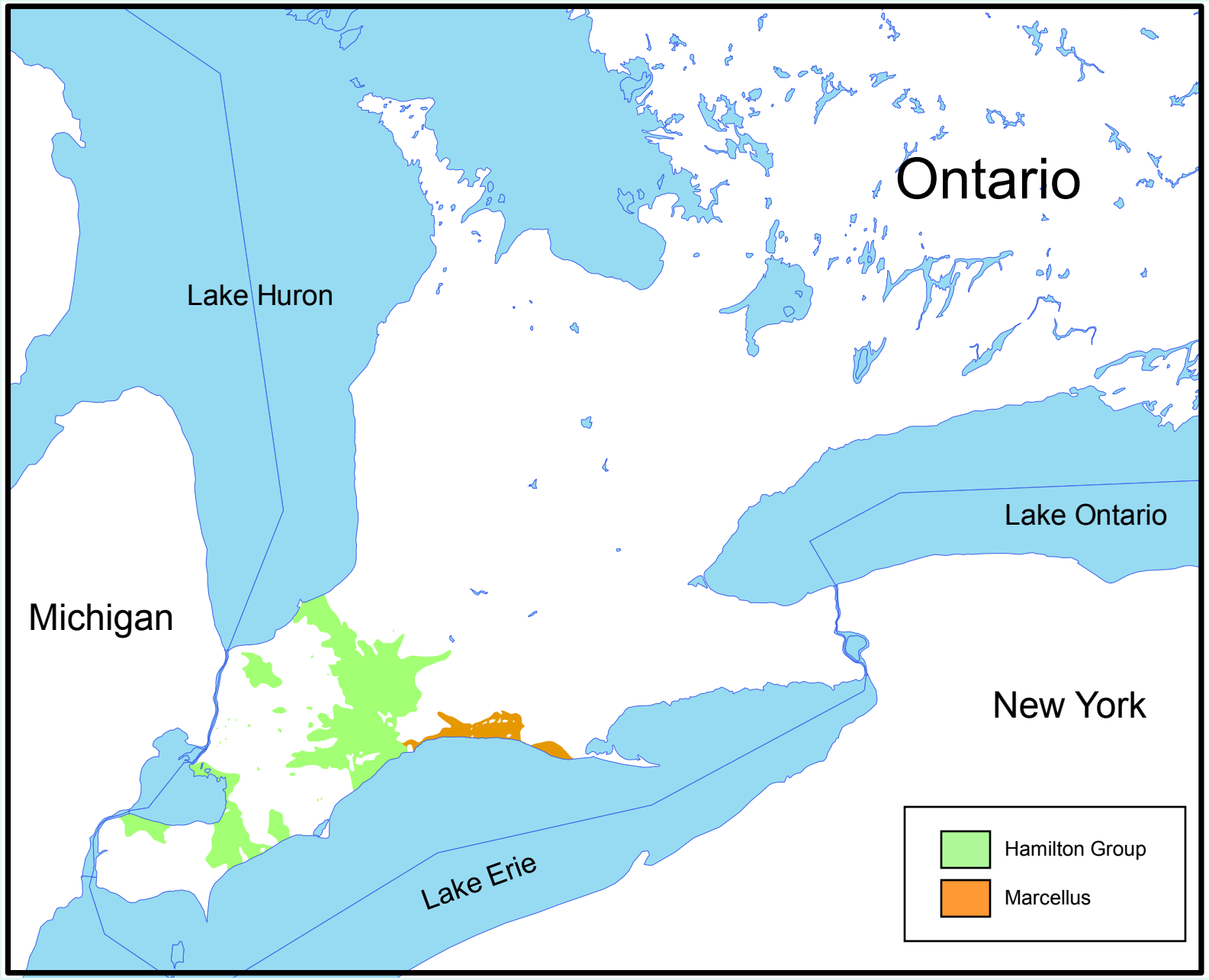
Maturity Studies

- Obermajer, Fowler & Snowdon, AAPG 1999
- Core, cuttings, outcrop
- Most samples are mature, in oil window
- Increase in maturity to southeast (Repetski et al, 2008)
- Lack of samples in southeast where shales are thickest – gas window?

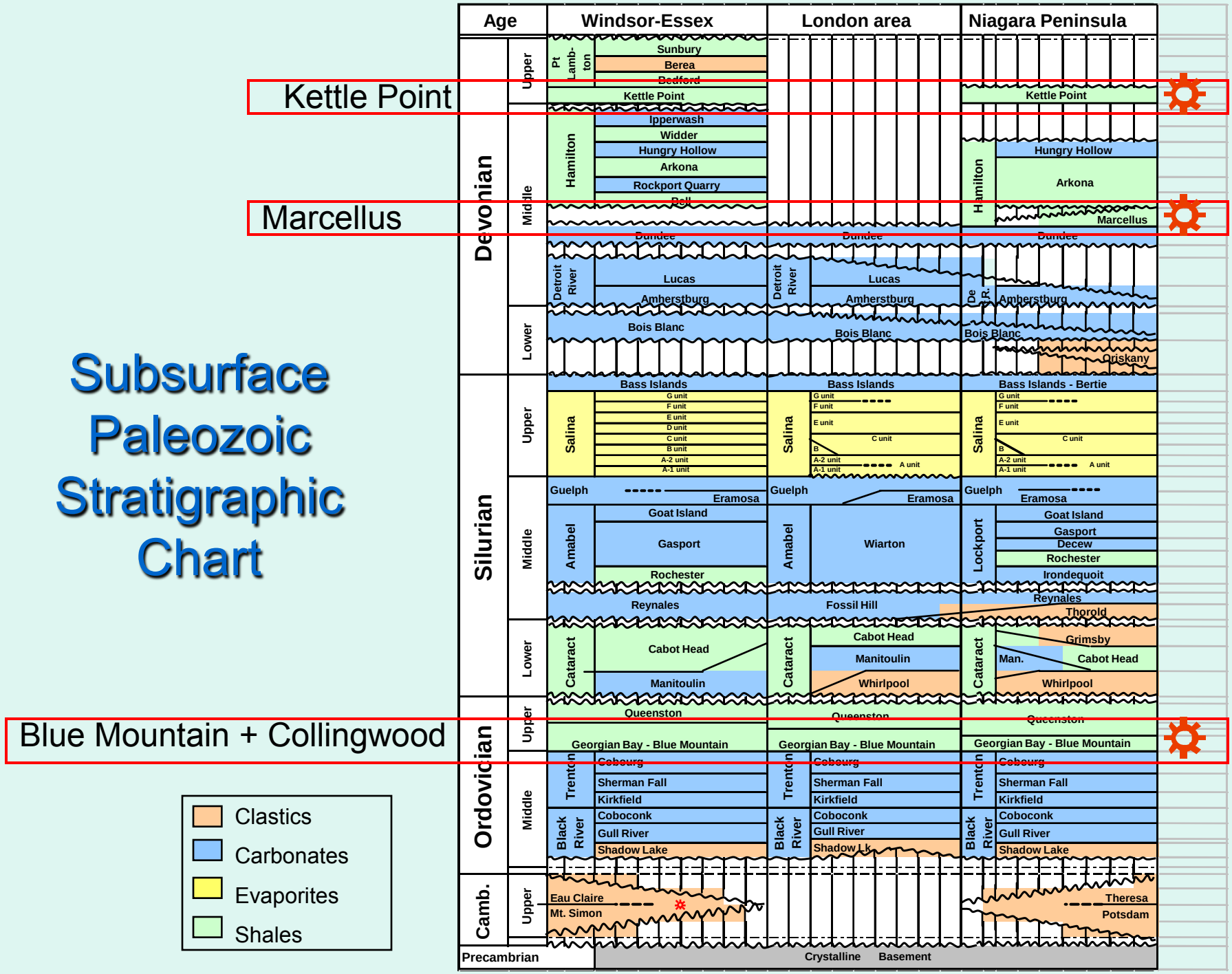


Obermajer, Fowler & Snowdon, 1999

Marcellus shale



Subsurface Paleozoic Stratigraphic Chart



Marcellus Shale

- No surface outcrop, subcrop beneath glacial drift
- Max 12 m thick beneath Lake Erie
- TOC: 1 to 11%
- Depth to top: subcrop to 225 m
- 4700 km^2, mostly beneath Lake Erie
- Marginally mature

Marcellus Formation

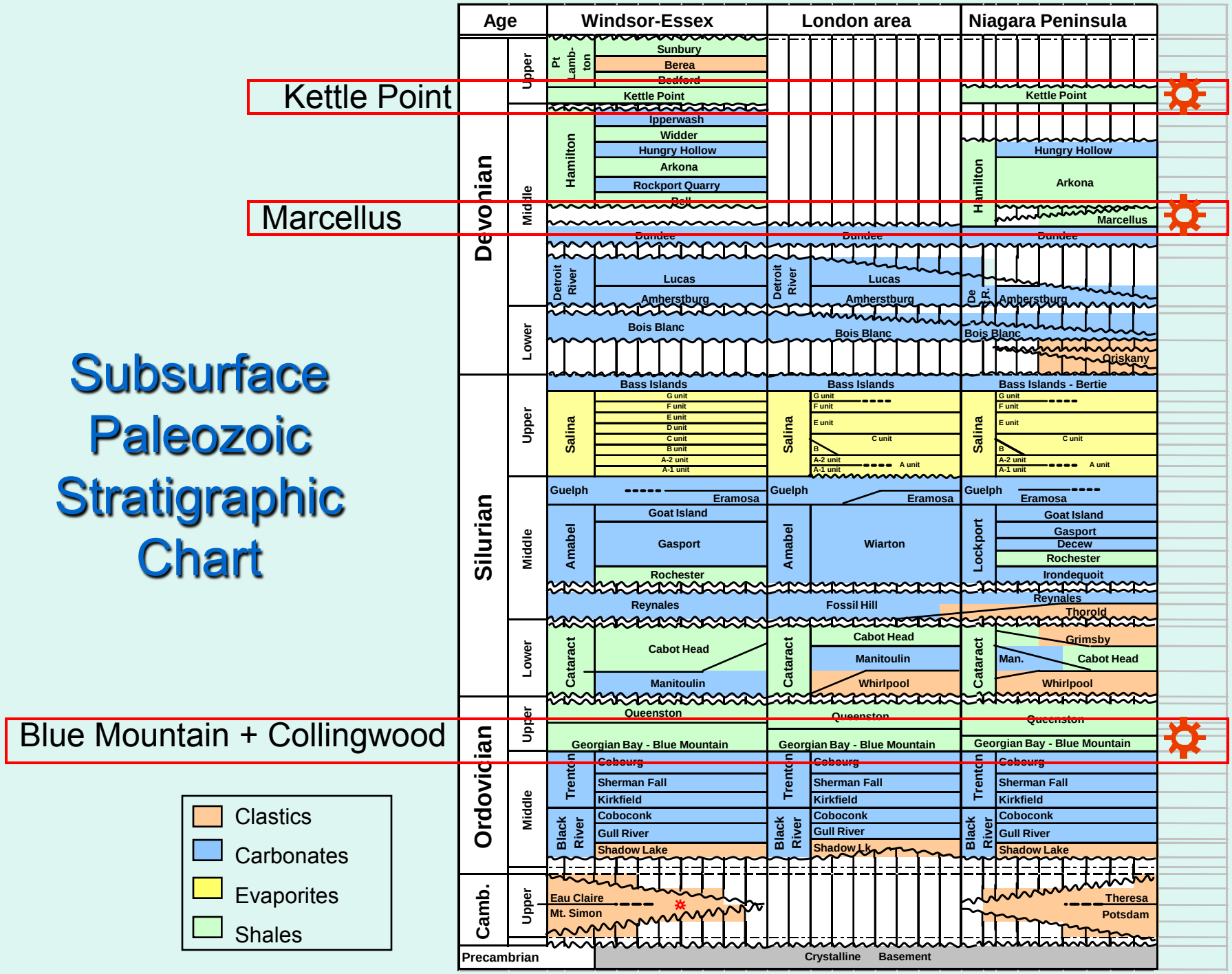
No outcrop at surface

Marcellus shale subcrop

Gas shows in Marcellus

Kettle Point Formation - outcrop

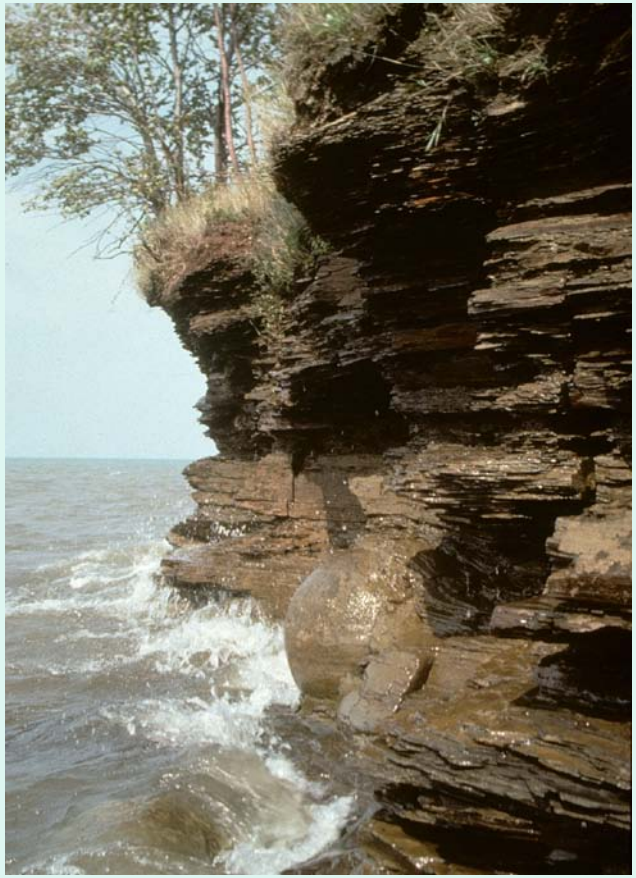
Subsurface Paleozoic Stratigraphic Chart

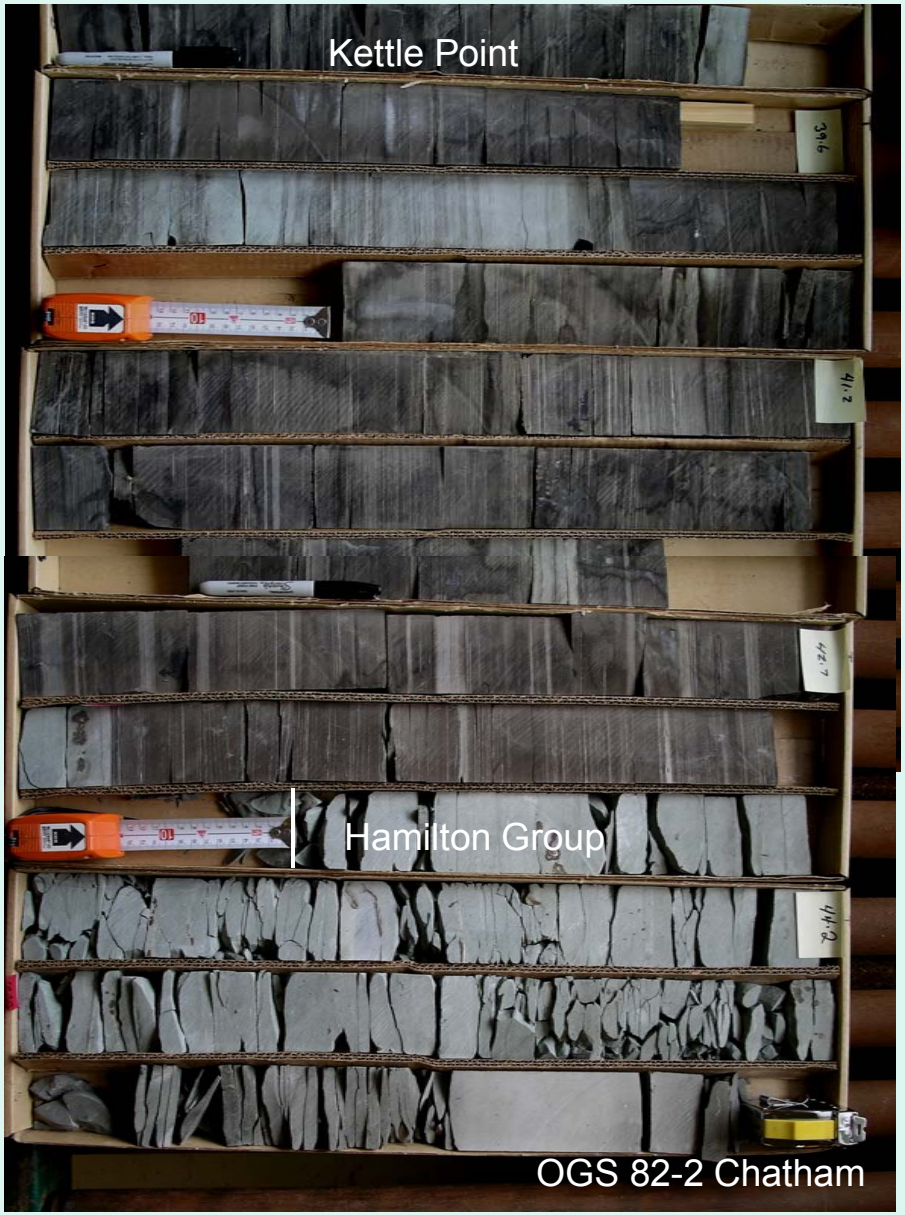


Kettle Point Formation

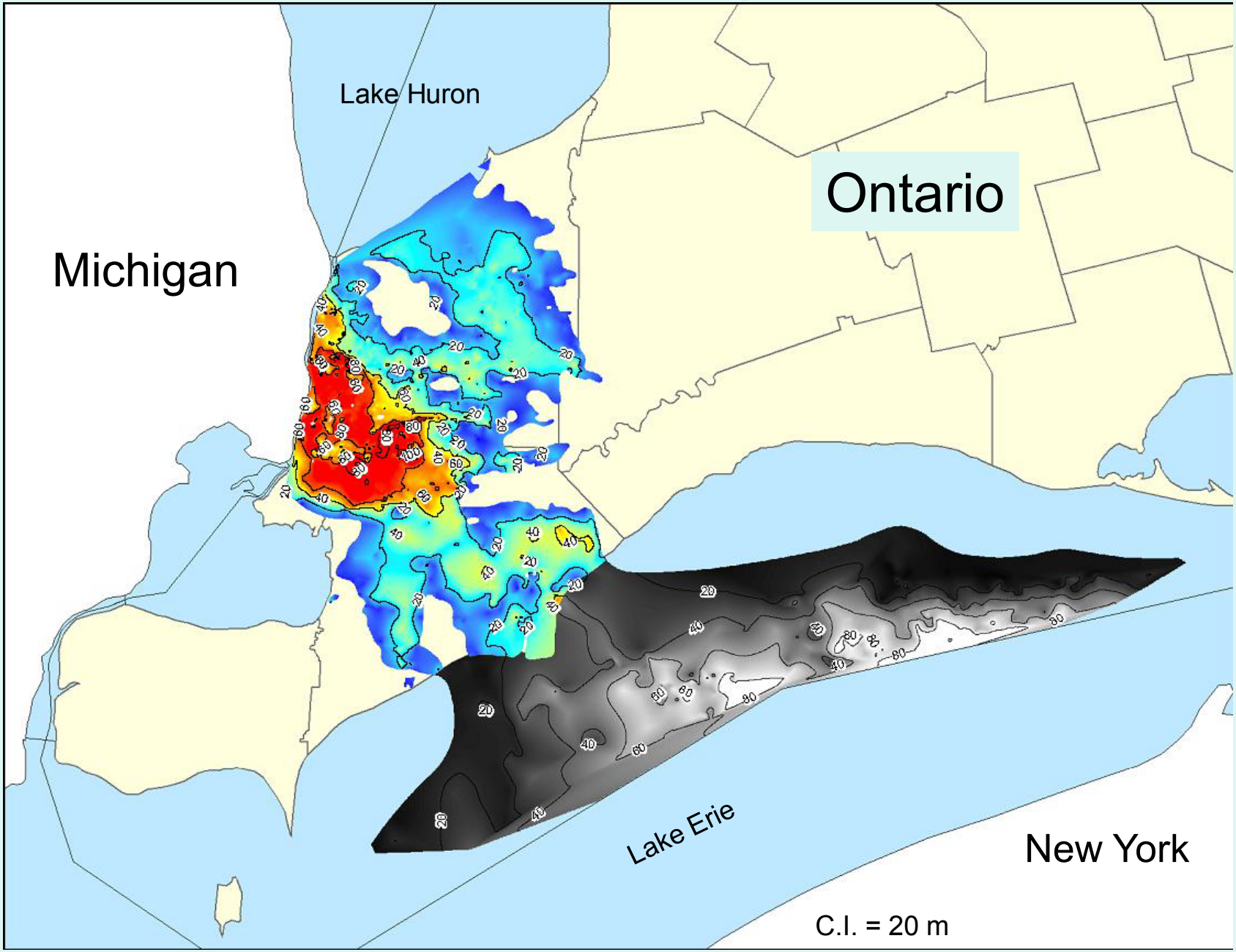
- Subcrop beneath glacial drift – only 3 outcrops
- Max 105 m thick, average 28 m
- TOC: 3 to 15%
- Depth to top: outcrop to 143 m
- 9500 km^2, 50% beneath Lake Erie
- Thermally immature
- Numerous gas shows in petroleum wells and water wells
- Production in late 1800's near Ridgetown for street lighting
- One exploratory well: OSN Gore of Chatham, Chatham 7-16-IV in 2006 – reported as plugged & abandoned with gas show

Kettle Point Formation

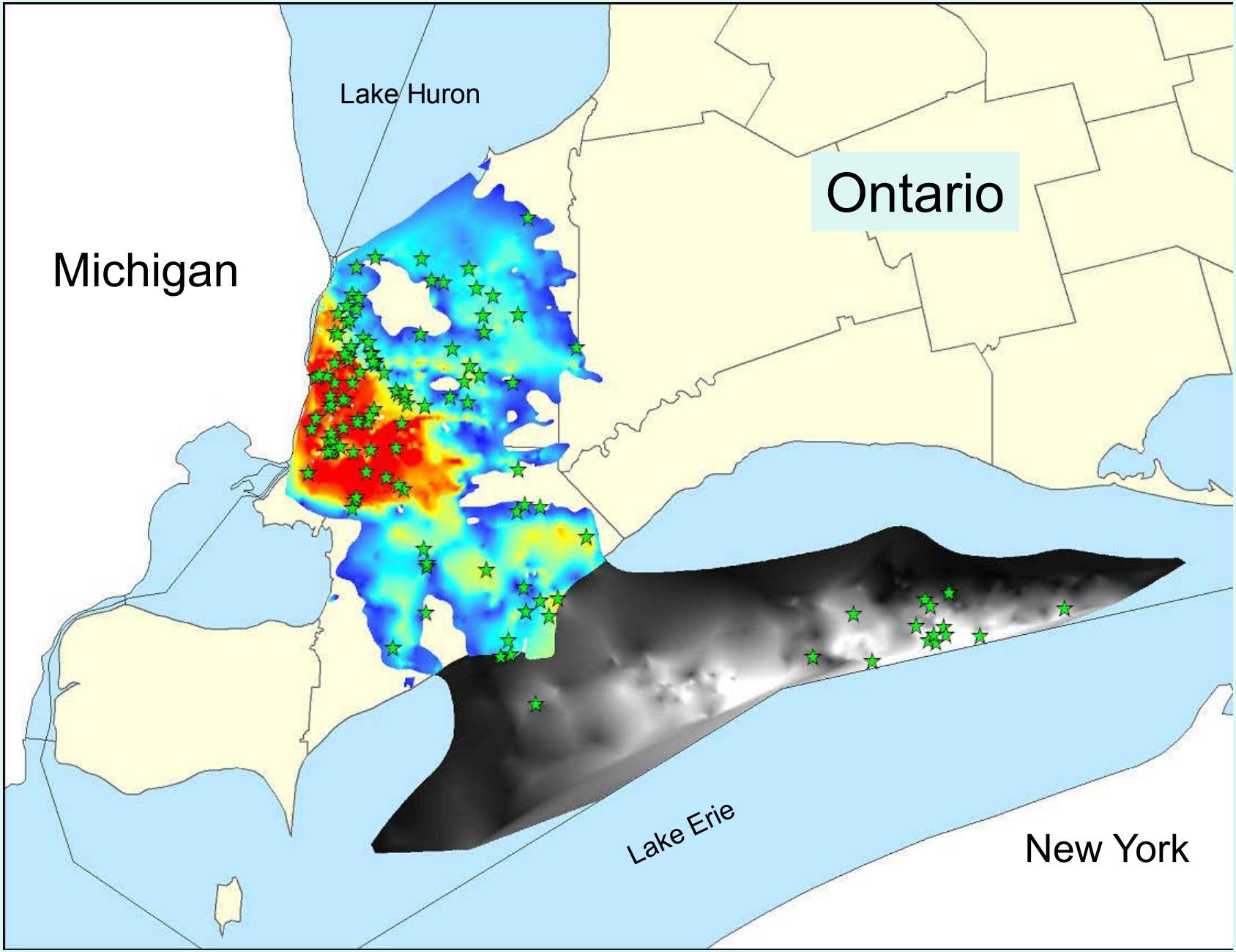




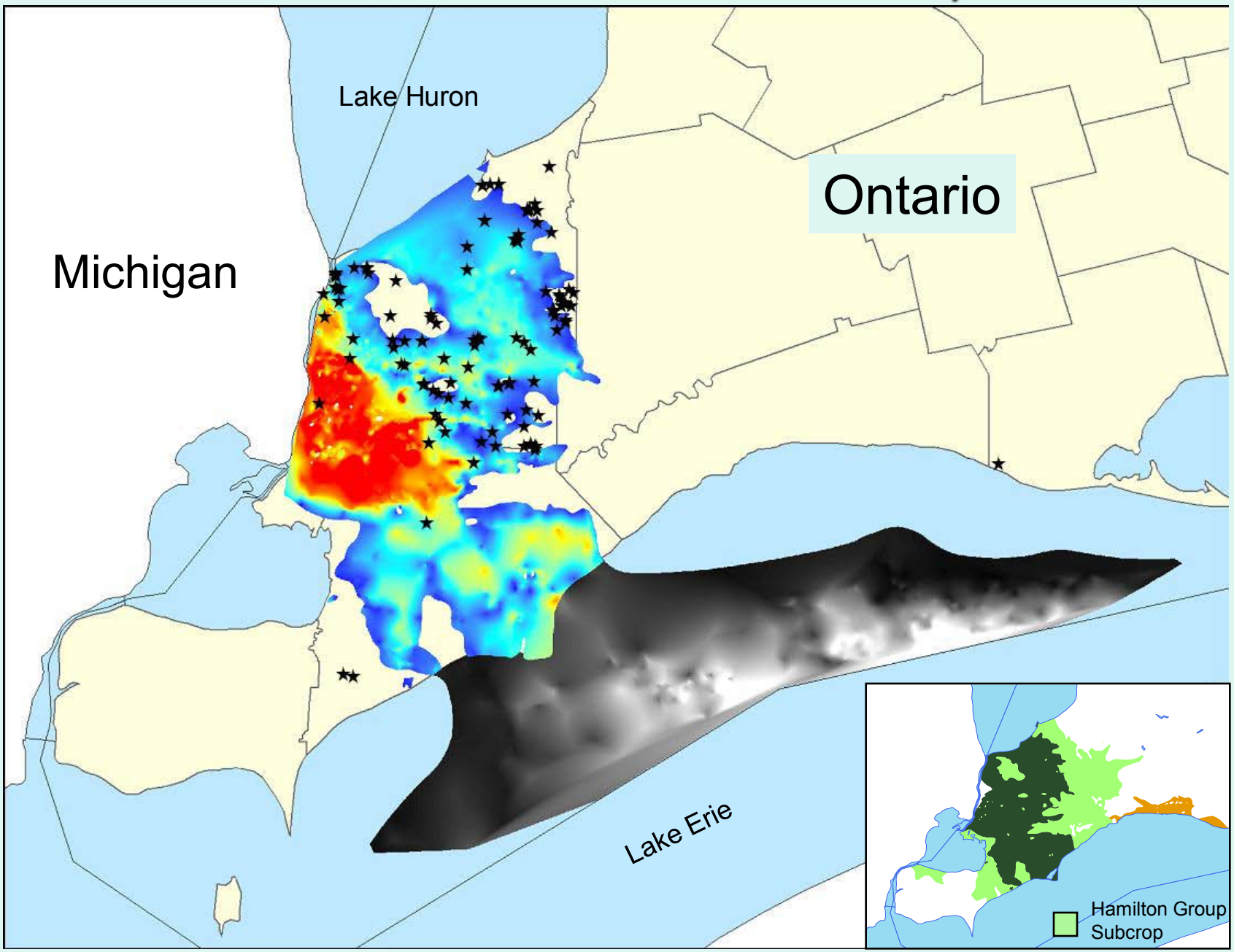
Kettle Point Isopach



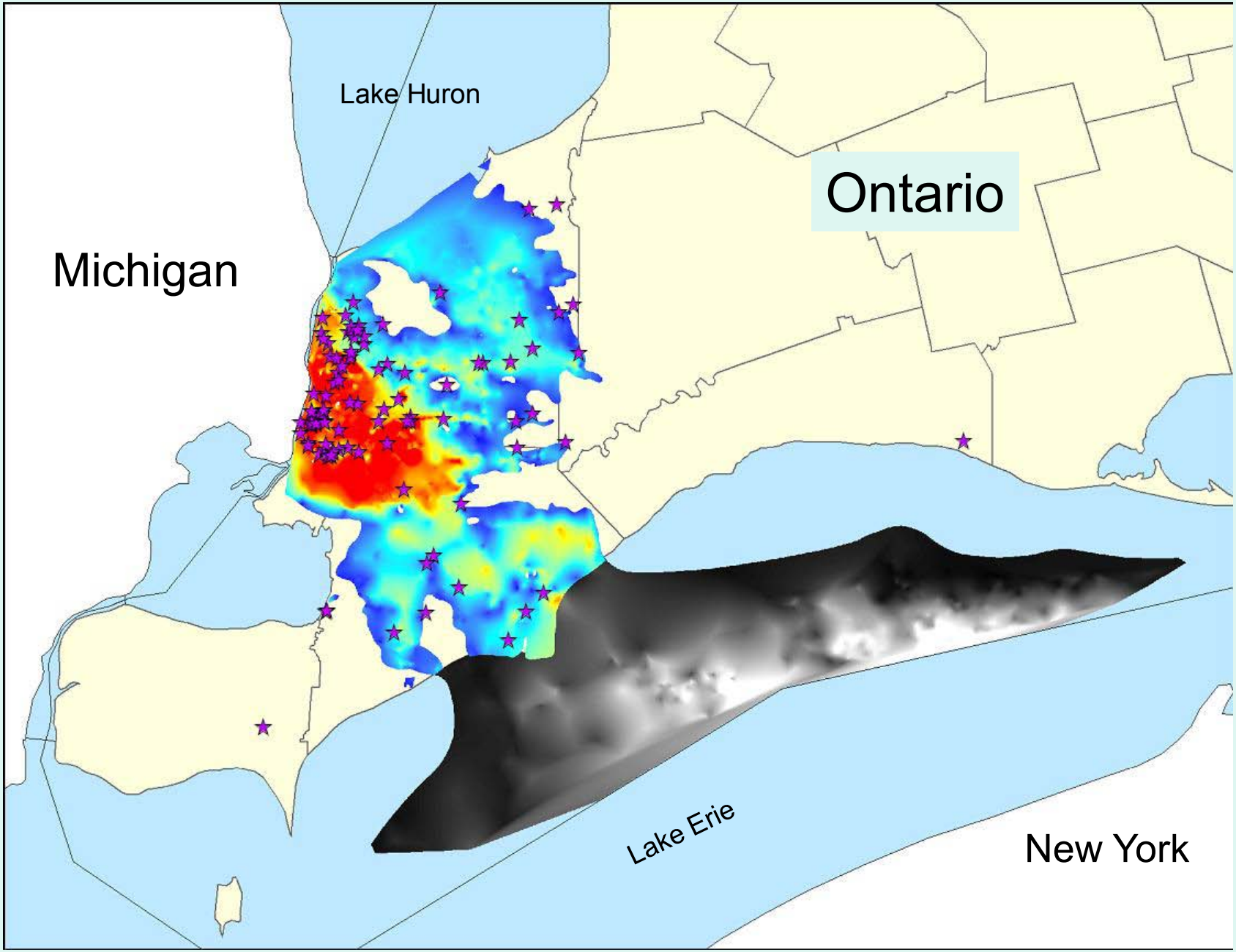
Gas Shows in Kettle Point



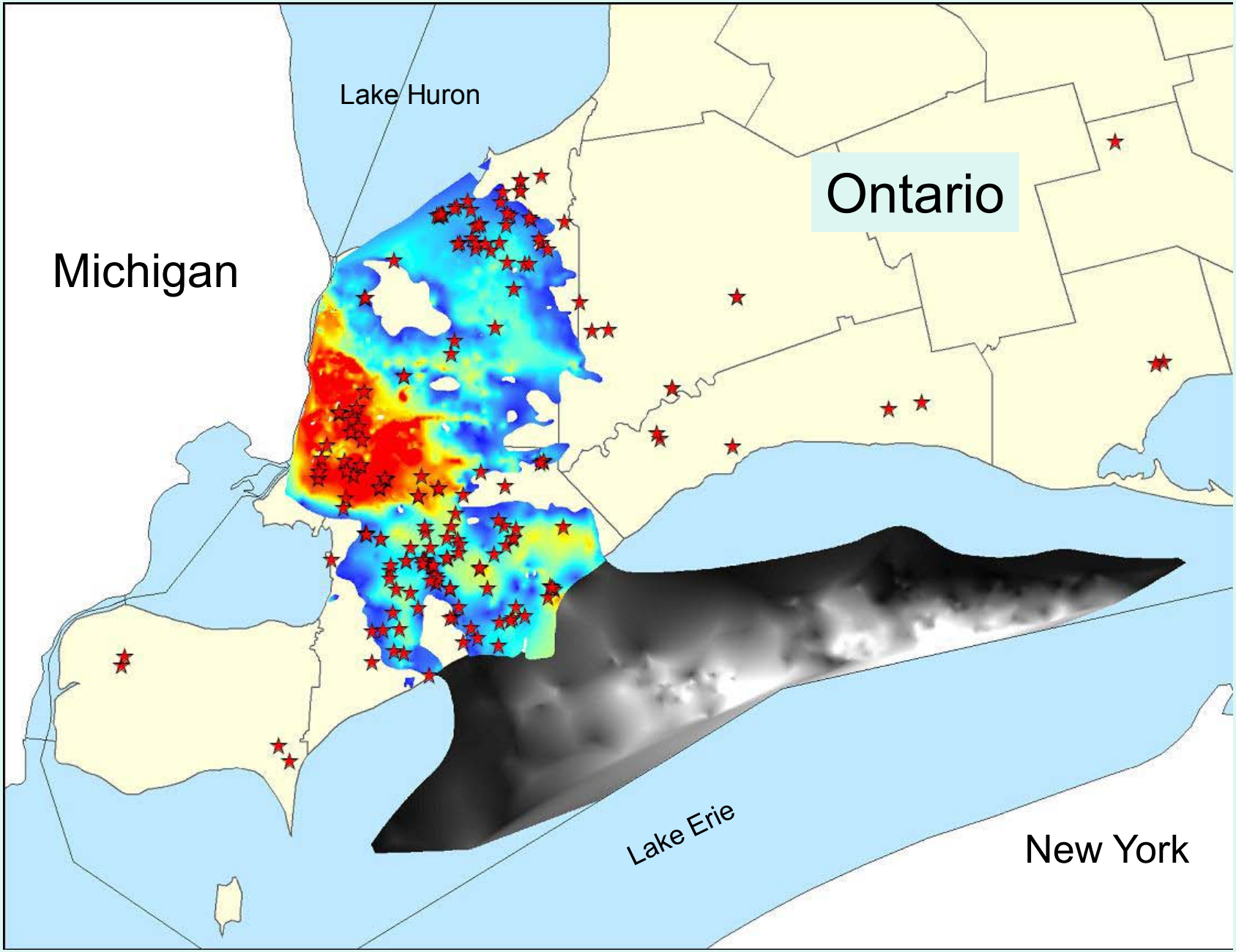
Gas Shows in Hamilton Group



Gas Shows in Drift

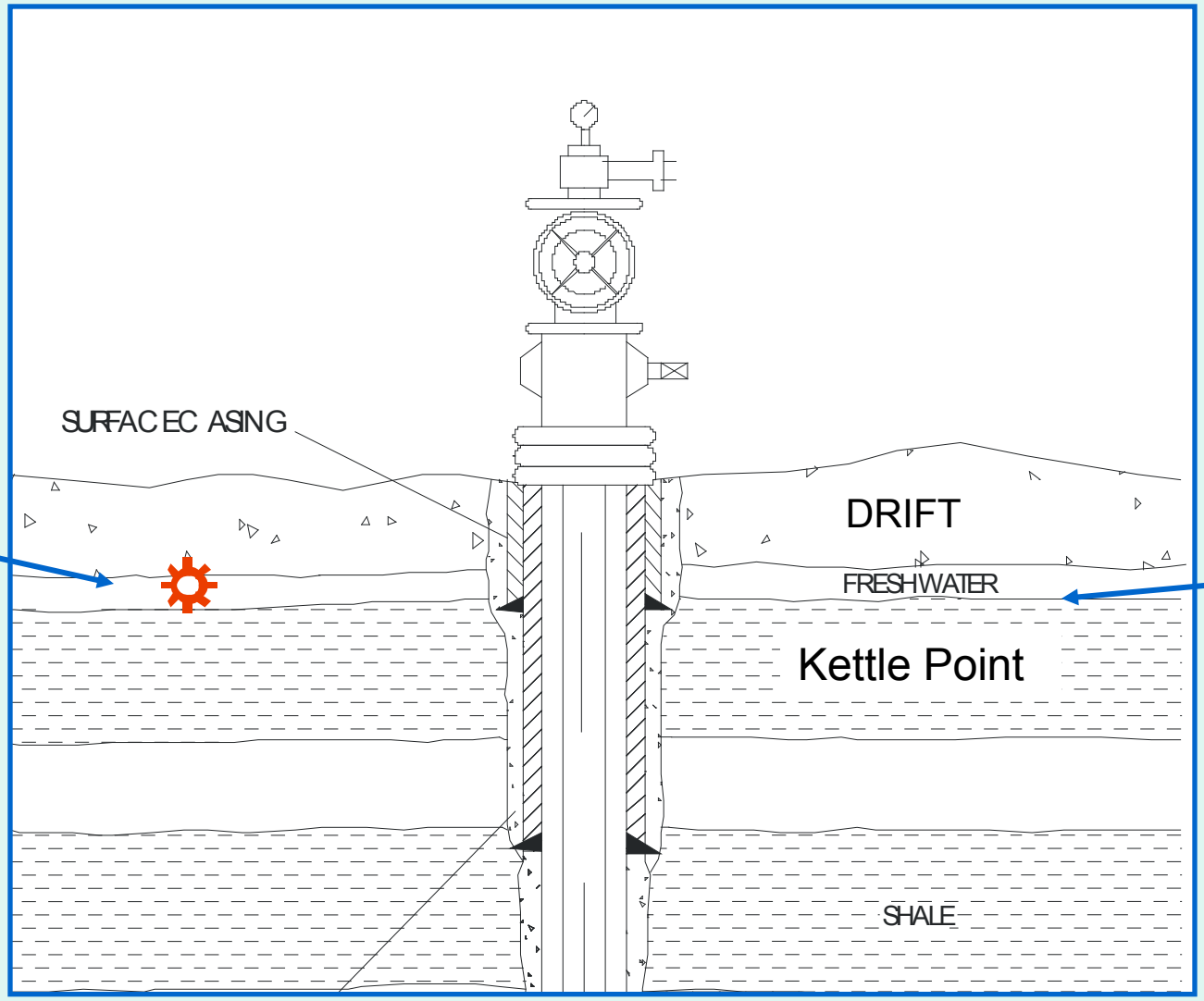


Gas Shows in Water Wells



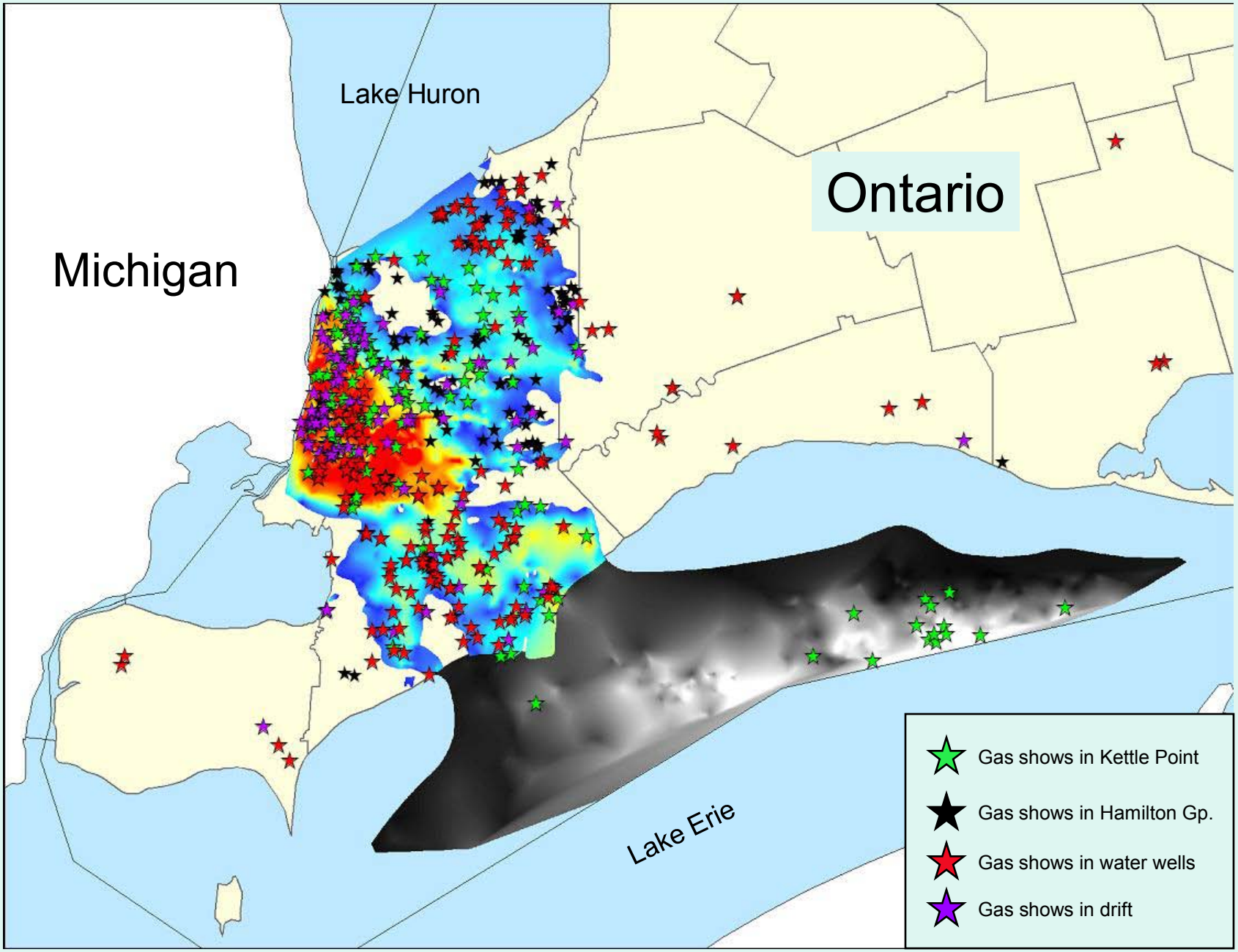
Natural Gas in Groundwater “Contact Aquifer”

Gas in “contact aquifer”



Top of bedrock

All Gas Shows associated with Kettle Point



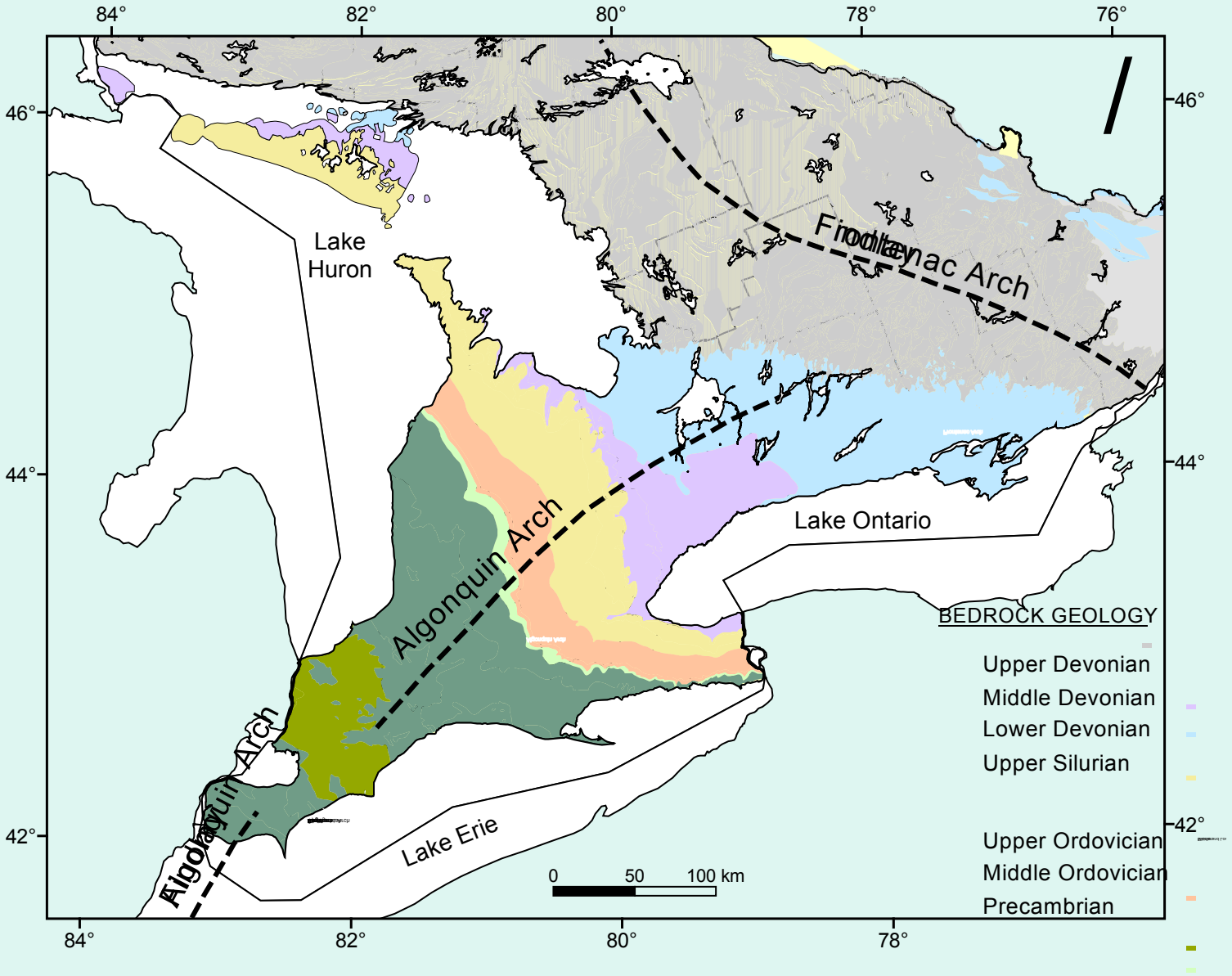
Biogenic or Thermogenic ?

- No direct evidence for any of the Ontario shales
- Natural gas in drift and bedrock over prospective shales is associated with fresh water and may be biogenic
- Shallow, low temperature
- Antrim shale in Michigan is at least in part biogenic
- Best potential for thermogenic gas may be in the deeper thermally mature Blue Mountain / Collingwood shales

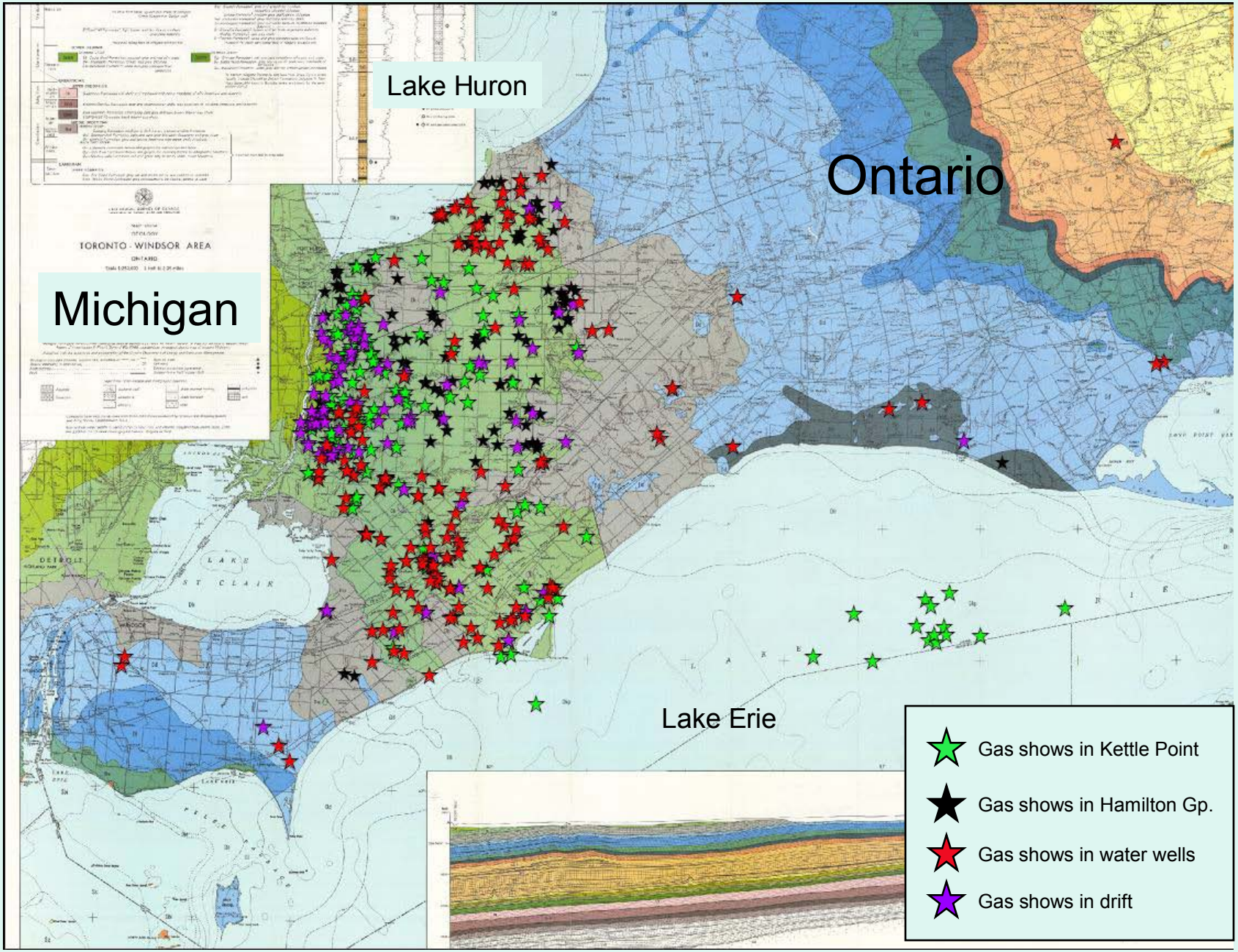
Summary

- Shale gas potential in Kettle Point, Marcellus, and Blue Mountain / Collingwood formations
- Large prospective areas
- Thermally immature to mature
- Favourable depths and thicknesses
- Natural gas shows reported – large number in Kettle Point formation
- Gas is there - Can it be commercially recovered?
- Research project initiated by Ontario Geological Survey in 2009 – Catherine Béland-Otis

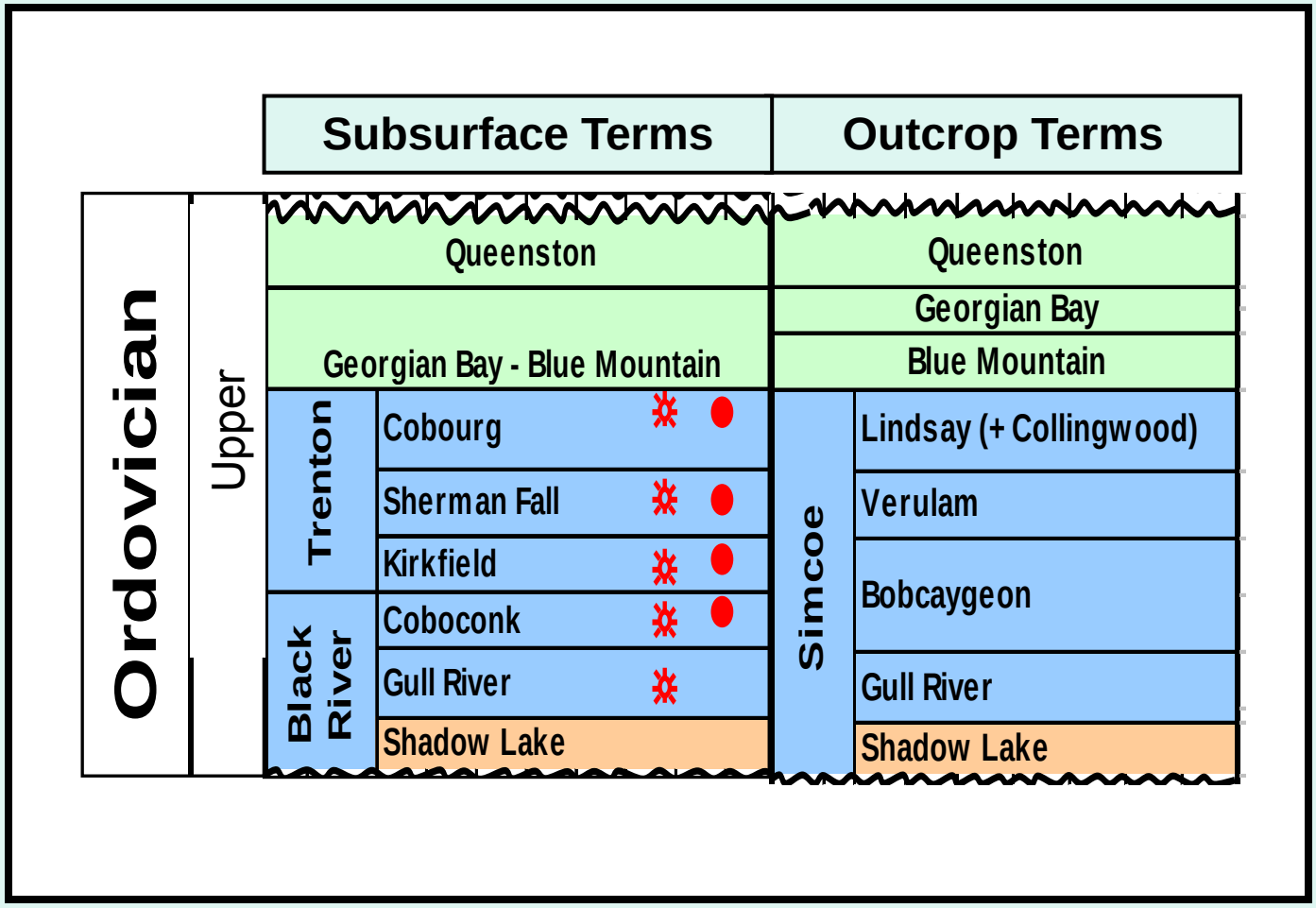
Ontario Bedrock Geology



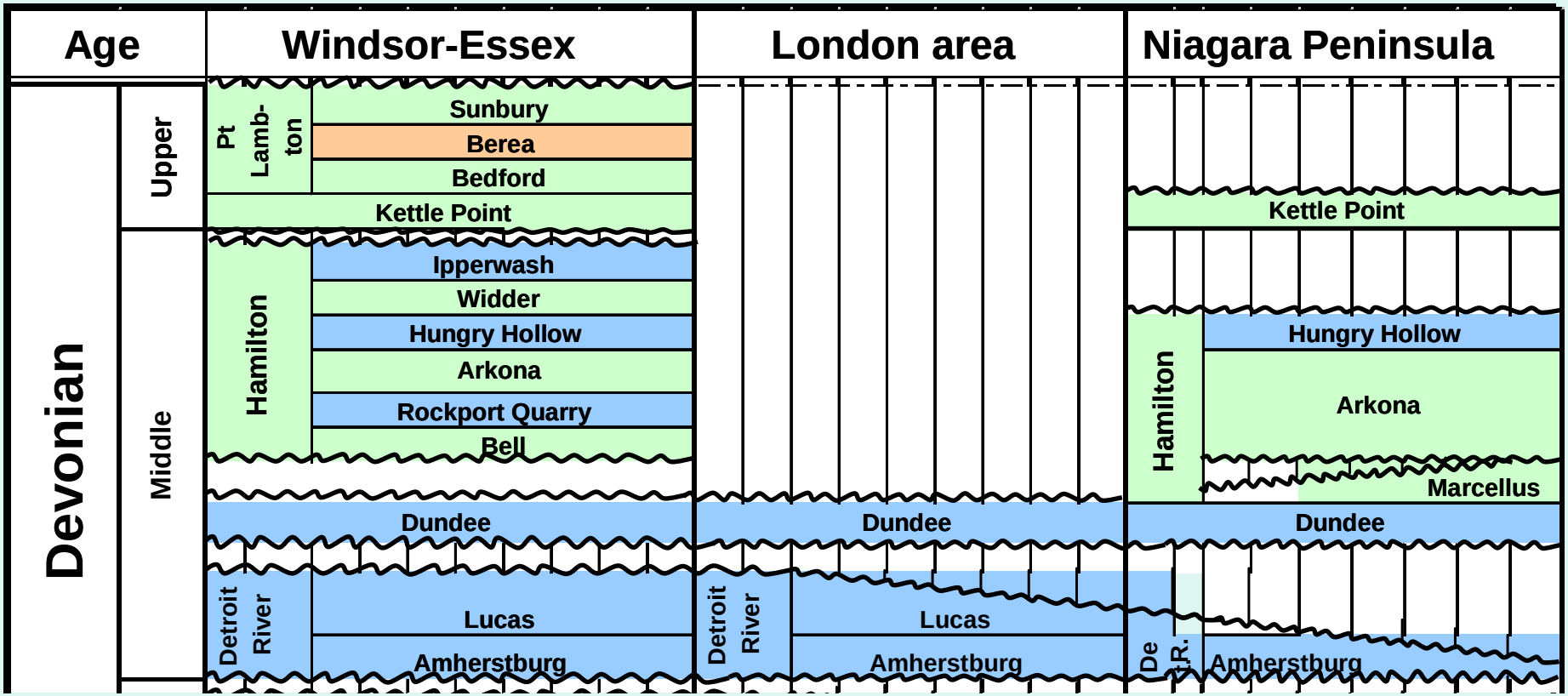
All Gas shows associated with Kettle Point



Blue Mountain / Collingwood Stratigraphy



Stratigraphy



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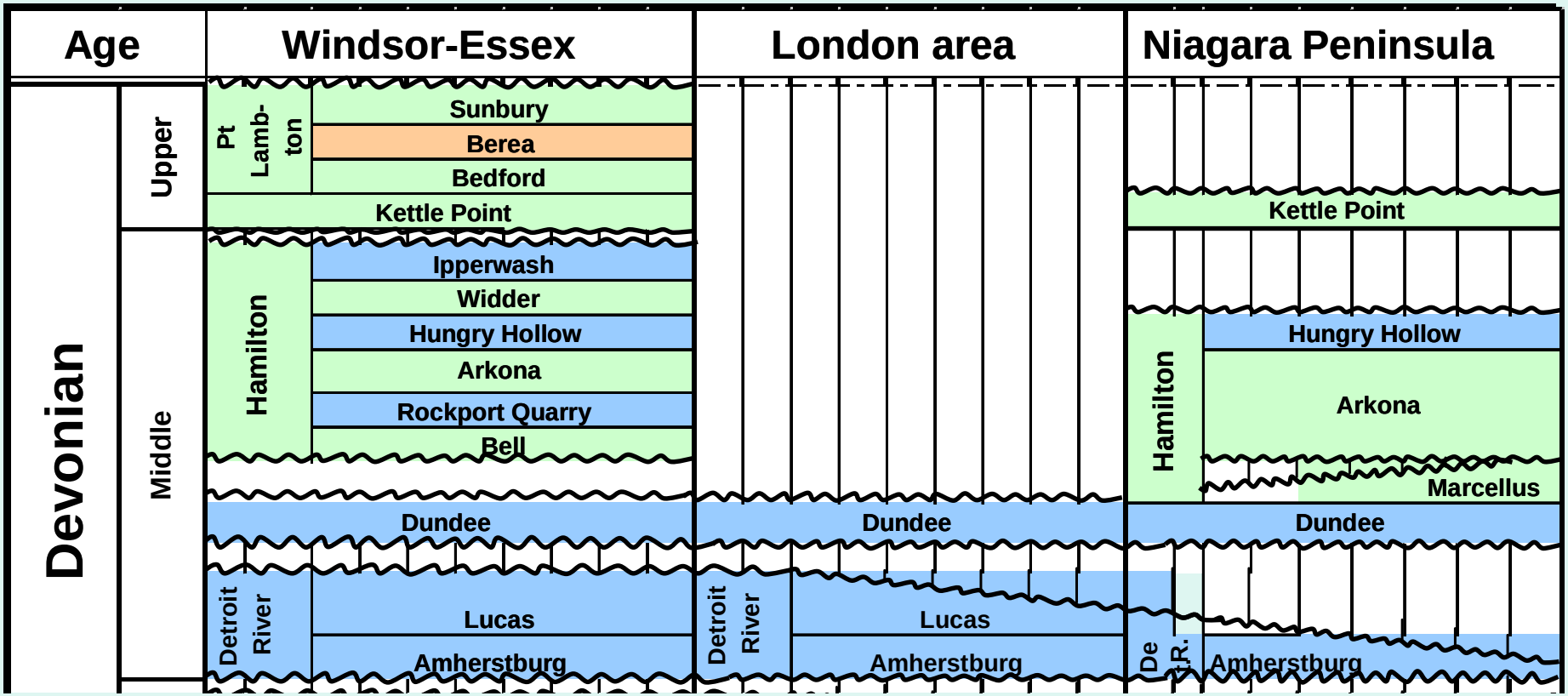

Stratigraphic Correlations