

Geology of the Maritime Provinces

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Workshop on the Role of Geochemical Data in
Ecological and Human Health Risk Assessment

March 17 - 18, 2010

Halifax, NS

Geology of the Maritime Provinces



Outline

Bedrock Geology - The Big Picture

Surficial Geology - The Ice Age

Soil - What is the Connection?

Geochemistry - What we are Trying to Understand?

Geology of the Maritime Provinces



Outline

Bedrock Geology – The Big Picture

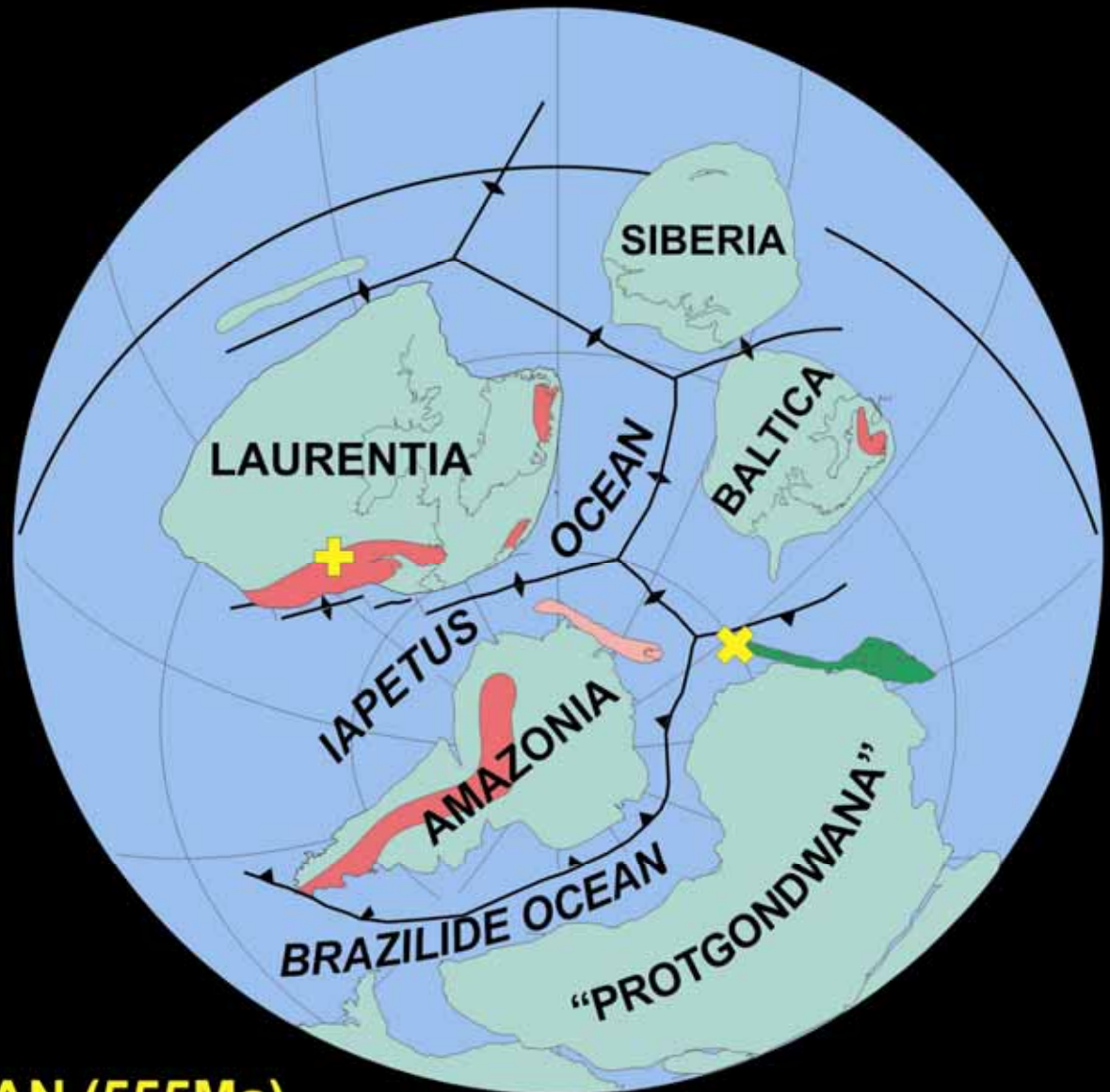
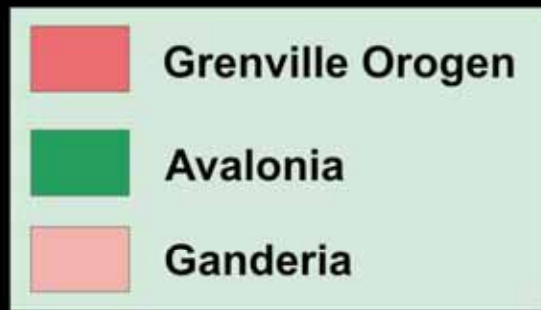
STAGE 1: Formation of the Appalachians

Surficial Geology – The Ice Age

Soil – What is the Connection?

Geochemistry – What we are Trying to Understand?

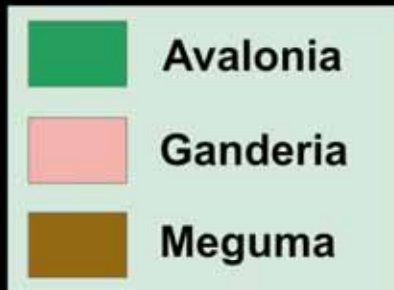
Geology of the Maritime Provinces



LATEST PRECAMBRIAN (555Ma)

modified from The Last Billion Years (AGS, 2001)

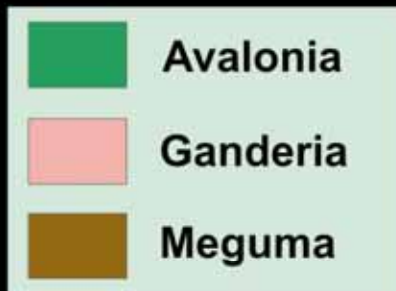
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**CAMBRIAN
(ABOUT 515 MILLION YEARS AGO)**

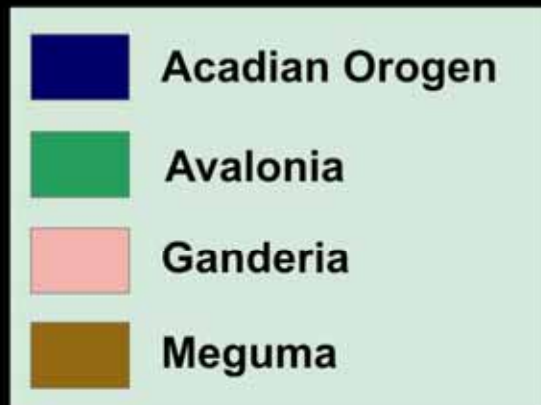
modified from The Last Billion Years (AGS, 2001)

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**EARLY ORDOVICIAN
(ABOUT 475 MILLION YEARS AGO)**

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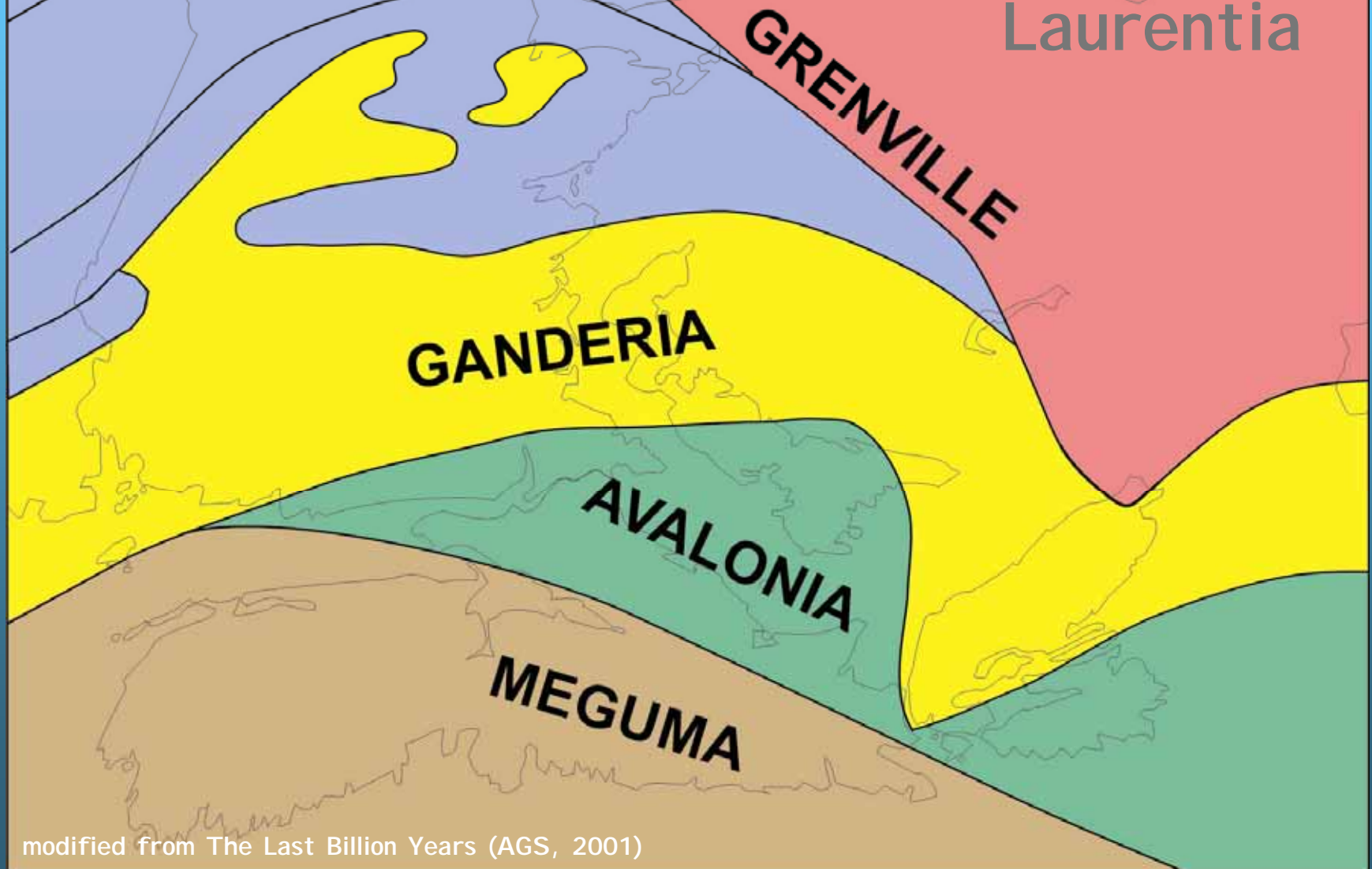


**EARLY SILURIAN
(ABOUT 435 MILLION YEARS AGO)**

modified from The Last Billion Years (AGS, 2001)

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IAPETUS - related terranes

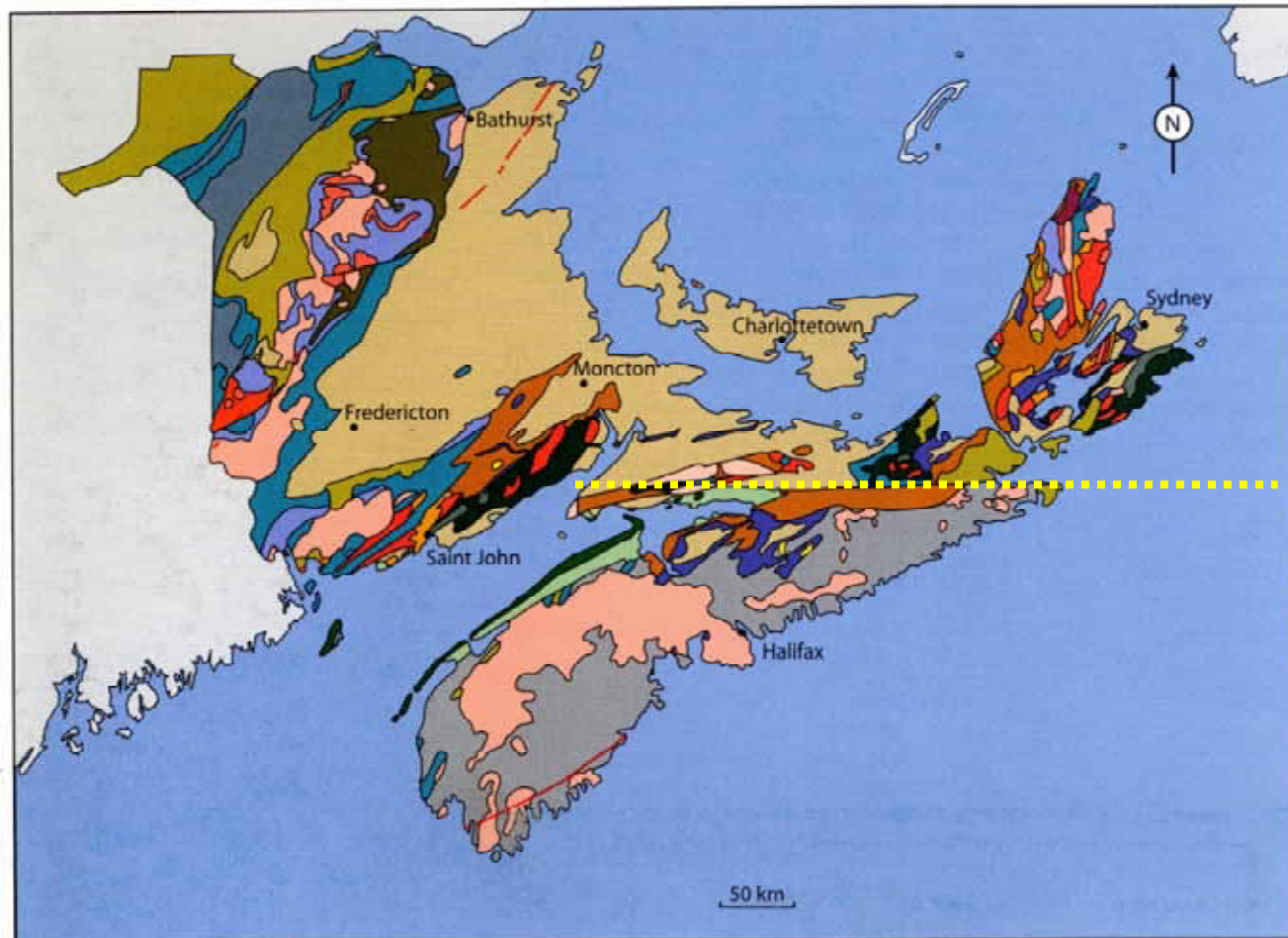




Geology of the Maritime Provinces

COMPLEX

Bedrock Geology



Mesozoic

- Cretaceous sedimentary rocks
- Early Jurassic dykes
- Early Jurassic volcanic rocks
- Triassic-Jurassic sedimentary rocks

Carboniferous and Permian

- Late Carboniferous-Permian terrestrial sedimentary rocks
- Early Carboniferous marine sedimentary rocks
- Early Carboniferous terrestrial sedimentary rocks
- Early Carboniferous plutonic rocks

Silurian and Devonian

- Silurian and Devonian plutonic rocks
- Devonian volcanic and sedimentary rocks
- Silurian volcanic and sedimentary rocks

Cambrian and Ordovician

- Late Ordovician sedimentary rocks
- Cambrian-Ordovician plutonic rocks
- Ordovician Tetagouche volcanic rocks
- Ordovician Popelogan volcanic rocks
- Cambrian-Ordovician Miramichi sedimentary rocks
- Cambrian-Ordovician Avalon sedimentary and volcanic rocks
- Cambrian-Ordovician Meguma sedimentary rocks

Precambrian

- Precambrian plutonic rocks
- Precambrian Bras d'Or volcanic and sedimentary rocks
- Precambrian Avalonian volcanic and sedimentary rocks
- Precambrian Grenville metamorphic and plutonic rocks

(The colours used in this map are not necessarily the same as those used for equivalent units in the geological maps of chapters 4-7.)

Yellow dotted line is the CCFZ - Cobequid Chedabucto Fault Zone

Geology of the Maritime Provinces



Outline

Bedrock Geology – The Big Picture

STAGE 2: Basin Overprinting

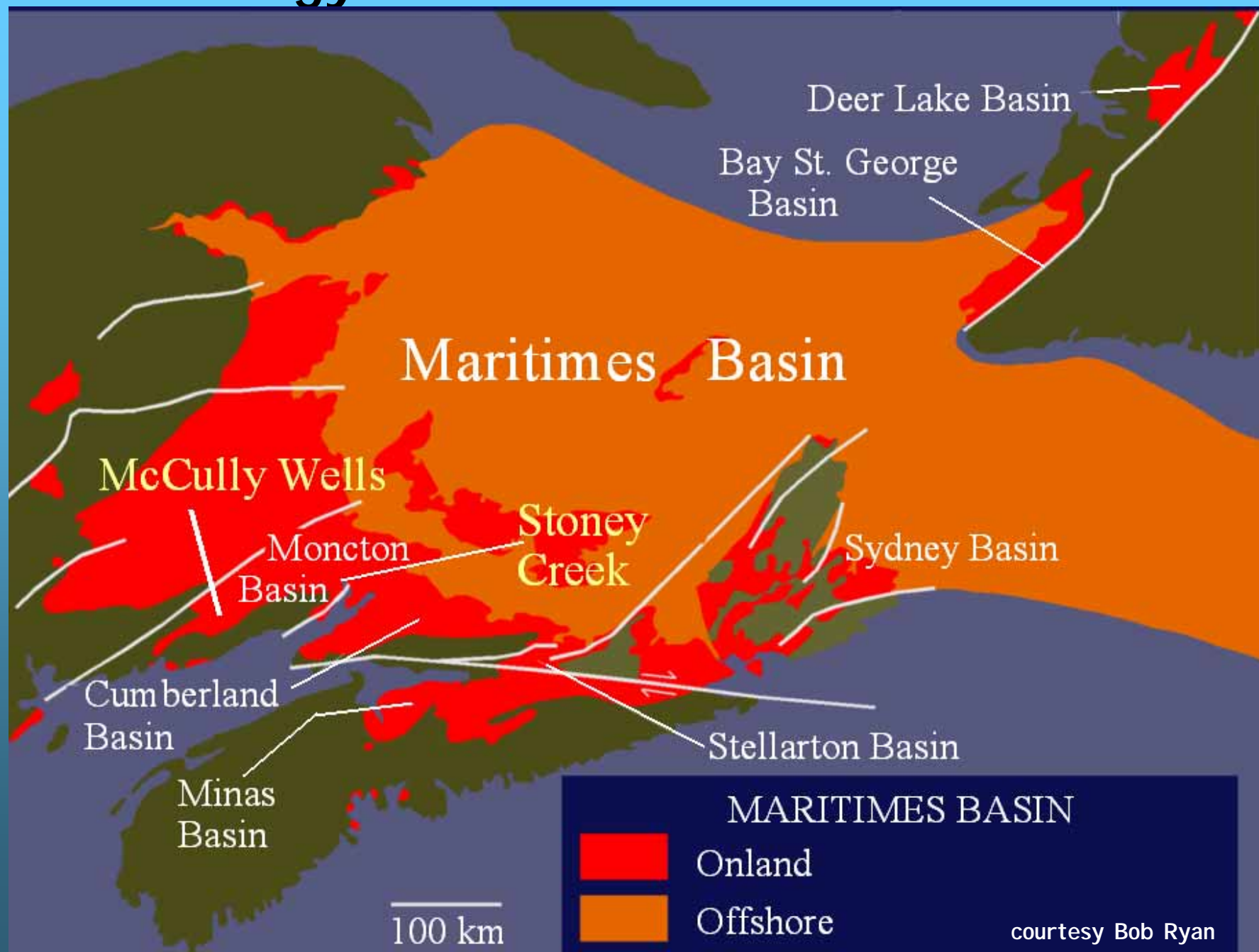
Surficial Geology – The Ice Age

Soil – What is the Connection?

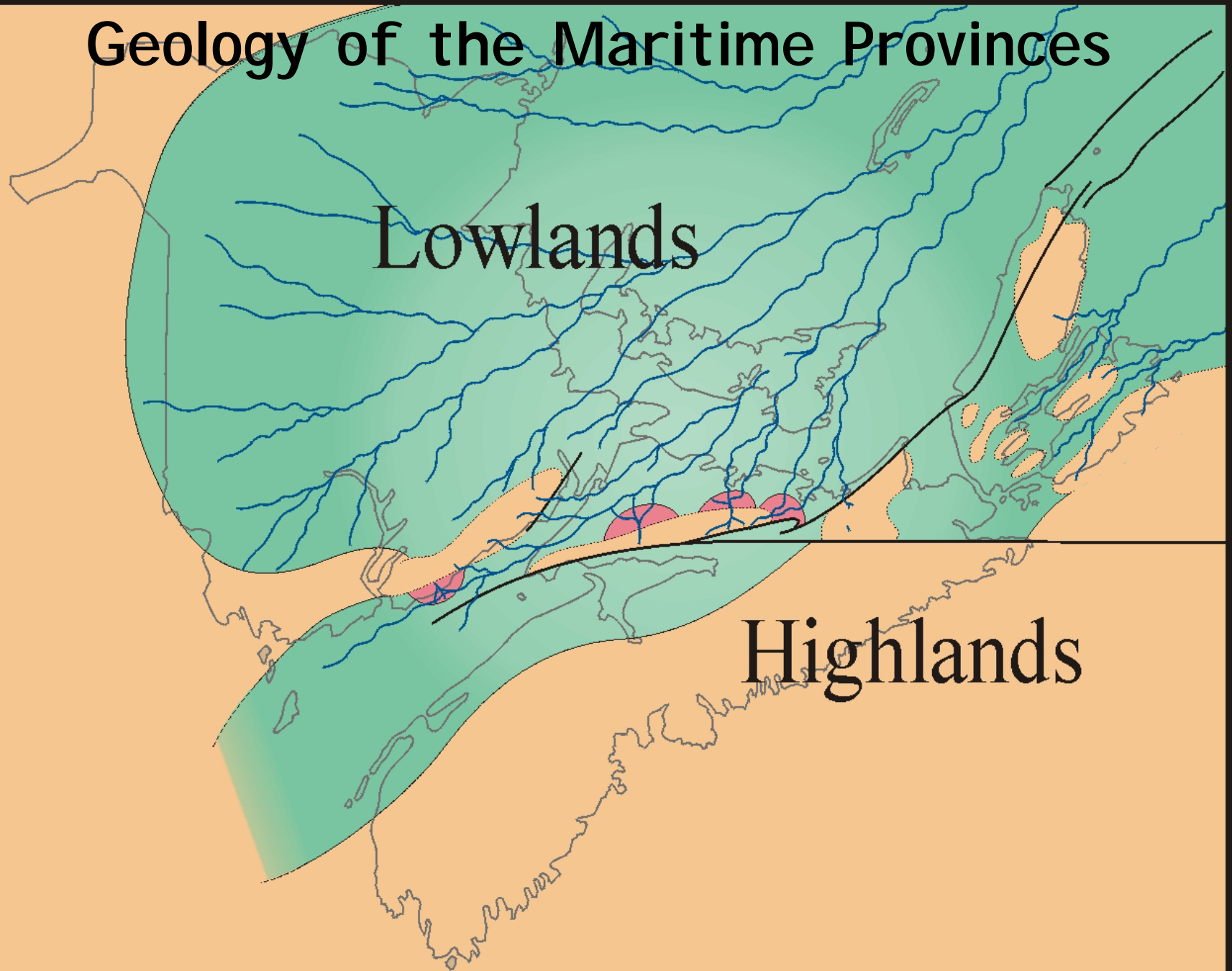
Geochemistry – What we are Trying to Understand?



Geology of the Maritime Provinces



Geology of the Maritime Provinces

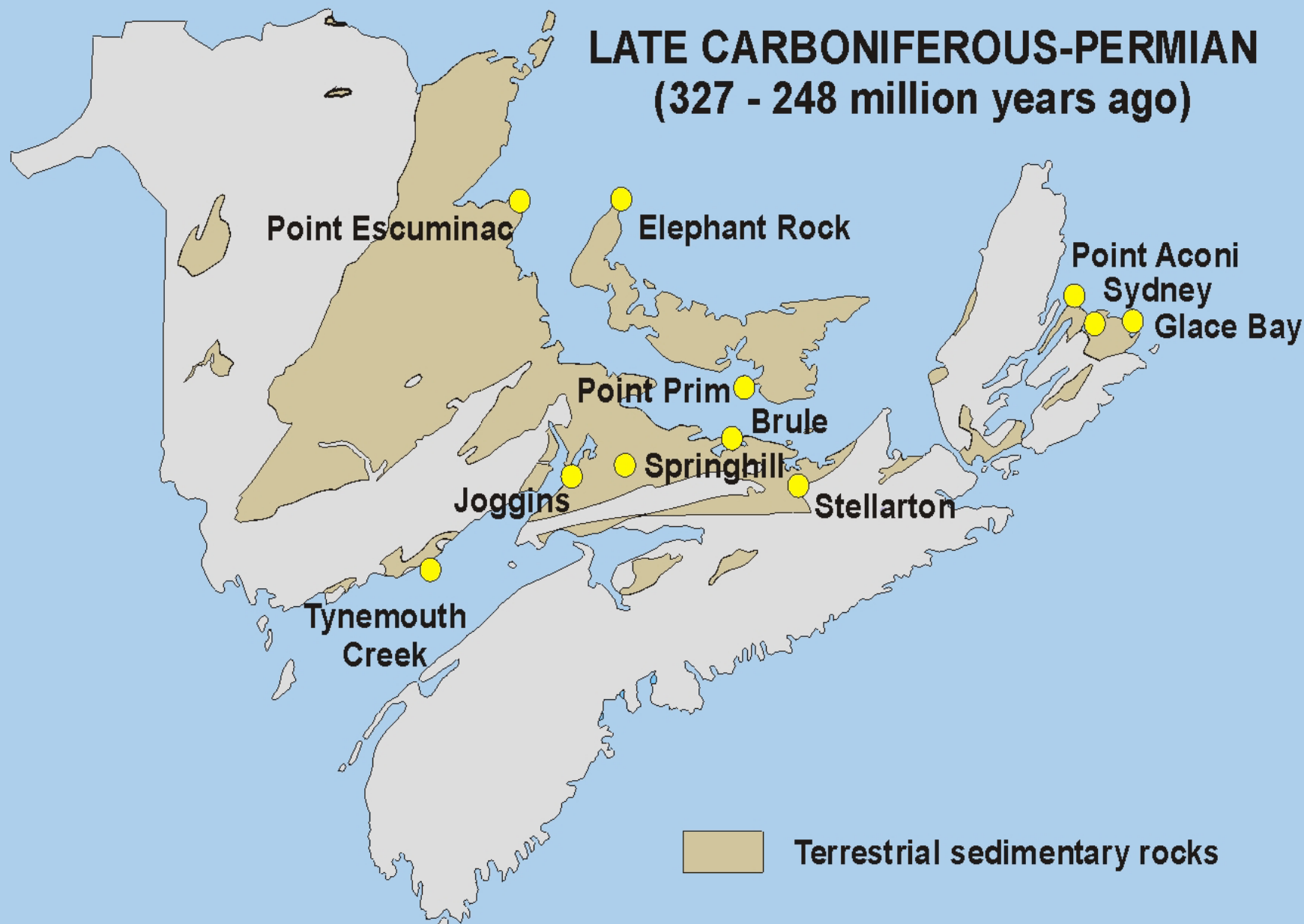


from The Last Billion Years (AGS, 2001) The Maritimes about 310 million years ago.



Geology of the Maritime Provinces

**LATE CARBONIFEROUS-PERMIAN
(327 - 248 million years ago)**



Geology of the Maritime Provinces



Outline

Bedrock Geology – The Big Picture

STAGE 3: Break-up of Pangea

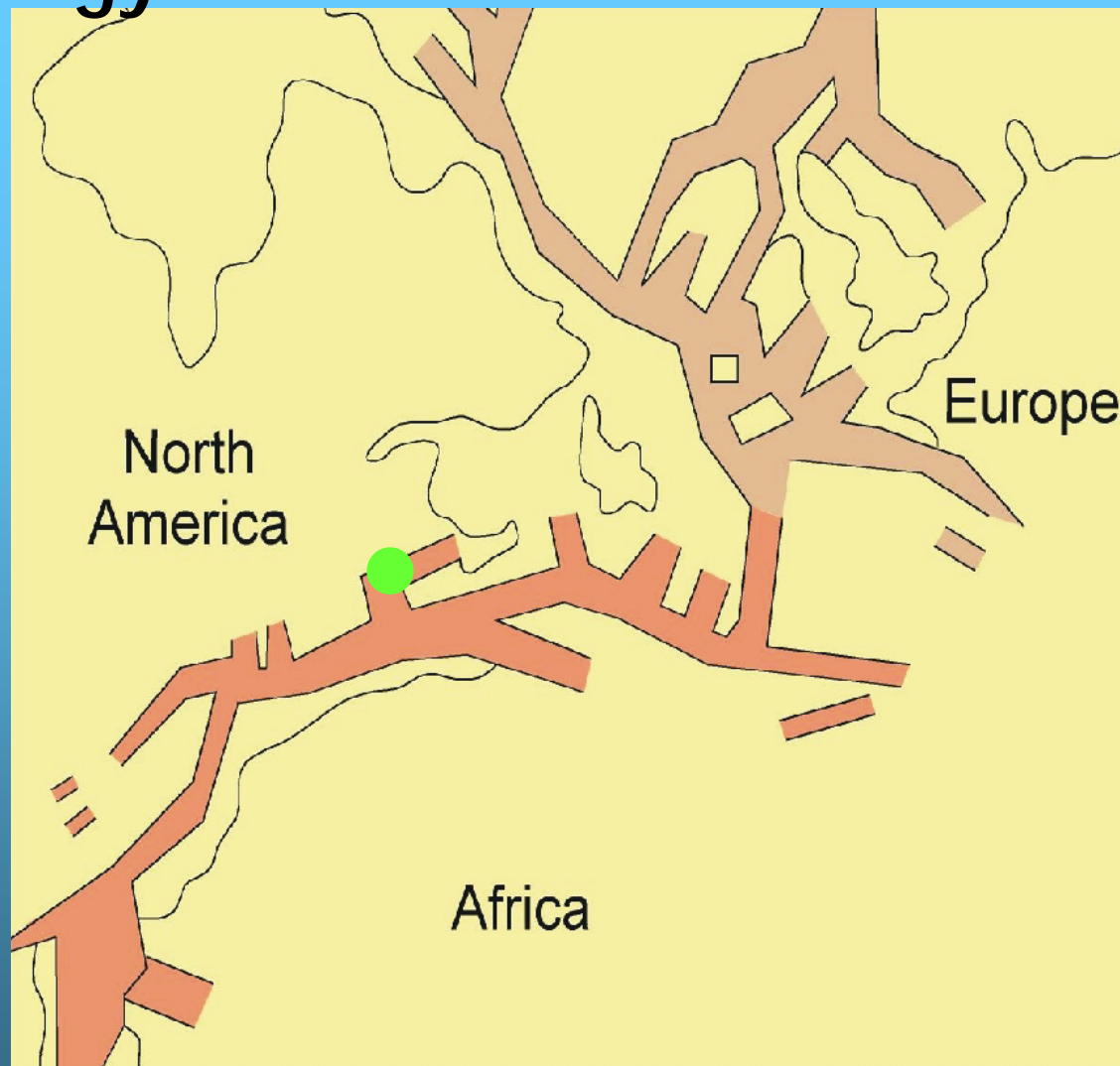
Surficial Geology – The Ice Age

Soil – What is the Connection?

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Rifts formed before 175 Ma



Rifts formed between 130 Ma and 75 Ma

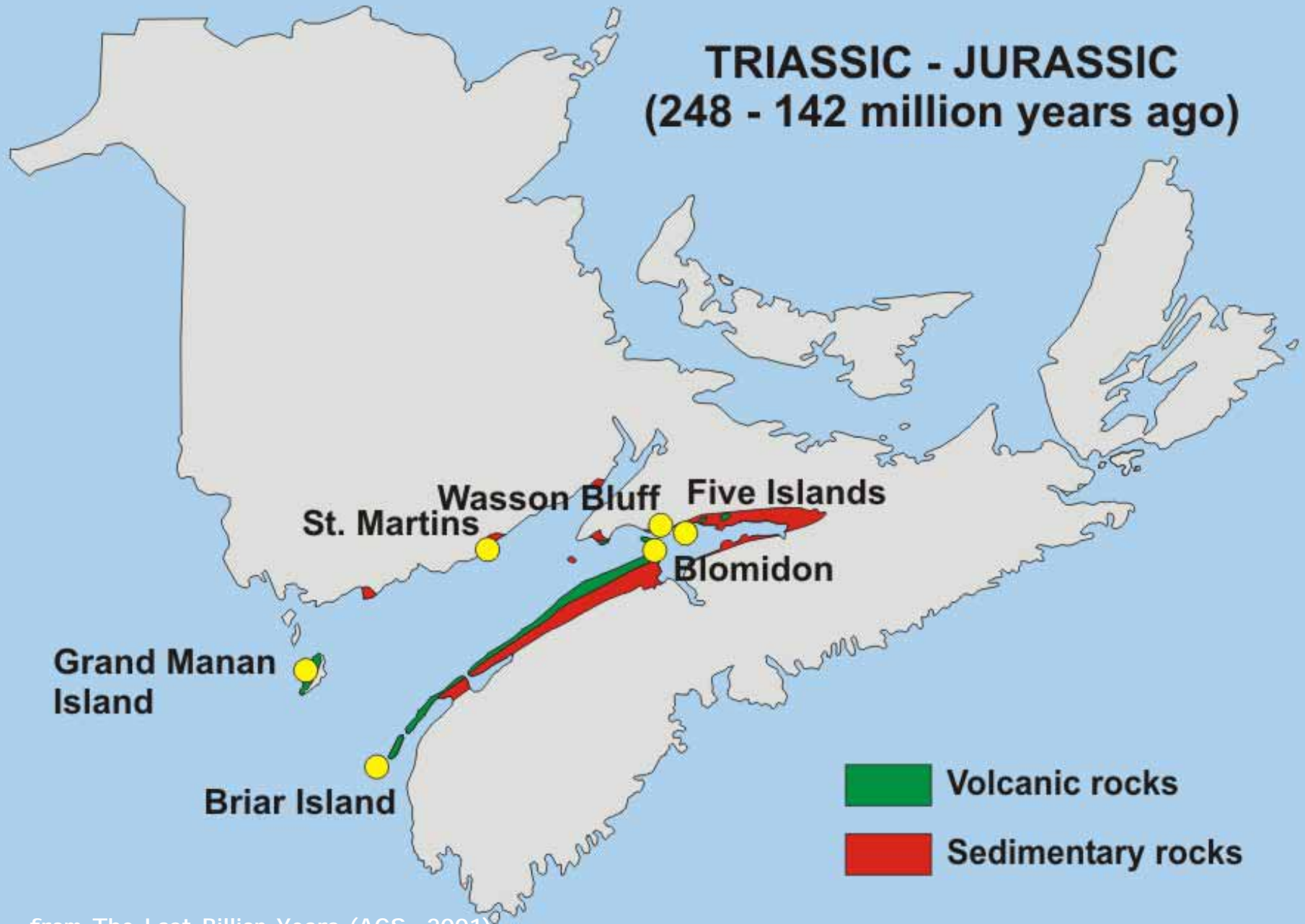


Land

courtesy Rob Fensome



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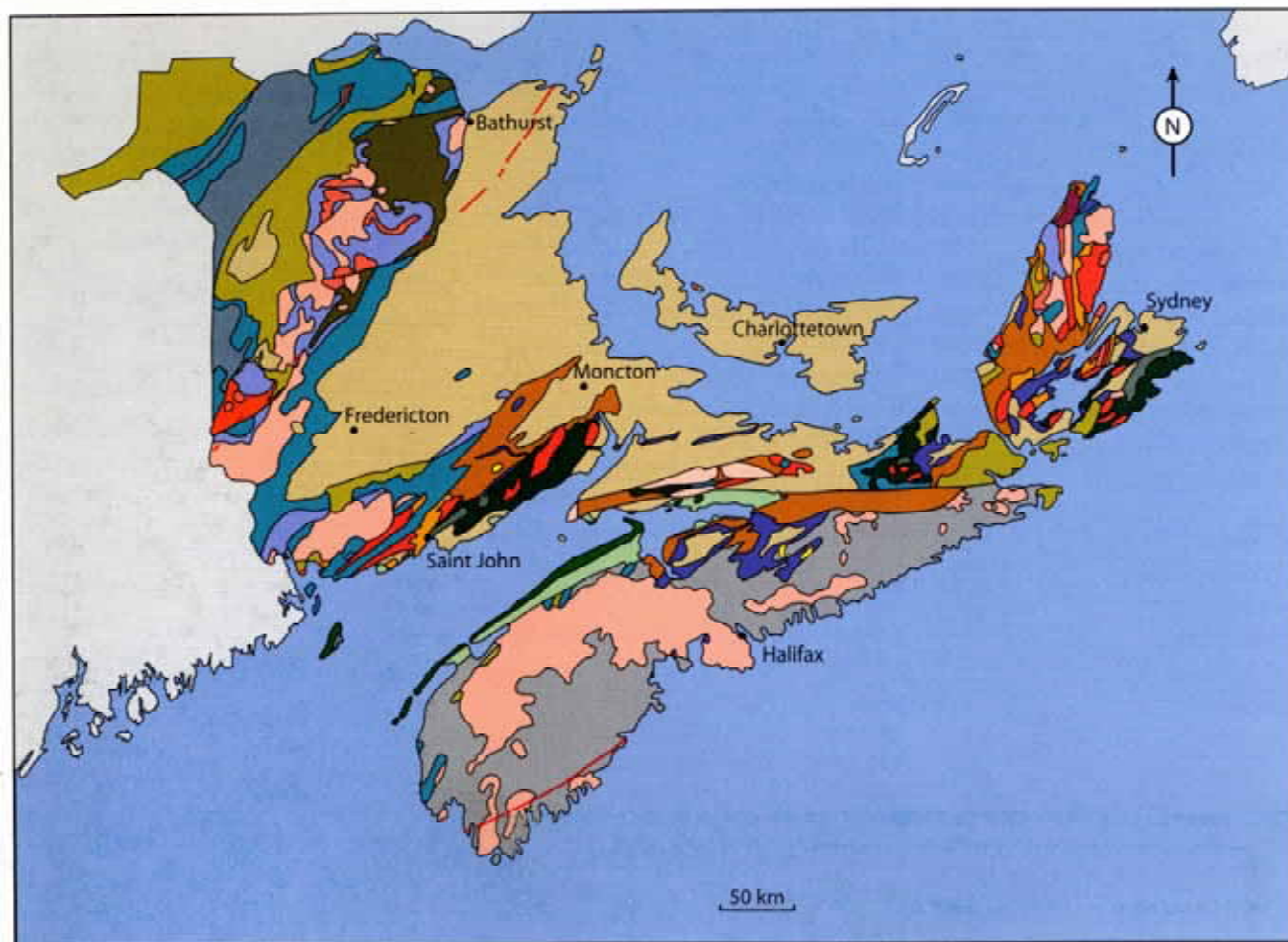




Geology of the Maritime Provinces

COMPLEX

Bedrock Geology ... but we understand it!!!



Mesozoic

- Cretaceous sedimentary rocks
- Early Jurassic dykes
- Early Jurassic volcanic rocks
- Triassic-Jurassic sedimentary rocks

Carboniferous and Permian

- Late Carboniferous-Permian terrestrial sedimentary rocks
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Silurian and Devonian

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Geology of the Maritime Provinces

EON	Era	Period	millions of years
PHANEROZOIC	Cenozoic	Quaternary	1.8
		Neogene	23
		Paleogene	65
	Mesozoic	Cretaceous	145
		Jurassic	200
		Triassic	253
	Paleozoic	Permian	300
		Carboniferous	360
		Devonian	418
		Silurian	443
		Ordovician	489
		Cambrian	542
PROTEROZOIC	Neoproterozoic		1000
	Mesoproterozoic		1600
	Paleoproterozoic		2500
ARCHEAN	Neoarchean		2900
	Mesoarchean		3400
	Paleoarchean		3600
	Eoarchean		4600

After Okulitch, A.V., 2004

courtesy Rob Fensome

Geology of the Maritime Provinces



Outline

Bedrock Geology – The Big Picture

Surficial Geology – The Ice Age (Stage 4)

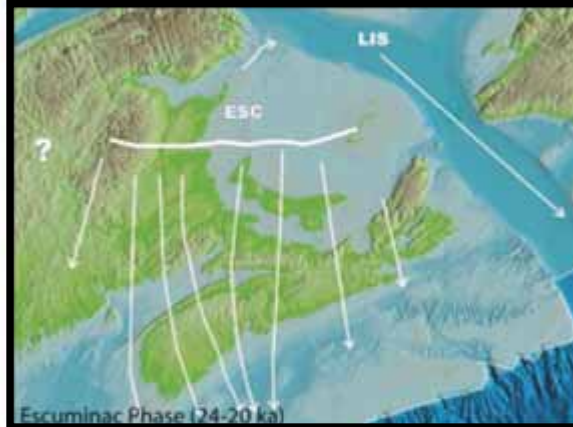
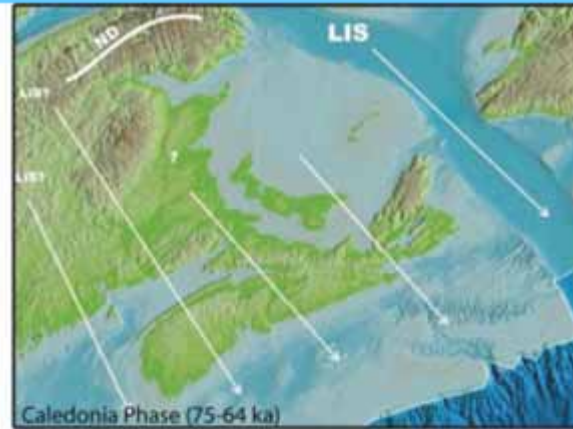
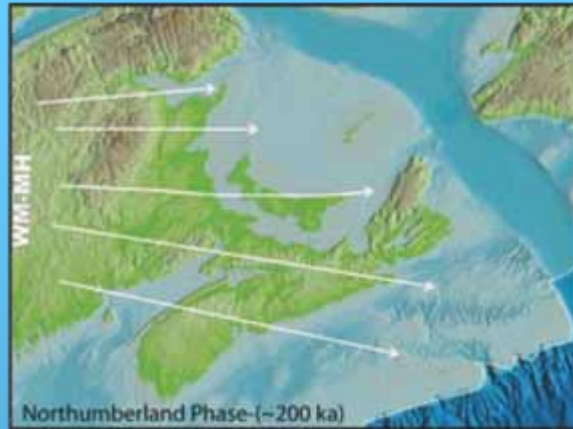
Soil – What is the Connection?

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Geology of the Maritime Provinces



Geology of the Maritime Provinces



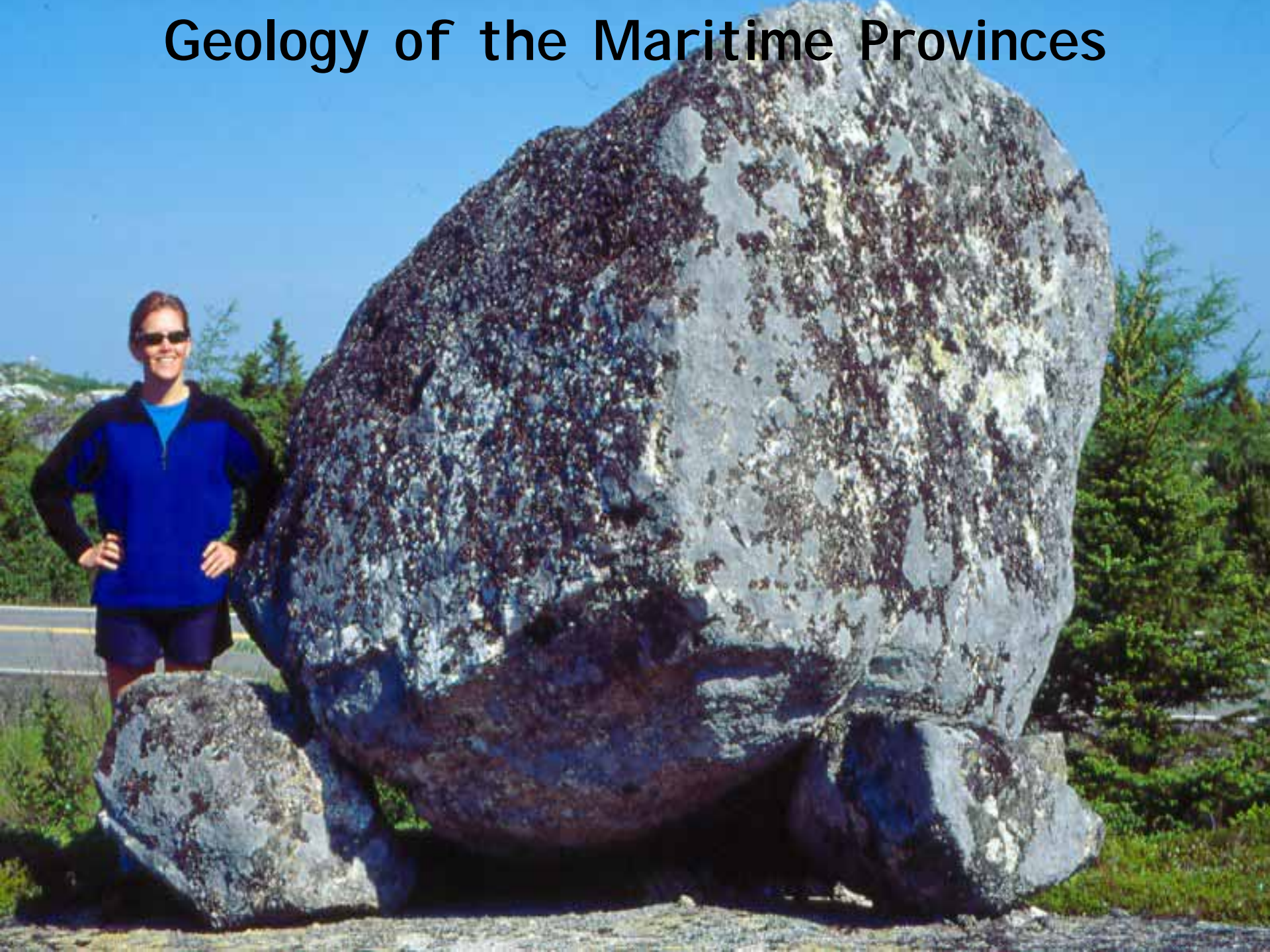
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Beaver River Till (Local)
(Scotian Phase)

Lawrencetown Till (Distal)
(Escuminac Phase)

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SOILS OF CANADA

Canada's landscape, with its wide range of climates, topography and geological conditions, has resulted in the development of a broad spectrum of soils. These soils are a major resource that not only sustains agriculture, forestry and wildlife, but also purifies groundwater. Sustaining soil quality is a major challenge facing our society.

DOMINANT SOILS (Great Groups)

LEGEND

PERMAFROST-AFFECTED SOILS	PERENNIAL SOILS	TRANSITIONING SOILS
Arctic (purple)	Black (green)	Black (yellow)
Arctic (pink)	Black (blue)	Black (brown)
Arctic (red)	Black (orange)	Black (grey)
Arctic (brown)	Black (purple)	Black (white)
PERMAFROST-AFFECTED SOILS	PERENNIAL SOILS	TRANSITIONING SOILS
Arctic (purple)	Black (green)	Black (yellow)
Arctic (pink)	Black (blue)	Black (brown)
Arctic (red)	Black (orange)	Black (grey)
Arctic (brown)	Black (purple)	Black (white)

GRASSLAND SOILS

Soils formed under grassland fall into three soil orders: Chernozems, Solonchaks and Mollisols. Differentiating criteria are based on soil development and soil chemistry.

ORGANIC SOILS

Organic soils are composed of peat or siltic materials and most are saturated with water for prolonged periods.

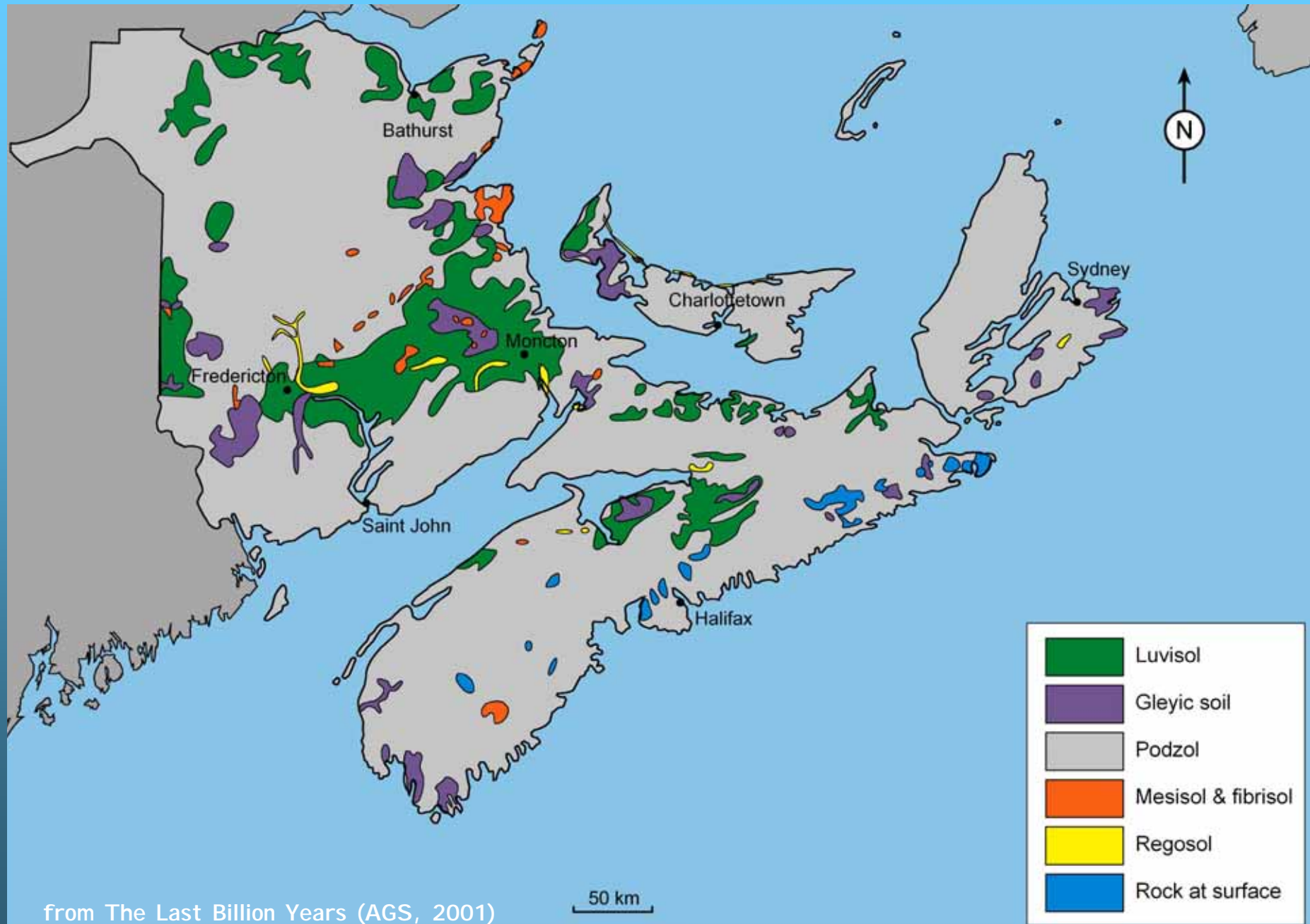
MINERAL SOILS DEVELOPED UNDER WET CONDITIONS

Gleysols develop during prolonged periods of saturation or continuous saturation with water.

NONSOILS

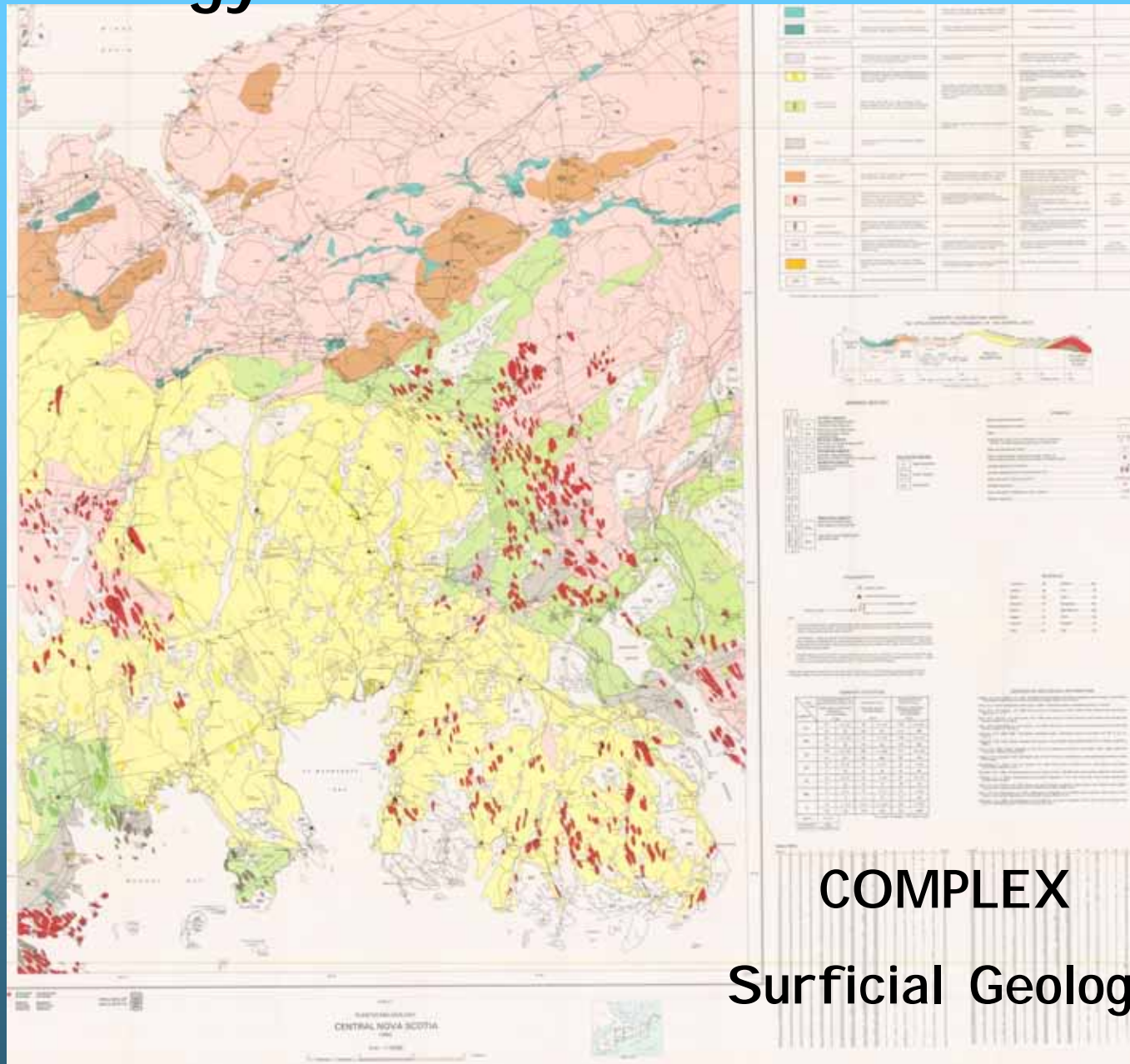
NOTES ON CONTOURING
The map uses contour lines to show the distribution of soil orders. The map uses contour lines to show the distribution of soil orders. The map uses contour lines to show the distribution of soil orders.

Geology of the Maritime Provinces





Geology of the Maritime Provinces



Geology of the Maritime Provinces



Outline

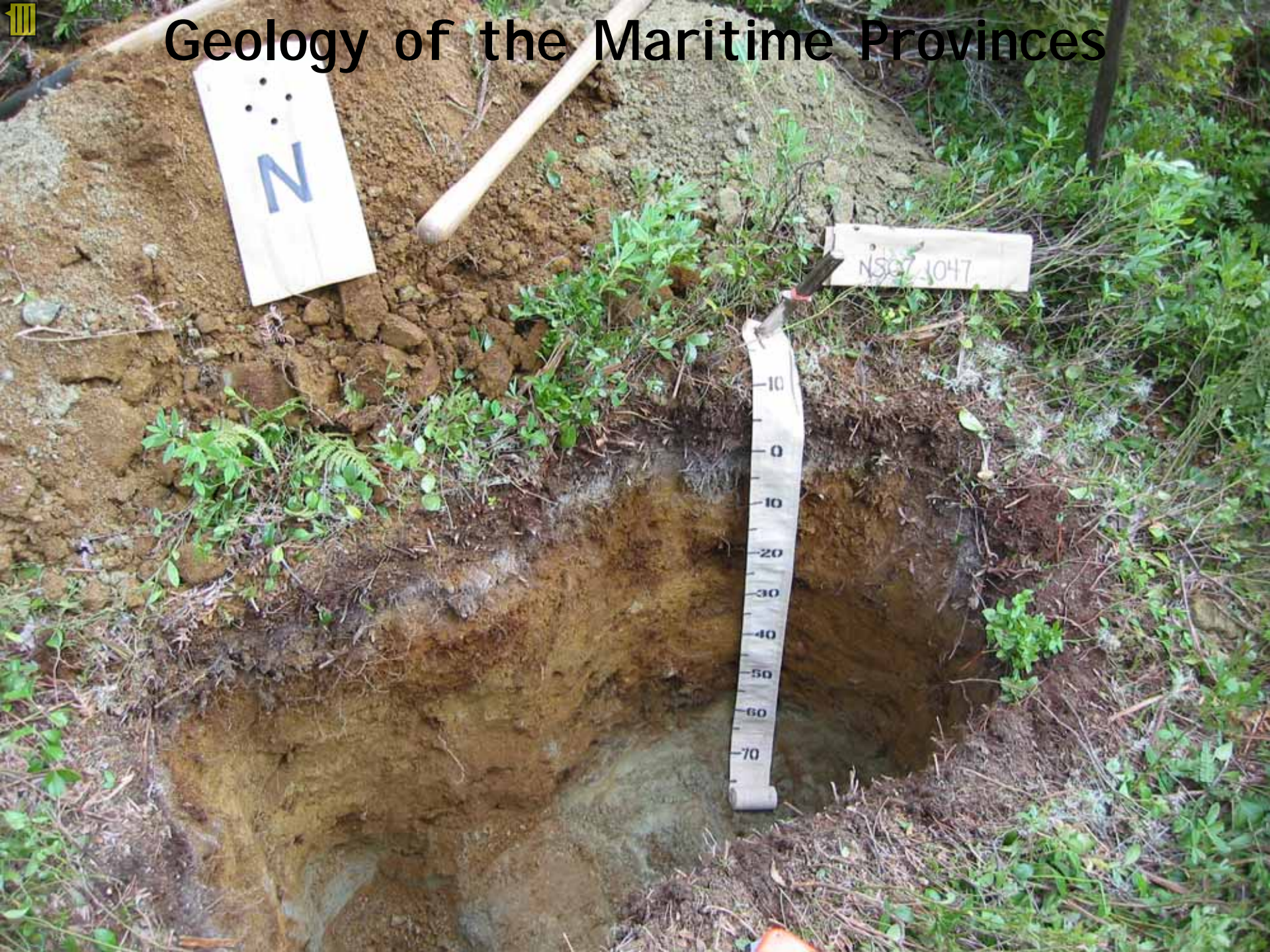
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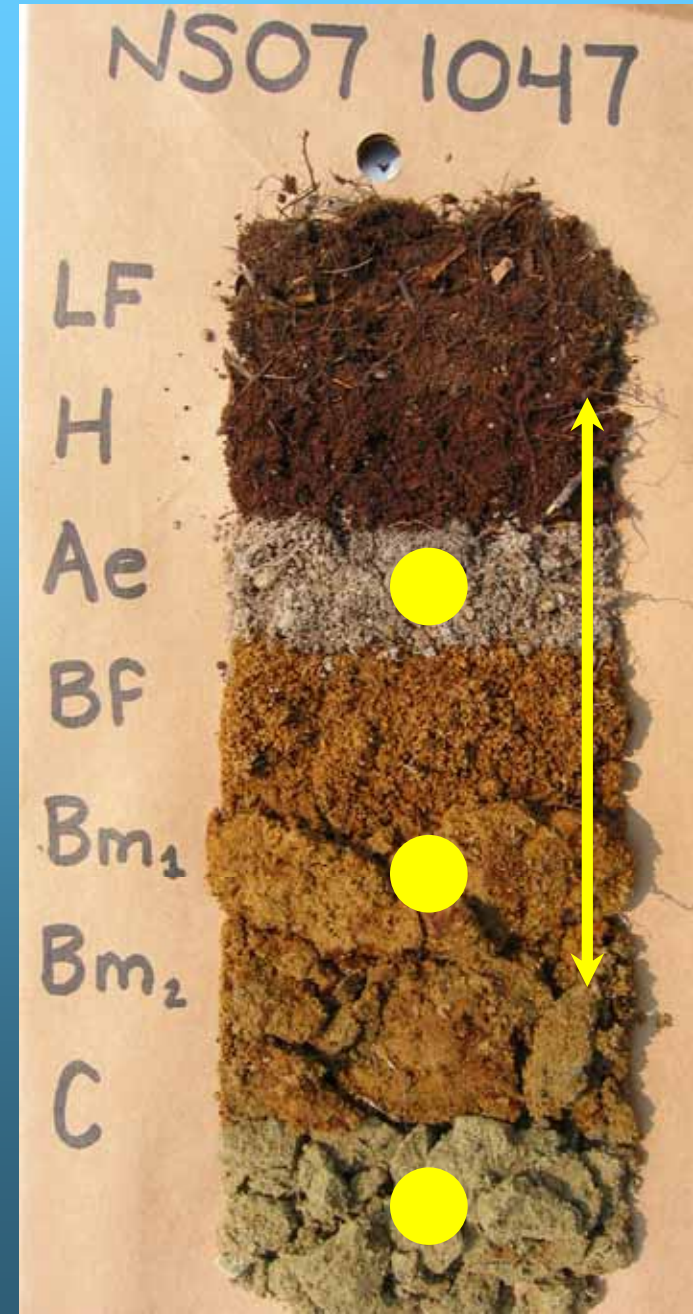
Geochemistry – What we are Trying to Understand?

Geology of the Maritime Provinces





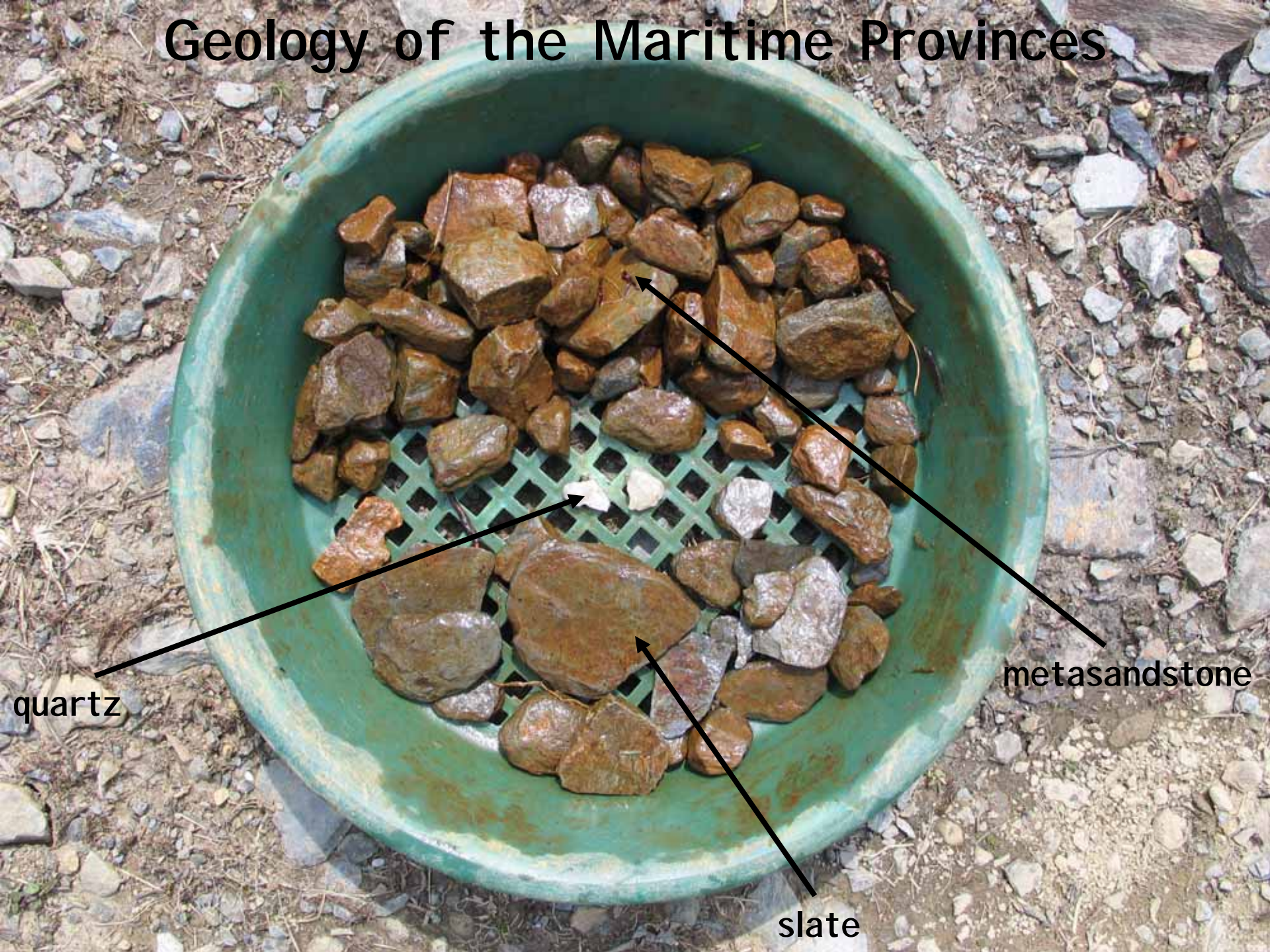
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quartz

metasandstone

slate

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arsenopyrite



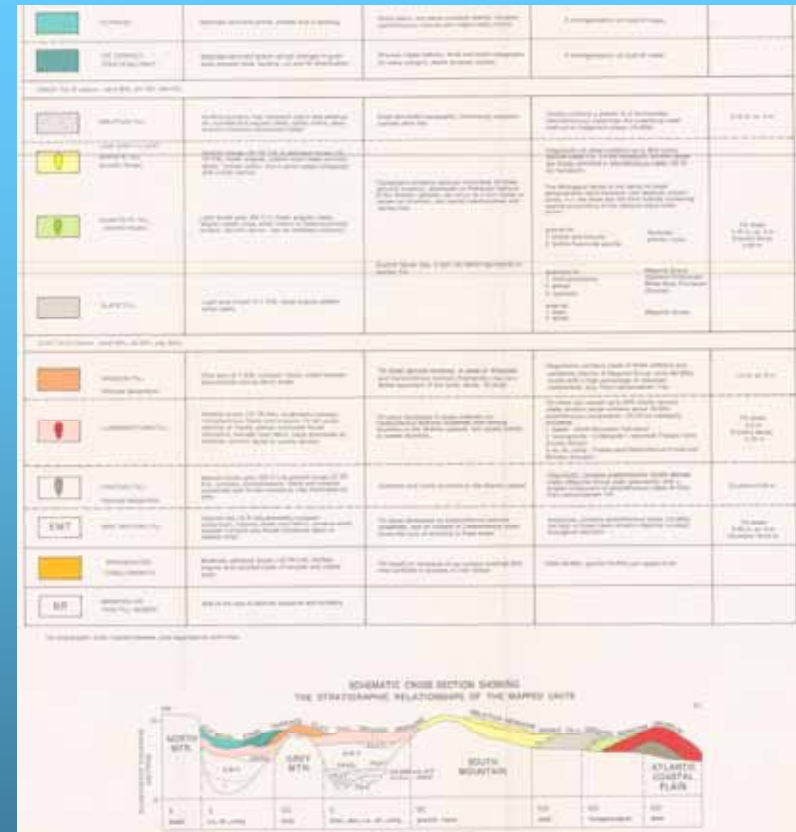
Geology of the Maritime Provinces

Sampling Objectives?

SUMMARY STATISTICS

TILL TYPE ELEMENT	LAWRENCETOWN TILL and EAST MILFORD TILL (Carboniferous & Triassic sedimentary rock derivatives) N=80		GRANITE TILL (Devonian granitic rock derivative) N=37		QUARTZITE and SLATE TILLS (Cambro-Ordovician metasedimentary rock derivative) N=21	
	MEAN	RANGE	MEAN	RANGE	MEAN	RANGE
Cu	47	16–220	68	10–910	133	40–550
	25	83	145	121	117	349
Pb	29	10–216	75	14–720	119	32–512
	24	43	113	120	132	423
Zn	134	10–250	245	8–1396	171	30–290
	47	217	245	900	62	279
Co	18	13–34	16	4–50	35	4–90
	3	23	10	40	23	84
Ni	47	30–67	33	2–84	66	8–116
	8	61	18	74	29	112
Mo	3	0–5	6	2–12	10	2–44
	1	5	3	12	12	43
U	1.6	.1–12.4	12.2	2.1–59.0	5.8	.2–35.0
	1.9	4.5	10.0	30.3	8.3	34.9
MEAN	RANGE		N=number of samples. All values in ppm.			
STANDARD DEVIATION	95th PERCENTILE					

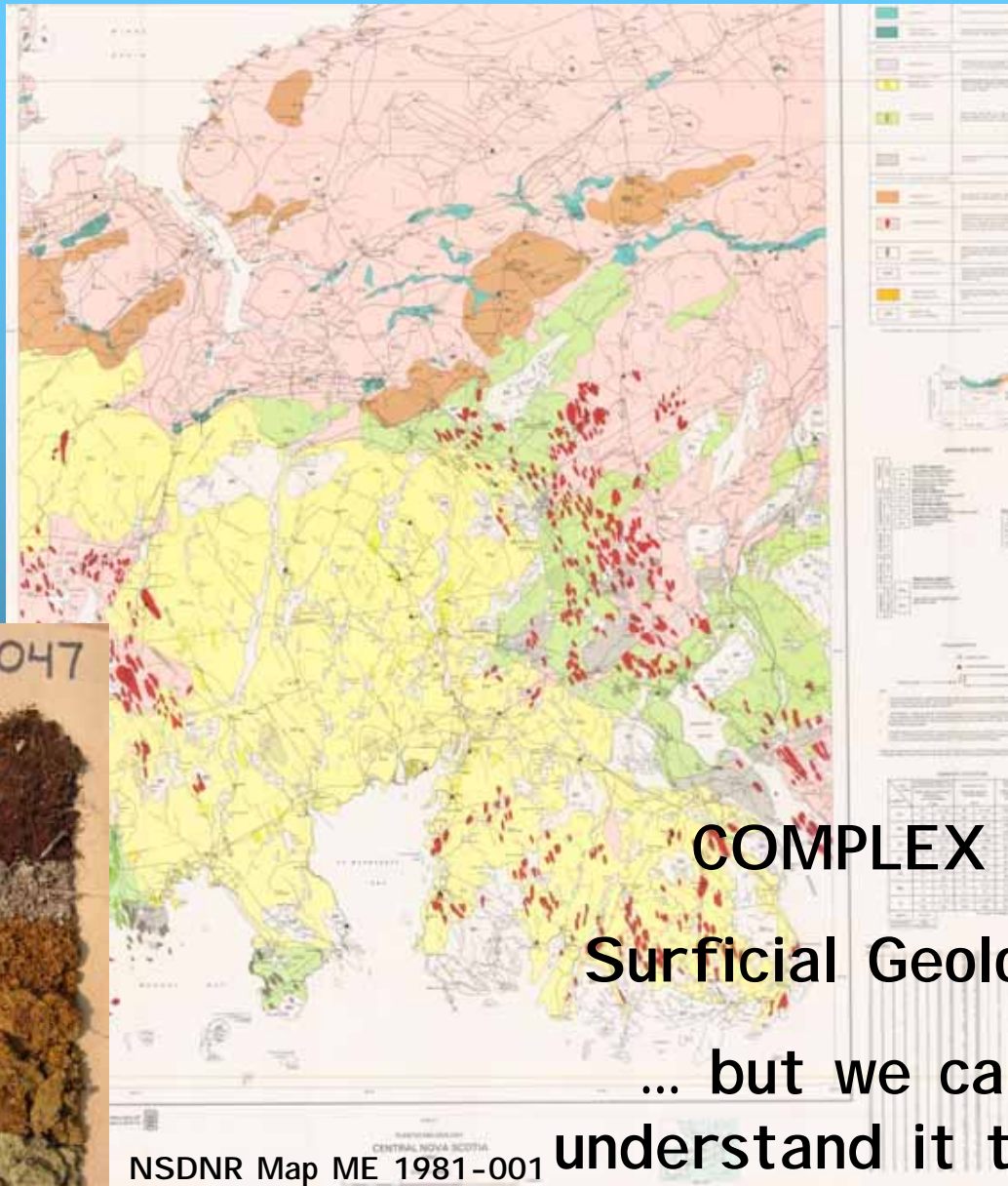
NSDNR Map ME 1981-001



COMPLEX
Surficial Geology



Geology of the Maritime Provinces



COMPLEX

Surficial Geology

... but we can
understand it too!!!

NSDNR Map ME 1981-001

Geology of the Maritime Provinces

Acknowledgements

Atlantic Geoscience Society

Grant Ferguson

Rob Fensome

Graham Williams

Ralph Stea

Beth McClenaghan

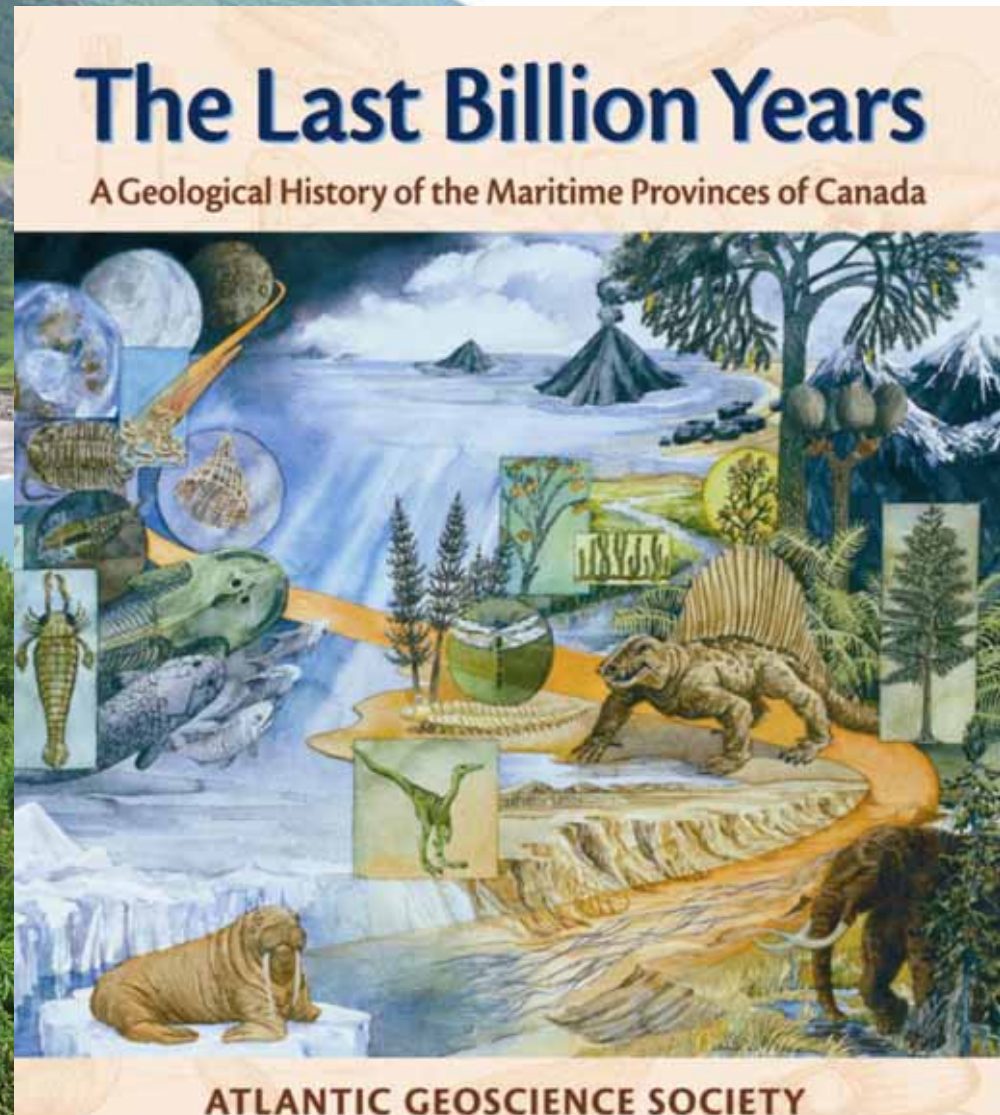
Dan Utting

Chris White

Toon Pronk

Garth Prime

Bob Ryan



Geology of the Maritime Provinces

HEALTH WARNING

Soils On This Site Contain Arsenic

*Keep Off This Site
at the Request of the Medical Officer of
Health*


NOVA SCOTIA

Thank You!
Questions

Selected References

- Fensome, R.A. and Williams, G.L. (eds), 2001. The Last Billion Years - A Geological History of the Maritime Provinces of Canada. Atlantic Geoscience Society Publications; 212 p., Nimbus Publishing.
- Stea, R. R, 2004. The Appalachian Glacier Complex in Maritime Canada in; Quaternary Glaciations - Extent and Chronology, Part II: North America Eds.; J. Ehlers and P. L. Gibbard pp. 213 – 232. Elsevier B. V.