

Geology of the Maritime Provinces

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(Environmental Geology and Geochemistry)

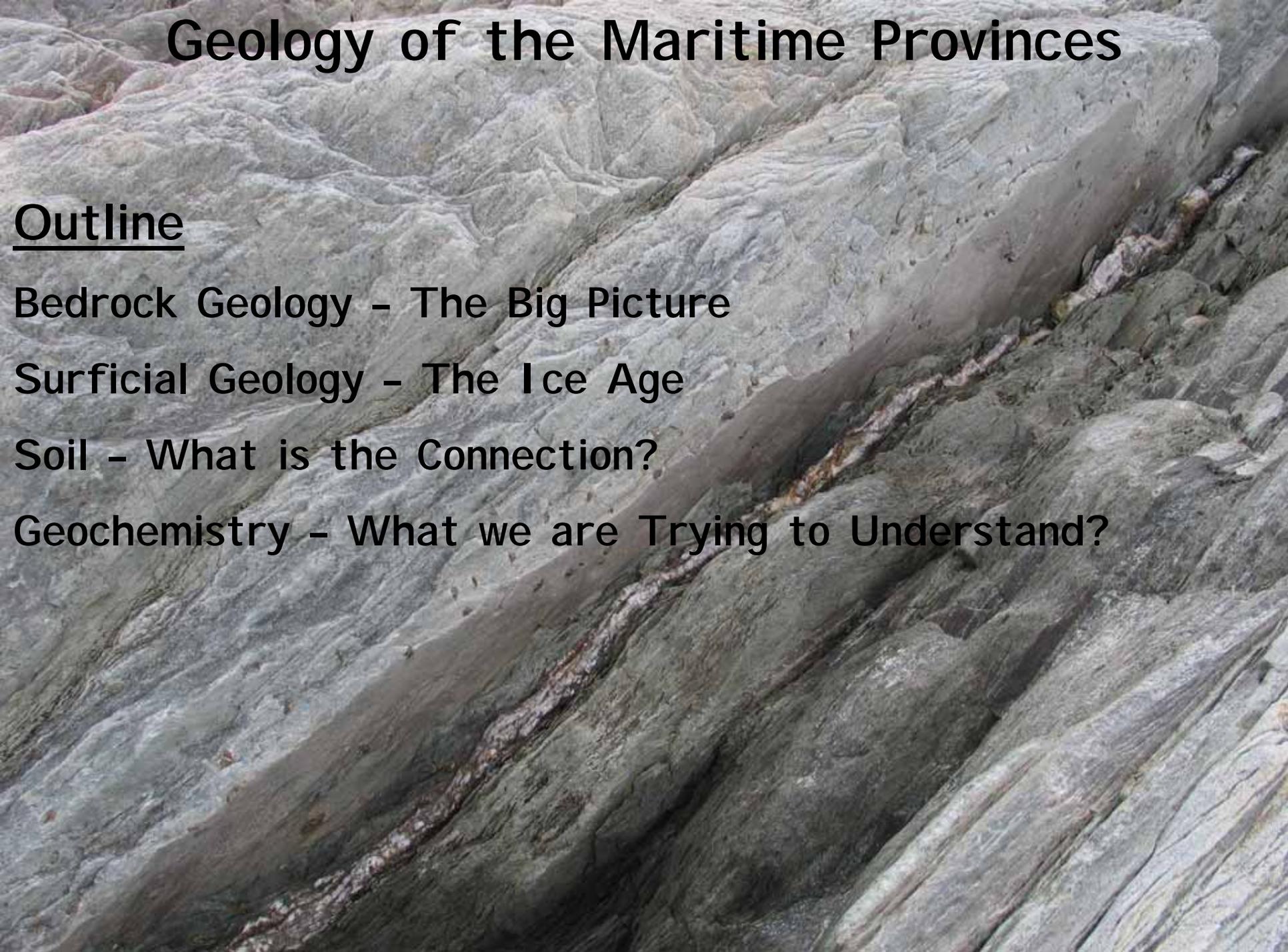
Nova Scotia Department of Natural Resources

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

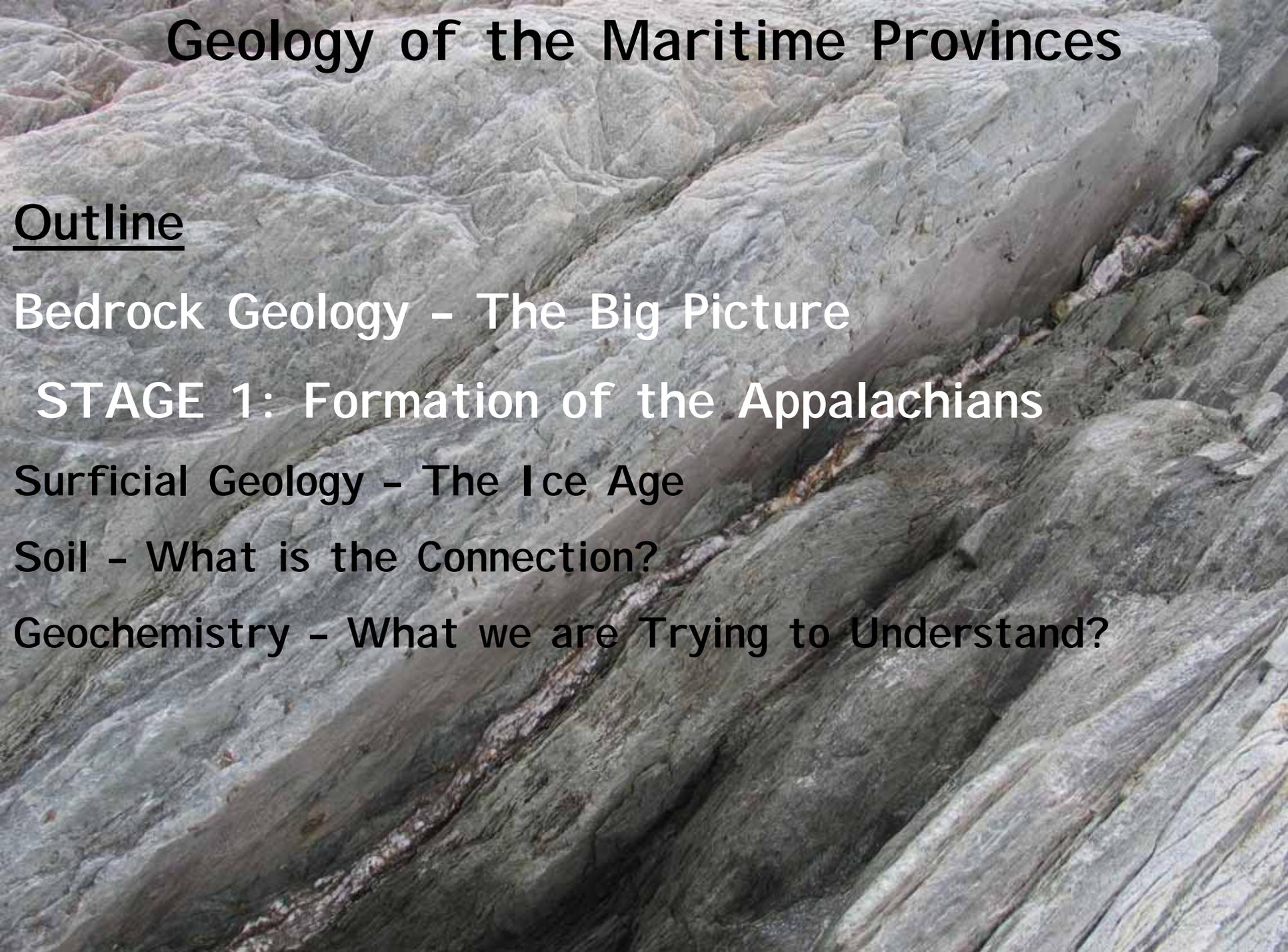
Bedrock Geology - The Big Picture

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

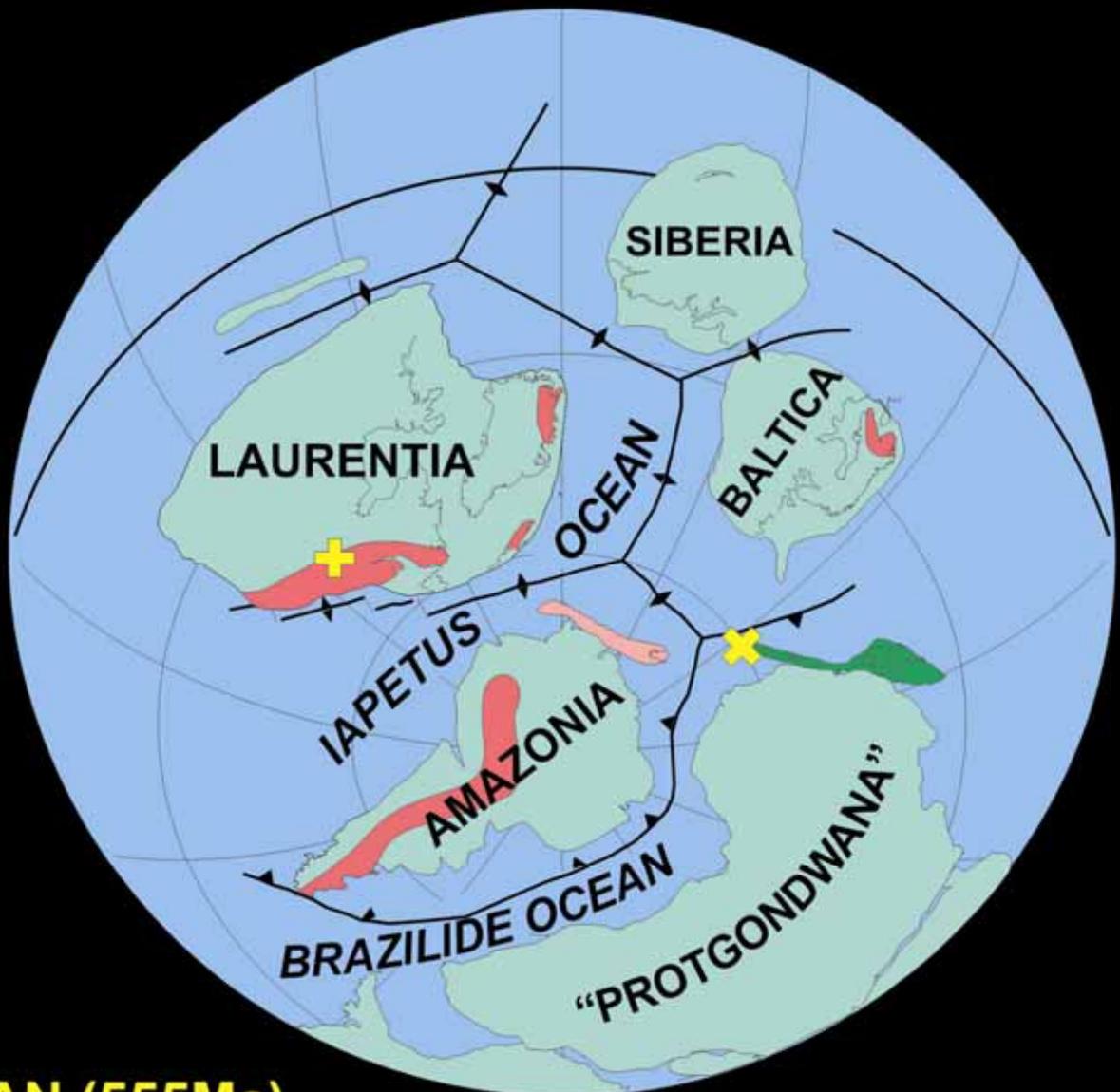
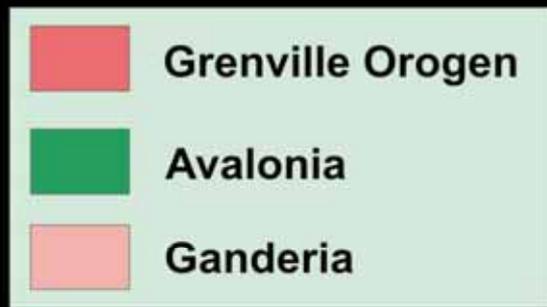
STAGE 1: Formation of the Appalachians

Surficial Geology - The Ice Age

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Geology of the Maritime Provinces



LATEST PRECAMBRIAN (555Ma)

Geology of the Maritime Provinces



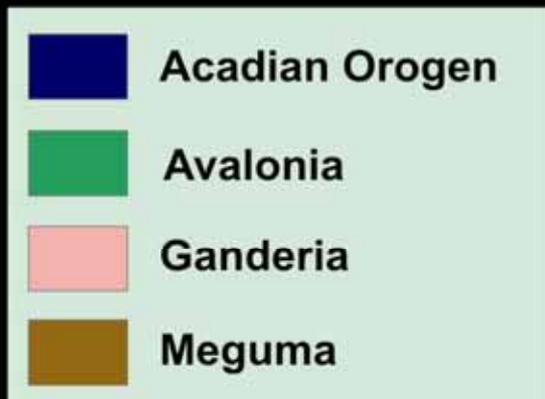
**CAMBRIAN
(ABOUT 515 MILLION YEARS AGO)**

Geology of the Maritime Provinces



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

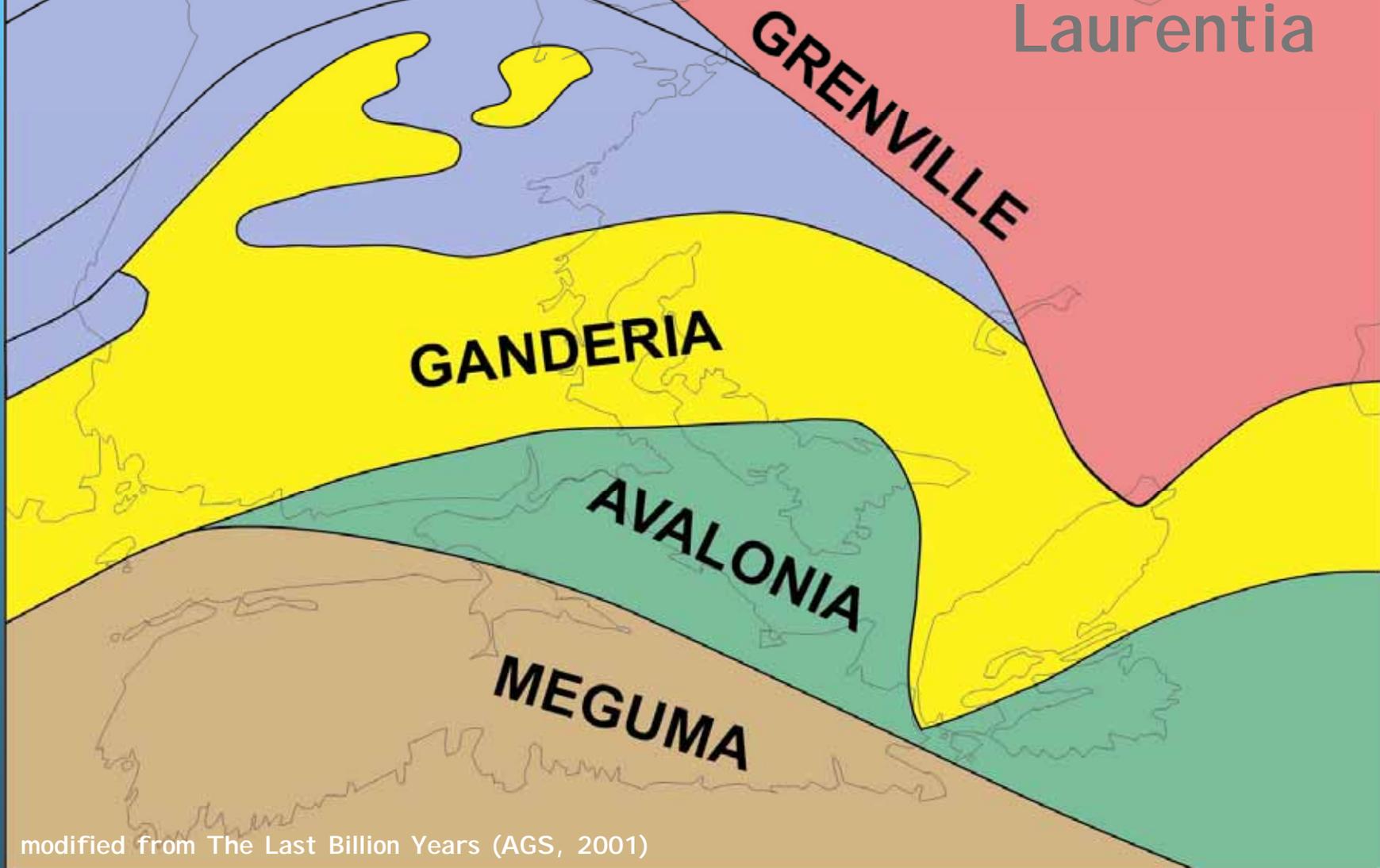
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**EARLY SILURIAN
(ABOUT 435 MILLION YEARS AGO)**

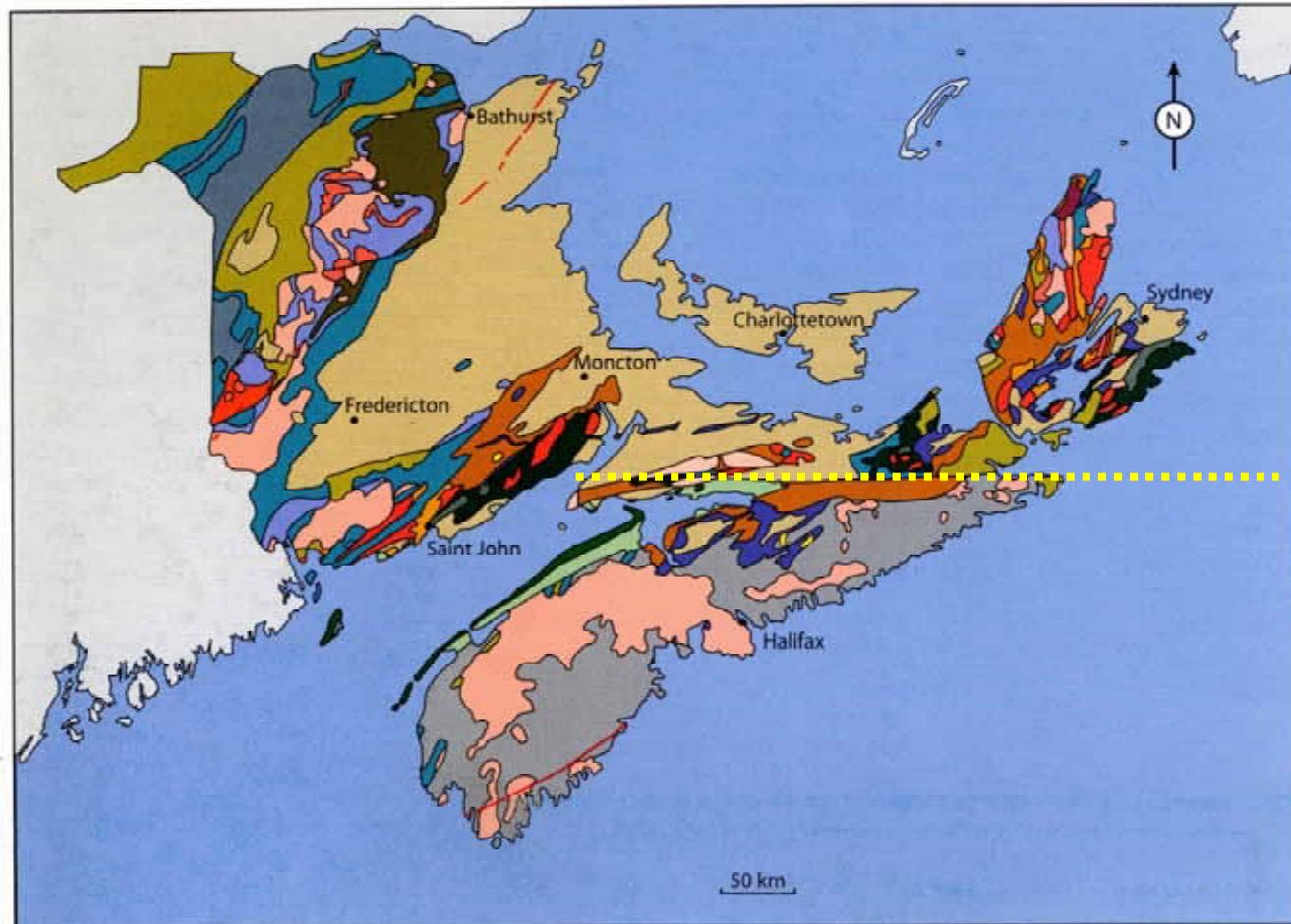
Geology of the Maritime Provinces

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

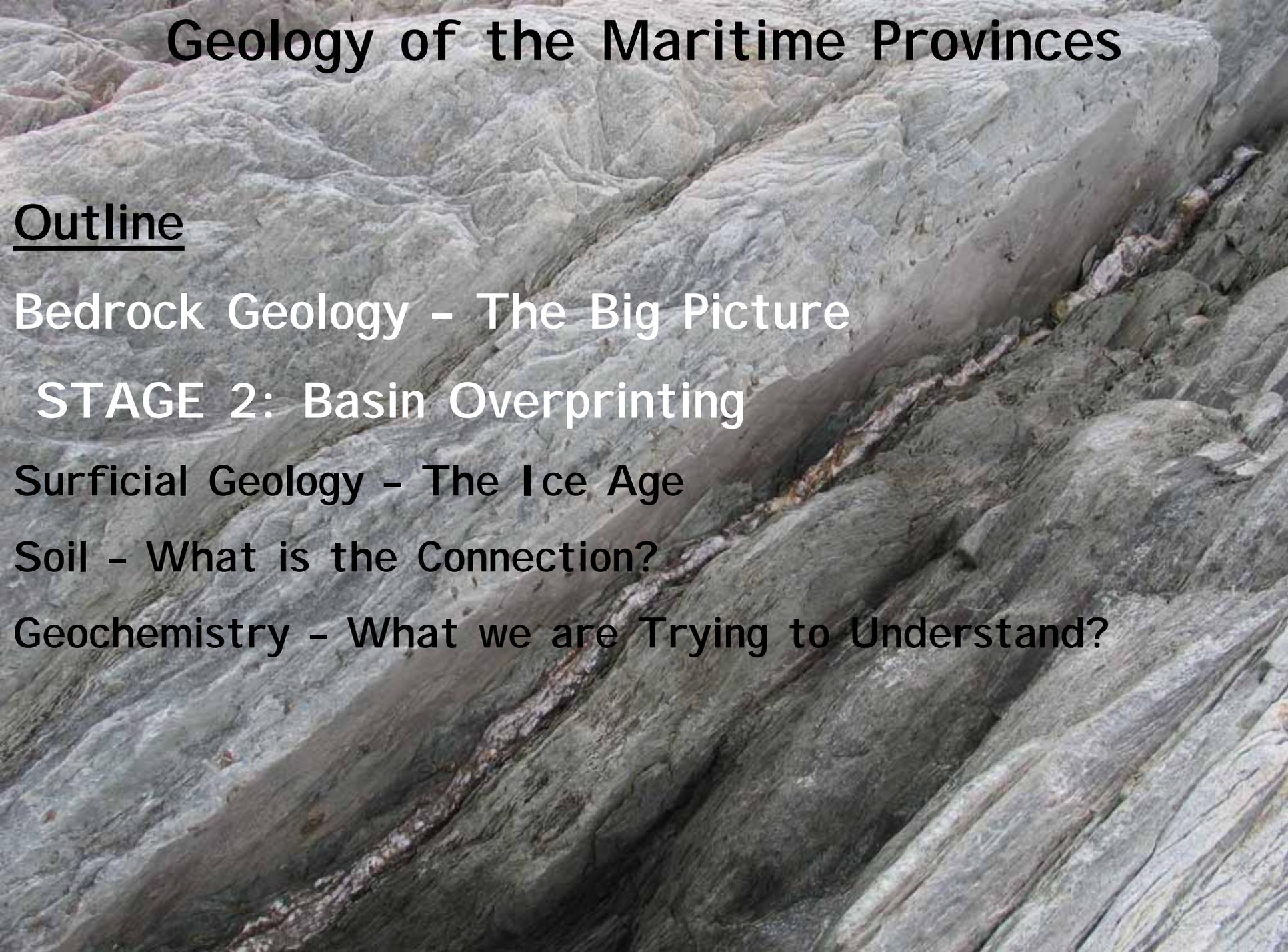
Precambrian

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

Yellow dotted line is the CCFZ - Cobequid Chedabucto Fault Zone

(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.)

Geology of the Maritime Provinces



Outline

Bedrock Geology - The Big Picture

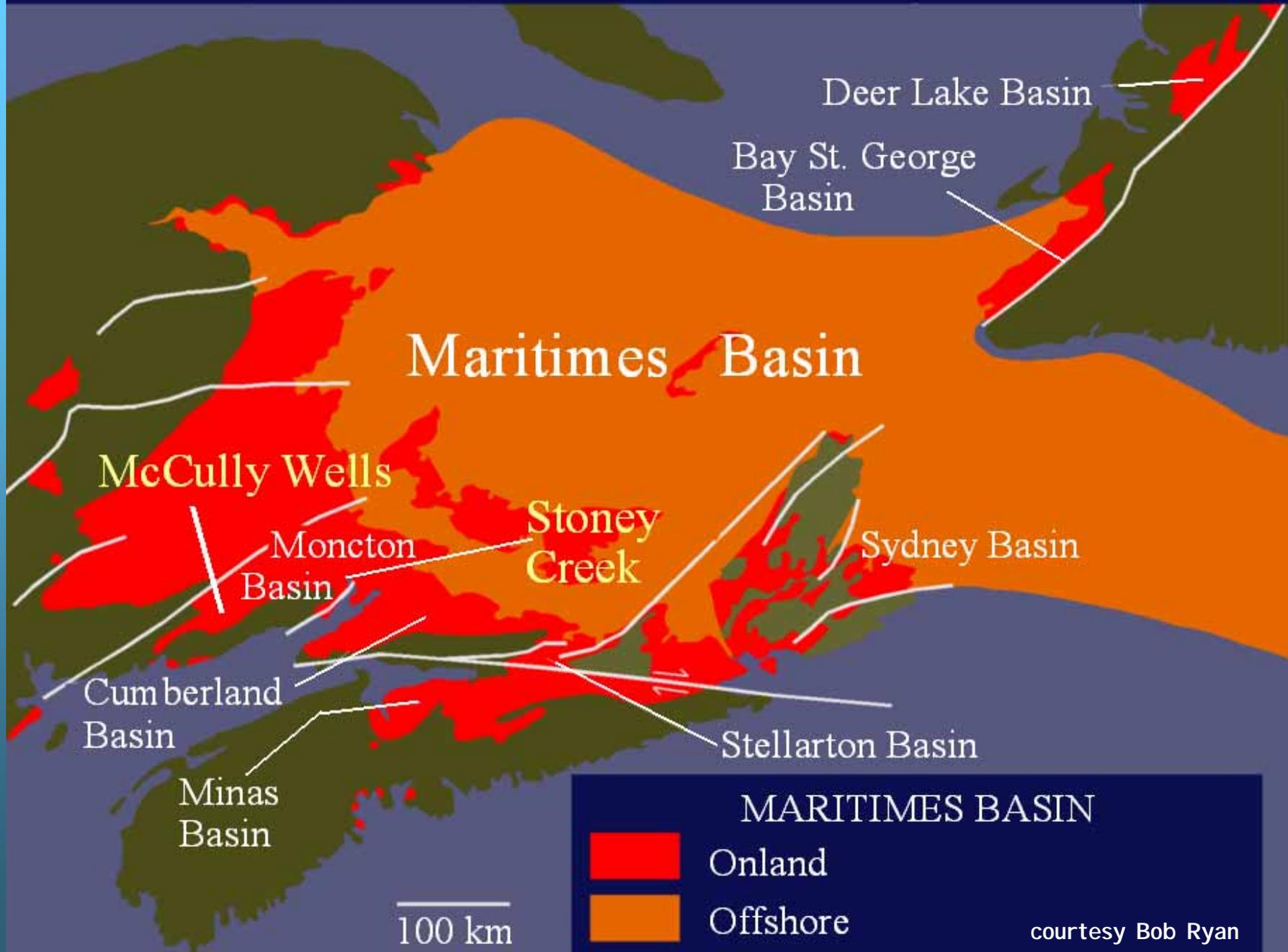
STAGE 2: Basin Overprinting

Surficial Geology - The Ice Age

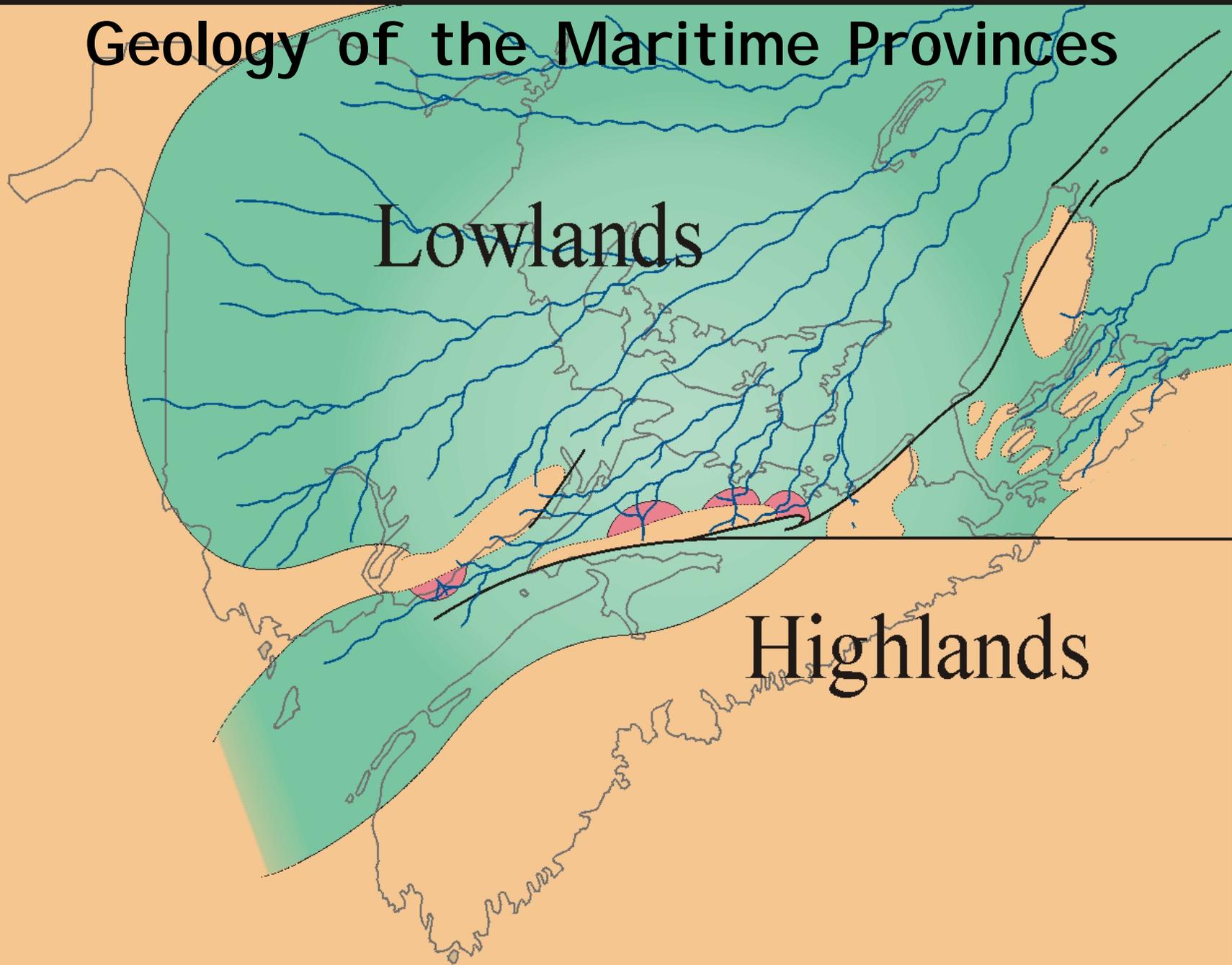
Soil - What is the Connection?

Geochemistry - What we are Trying to Understand?

Geology of the Maritime Provinces



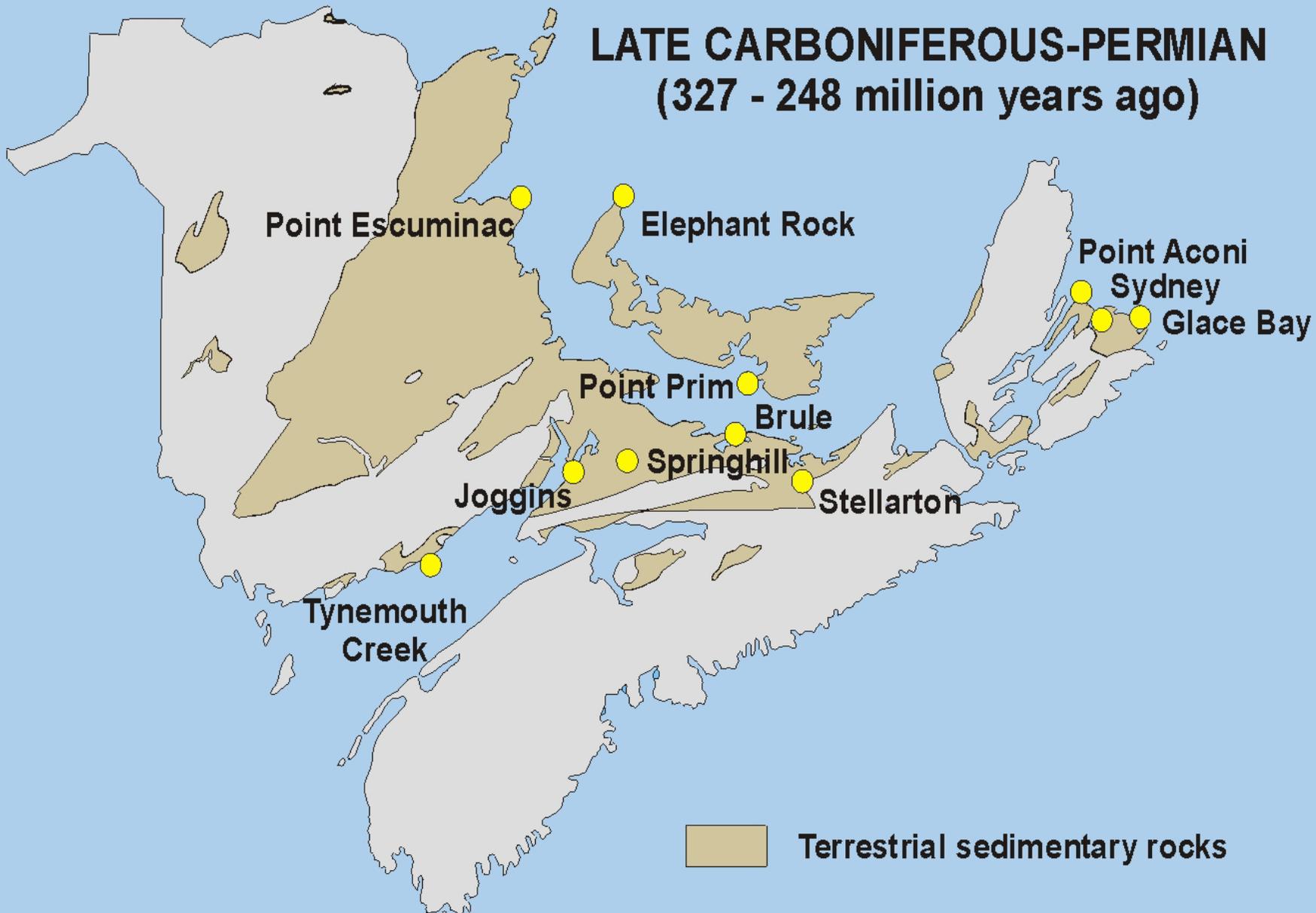
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from The Last Billion Years (AGS, 2001) **The Maritimes about 310 million years ago.**

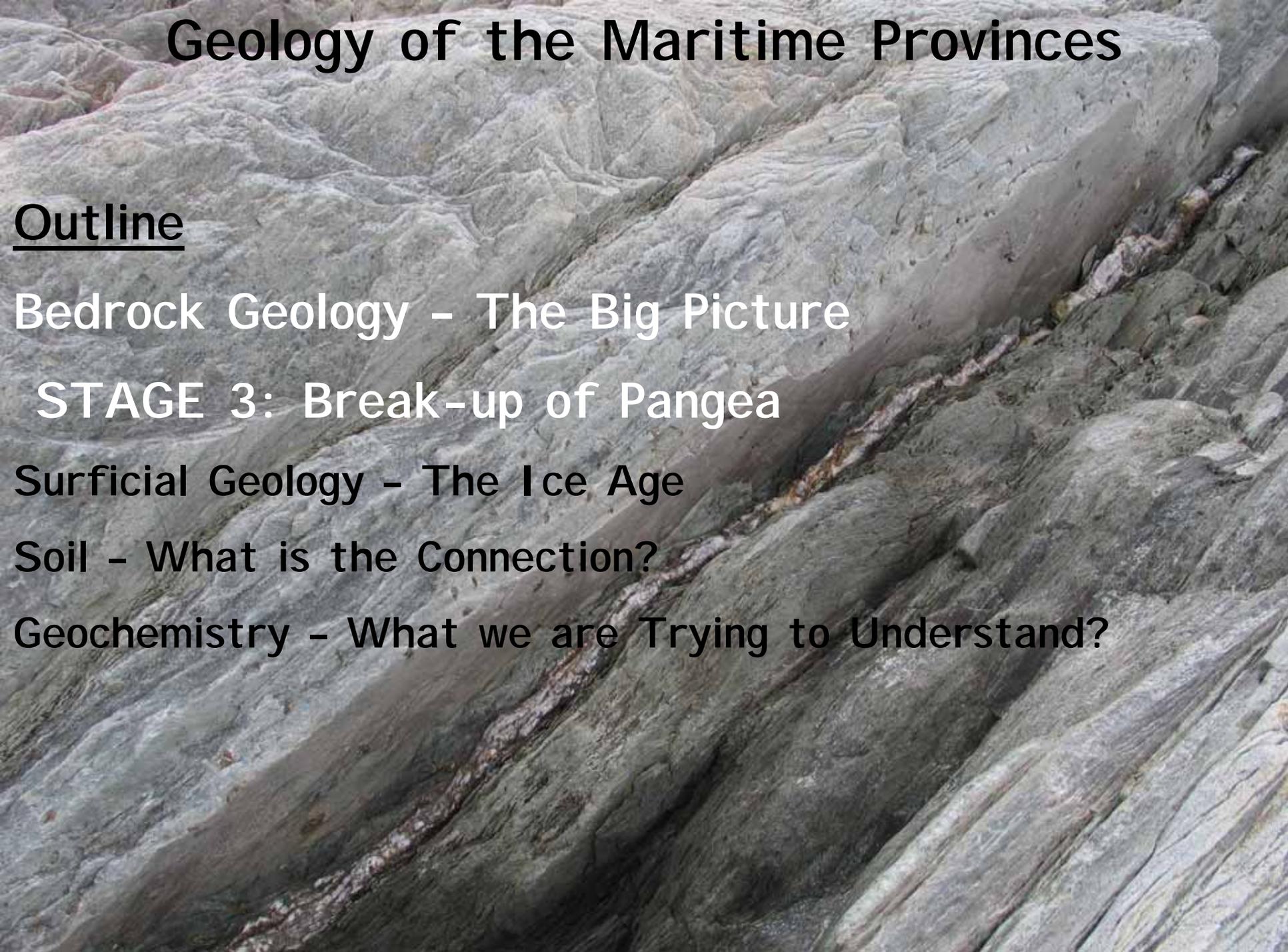
Geology of the Maritime Provinces

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



from The Last Billion Years (AGS, 2001)

Geology of the Maritime Provinces



Outline

Bedrock Geology - The Big Picture

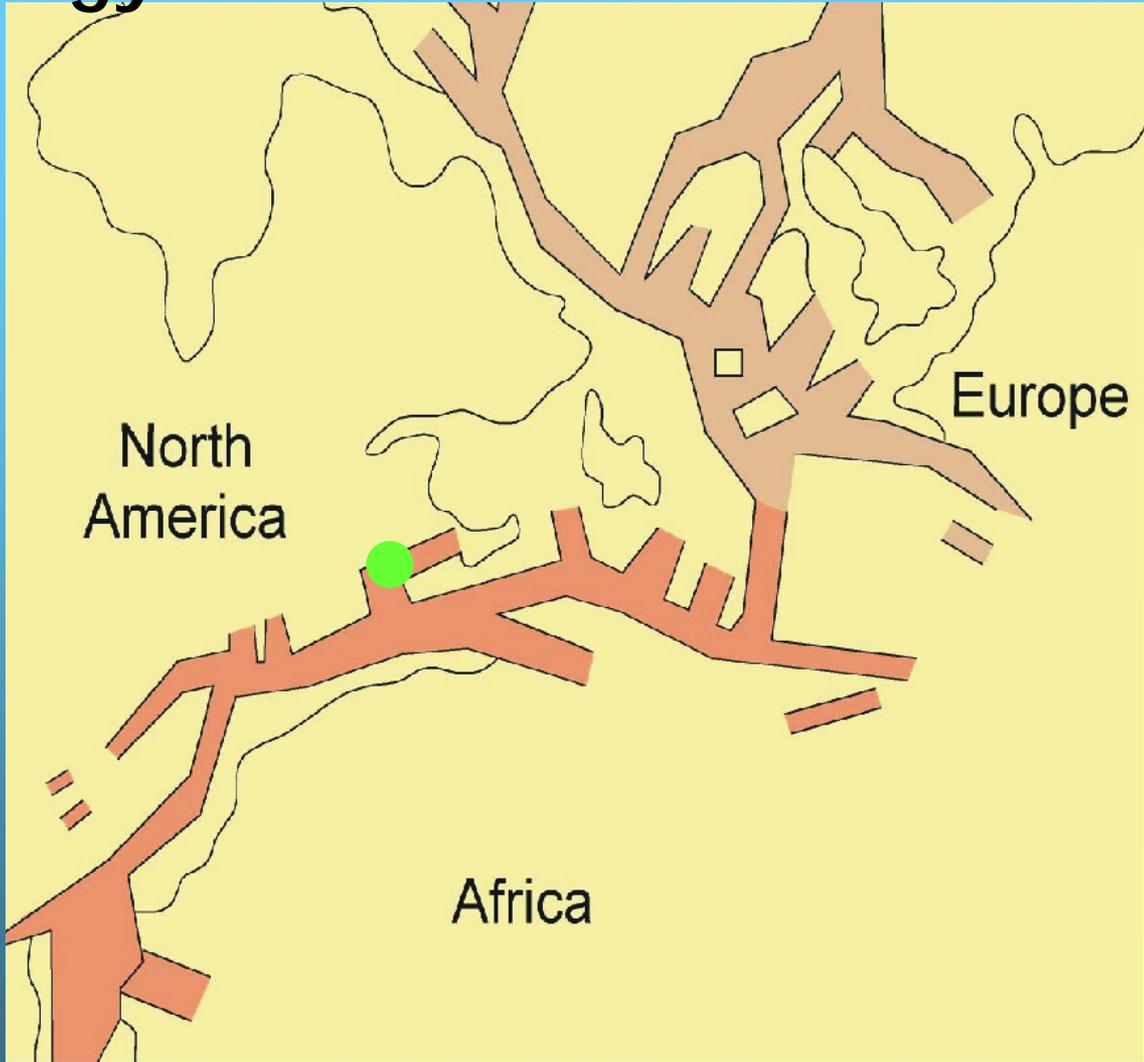
STAGE 3: Break-up of Pangea

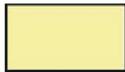
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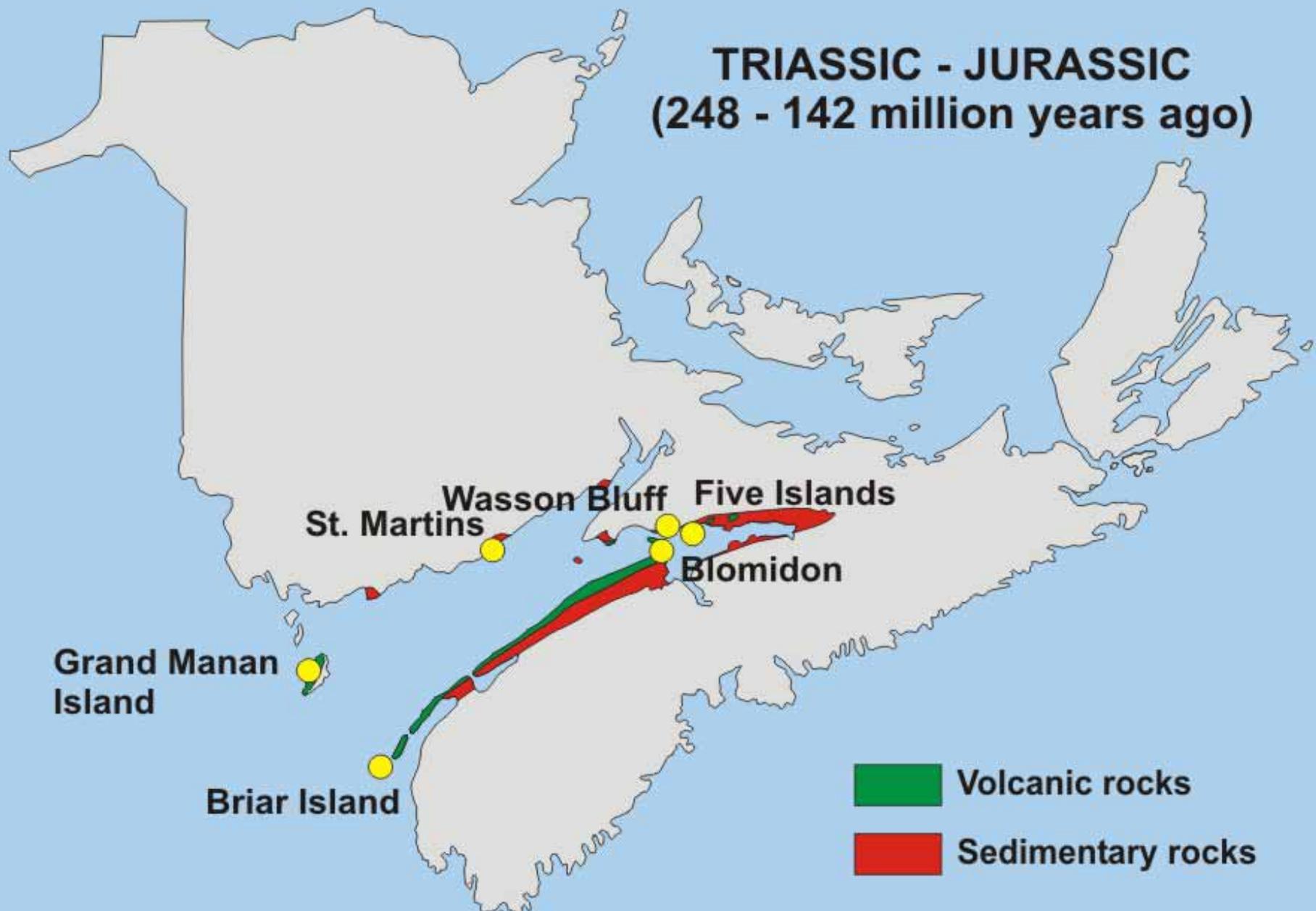
Geology of the Maritime Provinces



-  Rifts formed before 175 Ma
-  Rifts formed between 130 Ma and 75 Ma
-  Land

courtesy Rob Fensome

Geology of the Maritime Provinces

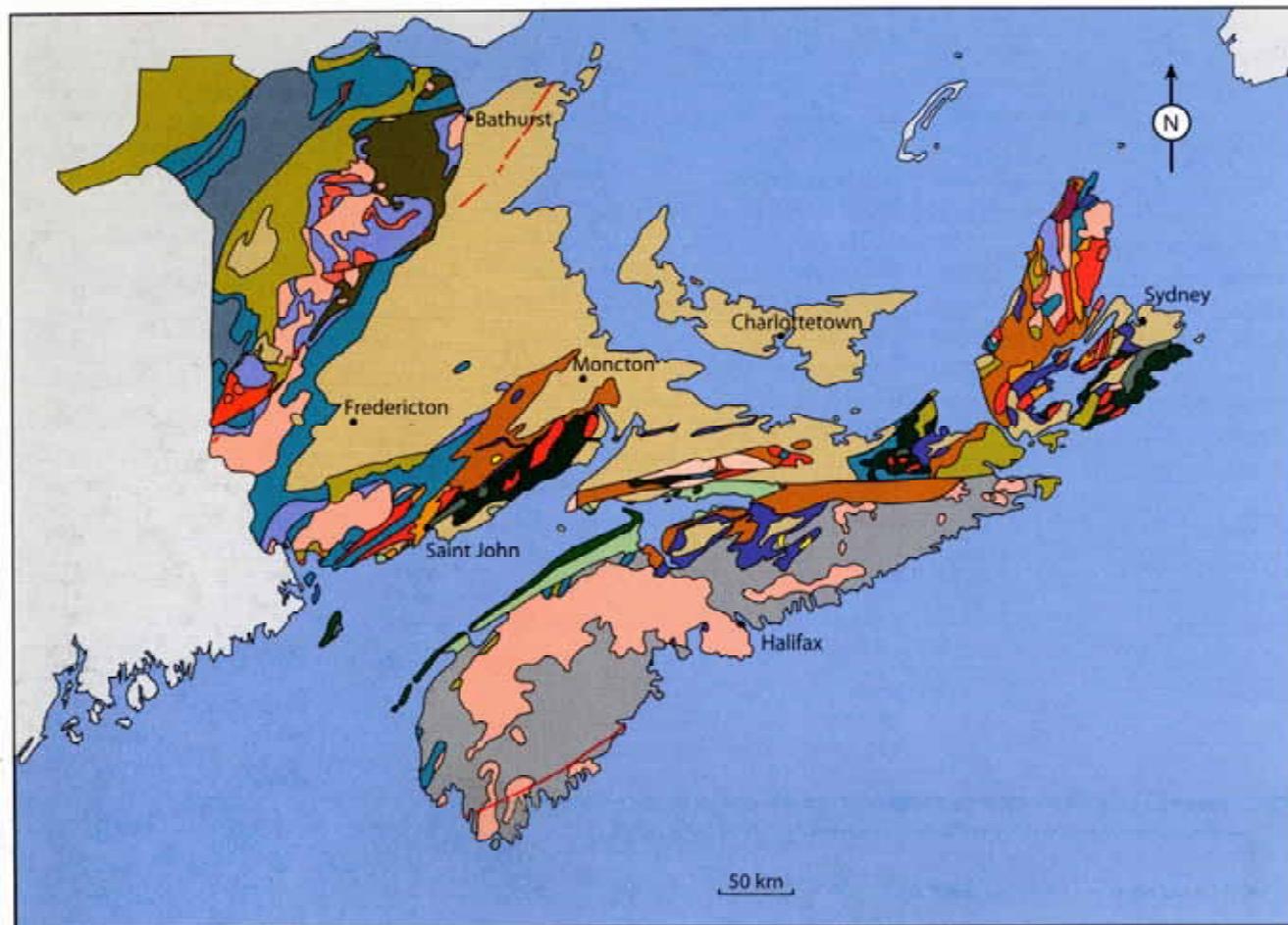


from The Last Billion Years (AGS, 2001)

Geology of the Maritime Provinces

COMPLEX

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



Mesozoic

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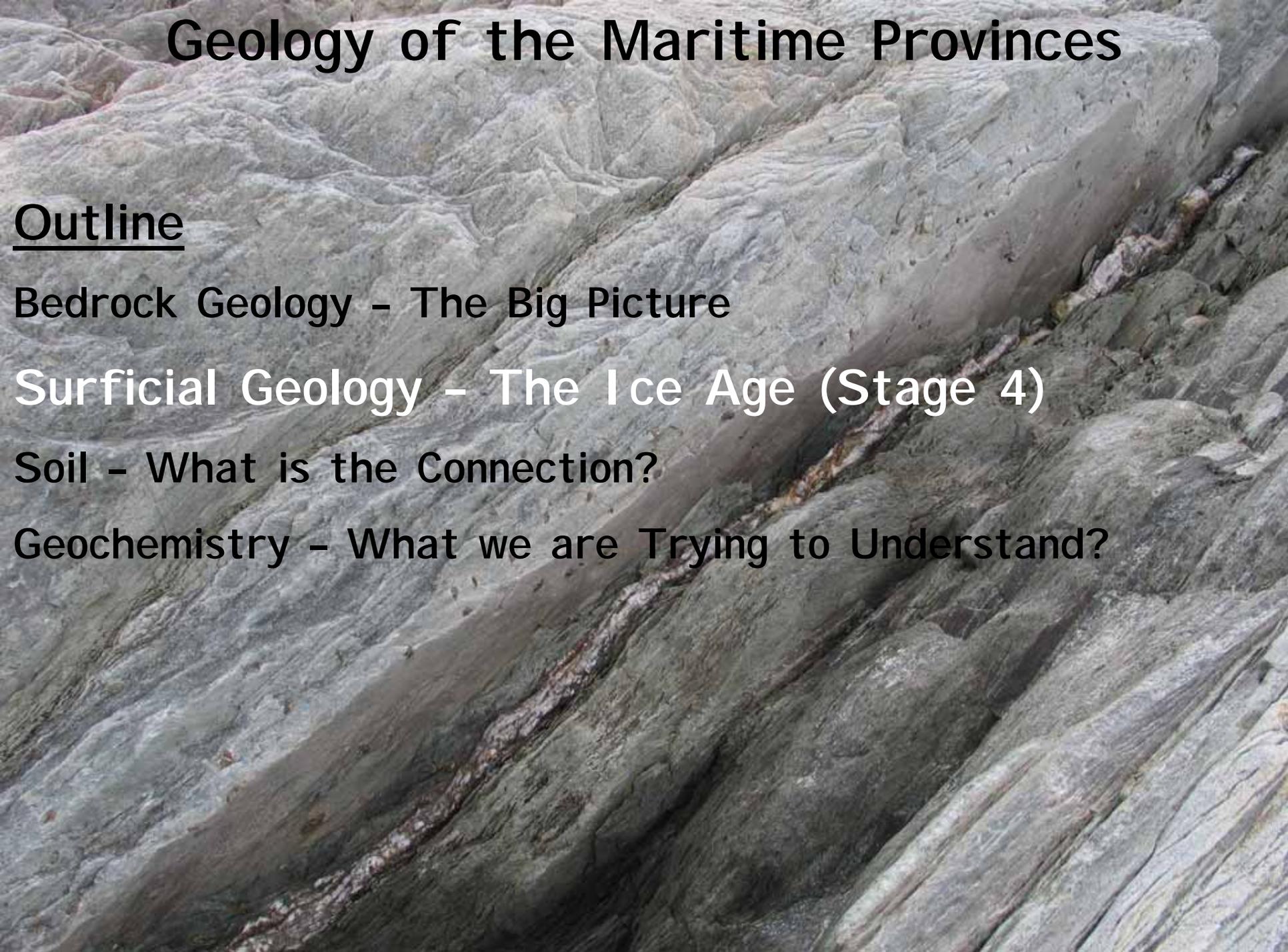
Geology of the Maritime Provinces

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
		Neoproterozoic	1000
	Mesoproterozoic	1600	
Paleoproterozoic	2500		
ARCHEAN	Neoarchean	2900	
	Mesoarchean	3400	
	Paleoarchean	3600	
	Eoarchean	4600	



After Okulitch, A.V., 2004

Geology of the Maritime Provinces



Outline

Bedrock Geology - The Big Picture

Surficial Geology - The Ice Age (Stage 4)

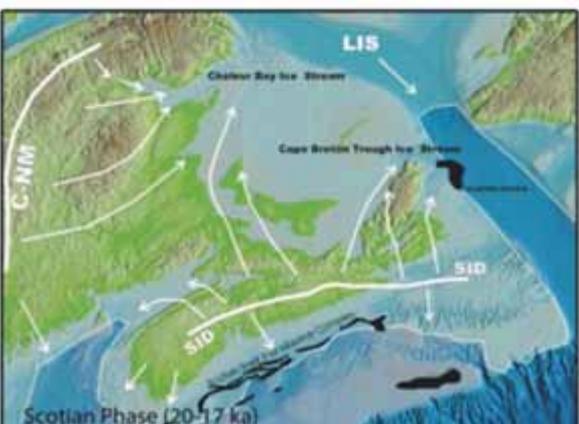
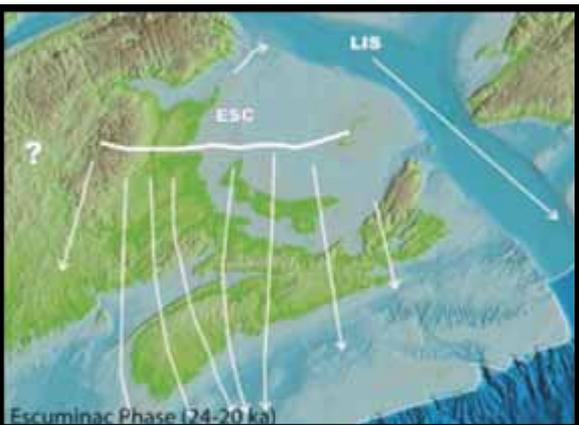
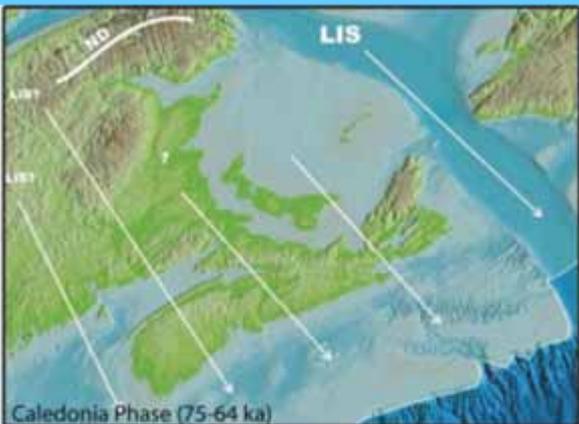
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Geology of the Maritime Provinces



Geology of the Maritime Provinces



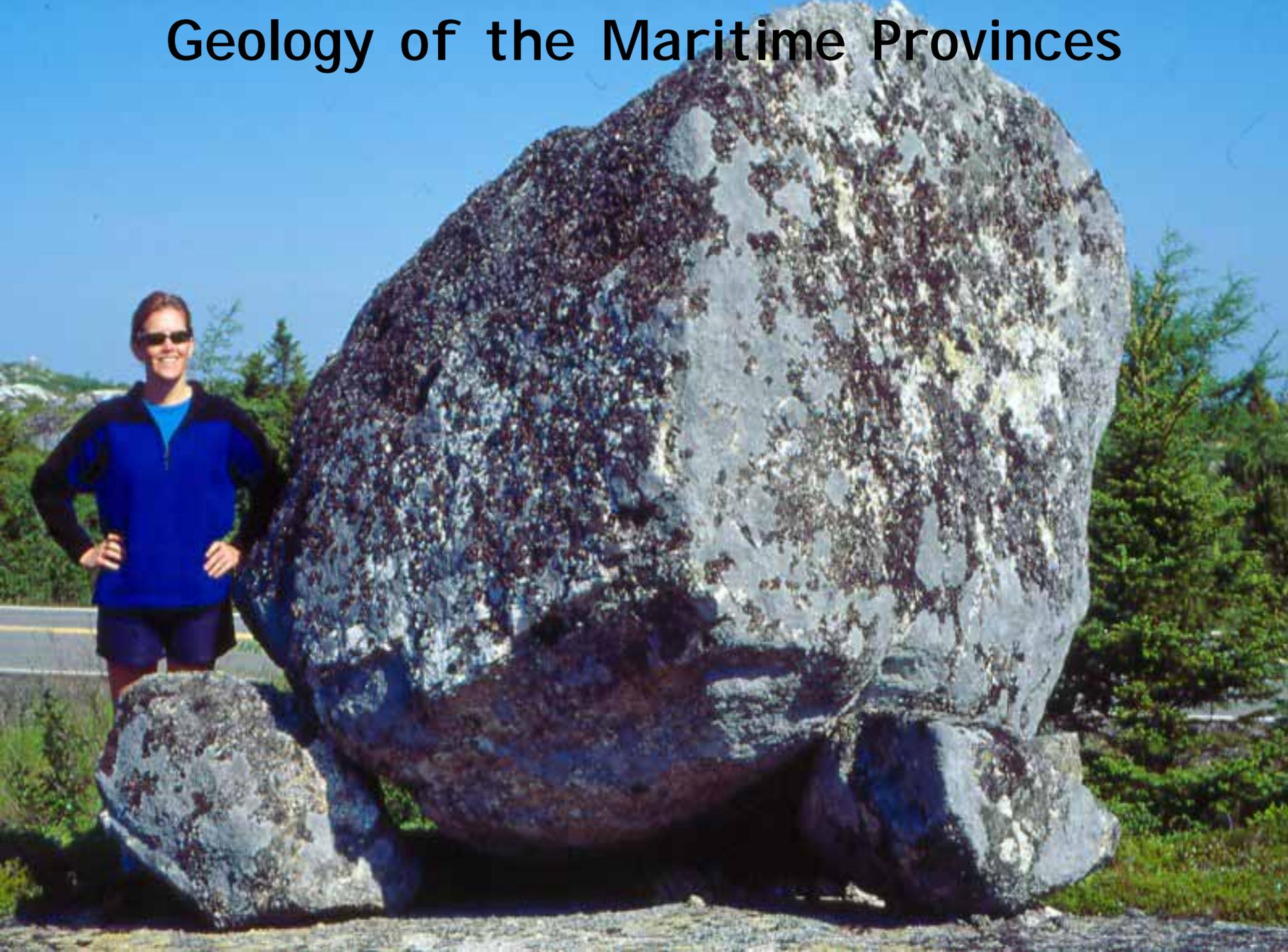
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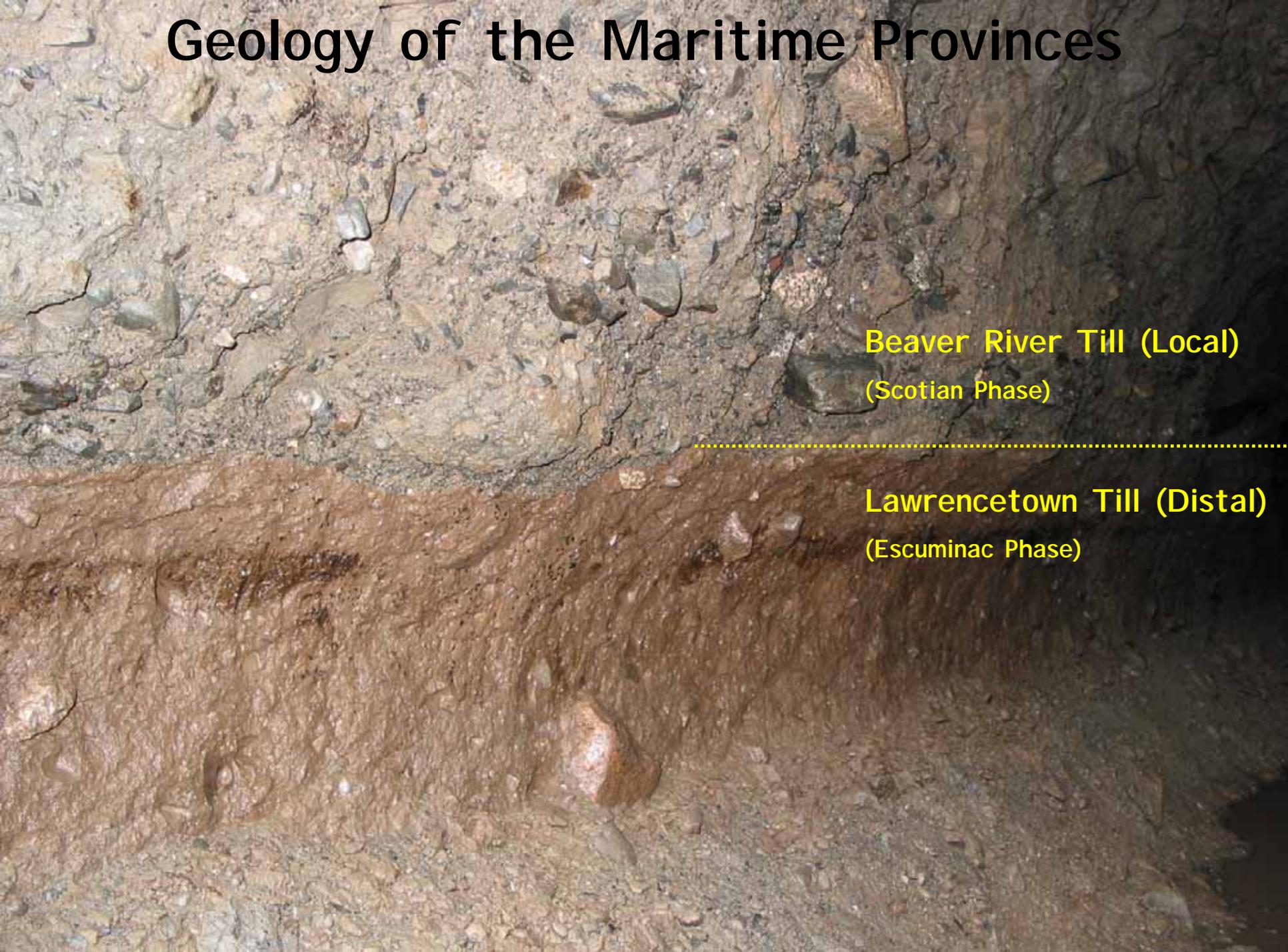
Geology of the Maritime Provinces



Geology of the Maritime Provinces



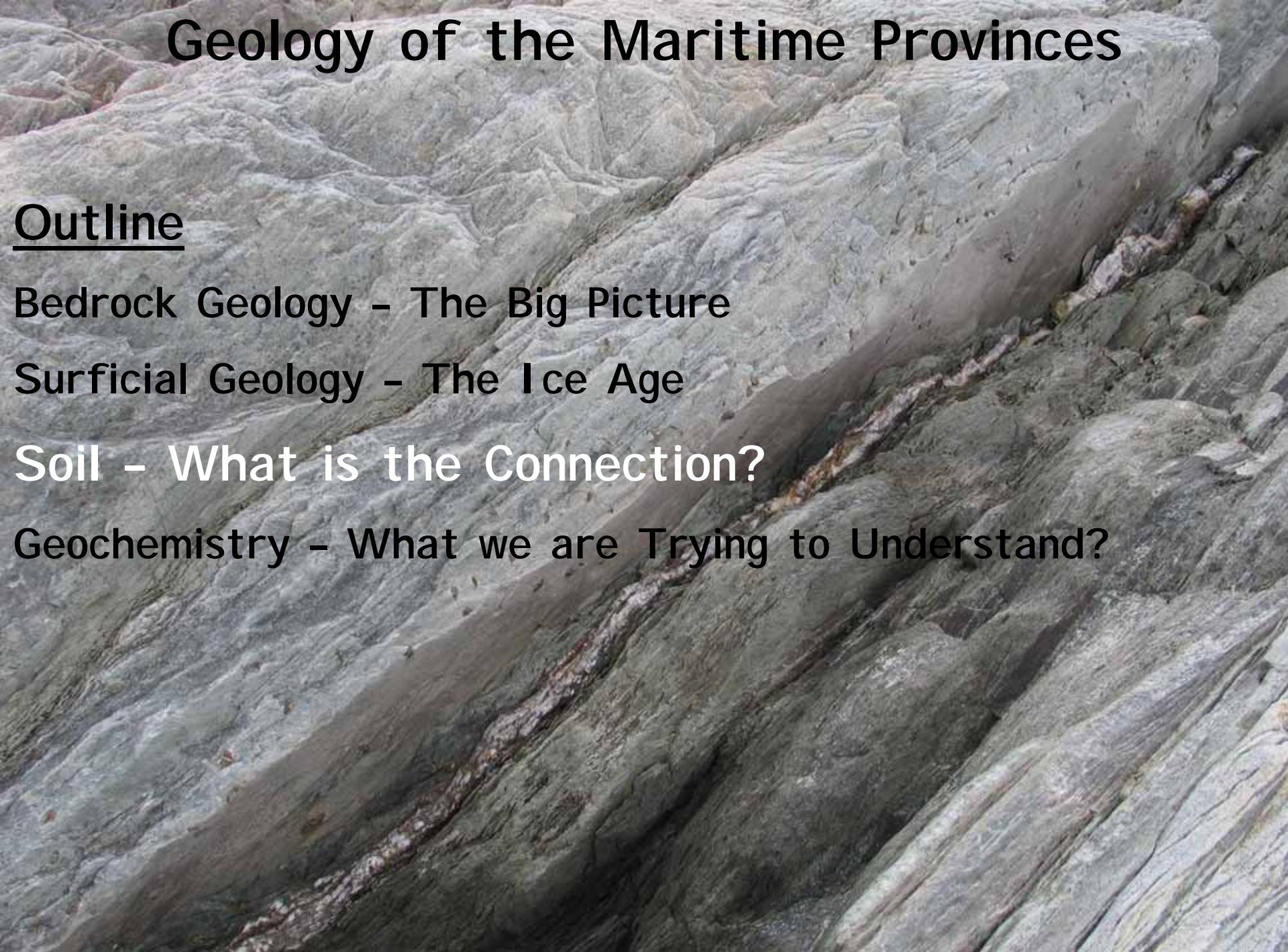
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Beaver River Till (Local)
(Scotian Phase)

Lawrencetown Till (Distal)
(Escuminac Phase)

Geology of the Maritime Provinces



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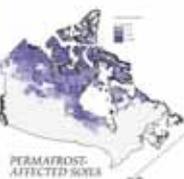
Geochemistry - What we are Trying to Understand?

Geology of the Maritime Provinces

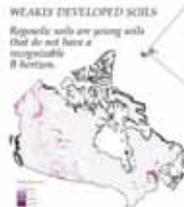
SOILS OF CANADA

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)



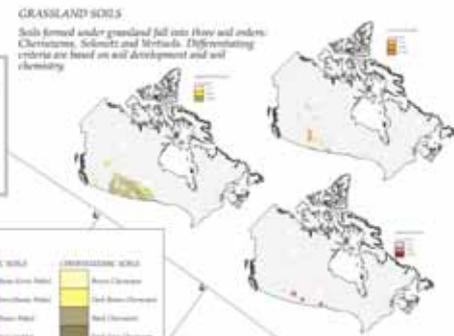
PERMAFROST AFFECTED SOILS
Cryosolic soils occupy much of the northern third of Canada, where permafrost exists in the surface of both mineral and organic soils. The Cryosolic Order is divided into three great groups based on degree of cryoturbation, nature of soil material and depth to permafrost.



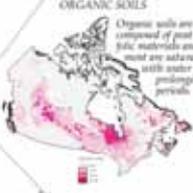
WEAKLY DEVELOPED SOILS
Regosolic soils are young soils that do not have a recognizable B horizon.



FOREST SOILS
Soils formed under forest fall into three soil orders: Podsol, Brunisol and Luvisol. Climatic criteria are based on the degree of soil development and the presence of diagnostic soil horizons.



GRASSLAND SOILS
Soils formed under grassland fall into three soil orders: Chernozem, Solonchik and Melonchik. Differentiating criteria are based on soil development and soil chemistry.



ORGANIC SOILS
Organic soils are composed of part or fully organic materials and most are saturated with water for prolonged periods.



MINERAL SOILS DEVELOPED UNDER WET CONDITIONS
Gleysolic soils develop during prolonged periods of saturation or conditions saturated with water.



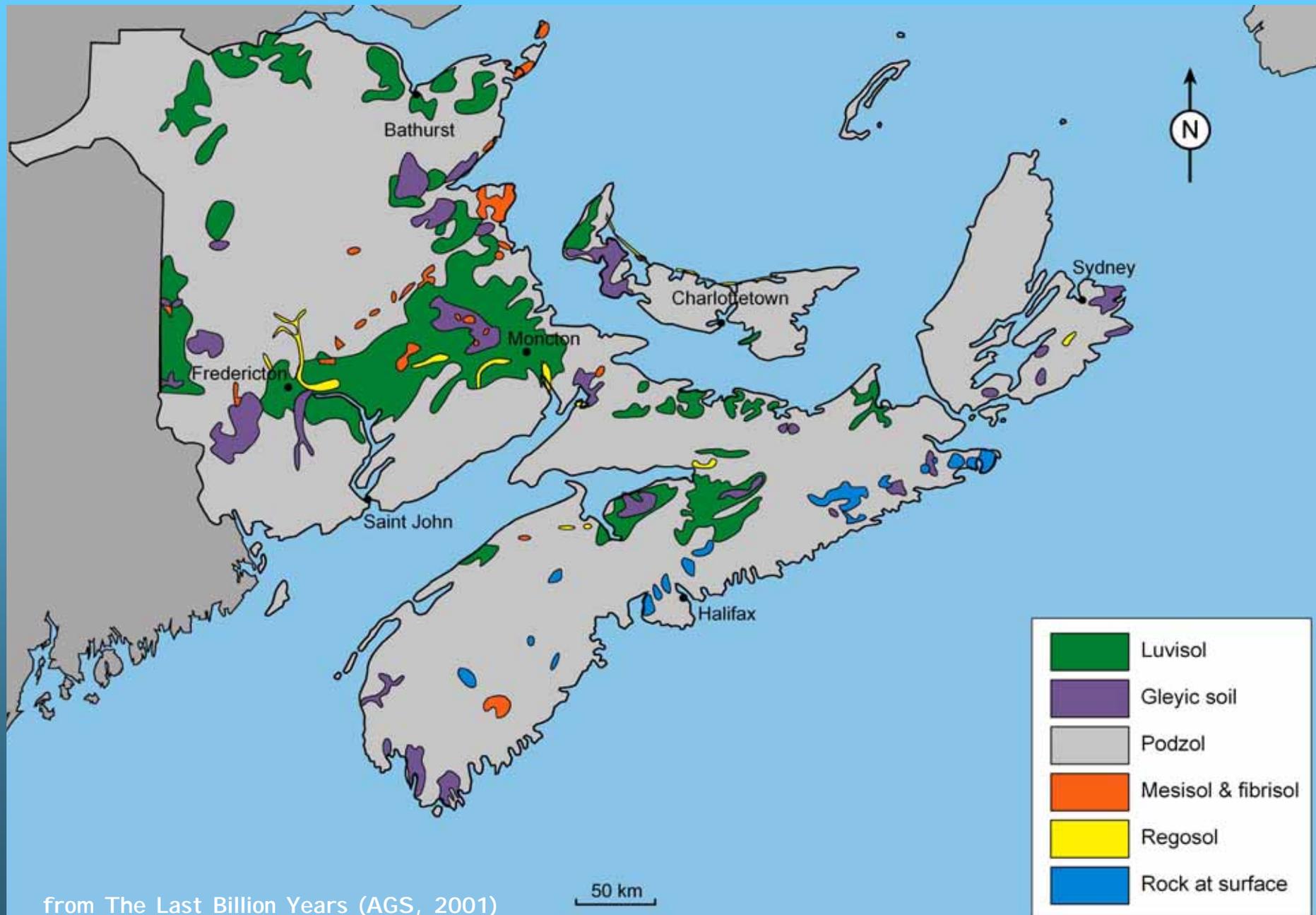
NONSOILS

MAP CONVENTIONS
The map uses colors to distinguish great groups of soils. The colors are based on the Cryosolic Order, the Organic Order, the Grassland Order, the Forest Order, and the Mineral Order. The colors are based on the Cryosolic Order, the Organic Order, the Grassland Order, the Forest Order, and the Mineral Order.

ABBREVIATIONS (continued)
The accompanying abbreviations, including the soil and soil order abbreviations, are based on the soil and soil order abbreviations used in the Canadian System of Soil Classification.



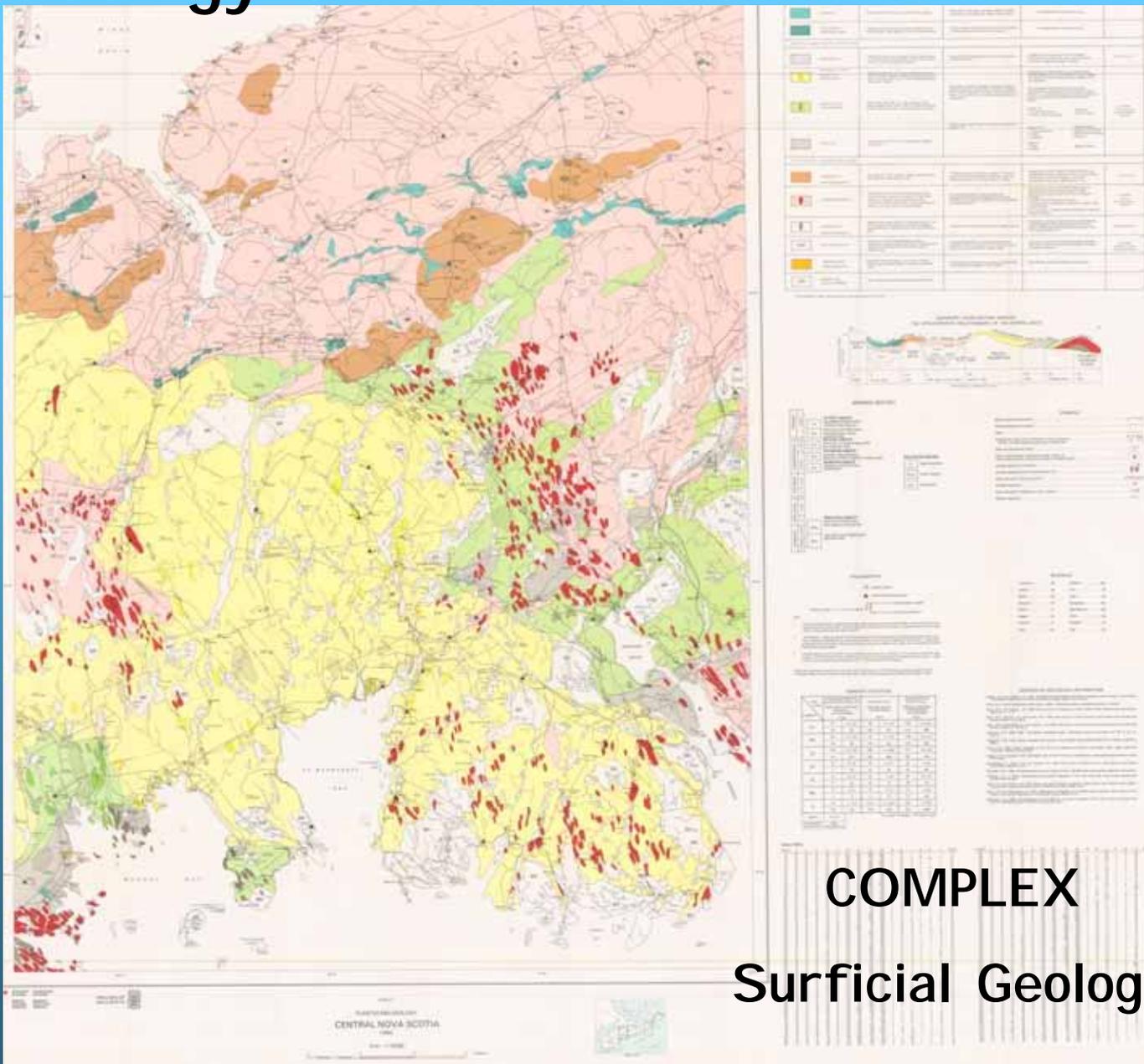
Geology of the Maritime Provinces



from The Last Billion Years (AGS, 2001)

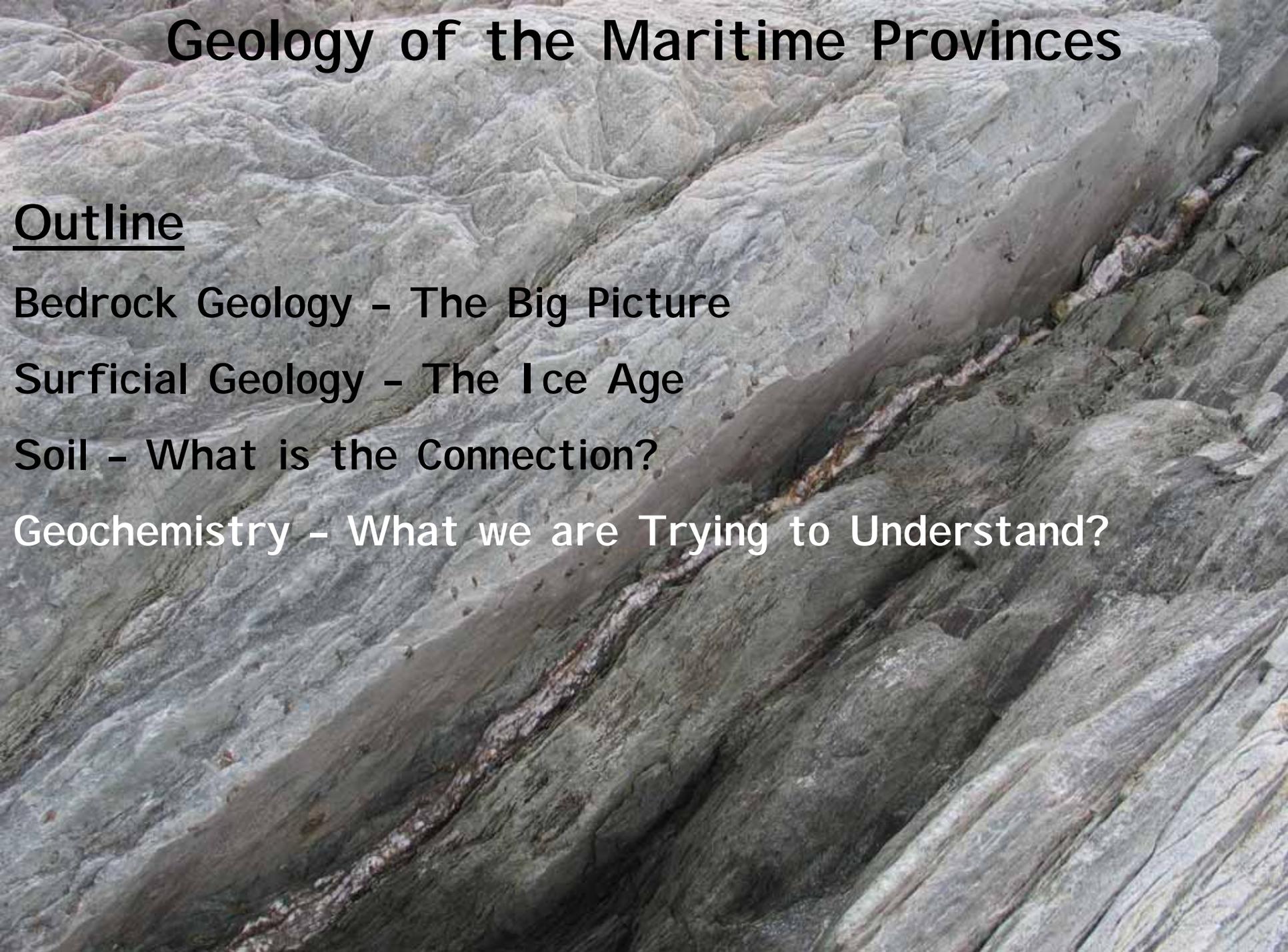
50 km

Geology of the Maritime Provinces



COMPLEX
Surficial Geology

Geology of the Maritime Provinces



Outline

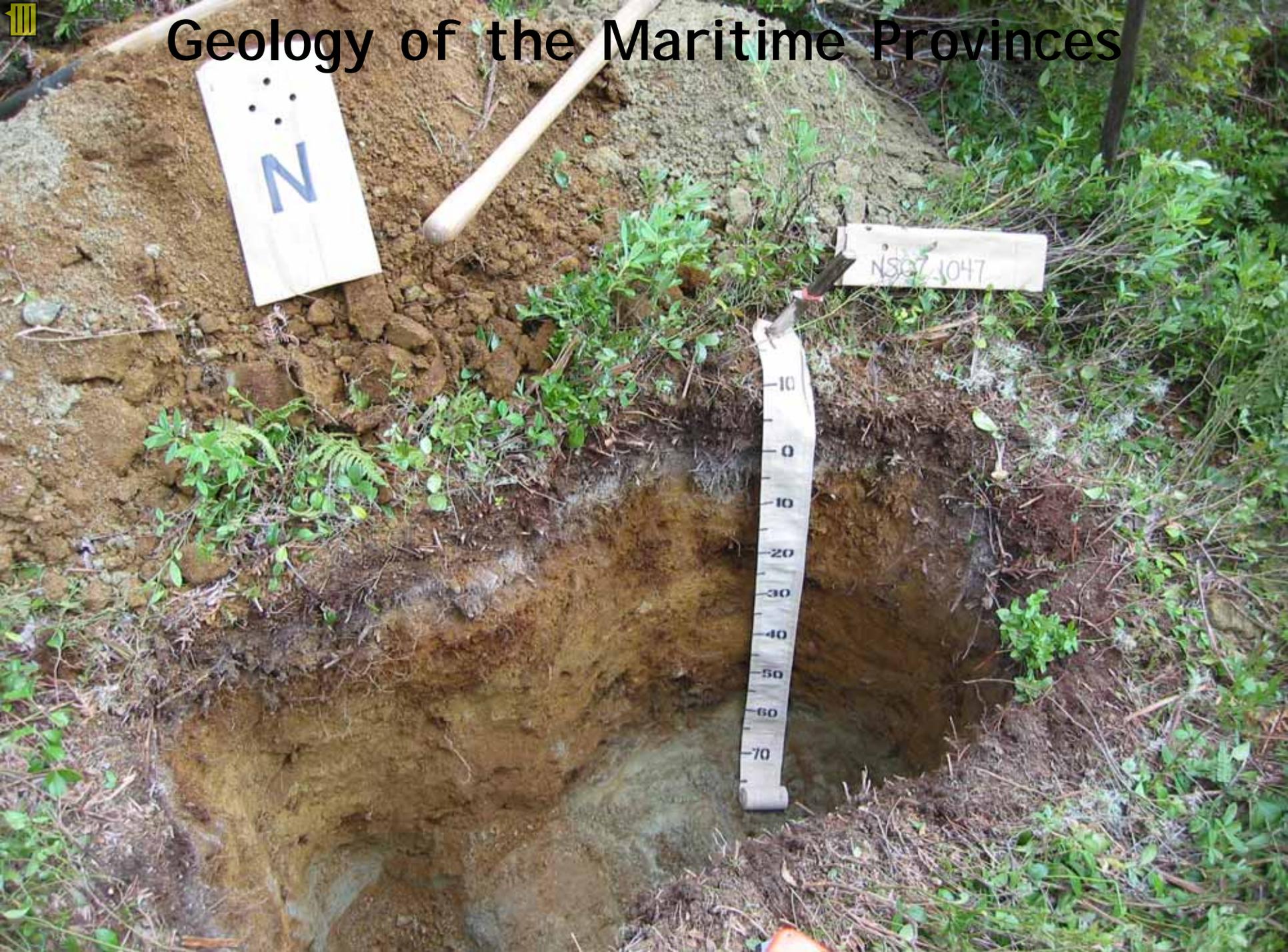
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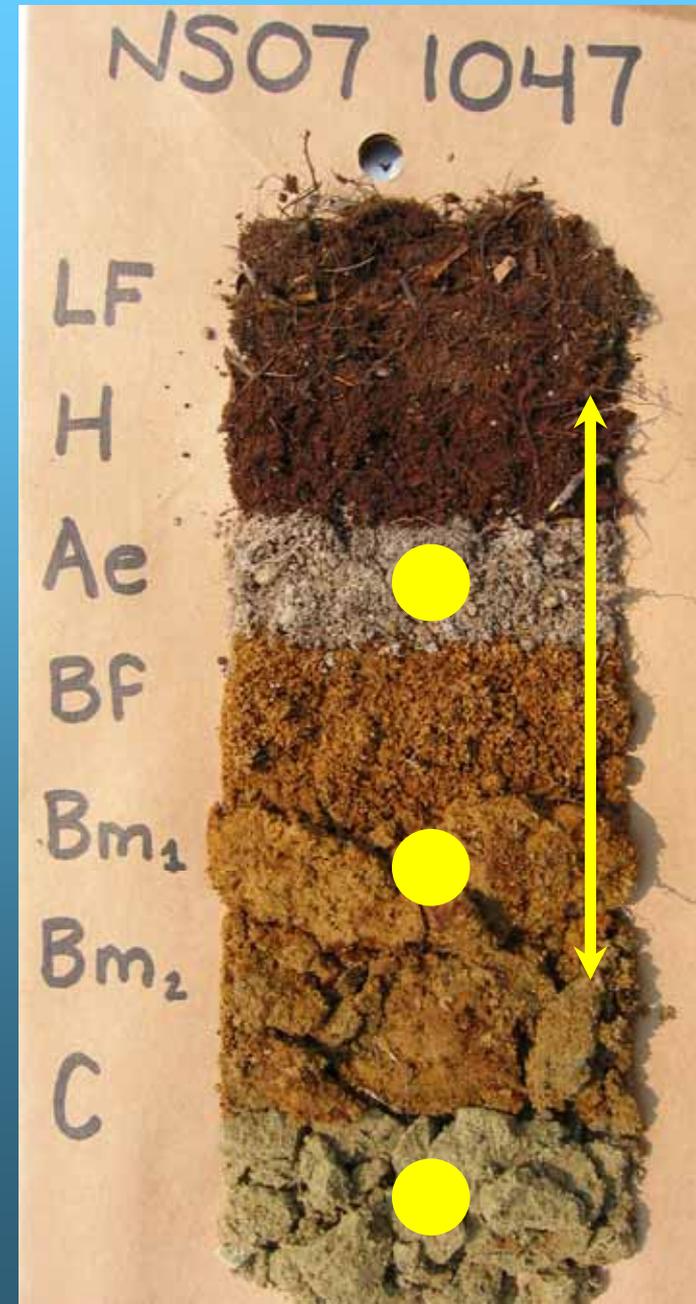
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Geology of the Maritime Provinces





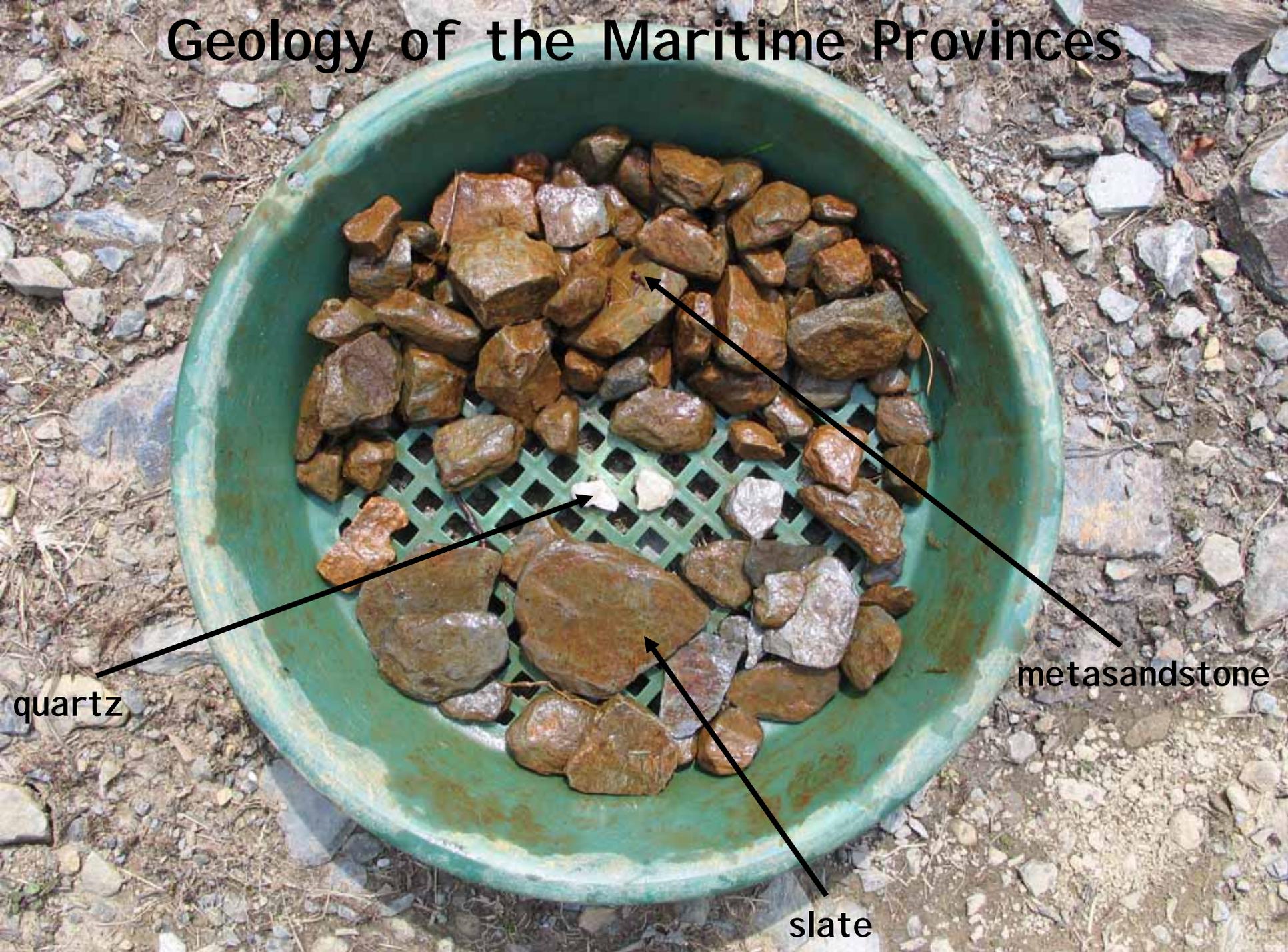
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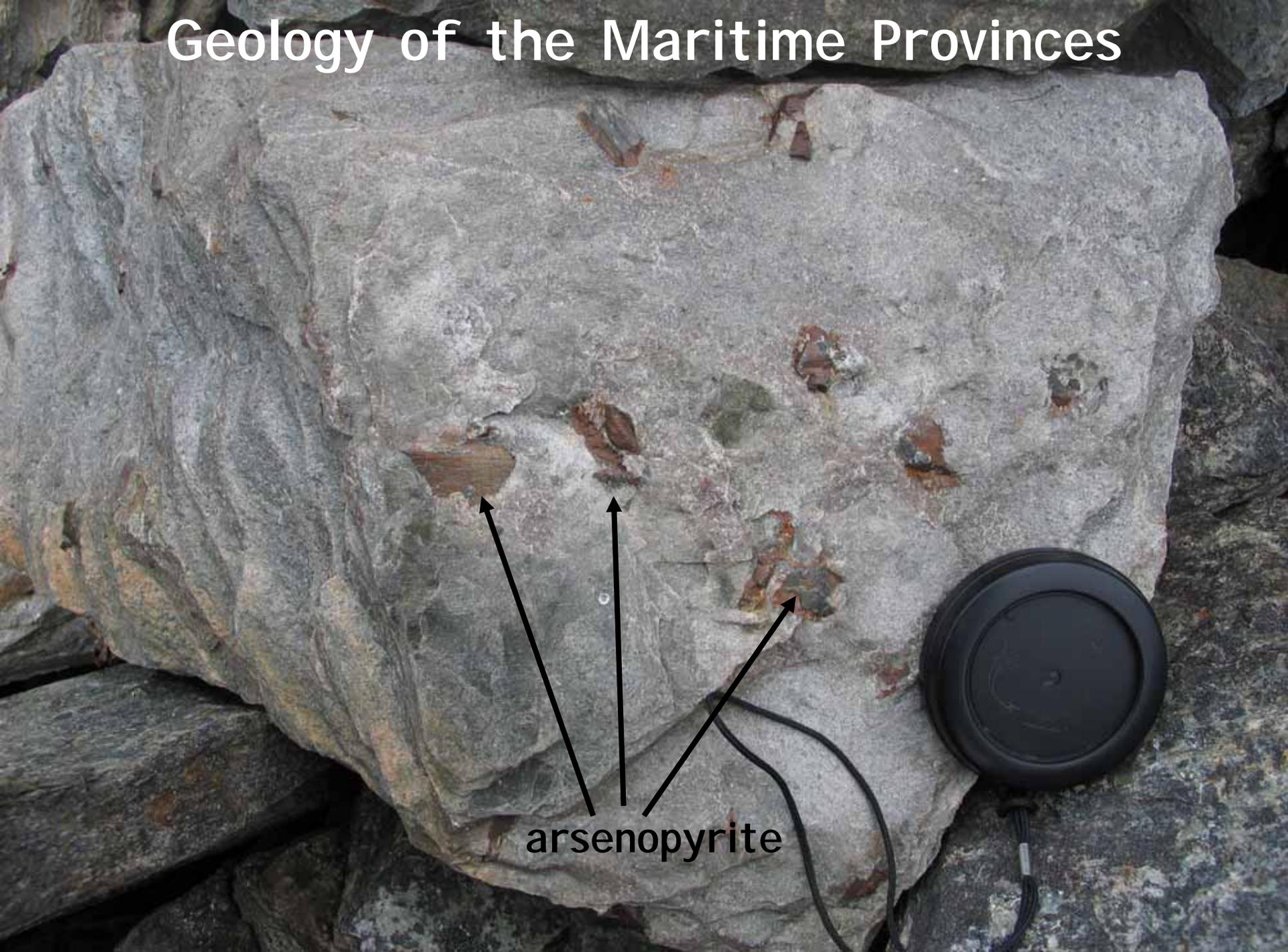


quartz

slate

metasandstone

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arsenopyrite

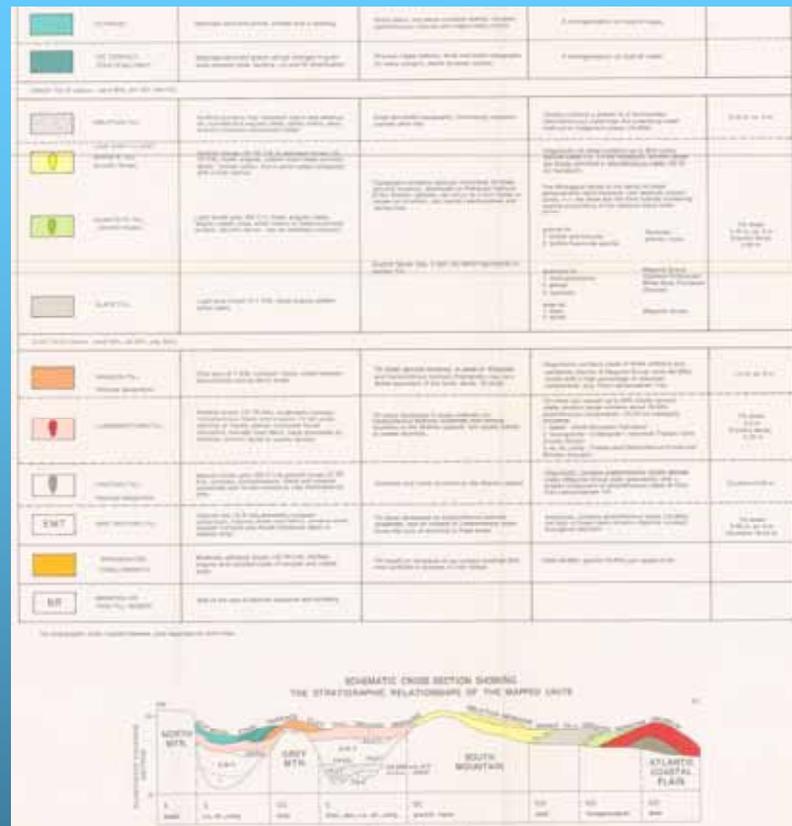
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Sampling Objectives?

SUMMARY STATISTICS

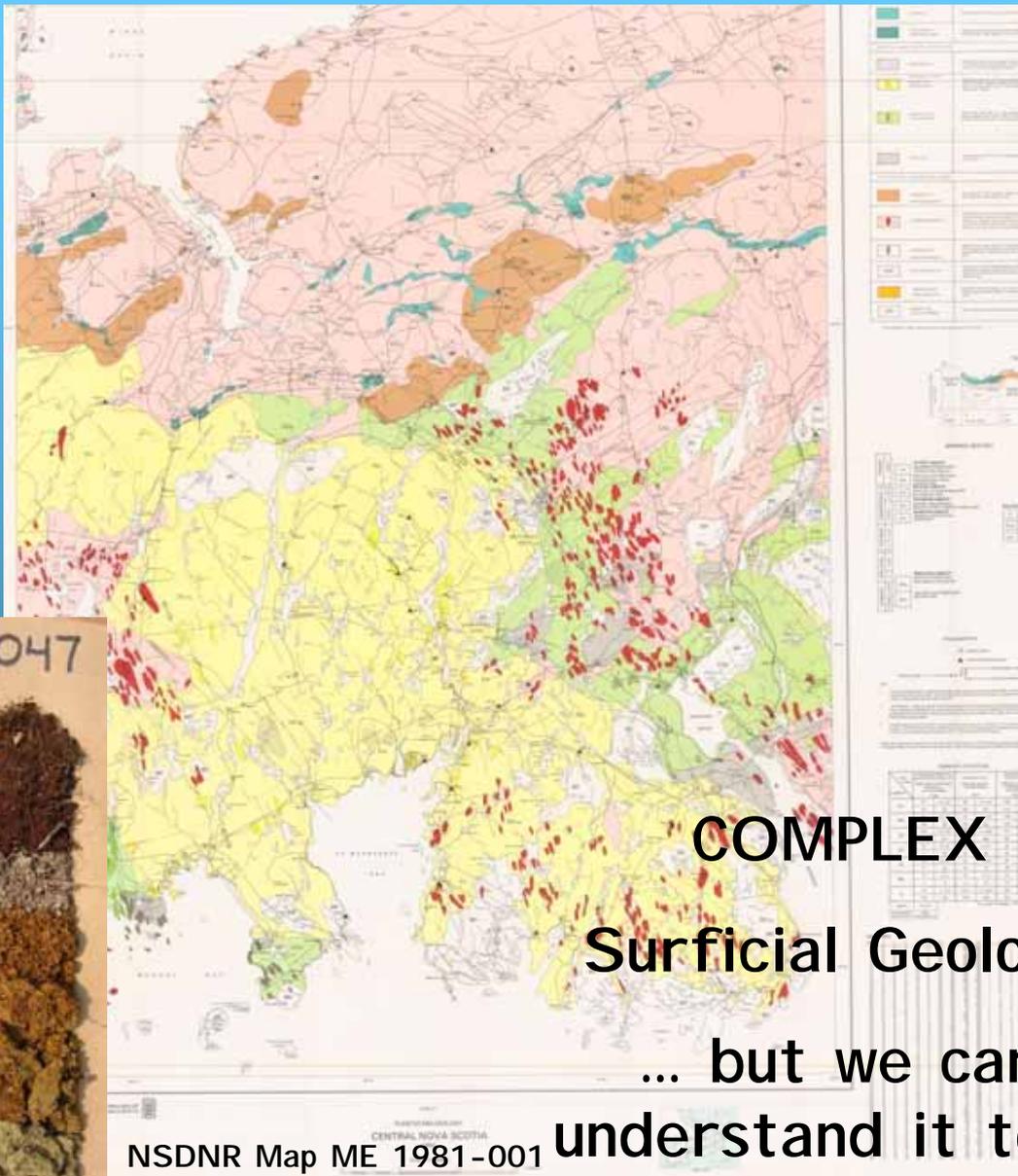
ELEMENT \ TILL TYPE	LAWRENCETOWN TILL and EAST MILFORD TILL (Carboniferous & Triassic sedimentary rock derivatives) N=80		GRANITE TILL (Devonian granitic rock derivative) N=37		QUARTZITE and SLATE TILLS (Cambro-Ordovician metasedimentary rock derivative) N=21	
	MEAN	RANGE	MEAN	RANGE	MEAN	RANGE
Cu	47	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

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COMPLEX

Surficial Geology

... but we can

understand it too!!!

Geology of the Maritime Provinces

Acknowledgements

Atlantic Geoscience Society

Grant Ferguson

Rob Fensome

Graham Williams

Ralph Stea

Beth McClenaghan

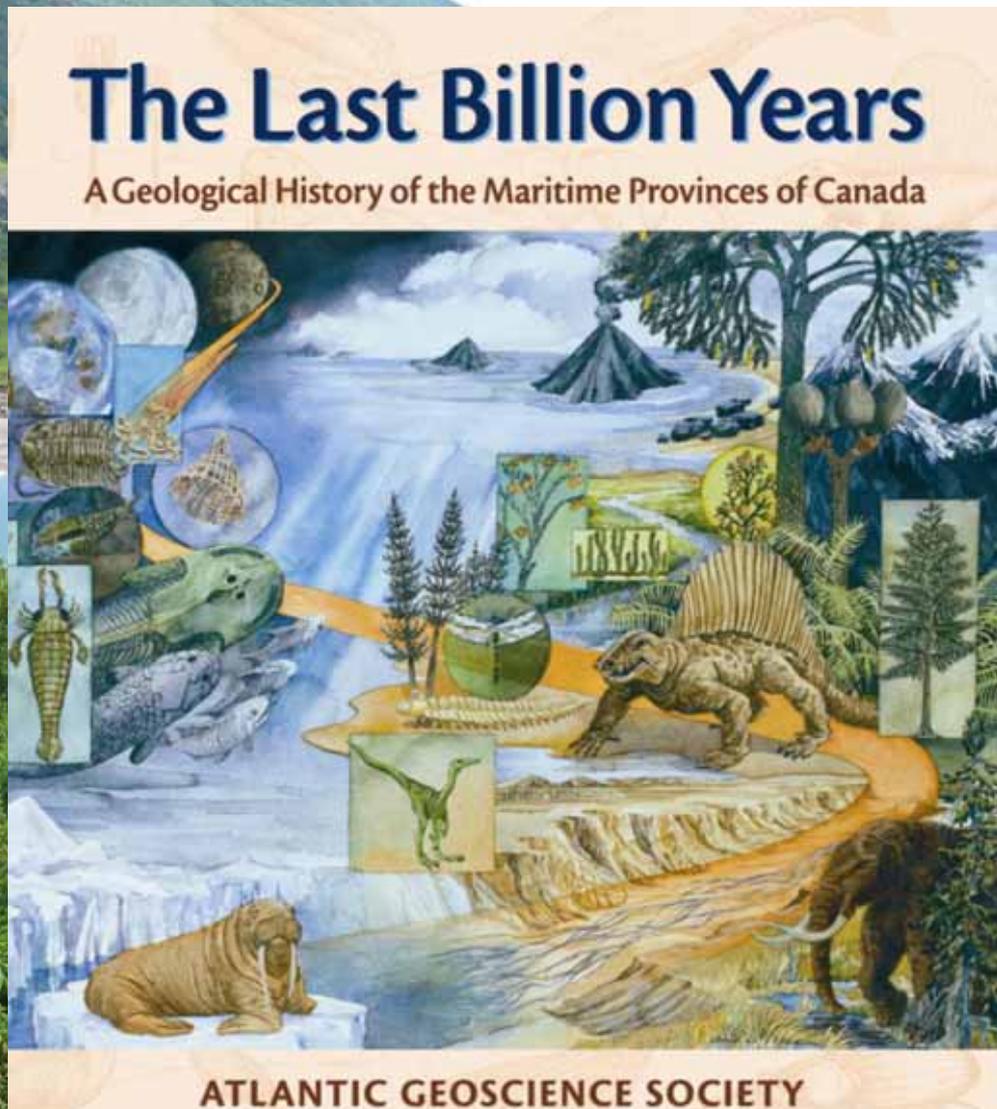
Dan Utting

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.