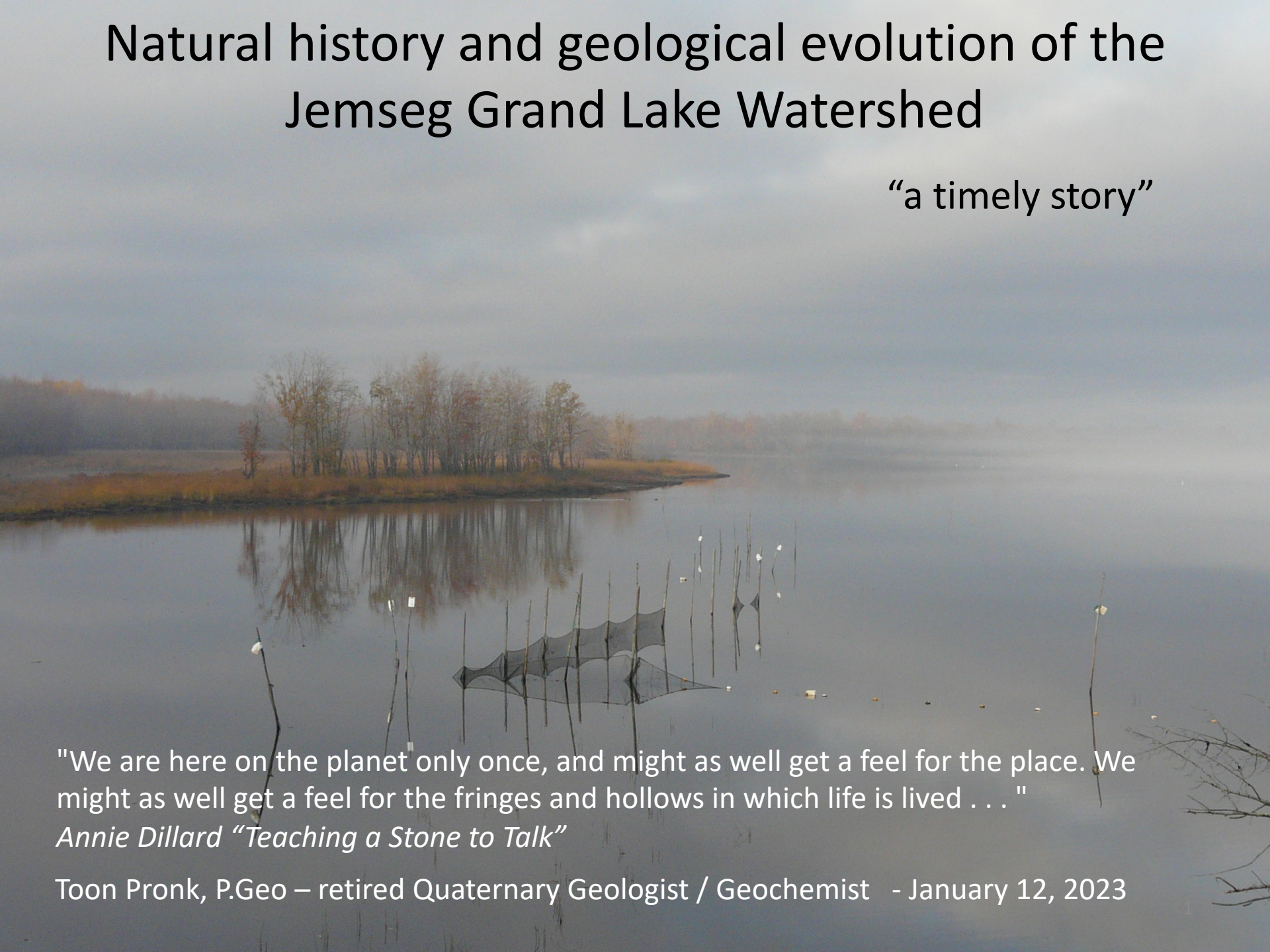
Natural history and geological evolution of the Jemseg Grand Lake Watershed

“a timely story”



"We are here on the planet only once, and might as well get a feel for the place. We might as well get a feel for the fringes and hollows in which life is lived . . . "
Annie Dillard “Teaching a Stone to Talk”

Toon Pronk, P.Geo – retired Quaternary Geologist / Geochemist - January 12, 2023



Outline:

1) basic concepts and processes – geology 101

2) “Super” and “micro” continents on the move

3) timelines

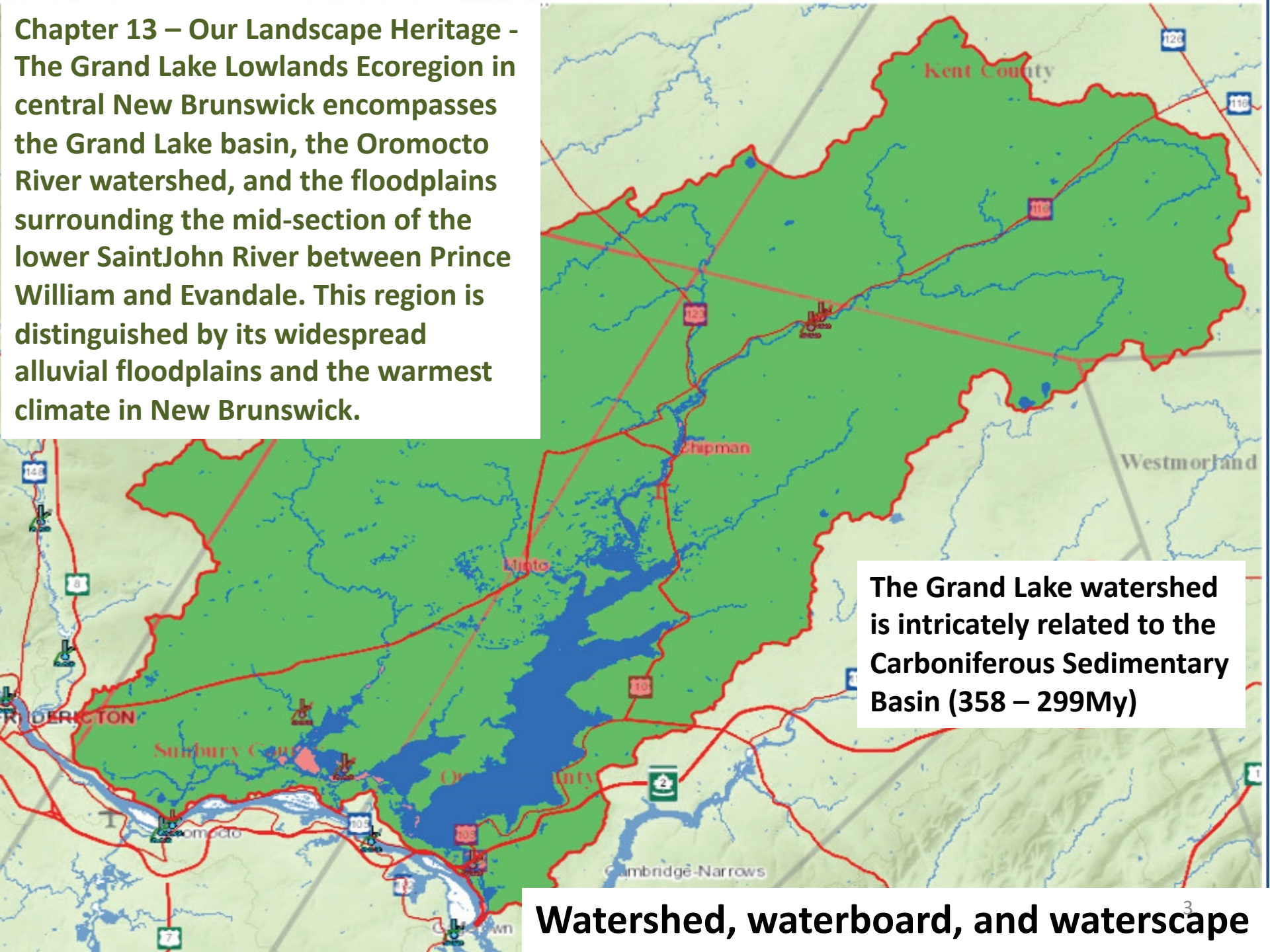
4) Ice Ages and

5) Water levels

What’s next?

Special thanks to Serge Allard and Shelley Pronk and Brad for technical and general support

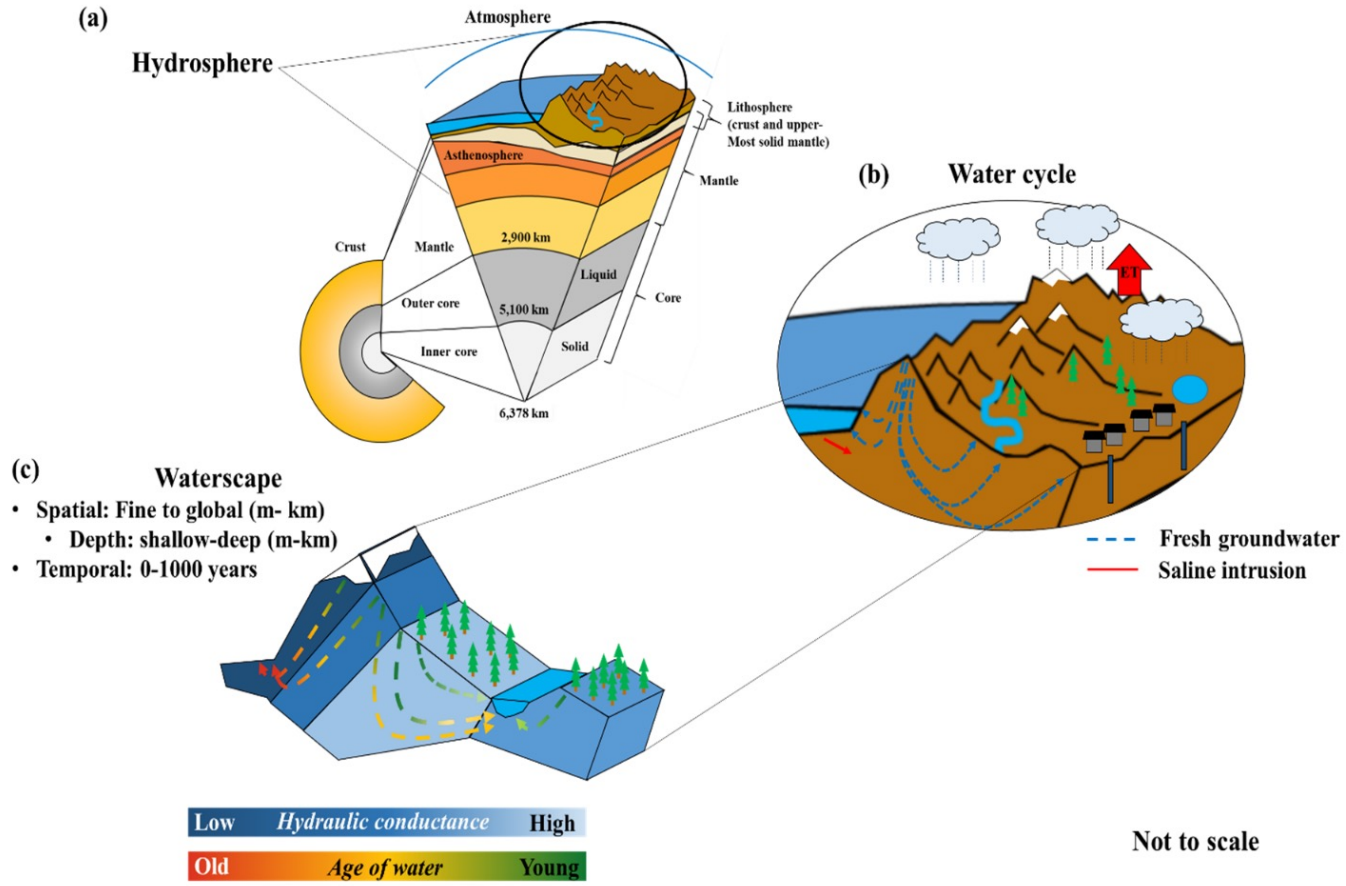
Chapter 13 – Our Landscape Heritage - The Grand Lake Lowlands Ecoregion in central New Brunswick encompasses the Grand Lake basin, the Oromocto River watershed, and the floodplains surrounding the mid-section of the lower SaintJohn River between Prince William and Evandale. This region is distinguished by its widespread alluvial floodplains and the warmest climate in New Brunswick.



The Grand Lake watershed is intricately related to the Carboniferous Sedimentary Basin (358 – 299My)

Watershed, waterboard, and waterscape

Waterscape continuum -The importance of geology in aquatic habitat research – connecting with the ***Critical Zone***



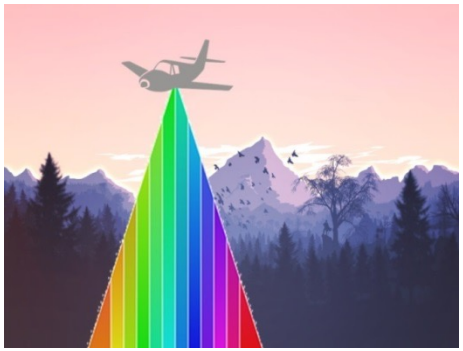
Context:
Water in / out
Storage
- Surface
- Ground
- Atmosphere
- Biosphere

Influenced by
- Temperature
- Ecosystem
- Hydraulic conductivity and gradient

"Effects of topographic resolution and geologic setting on spatial statistical river temperature models" *from* Water Resources Research, Antoin O'Sullivan, Ph.D. Canadian River Institute

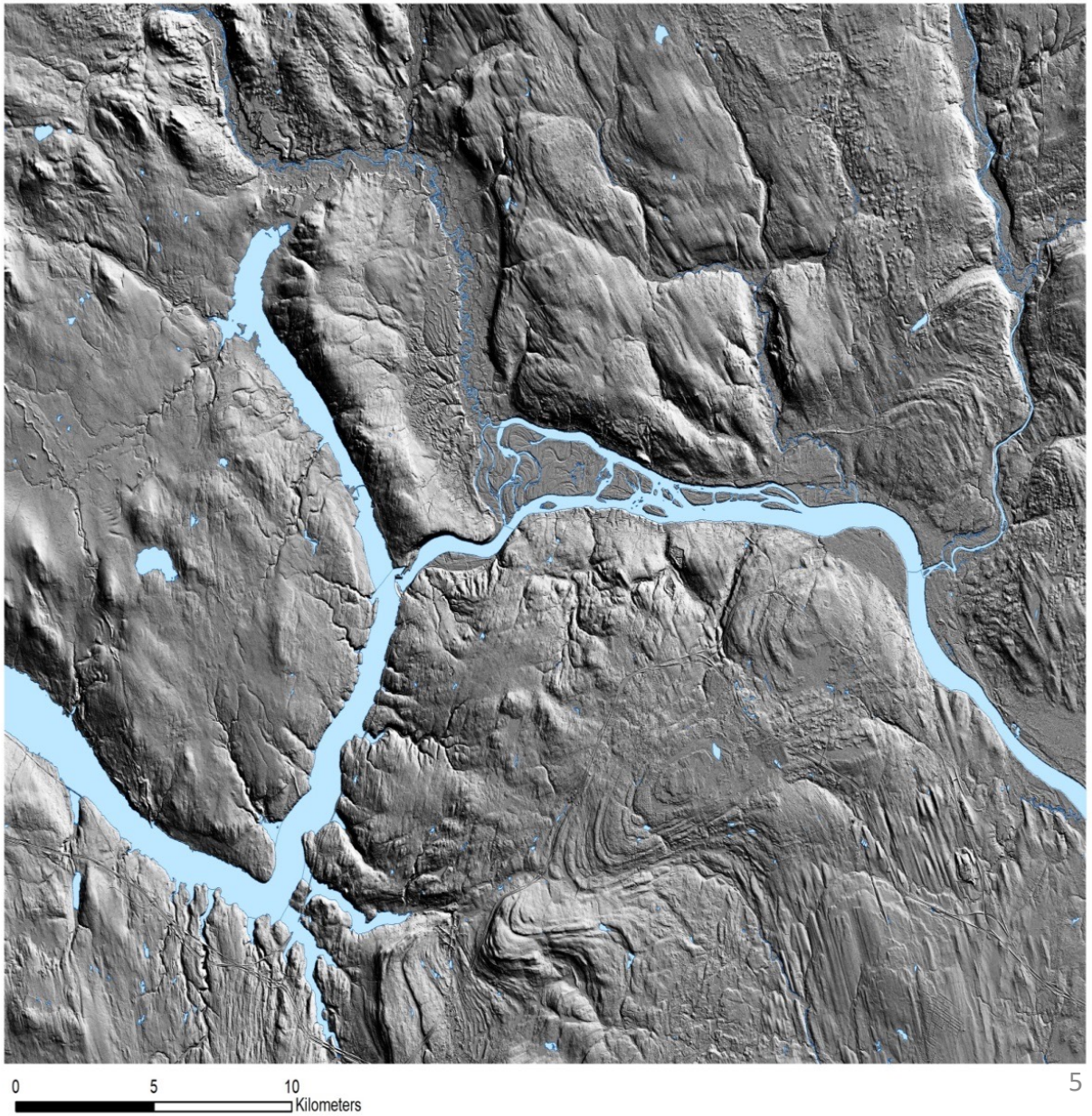
LiDAR image of the Mactaquac area

Light Detection
And Radar

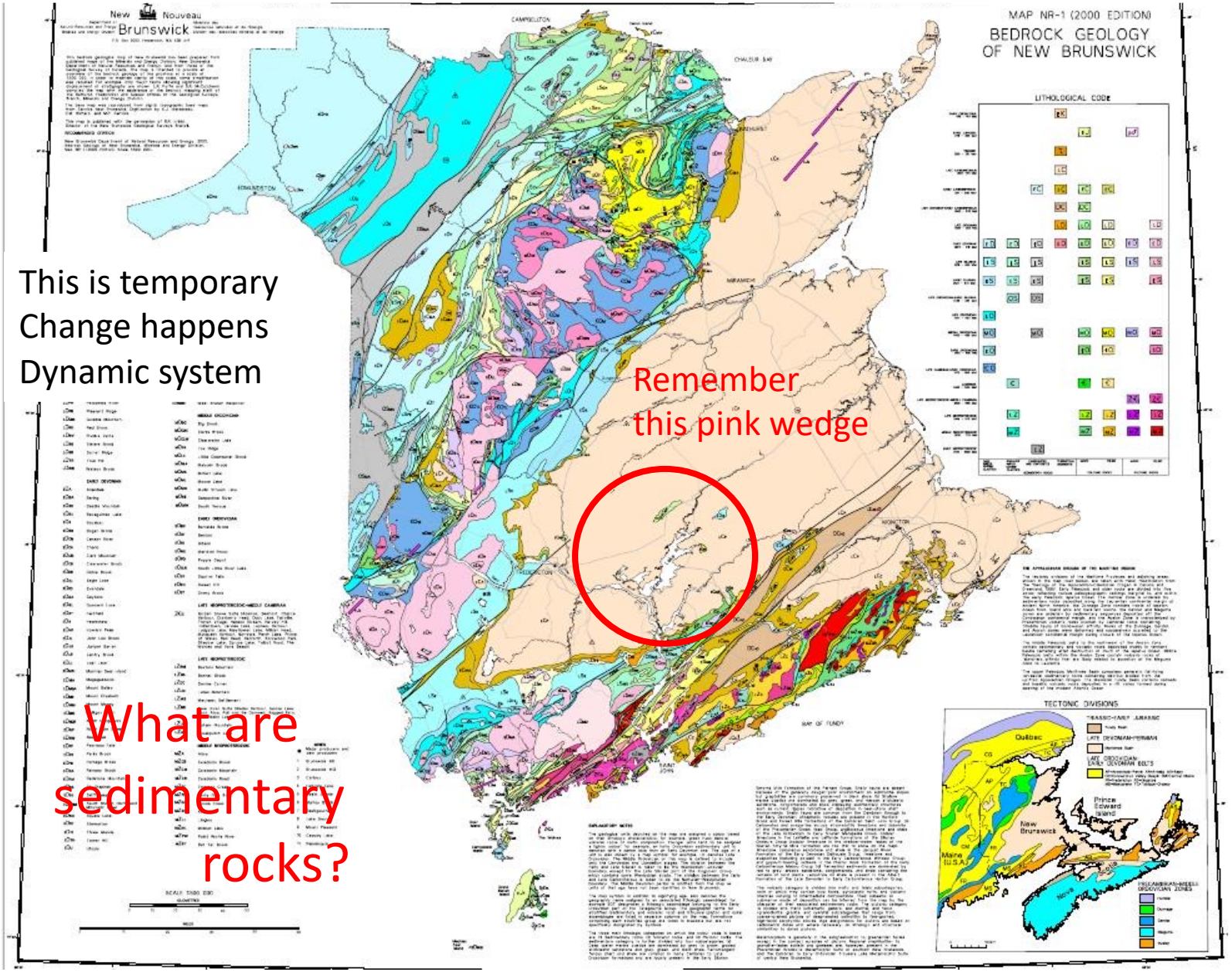


From an airplane, a drone, your backpack or a sled

Let’s Zoom in!

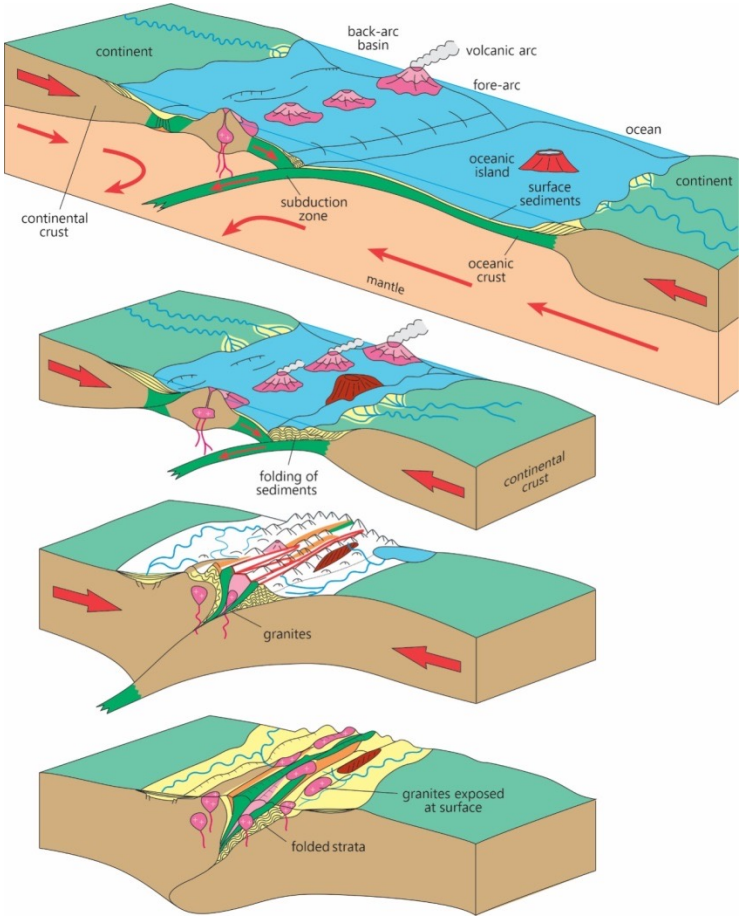


How did this colorful puzzle evolve?



This is temporary
Change happens
Dynamic system

Continent-building processes. The ‘cyclical’ opening and closing of ocean basins, subduction of ocean crust, volcanism, and the formation of mountain chains – aka ‘accretionary terrains’



Mt Assiniboine AB/BC border

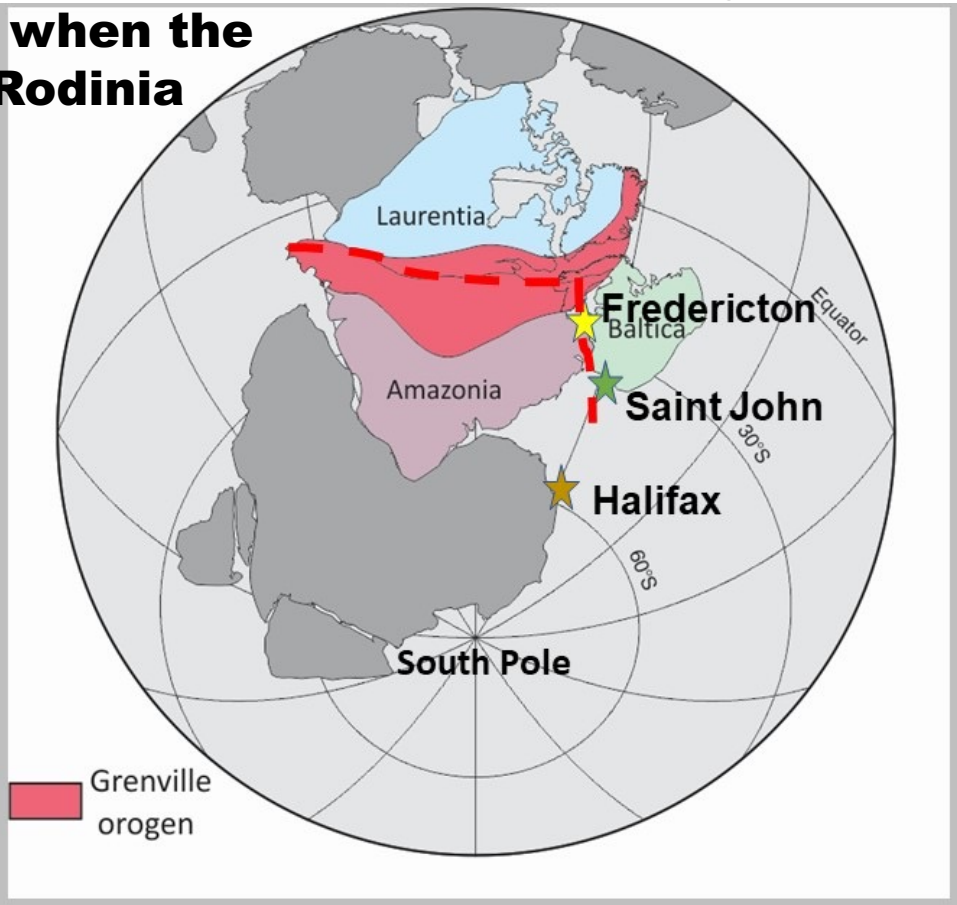


Sedimentary rocks pushed up several kilometers in today’s mountain ranges

What goes up will come down – the power of gravity

- weathering, erosion, sedimentation

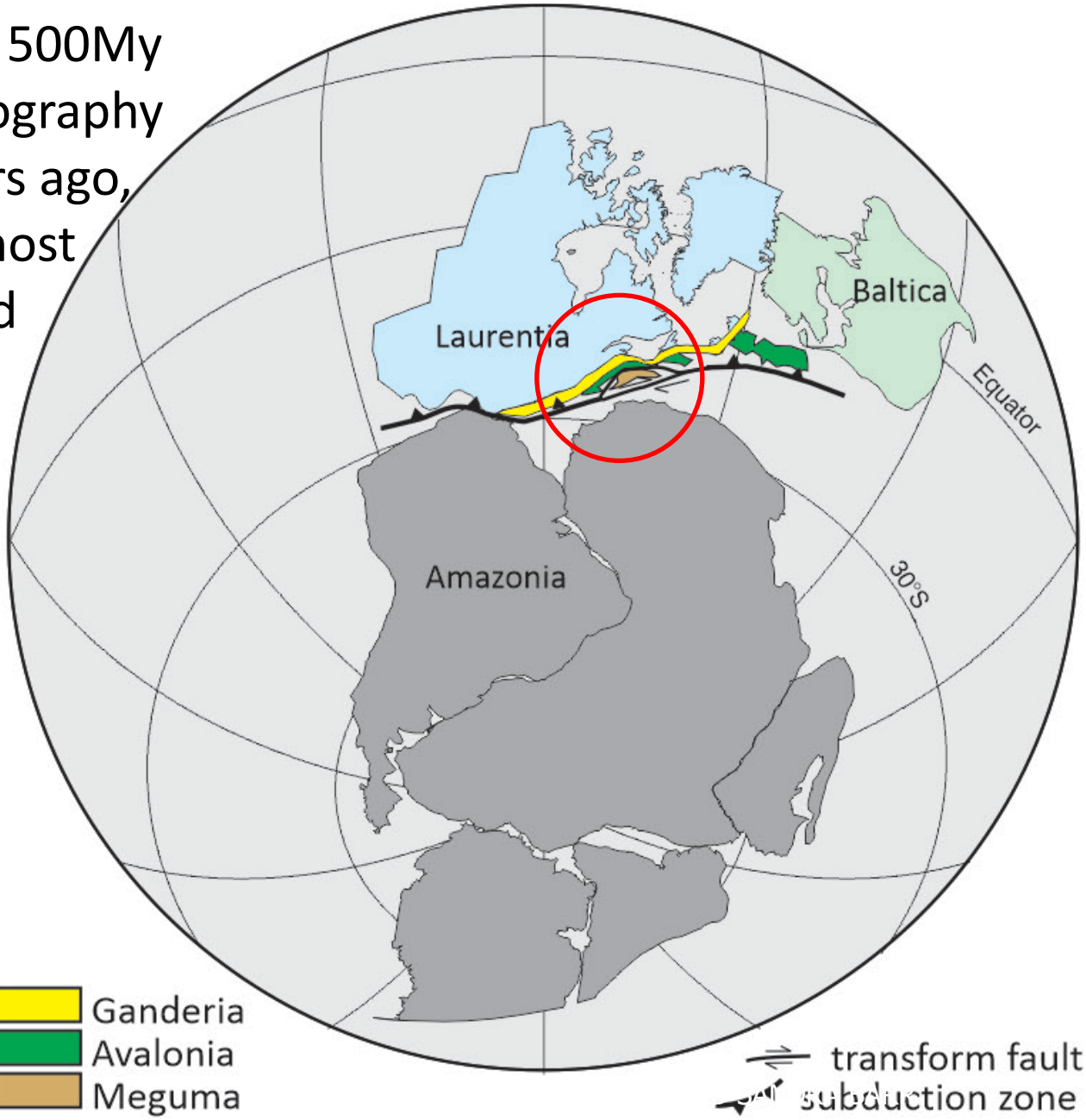
The story of the Grand Lake watershed really started with the Grenville Orogen when the Super continent Rodinia was formed



The origin of the Maritime Provinces: The late Proterozoic supercontinent Rodinia, 850 million years ago. Note that the terranes now forming the Maritimes were all located well south of the equator.

Source: The Last Billion Years
A geological history of the Maritime Provinces
(Atlantic Geoscience Society, 2022) **>> 500My**

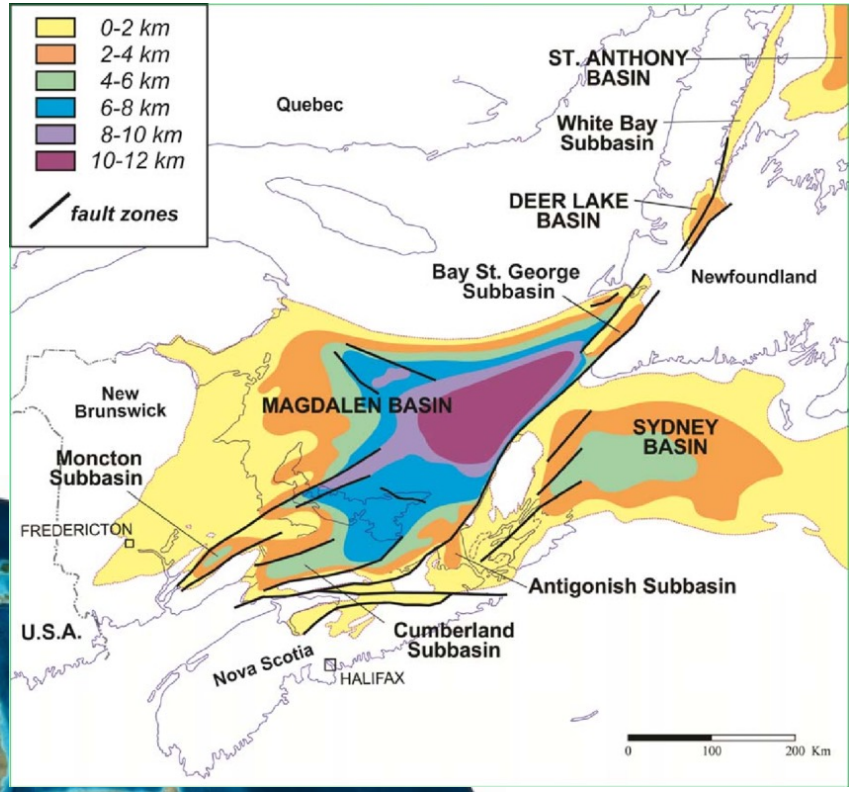
Fast forward >> 500My
Global paleogeography
330 million years ago,
Pangea was almost
fully formed and
an inland sea
opened in the
area we call
the Maritime
Provinces



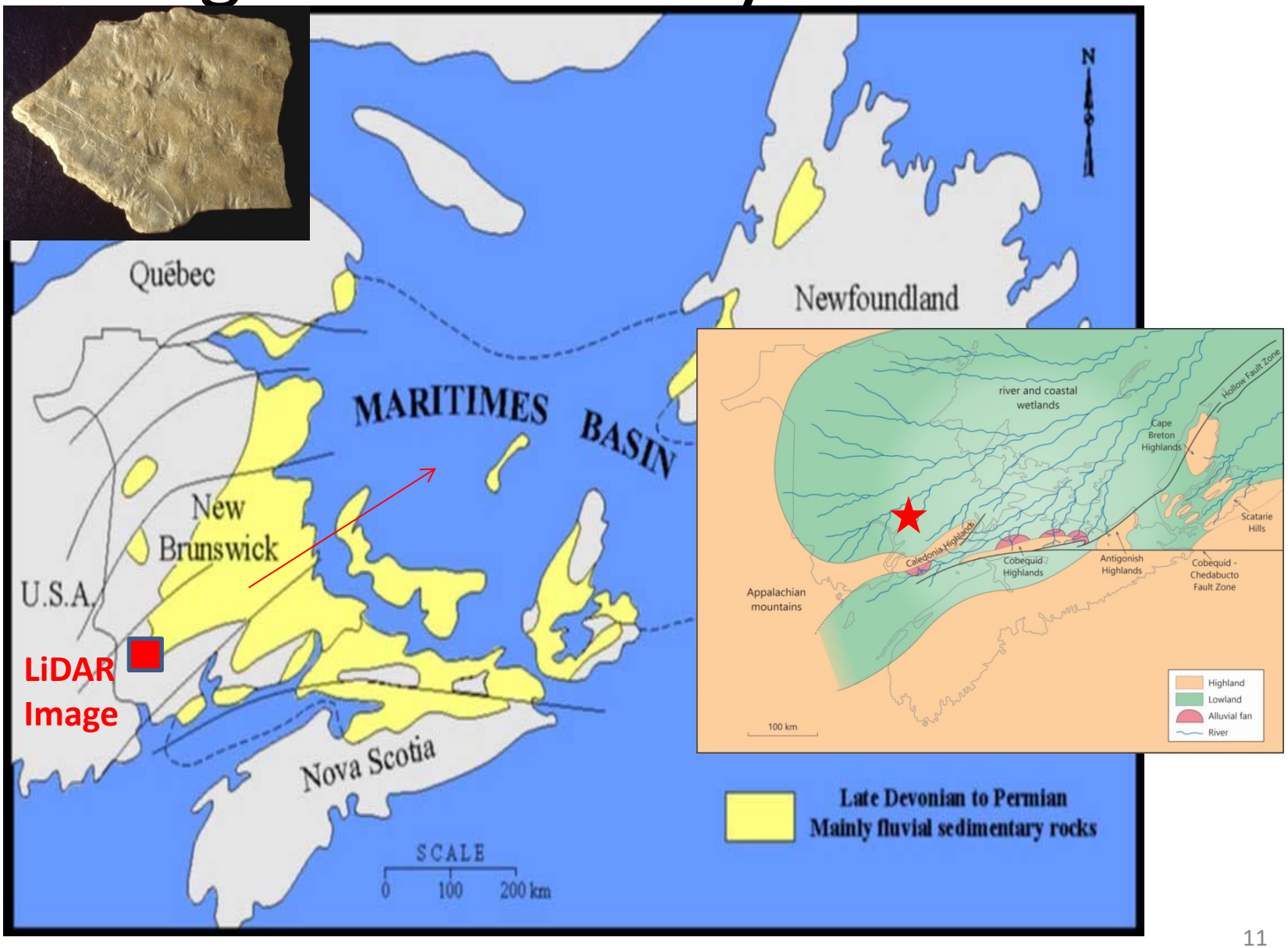
Alleghanian
Orogeny

Global paleogeography 315 My ago an inland sea is formed





Large sedimentary basins



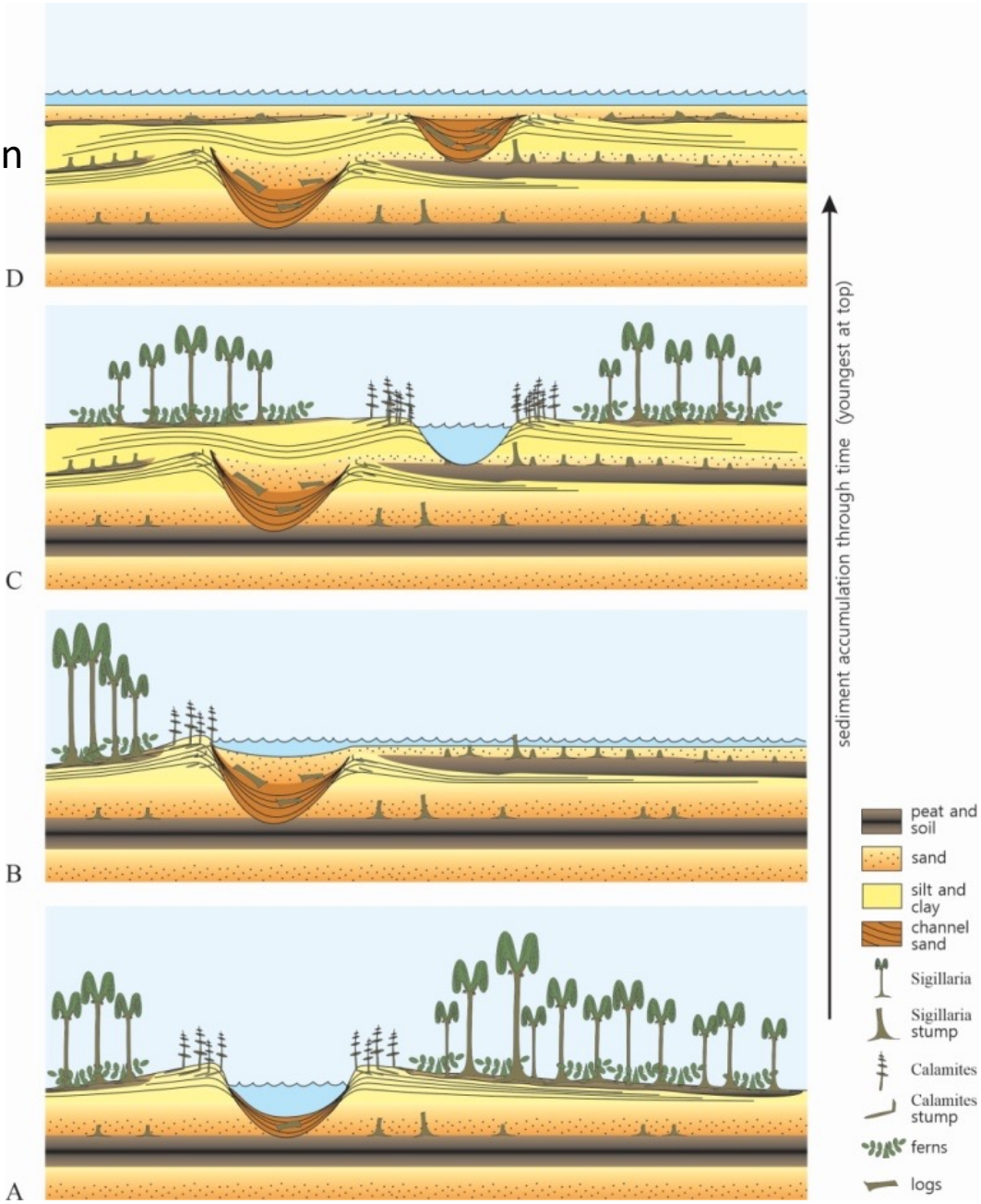
Required conditions:

Further burial and preservation

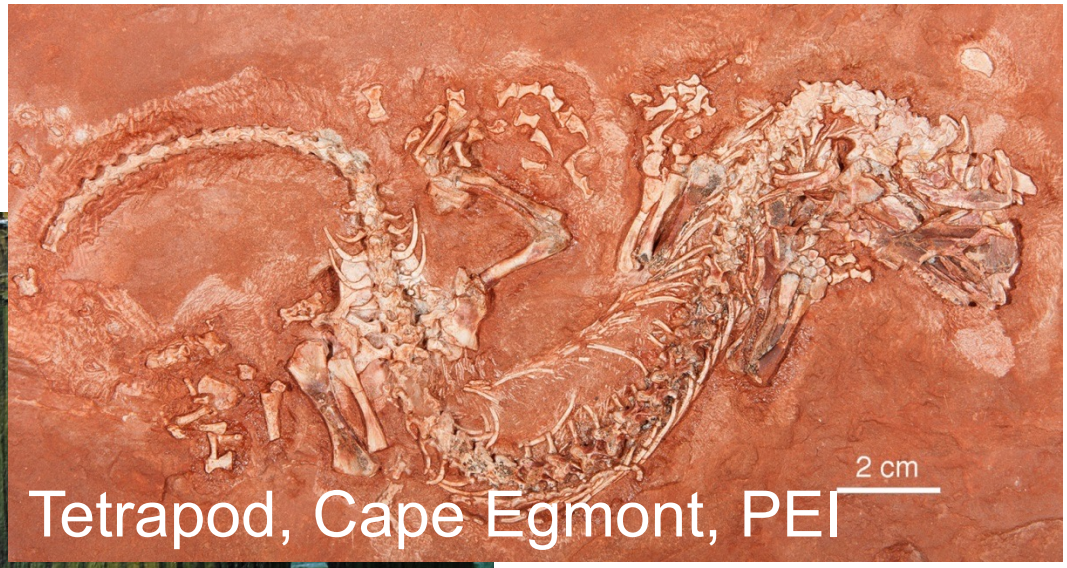
Pressure, which means continuous sedimentation, subsiding basin,etc.

Formation of peat/burial (relatively horizontal bedding, non-oxidizing environment

Heavy growth of vegetation (soil/climate), notice the back swamp conditions and levees



Carboniferous - Ecosystems



Tetrapod, Cape Egmont, PEI

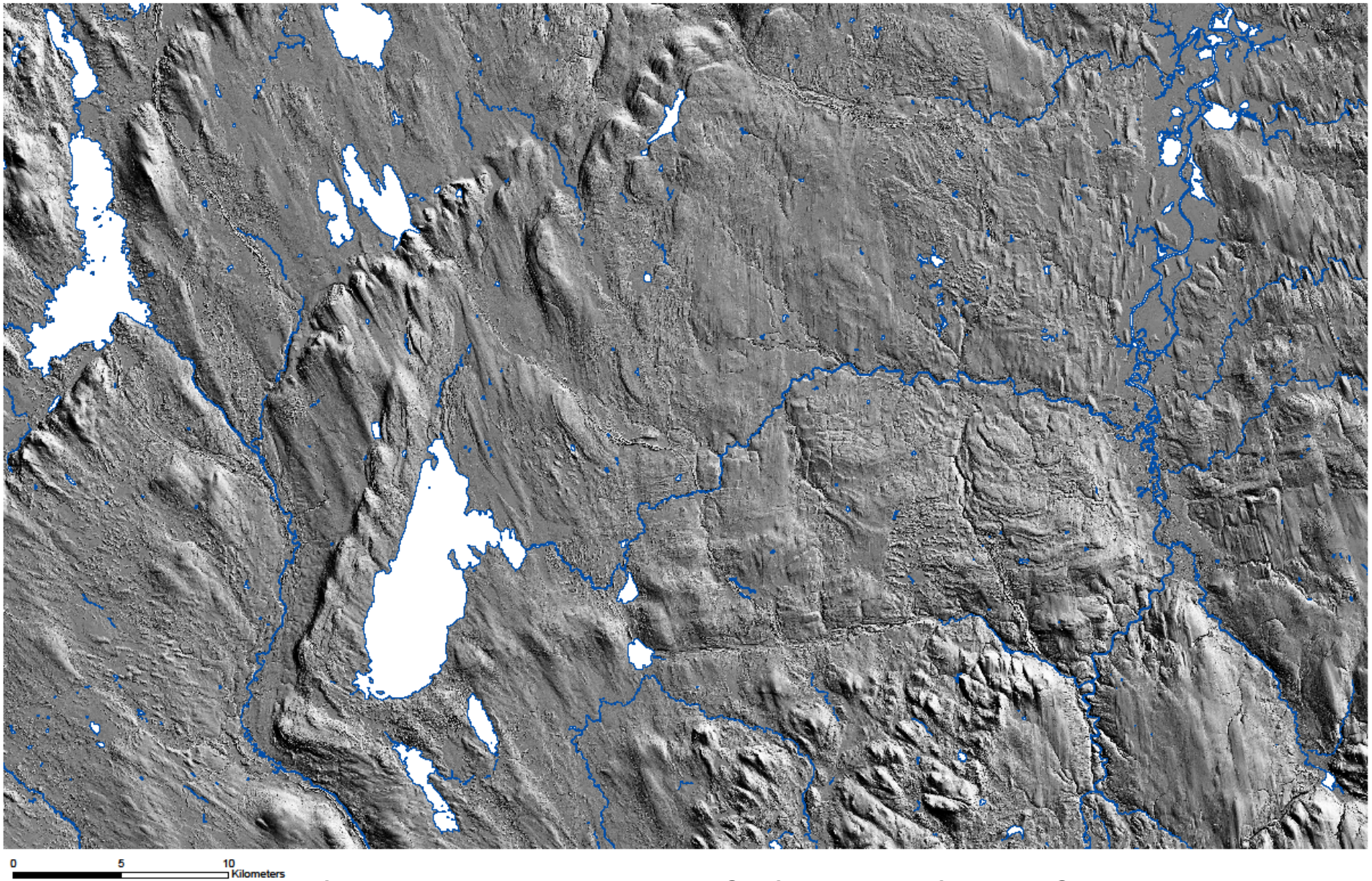


Calamites (horsetail)



Dimetrodon, New London PEI

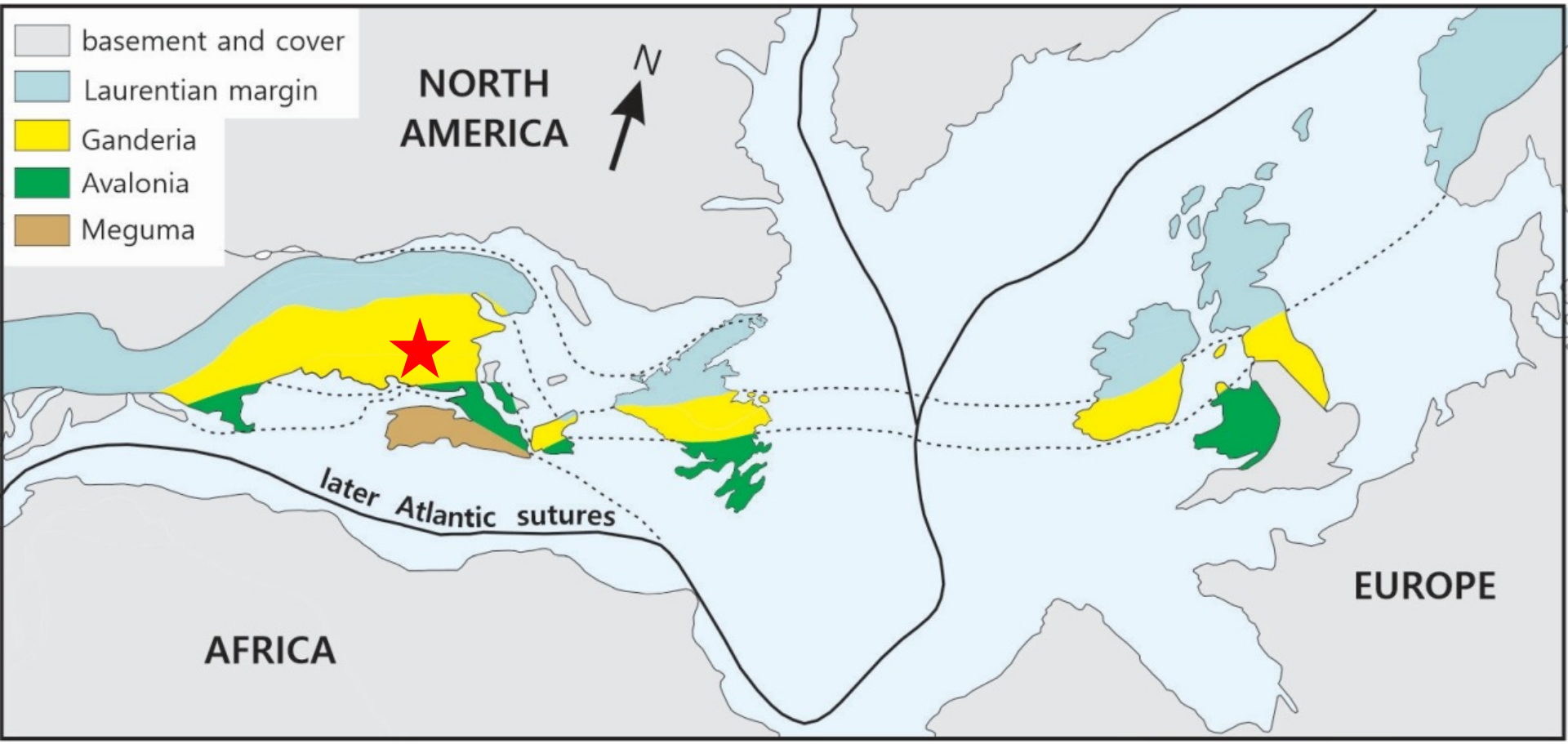
360-300My



Oromocto Lake, SW corner of the Carboniferous Basin

Cuestas, drumlins, granitic terrane, pro-glacial outwash channels, Oromocto/Nerepis

At the end of the Permian we had the “Biggest Dying”, then starting in the Triassic, 200My ago, Pangea started ‘breaking up’ – Bay of Fundy (a ‘failed rift’) – the Atlantic Ocean started forming, we are now on a “passive margin”.

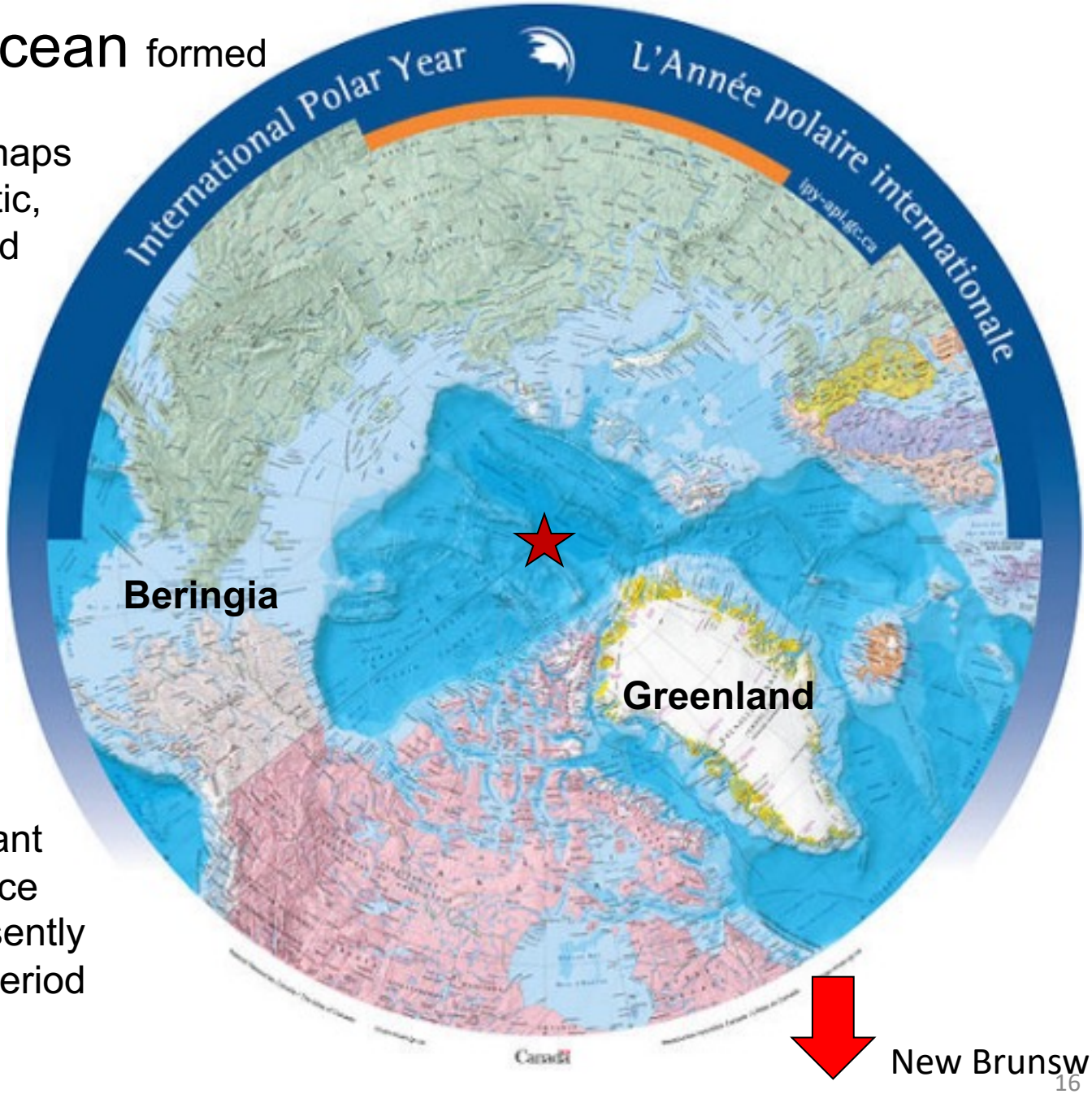


Appalachian Mountain range across the Atlantic

(as composed of different slices of micro-continents)

… the Arctic Ocean formed

One of my favorite maps … of the north Atlantic, the Arctic Ocean, and surrounding lands



Geographical North Pole

Why access and location is important to the start of the ice ages. We are presently in an interglacial period

New Brunswick

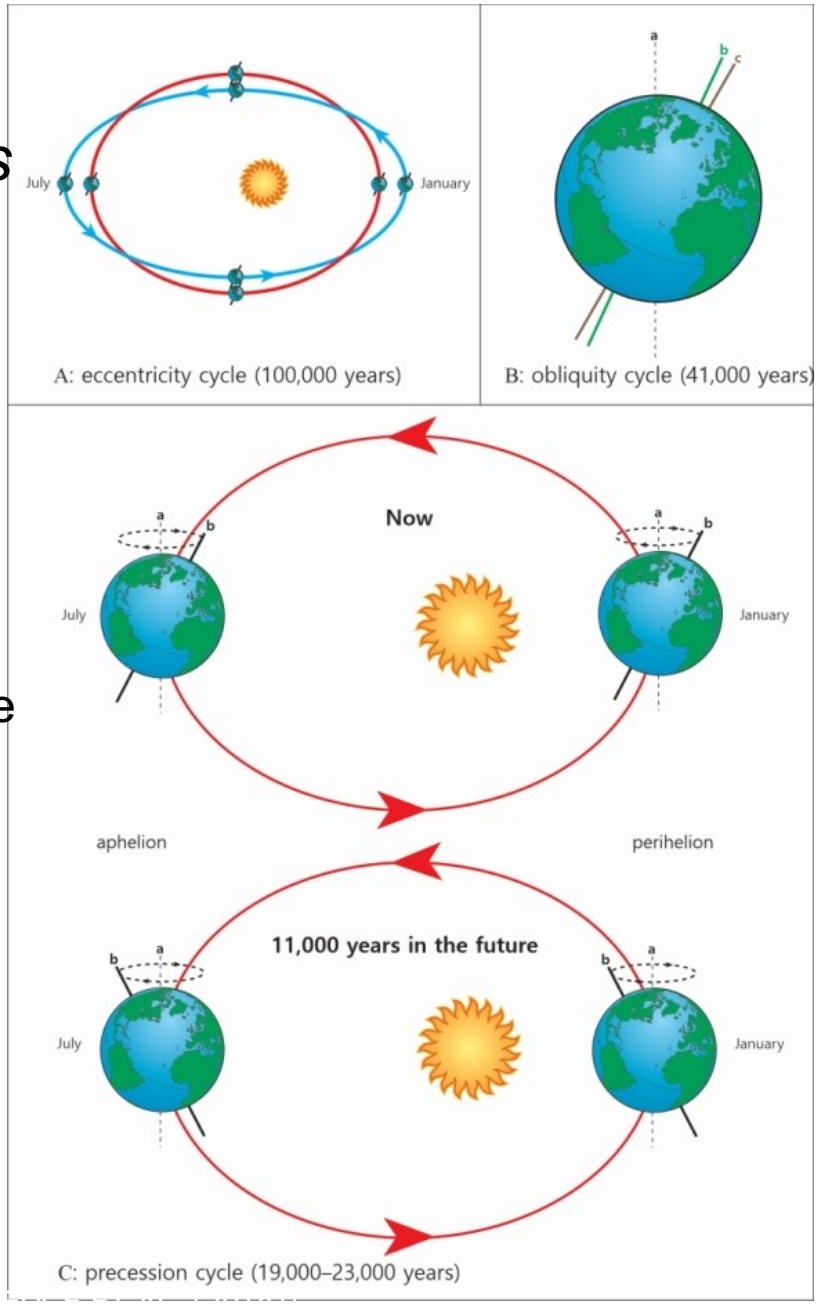
Milankovitch Cycles

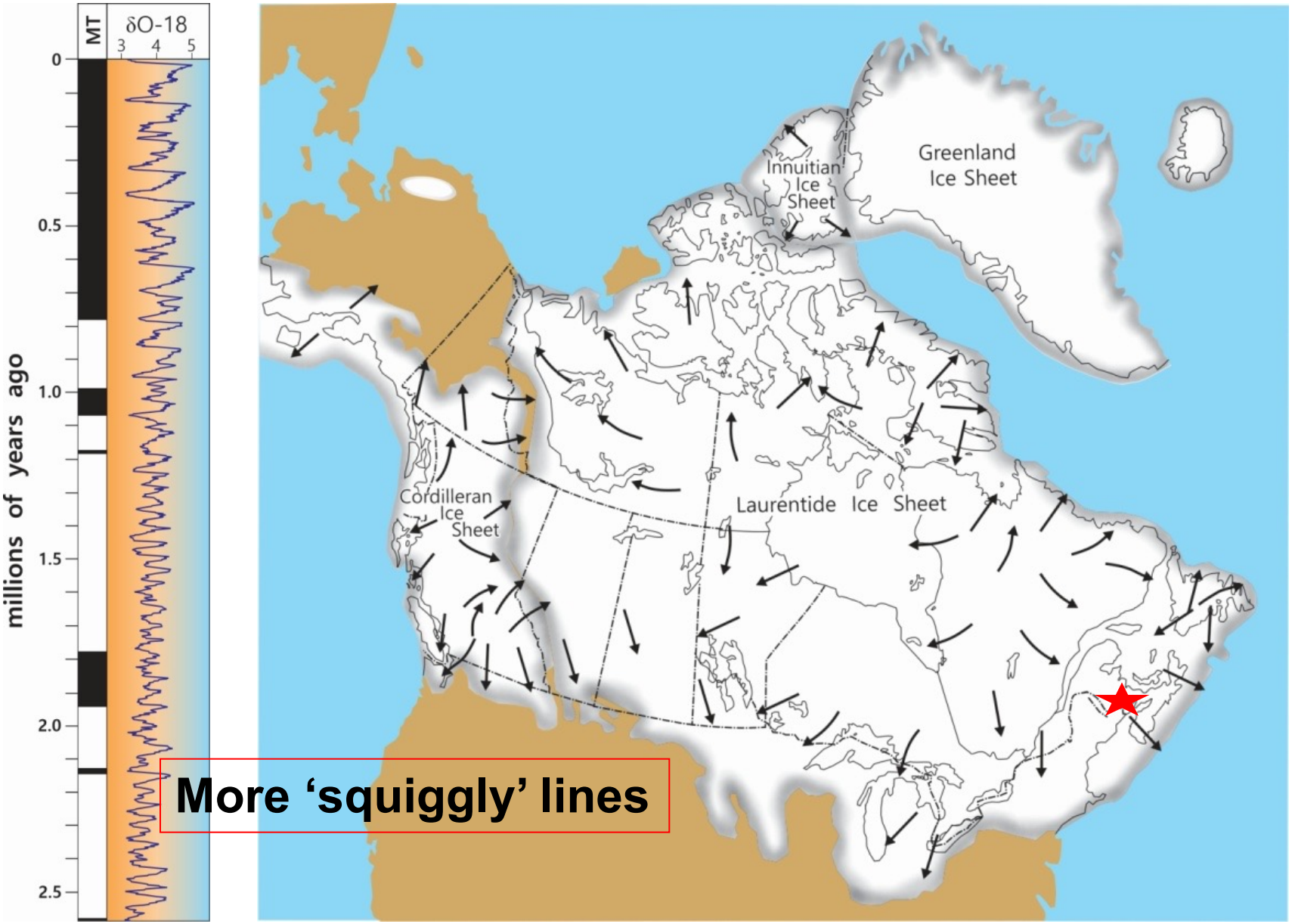
Orbits, angles, and more cycles

The solar system connection

The ‘ebb and flow’ of continental ice sheets is closely related to the interaction of Earth with our sun.

1) Our elliptical orbit “stretches and contracts” with a 100K periodicity
2) The Earth’s axis angle in relation to the solar plane (obliquity) varies between 22 and 24.5 degrees with a 41K periodicity
3) The Earth’s axis ‘wobbles’ like a top spinning out. Today this causes the northern hemisphere to be titled toward the sun in the summer and away during winter. This cycle has a length of 19-23K




MT
δO-18
3
4
5
0
0.5
1.0
1.5
2.0
2.5
millions of years ago
Innuitian Ice Sheet
Greenland Ice Sheet
Cordilleran Ice Sheet
Laurentide Ice Sheet
More 'squiggly' lines

Fast forward to 20,000 years ago

Maximum ice extent



18 ka (21 ka cal BP)

14 ka (c. 16.8 ka cal BP)

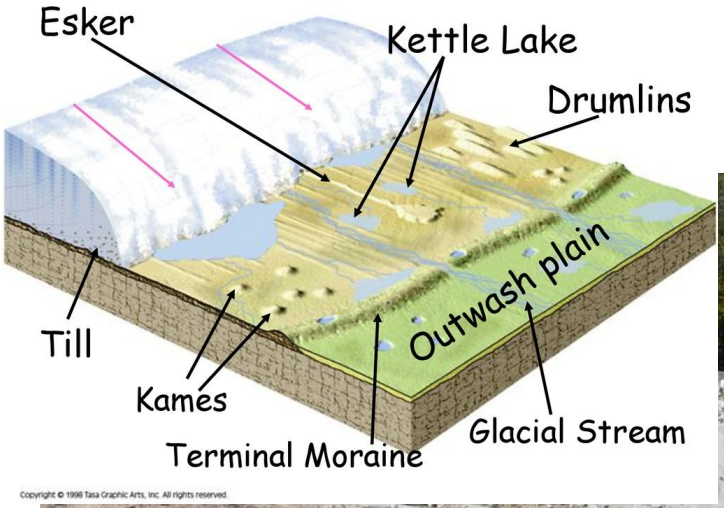
… and people arrived

12 ka (c. 14 ka cal BP)

What New Brunswick may have looked like during the last ice age



Glacially sculpted landscape

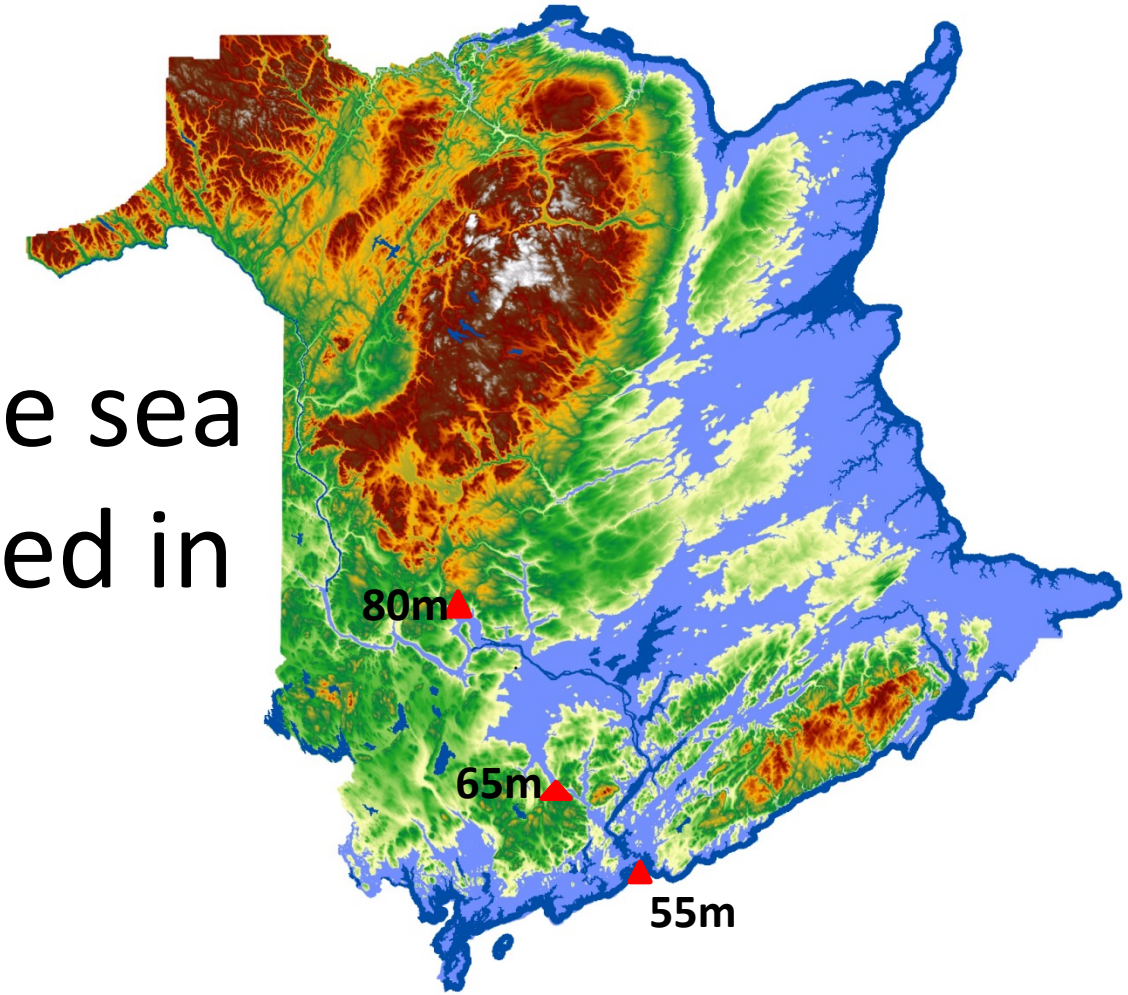


Whalebacks >2m high near Prince of Wales, NB. (photo Serge Allard)

"Stones are the most interesting things in the world" quote from a 5-yo in "*A country called childhood*" by *Jay Griffiths*

When the ice melted / retreated

… the sea moved in



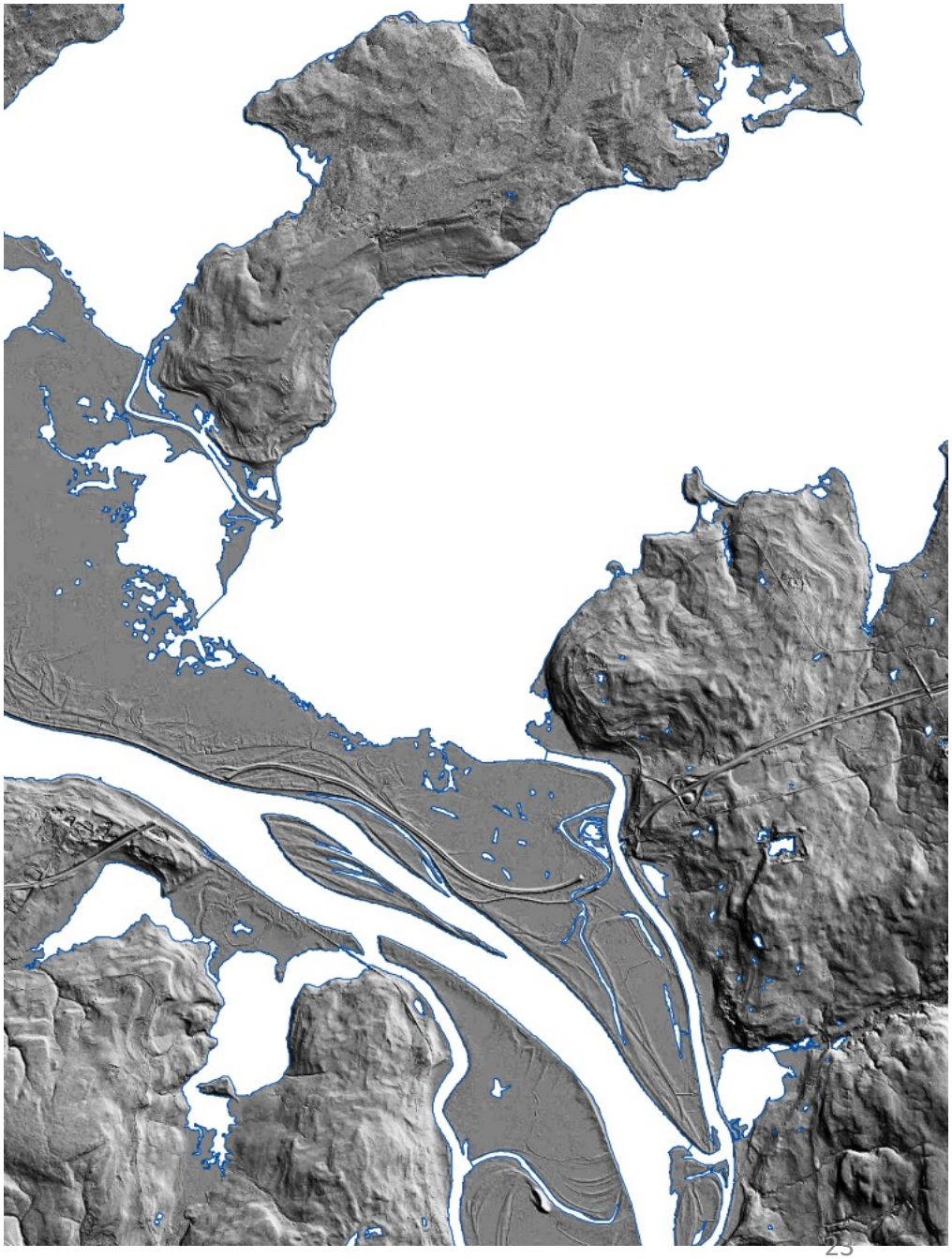
Isostatic - crust
Eustatic - water

DeGeer Sea

Map by Serge Allard

Landscape features

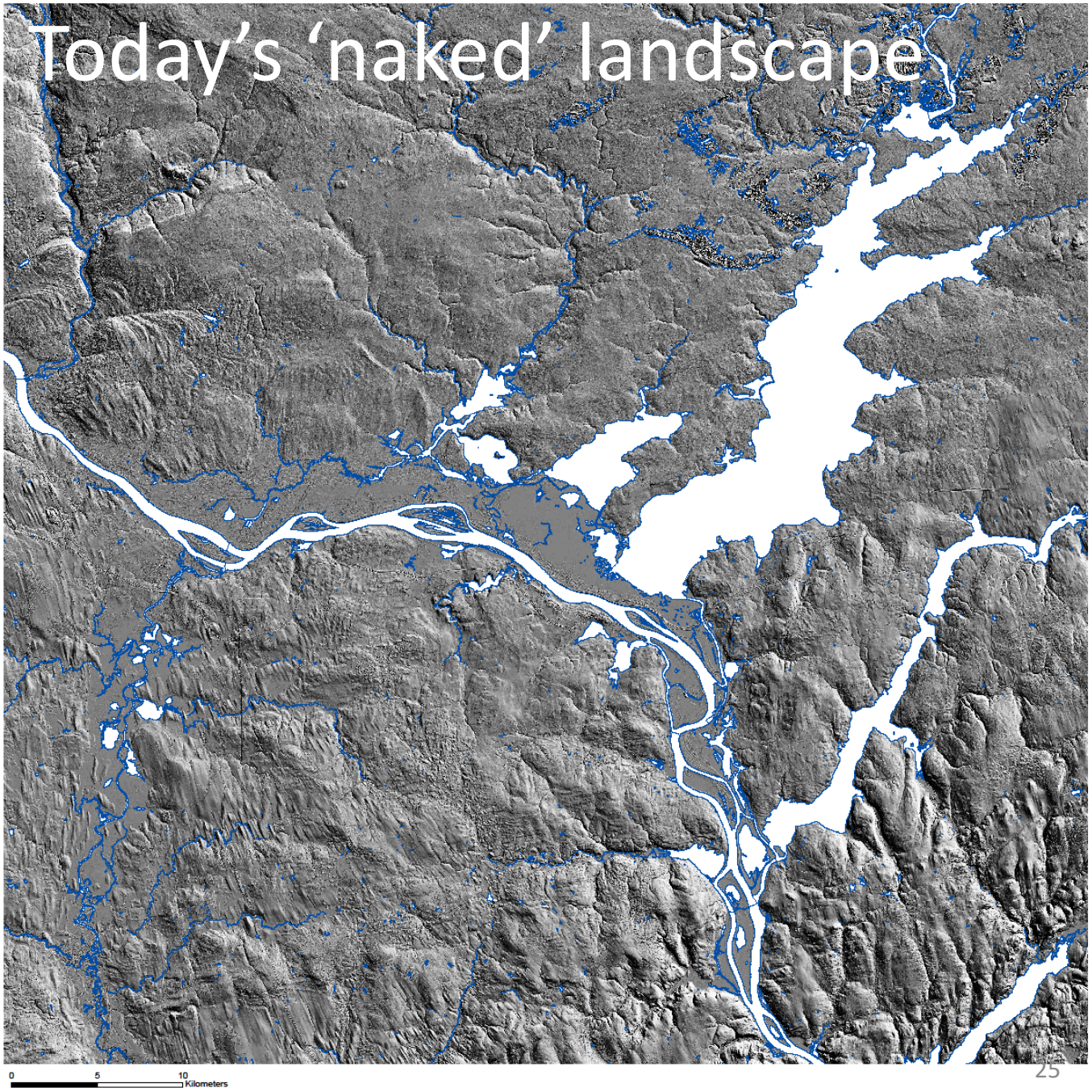
Strandlines (beaches)
Levees
Moraines
Drumlins





Today's 'naked' landscape

Sum of:
Bedrock geology
Glaciation
Erosion
Deposition
Wave washing
Human influence



Grand Point Bar – a wave-washed moraine ridge?

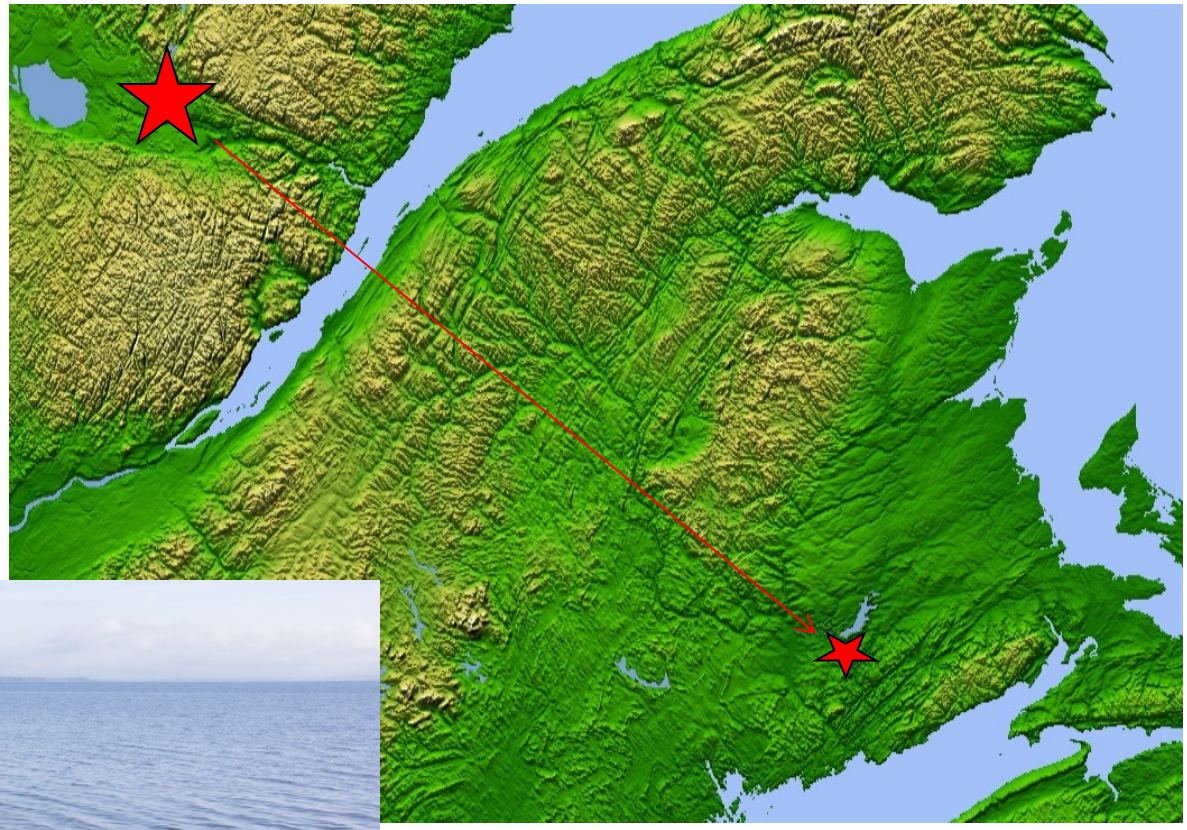


Indian Point glacial erratic – charnockite from the Saguenay region



How do we know about glaciers in the Maritimes?

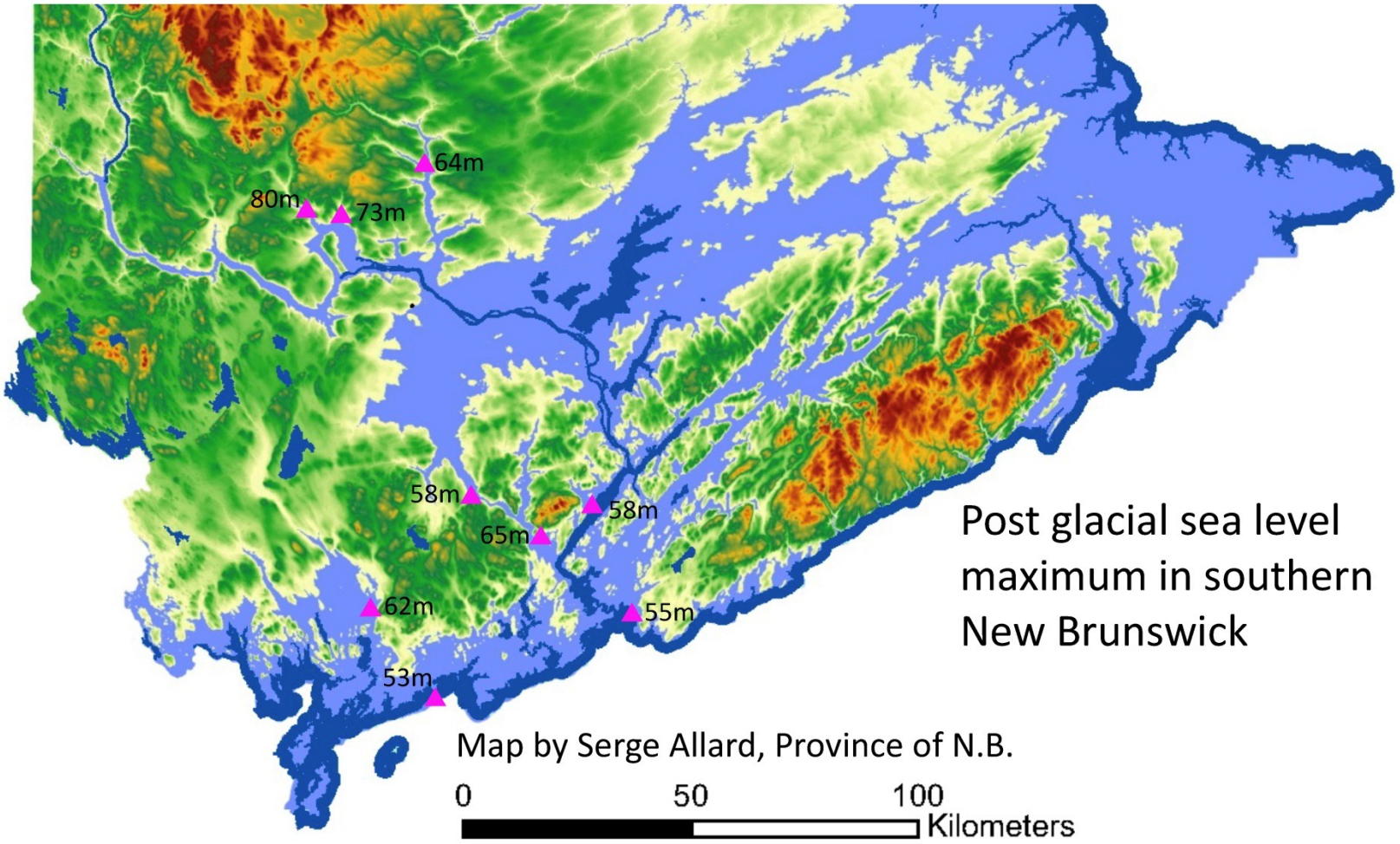
A traveling ‘Rock show’





Glacial Erratic at Indian Point, Grand Lake – Origin: Saguenay Qc, 1.06By old

Post glacial deltas in southern New Brunswick



Blagdon Delta – Welsford – aggregate resources for the region
Note the horizontal top of the delta, marking the sea-level stand at the time 65m ASL



The formation of Deltas

This causes bars or islands of sediment to build in the middle of the main channel

River spreads out and slows down as it approaches the sea

Deposition is therefore encouraged as the hydraulic radius drops and the river becomes less efficient, the biggest sediments are dropped first and the finest further away

The river splits into distributaries

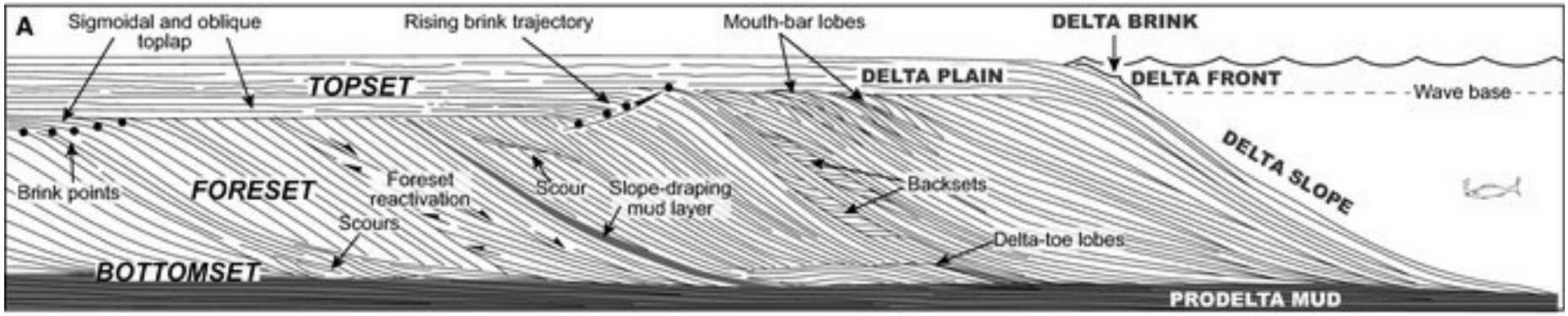
The land

Sea or lake

Sea or lake bed

Layers of sediment build the delta out into the sea, as top set, foreset and bottom set beds

By Rob Gamesby

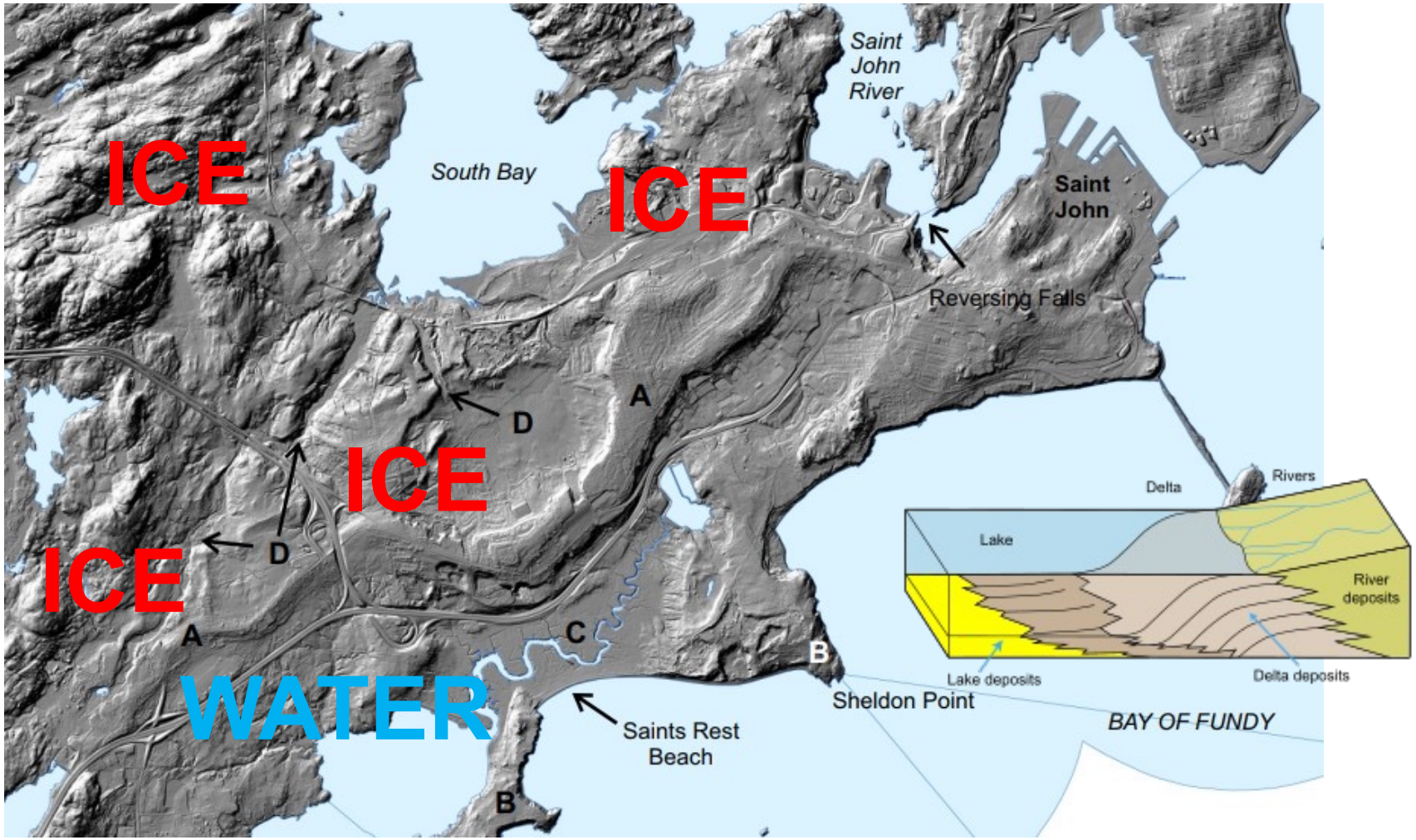


View toward Grand Bay from Bald Peak/Mt Douglas



Photo Credit Peter Duguid

Saint John area, Manawagonish Moraine, in LiDAR (Light Detection And Ranging, or Laser imaging, Detection, and Ranging – 3D Laser Imaging)



When river water and/or meltwater and sediment flow into a lake or sea the sediment will drop down , less energy, and form a delta



Before

Confined vs unconfined Valleys

The new TCH did not help

After



Inland floods … and storm floods



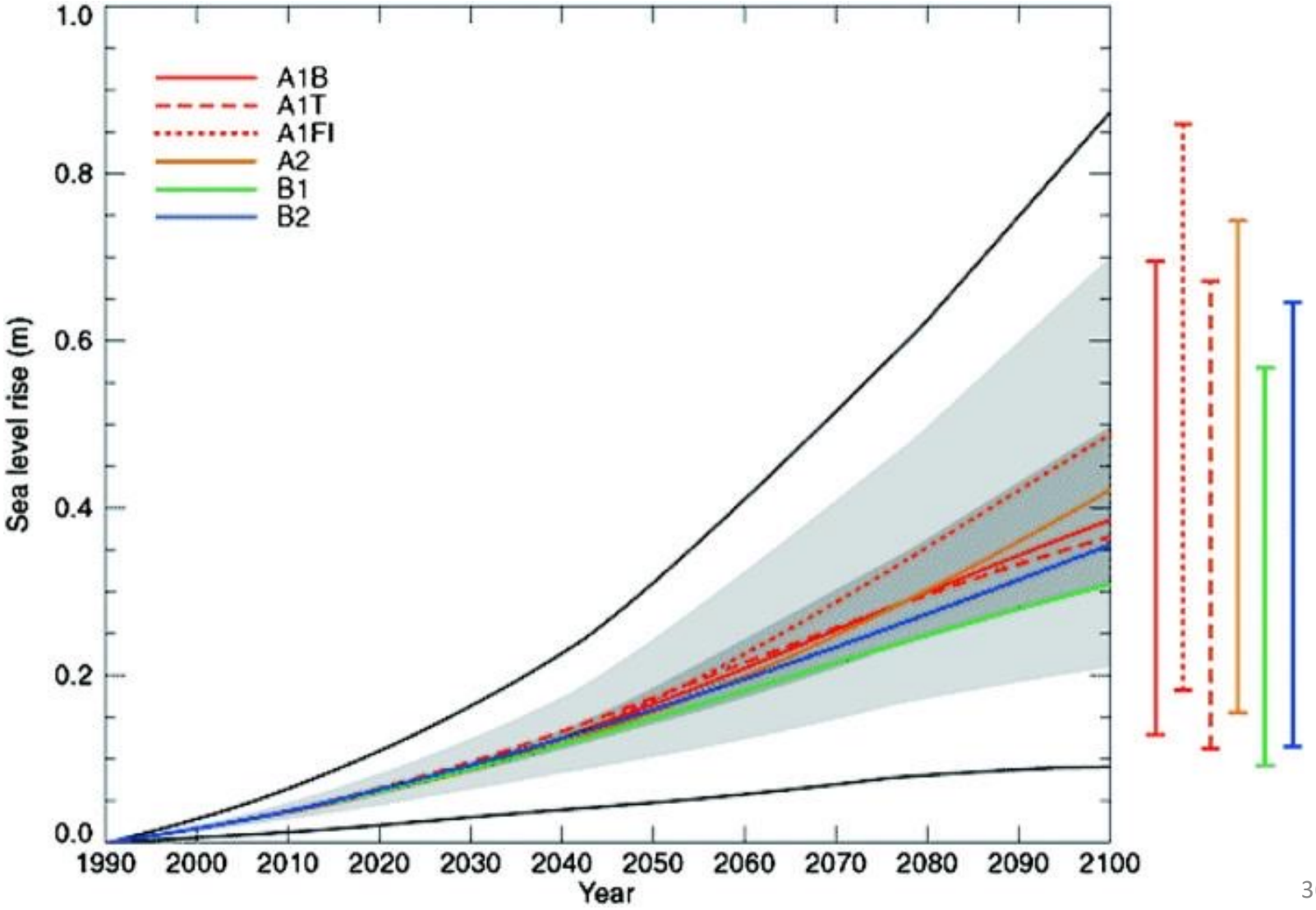
Sea level - Tantramar Marshes

Rivers - Fredericton



What does “Climate Change, Mean Sea Level rise and Higher Tides in the Bay of Fundy” mean for the Grand Lake Basin

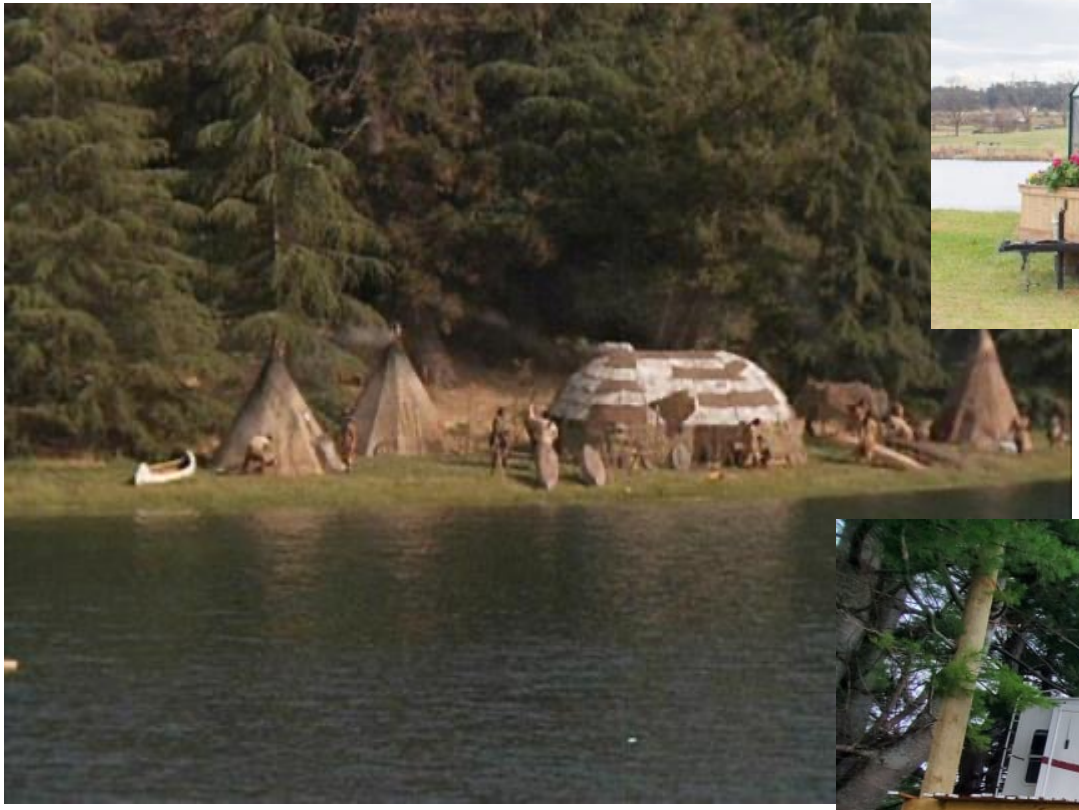
Global average sea level rise 1990 to 2100 for the SRES scenarios. David A. Greenberg etal 2012



How do we prepare for these changes?



Now?



Then

Build-in adaptability

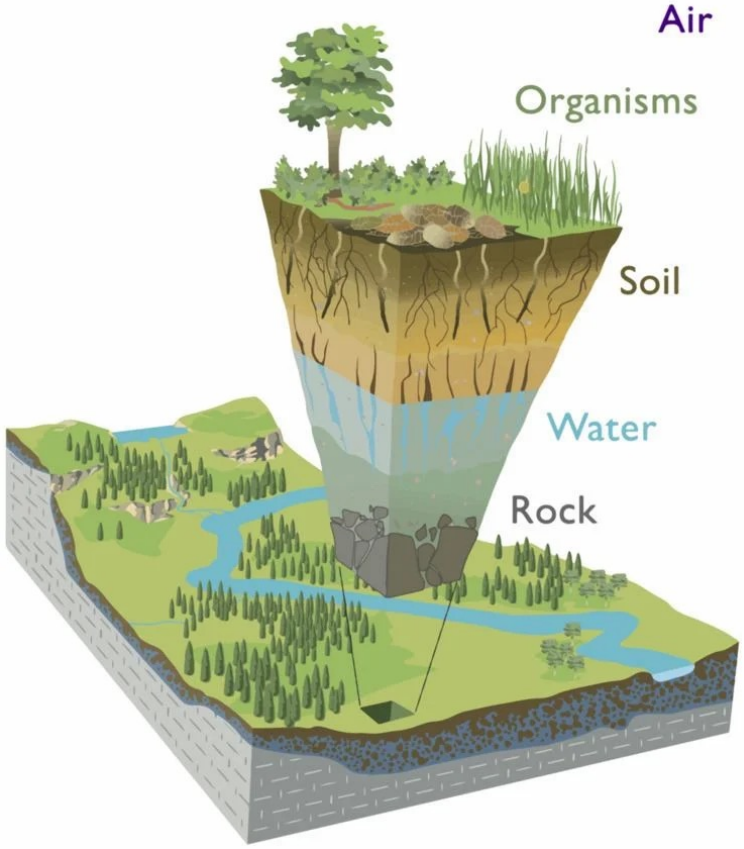


Adaptation



"The only real voyage of discovery consists not in seeking new landscapes but in having new eyes."
(Marcel Proust)

The "Critical Zone" concept

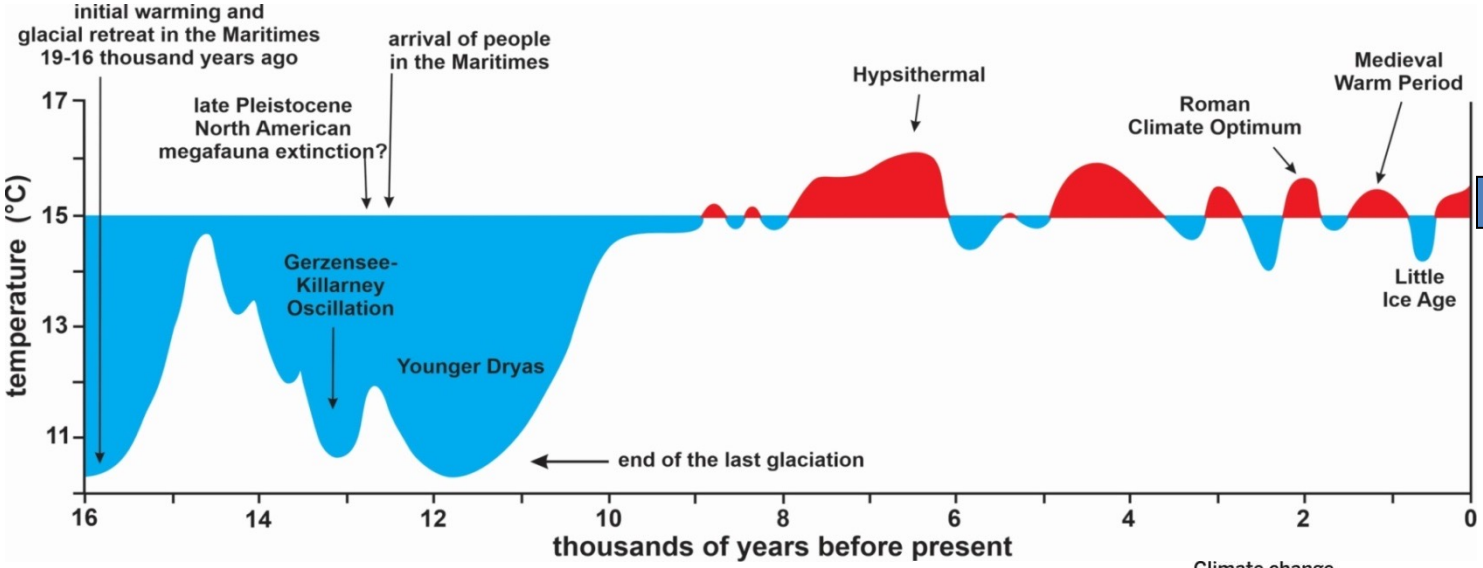


How we are connected through the soil and the landscape

Disciplines and scales
Physical and chemical controls
Biochemical processes
Biota and Earth materials
Atmospheric contributions

Now we have a "feel for the place" – what will we do?

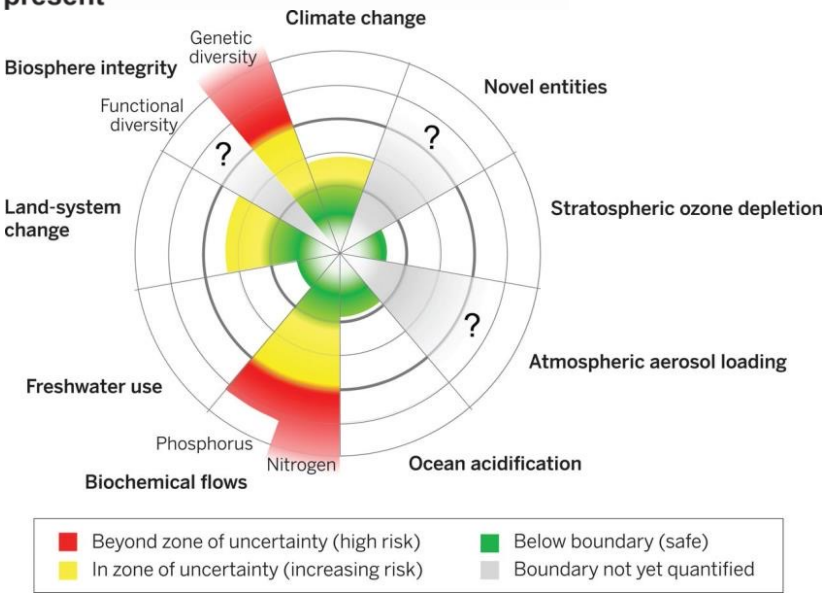
So what's next for Grand Lake Basin (and the planet)?



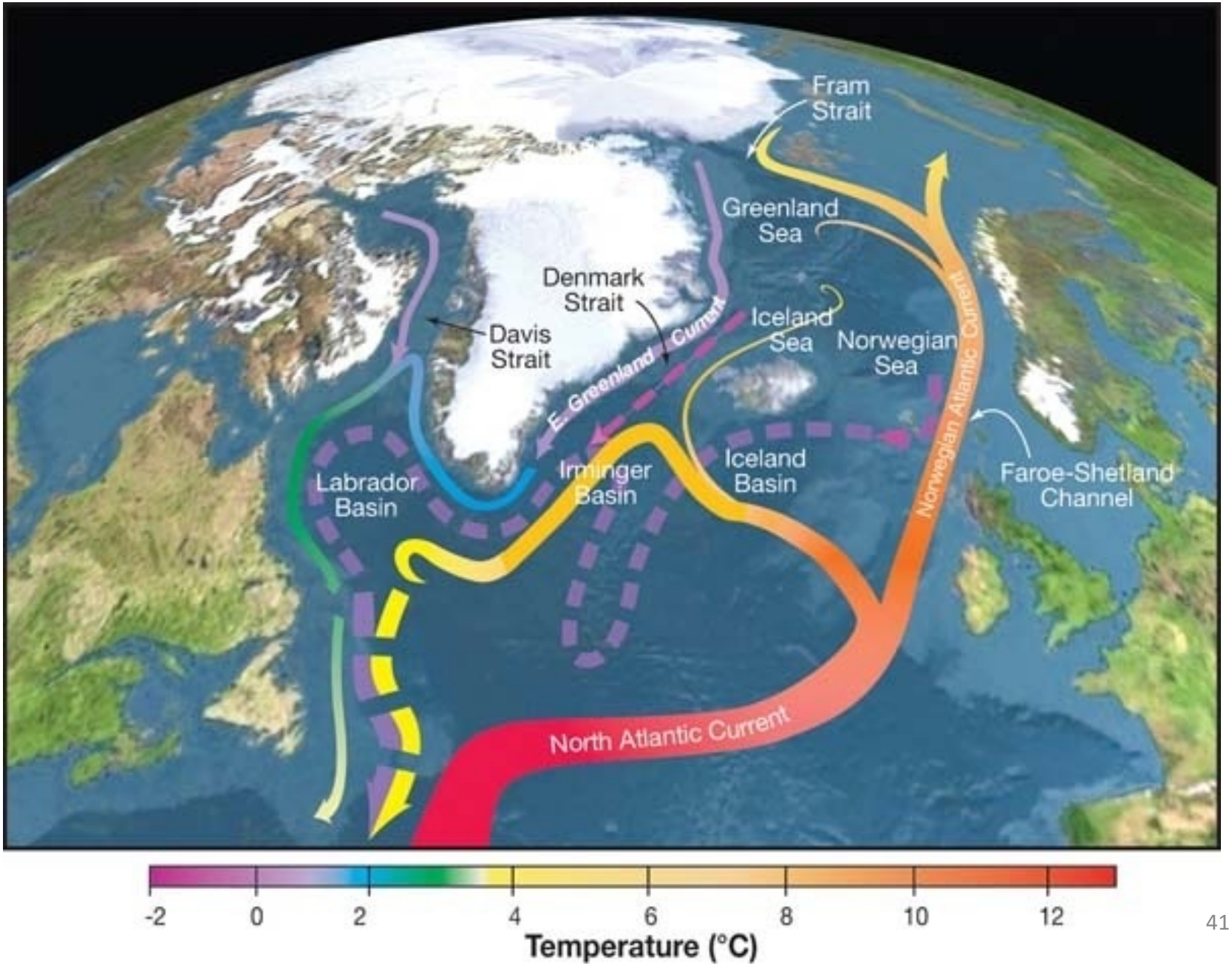
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Planetary Boundaries - Stockholm Resilience Center

Watch: Netflix doc "Breaking Boundaries"

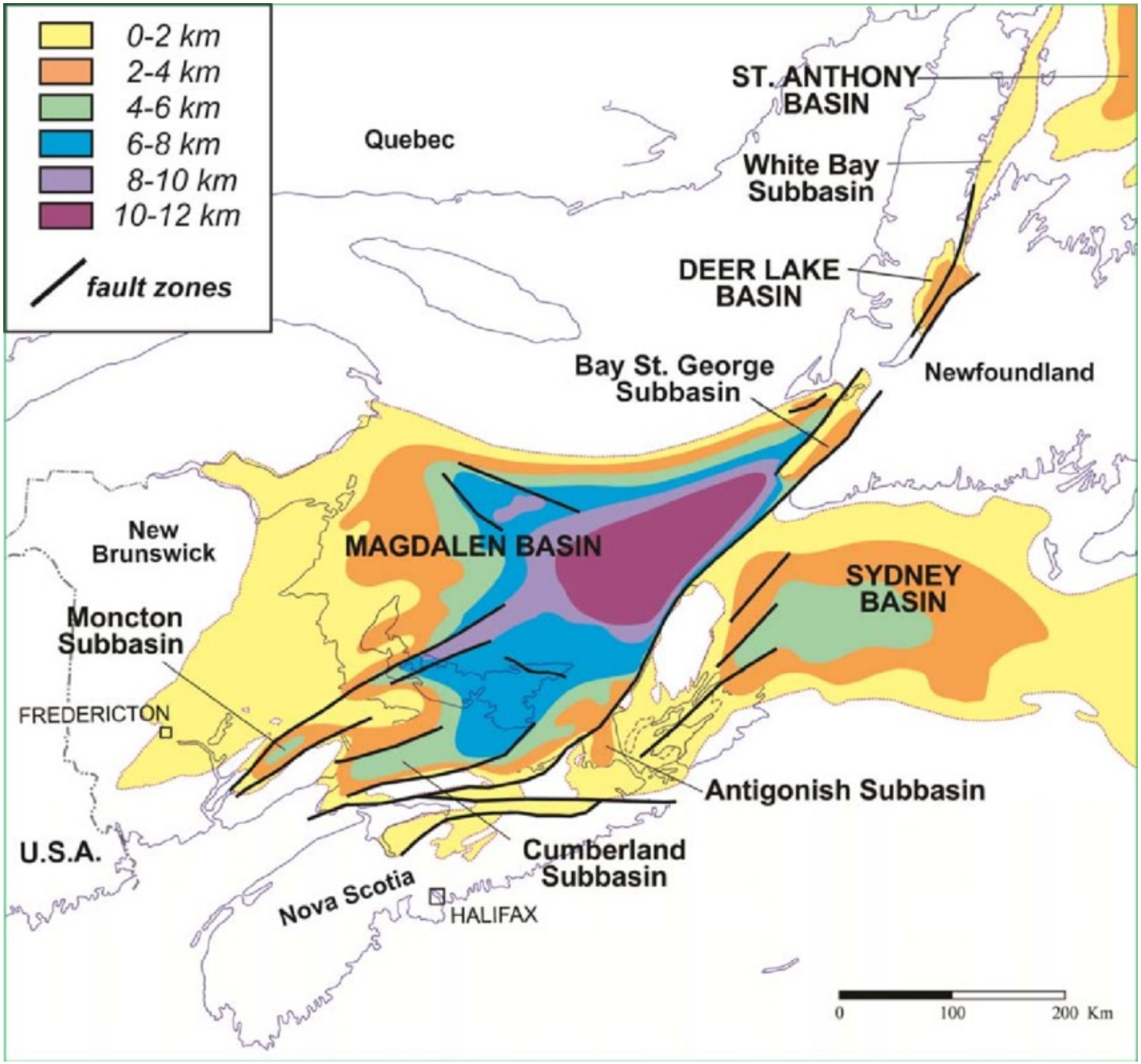


The **Atlantic meridional overturning circulation**



End of Presentation

Beginning of Additional Explanatory Slides


0-2 km
2-4 km
4-6 km
6-8 km
8-10 km
10-12 km
fault zones
ST. ANTHONY BASIN
Quebec
White Bay Subbasin
DEER LAKE BASIN
Bay St. George Subbasin
Newfoundland
New Brunswick
MAGDALEN BASIN
SYDNEY BASIN
Moncton Subbasin
FREDERICTON
Antigonish Subbasin
U.S.A.
Cumberland Subbasin
Nova Scotia
HALIFAX
0
100
200 Km

When people arrived



PHOTO DREW GILBERT
ARTIFACT WAS FOUND IN
WOLASTOQIYIK FIRST
NATION TERRITORY
Kingsclear FN, NB



What is resilience anyway?

Engineering resilience: efficiency, consistency, and predictability
Ecological resilience: persistence, change, and unpredictability

Besides being the all-important substance for the origin of life as we know it, surface water is important for stabilizing a planet's climate over long periods of time, allowing evolution to happen. Even small amounts of water deep below the surface are known to dramatically increase rock plasticity, which is essential for plate tectonics — a process that shapes the continents and oceans, and drives earthquakes and volcanism. But despite its huge importance for the evolution of rocky planets like ours, we don't know where the Earth's water originated.

Earth is beset with turbulent systems which are usually irregular and chaotic, and are thus extremely difficult to model.

Room for the River, Nijmegen, NL



- **Giving up on higher dikes**
  "After 800 years of building dikes, we've been making them higher and higher," said Gert-Jan Meulepas, project manager at Royal Haskoning, an engineering and environmental consultancy that developed the project. "But if something goes wrong, the damage will be greater."



Our fascination with stones

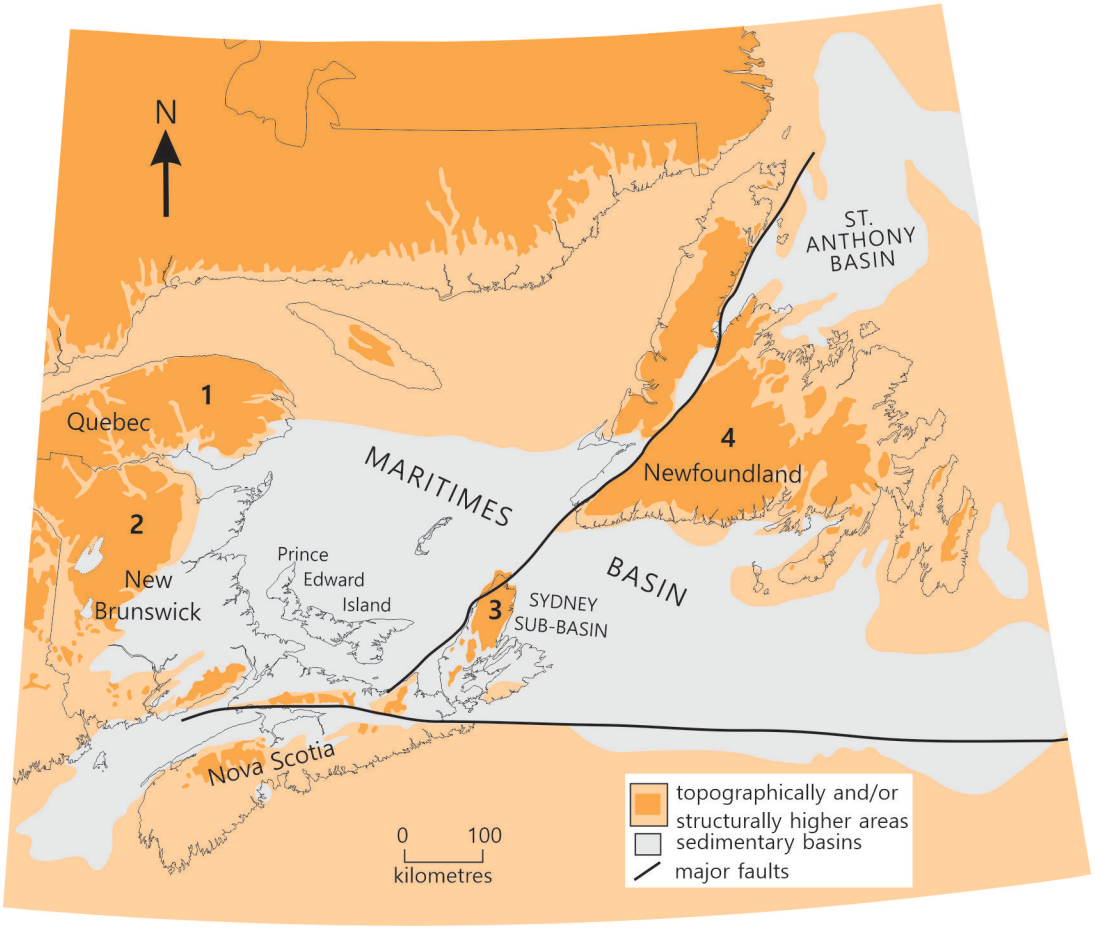
"Stones are the most interesting things in the world"
quote from a 5-yo in "*A country called childhood*"
by *Jay Griffiths*

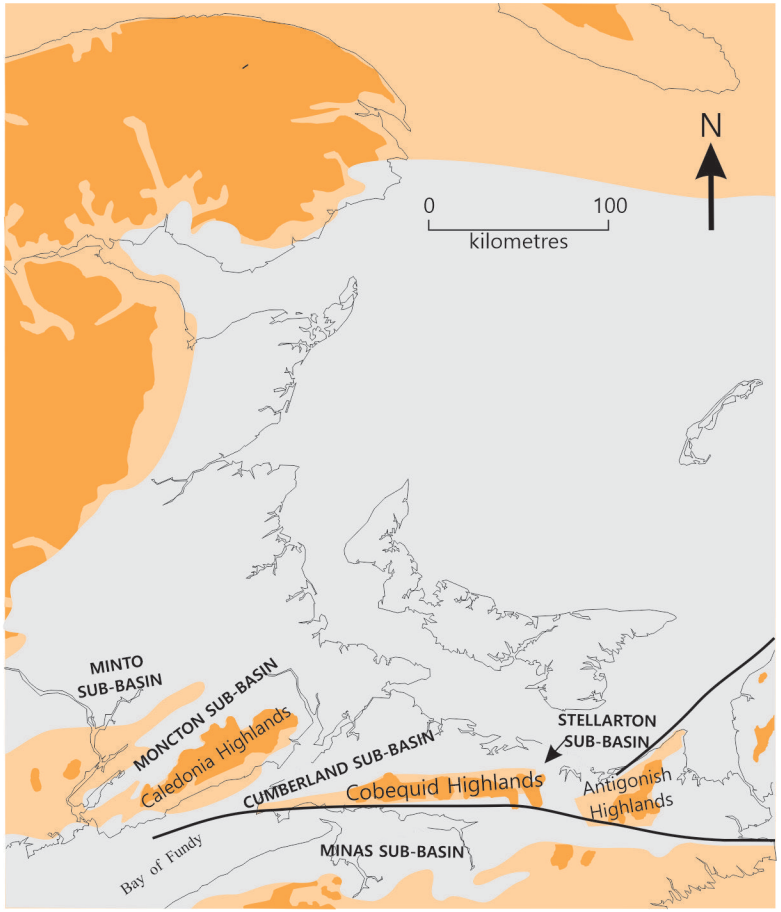


"We are transported beyond ourselves, because the story is universal. Ironically, the things that move us the most are the things that cause us to leave ourselves behind as we unconsciously feel a sense of belonging to a larger pattern. " *Gwen Martin*



"We are here on the planet only once, and might as well get a feel for the place. We might as well get a feel for the fringes and hollows in which life is lived . . . "
Annie Dillard "Teaching a Stone to Talk"


N
ST.
ANTHONY
BASIN
1
Quebec
2
New
Brunswick
Prince
Edward
Island
MARITIMES
BASIN
3
SYDNEY
SUB-BASIN
4
Newfoundland
Nova Scotia
0
100
kilometres
topographically and/or
structurally higher areas
sedimentary basins
major faults


N
0
100
kilometres
MINTO
SUB-BASIN
MONCTON SUB-BASIN
Caledonia Highlands
CUMBERLAND SUB-BASIN
Cobequid Highlands
STELLARTON
SUB-BASIN
Antigonish
Highlands
Bay of Fundy
MINAS SUB-BASIN

2018 Douglas Harbor



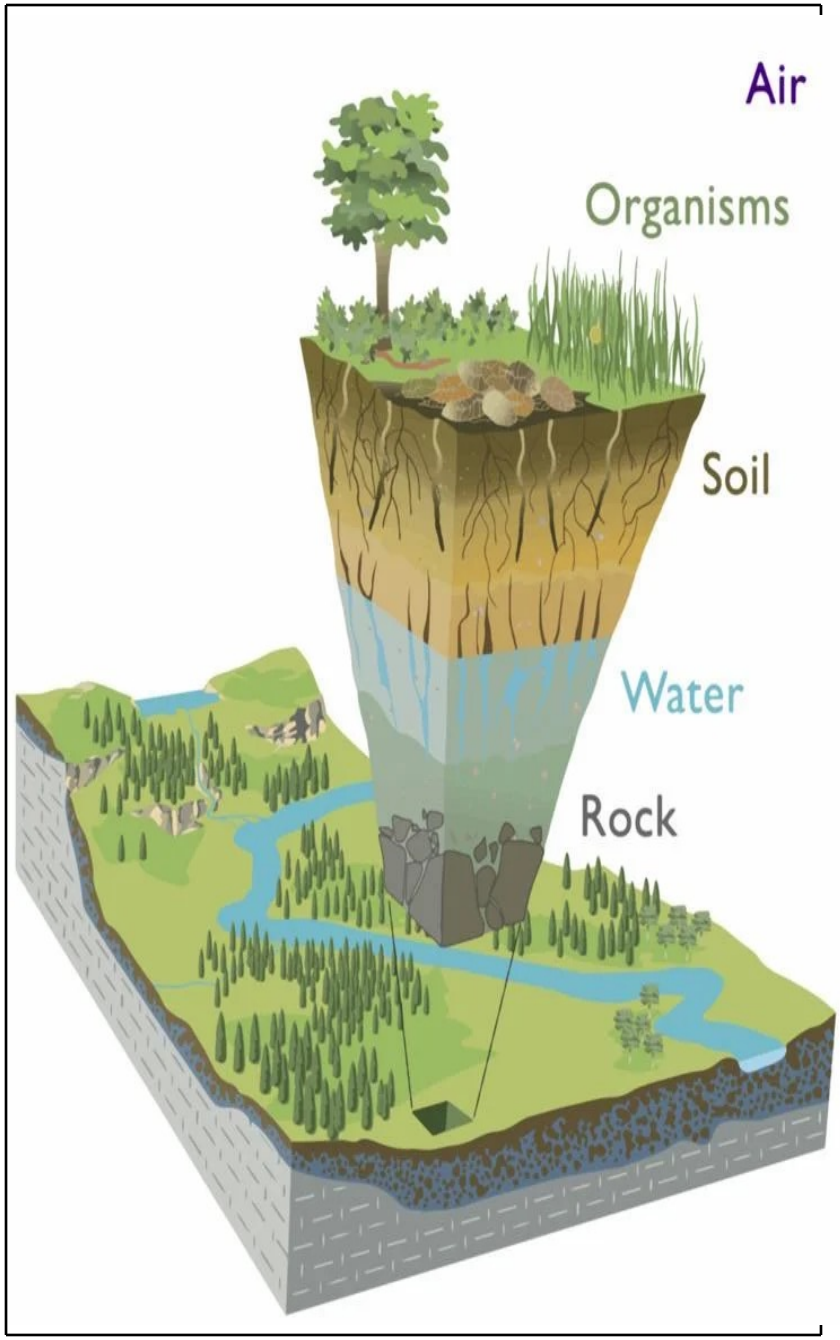




… imagine a miniature canyon landscape with strata, fault line, peneplain, and erosional features



Pebble Art or …



The Critical Zone

How we are connected through the soil

Disciplines and scales

Physical and chemical controls

Biochemical processes

Biota and Earth materials

Earth’s Atmosphere contributions