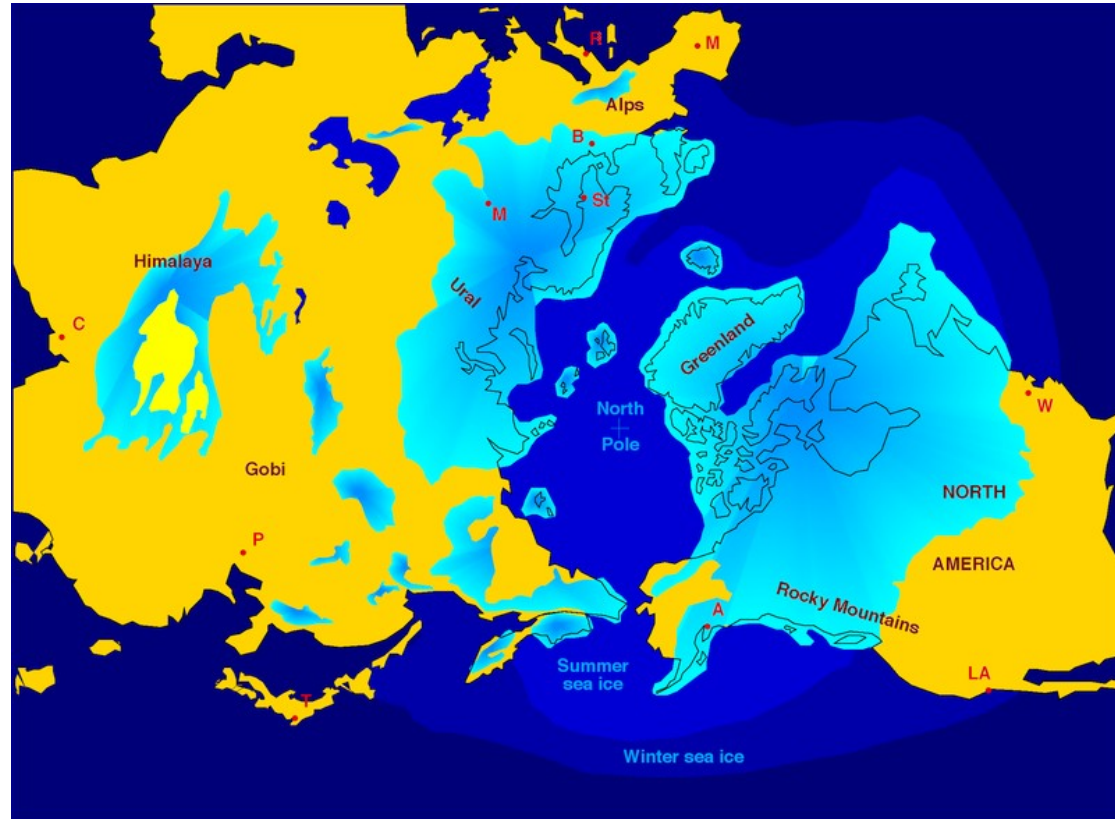


Ice Age features of
Eastern Annapolis Valley
Nova Scotia
indicative of Unseen Forces

J. Duncan Keppie

Extent of Northern Ice sheet during last Ice Age



Reconstruction of
Ice sheet ~16
thousand years
ago

Shaw et al. 2006

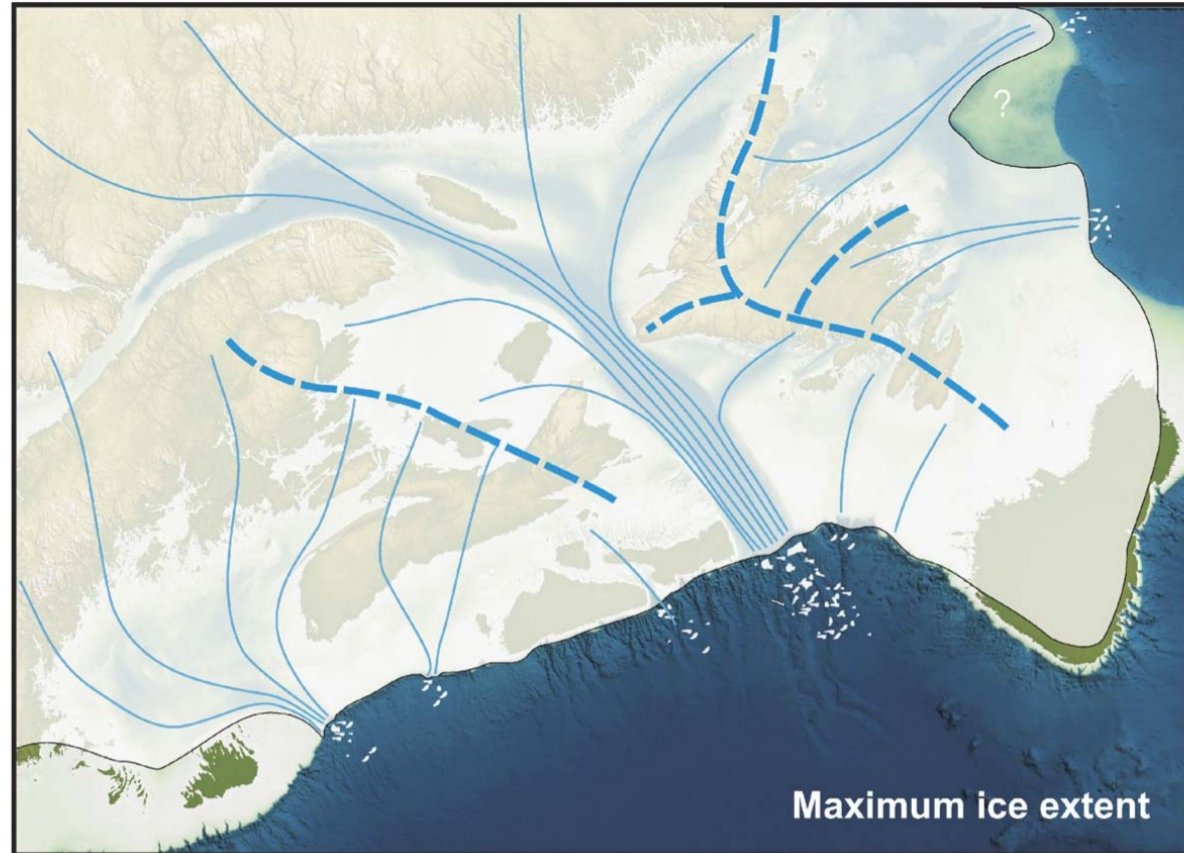
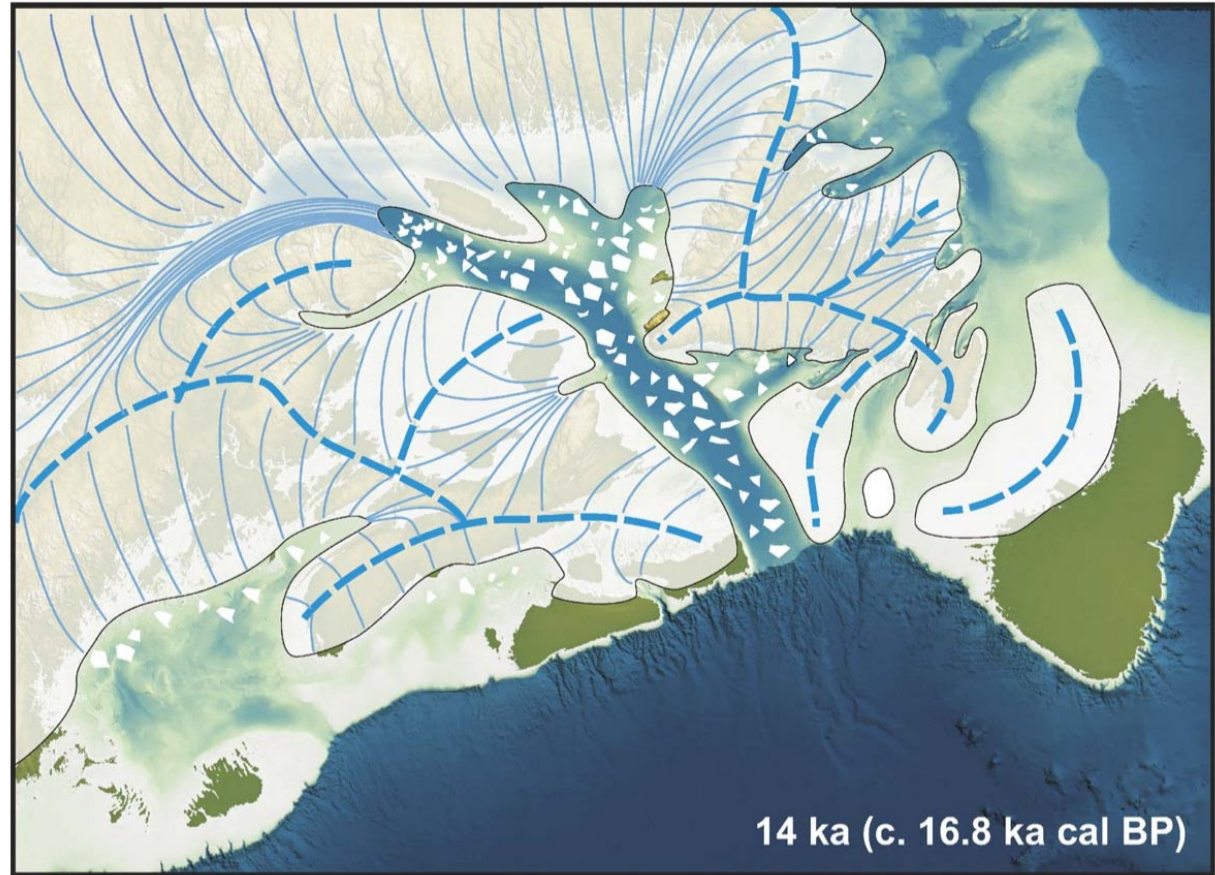


Fig. 8. Maximum extent ice. Thin blue lines are generalized flow lines; heavy blue dashed lines are major ice divides. The underlying digital elevation model shown here, and also on Figs. 9–12, depicts the distribution of land and water at 13 ka (Shaw et al., 2002), and is therefore an approximation only.

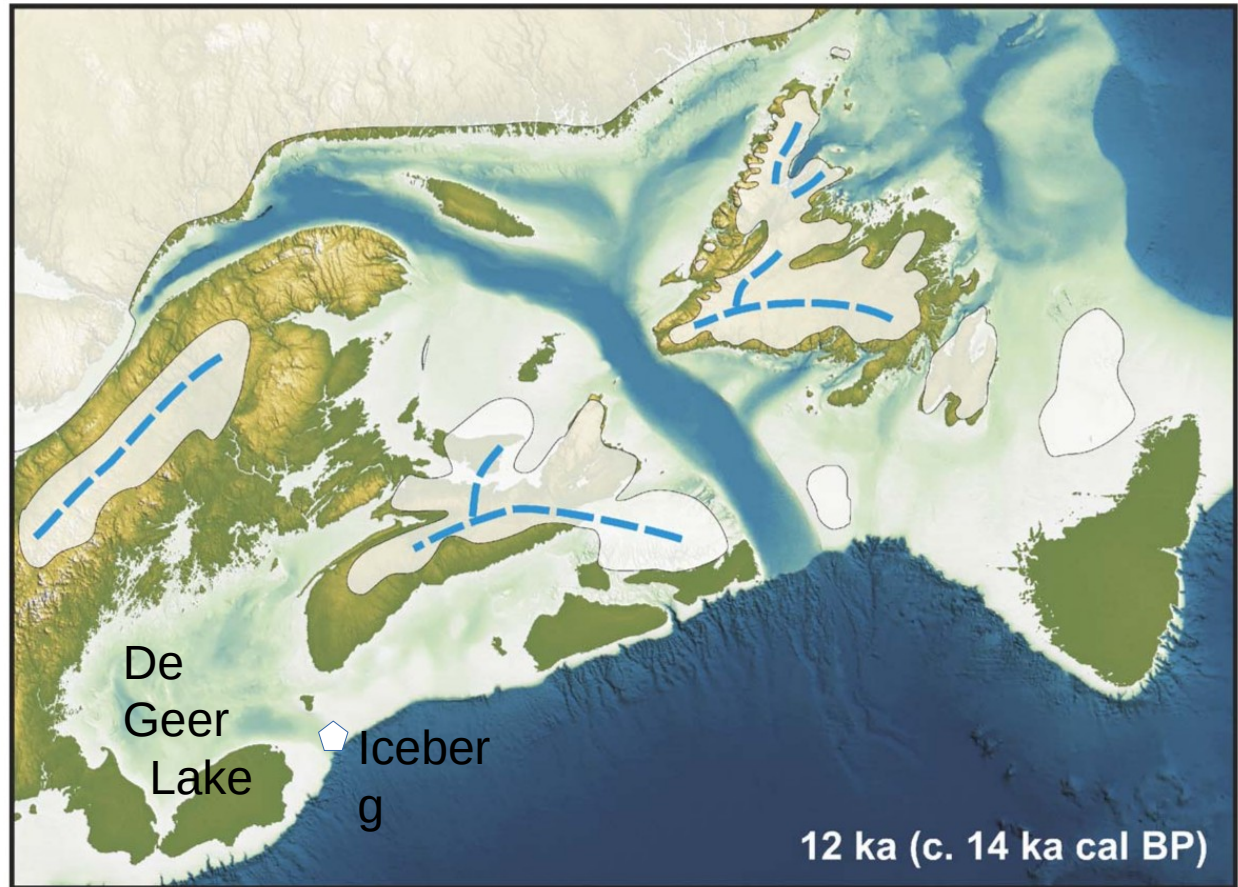
Reconstruction of
Ice sheet ~16.8
thousand years
ago

Shaw et al. 2006



Reconstruction of
Ice sheet ~14
thousand years
ago

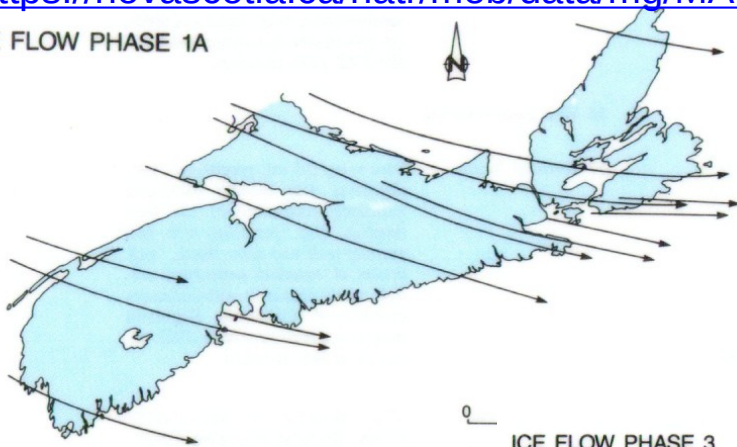
Shaw et al. 2006



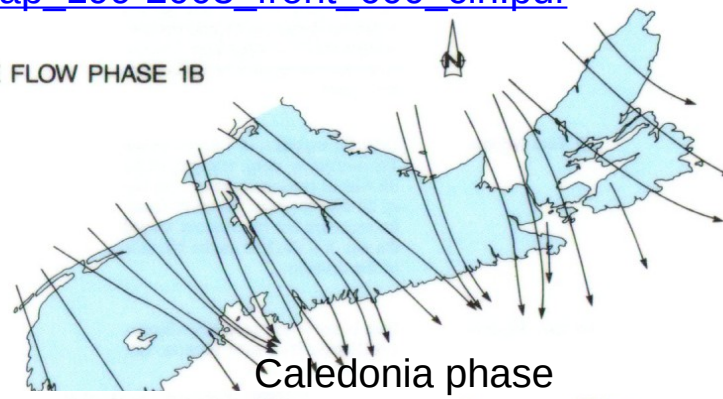
Reconstruction of ice flow directions between 35 and 10 ka

https://novascotia.ca/natr/meb/data/mg/MAP/pdf/map_199-2003_front_600_cln.pdf

ICE FLOW PHASE 1A

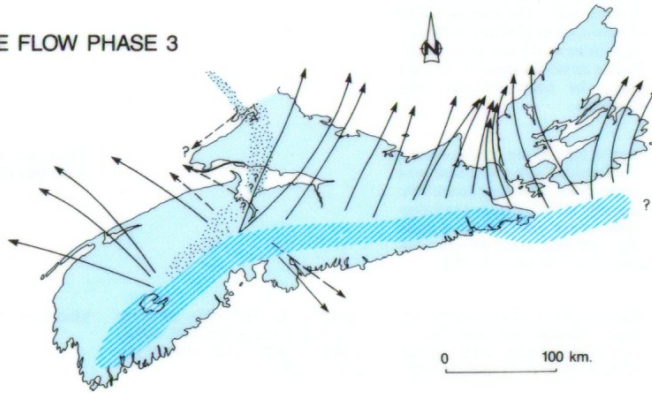


ICE FLOW PHASE 1B

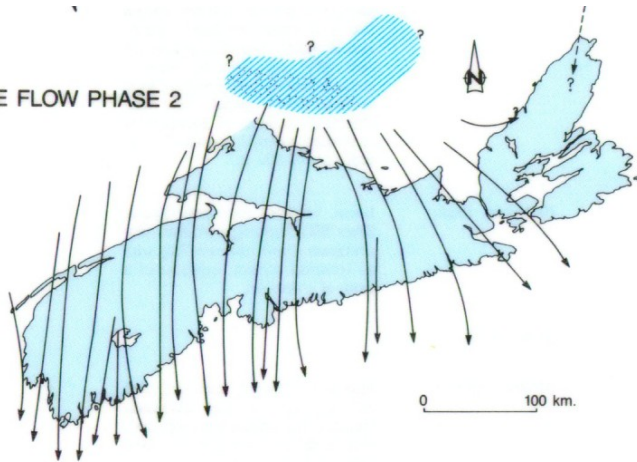


Caledonia phase

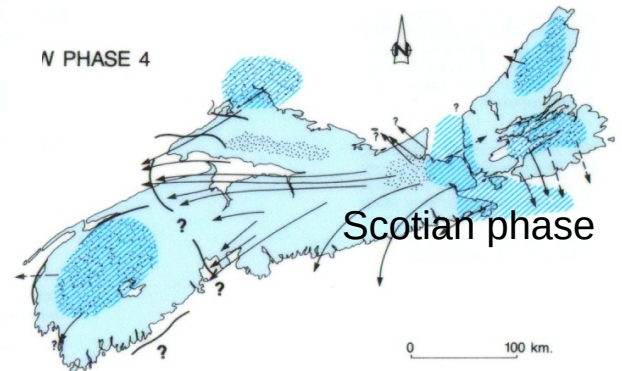
ICE FLOW PHASE 3



ICE FLOW PHASE 2



ICE FLOW PHASE 4

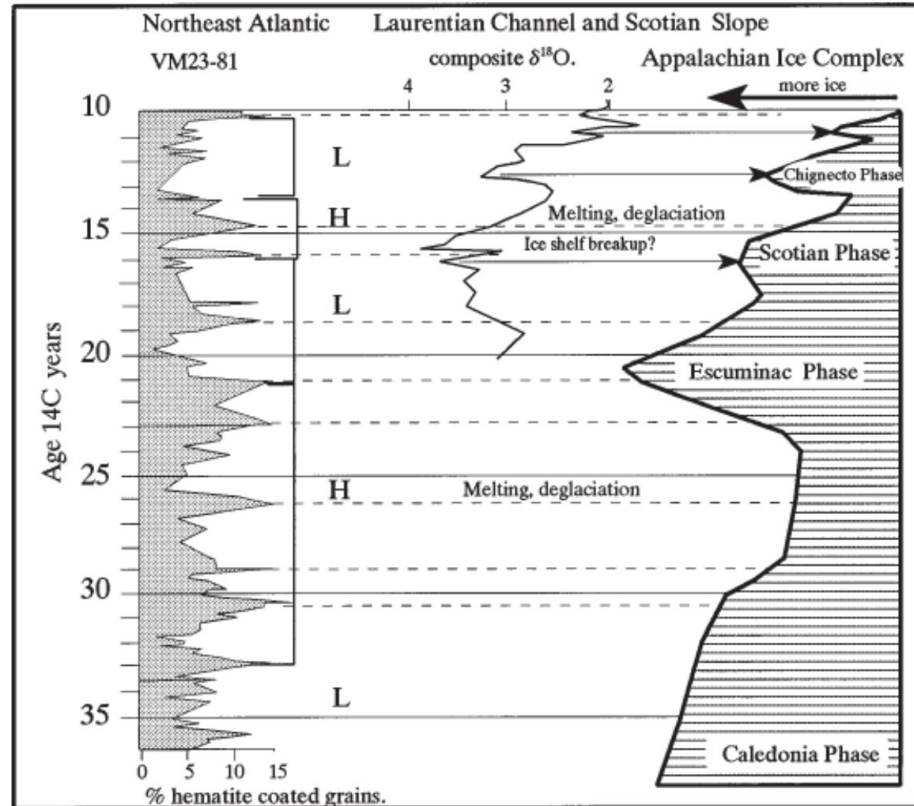


Dark blue: ice centres
Light blue: lower elevations

Scotian phase

Chignecto phase

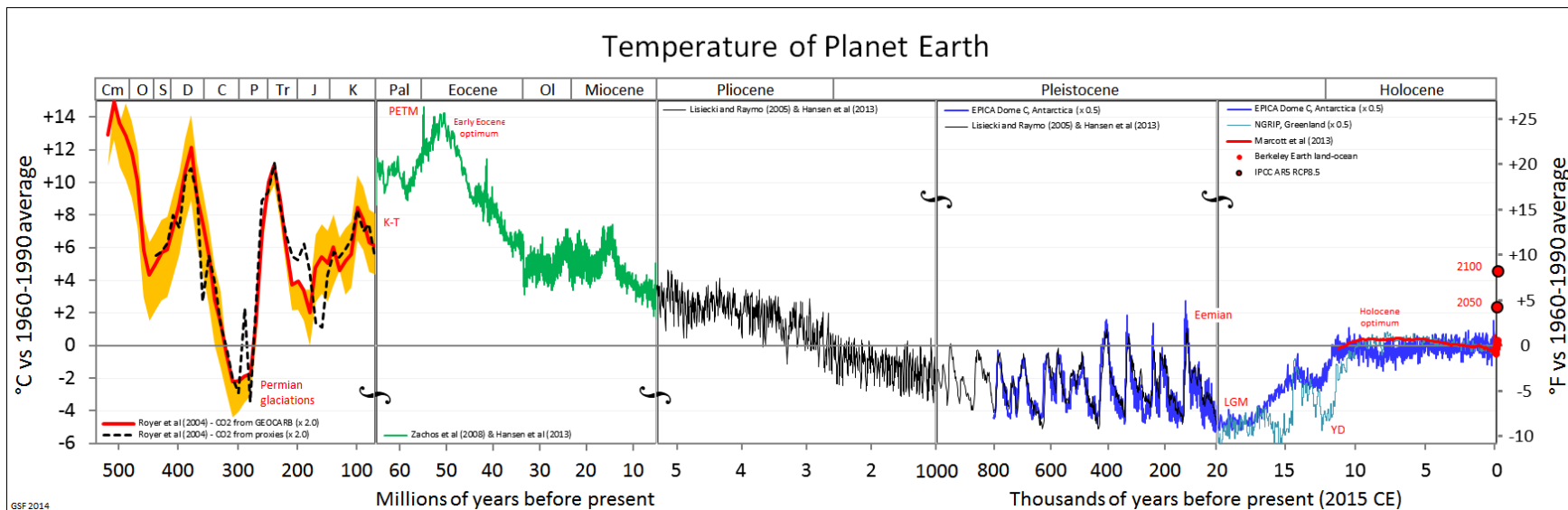
Last Ice Age phases in Nova Scotia
<https://novascotia.ca/natr/meb/fieldtrip/glacier.asp>



Cross-cutting striations with
different orientations & ages
Wittenburg Mountain

[https://novascotia.ca/
natr/meb/fieldtrip/stop9.asp](https://novascotia.ca/natr/meb/fieldtrip/stop9.asp)

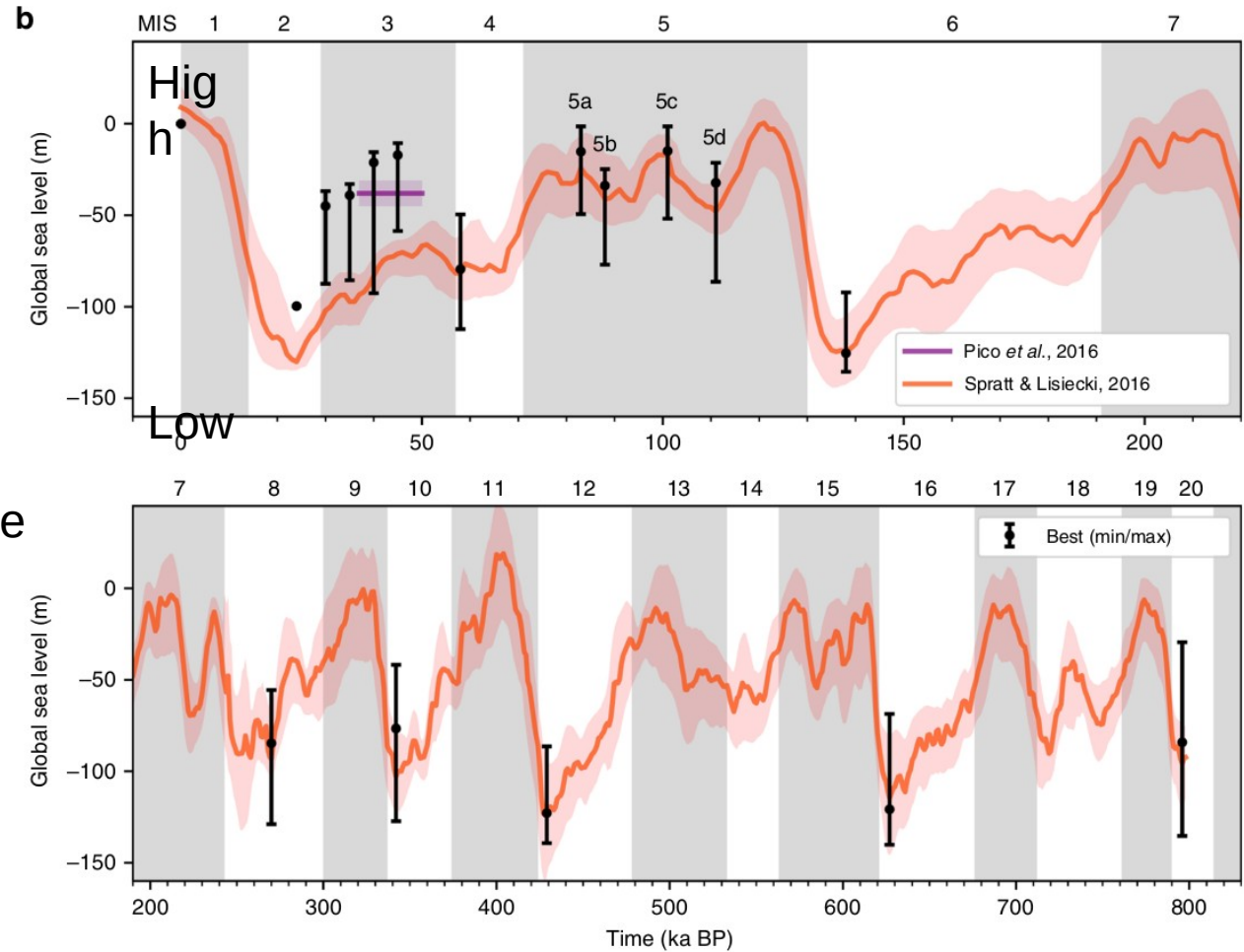




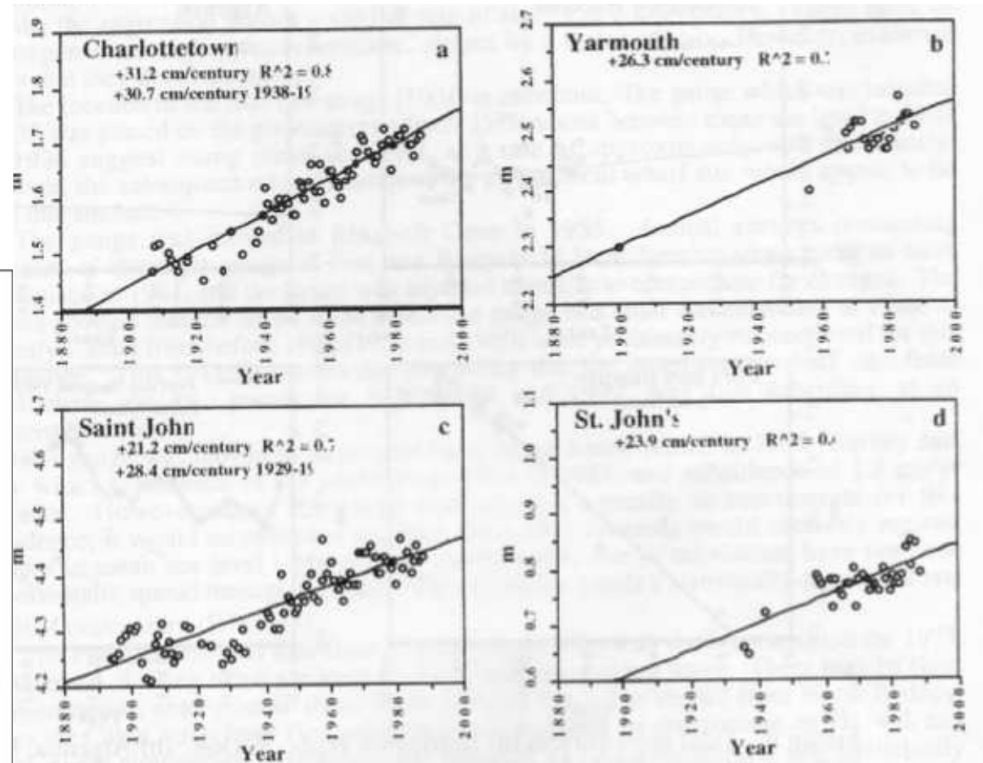
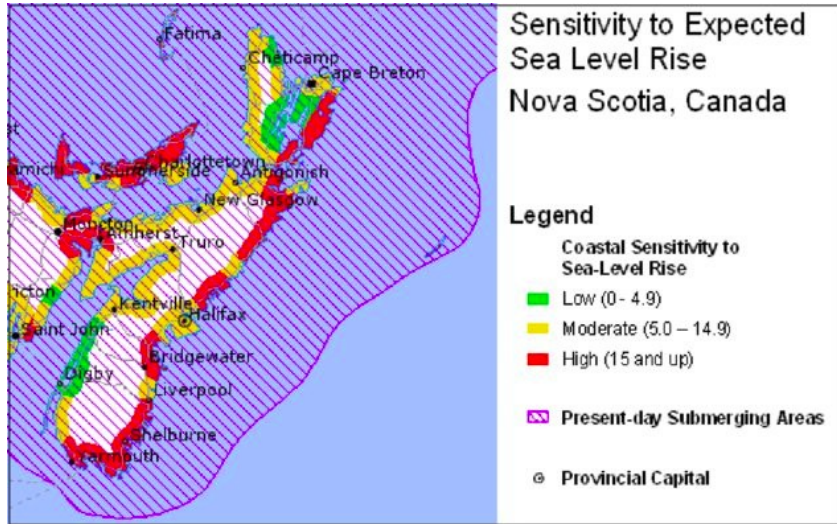
Latest Ice Age lasted from ~3 million years to 10,000 years ago. As a result of global warming, temperatures in 2050 and 2100 are forecast to be similar to those between 7,000 years ago and 200 million years ago do NOT fit natural patterns indicating the influence humans

Sea Level over Time
(ka = thousand years)
Batchelor et al 2019

Sea level varied
between -150 and 0
Metres over the last
800 thousand years,
i.e. over the last Ice Age

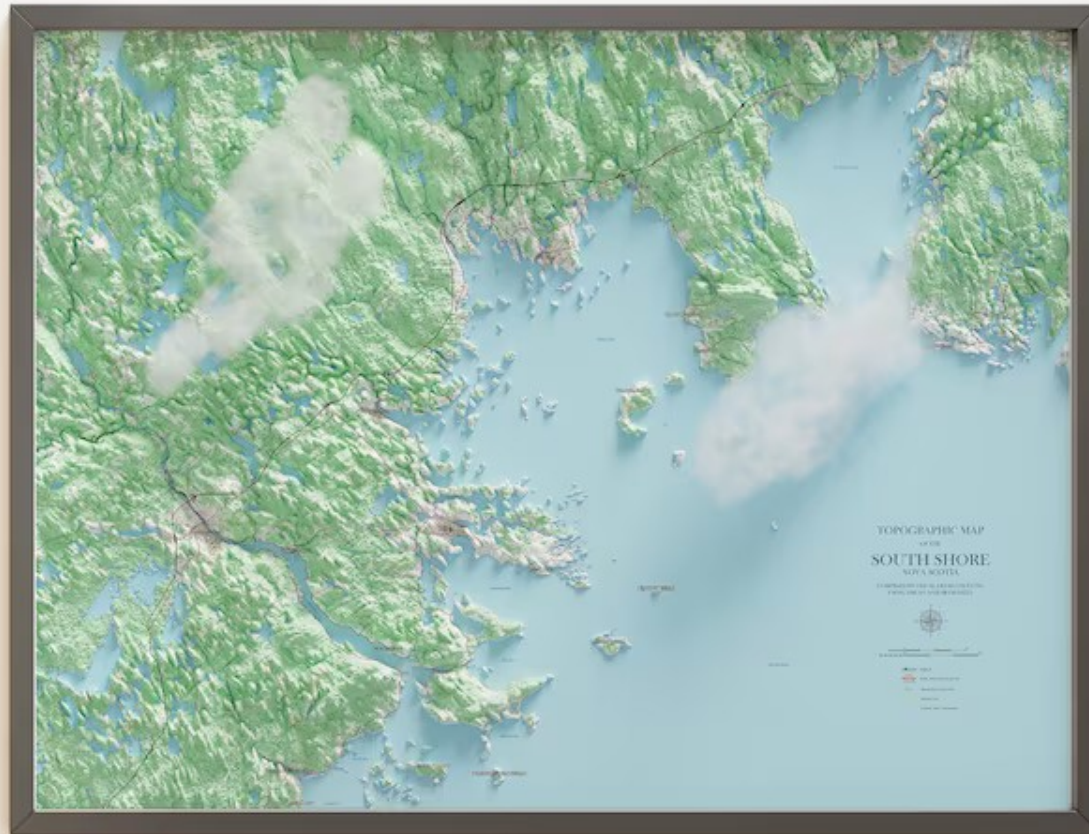


Forecast Sea level rise in NS

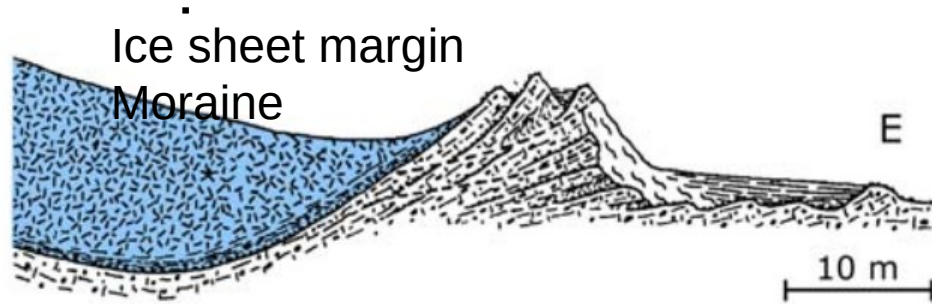


Shaw and Forbes
1990

Drowned landscape of South Shore of Nova Scotia



Terminal moraine formation

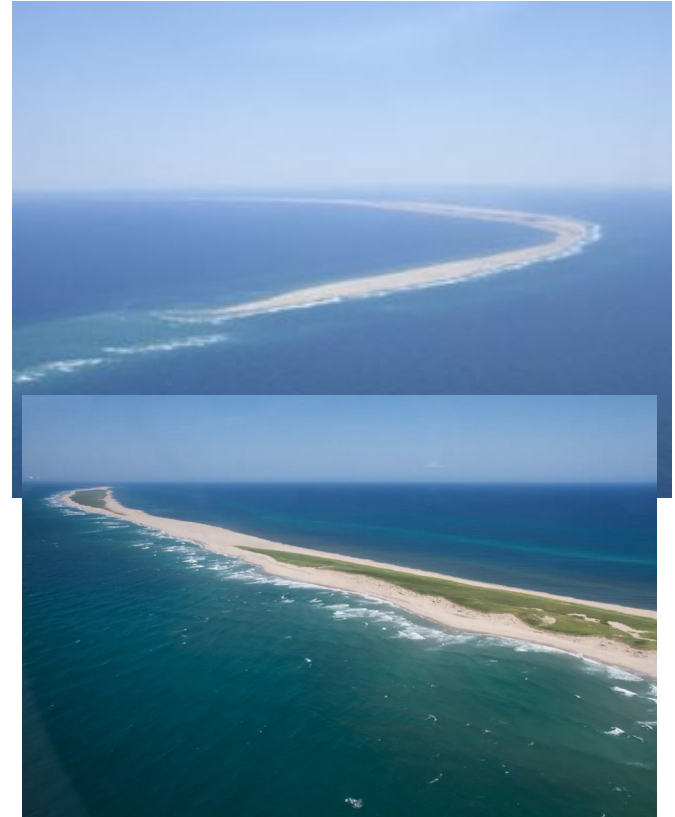


Krüger, 1994. *Geographica Danica* 21, 1–233.

Boulder clay
in drumlin



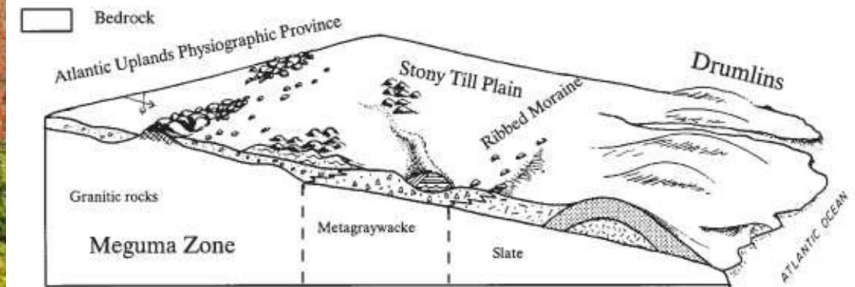
Sable Island



Drumlins at Kejimakujik



NW-SE traverse across SW Nova Scotia

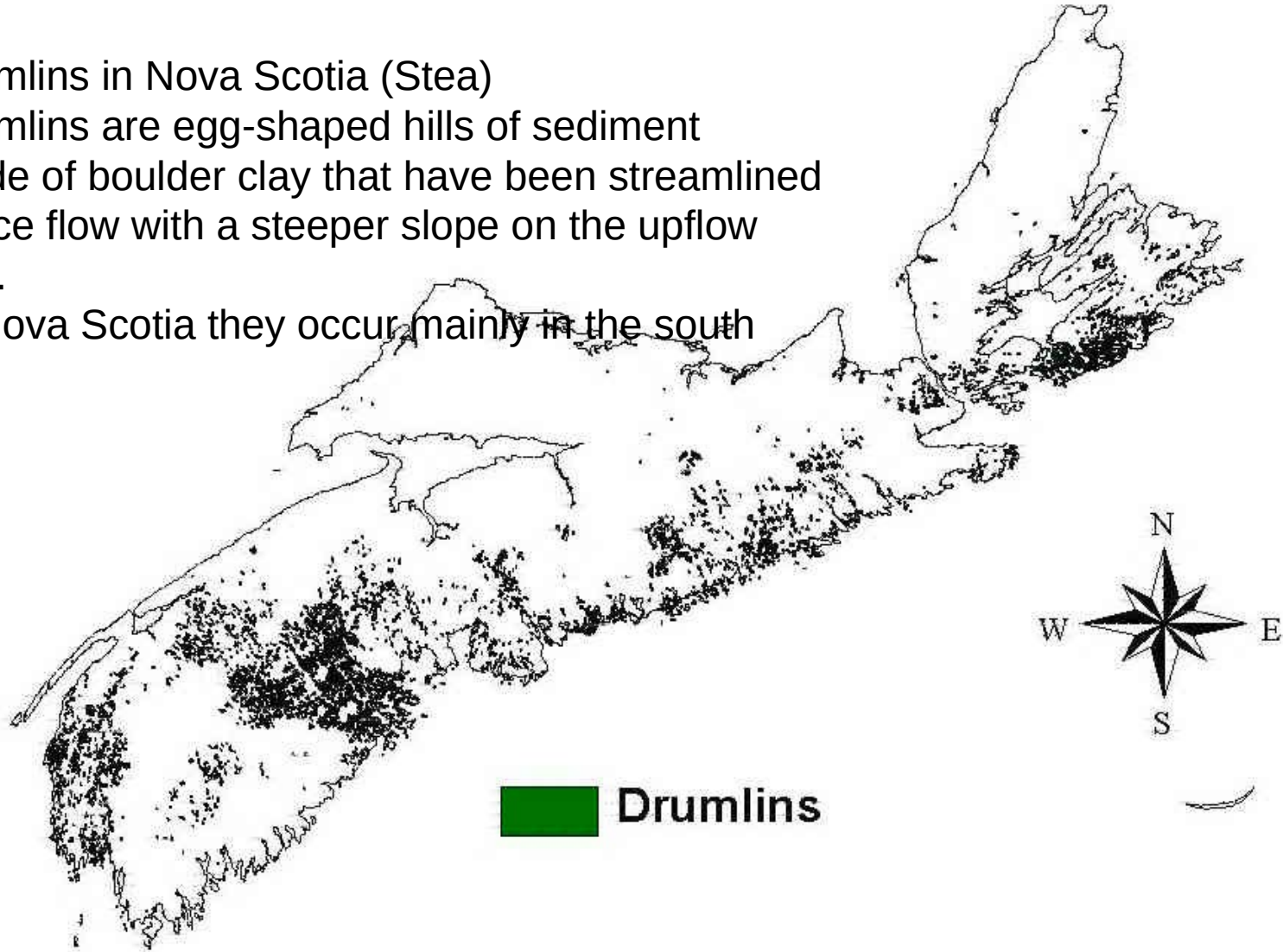


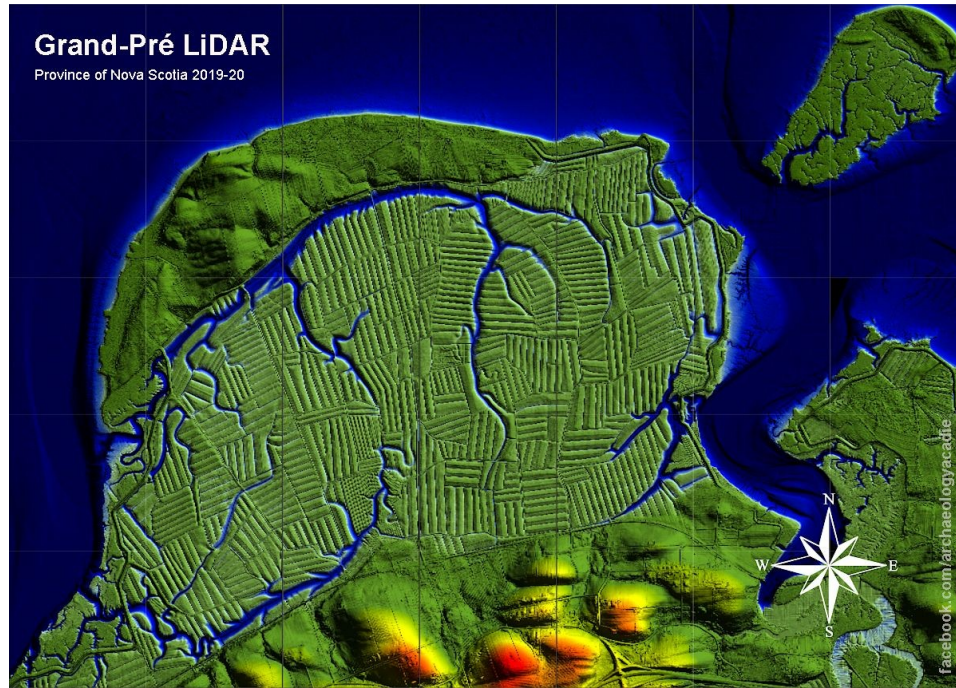
<https://novascotia.ca/natr/meb/fieldtrip/START.ASP>

Drumlins in Nova Scotia (Stea)

Drumlins are egg-shaped hills of sediment made of boulder clay that have been streamlined by ice flow with a steeper slope on the upflow end.

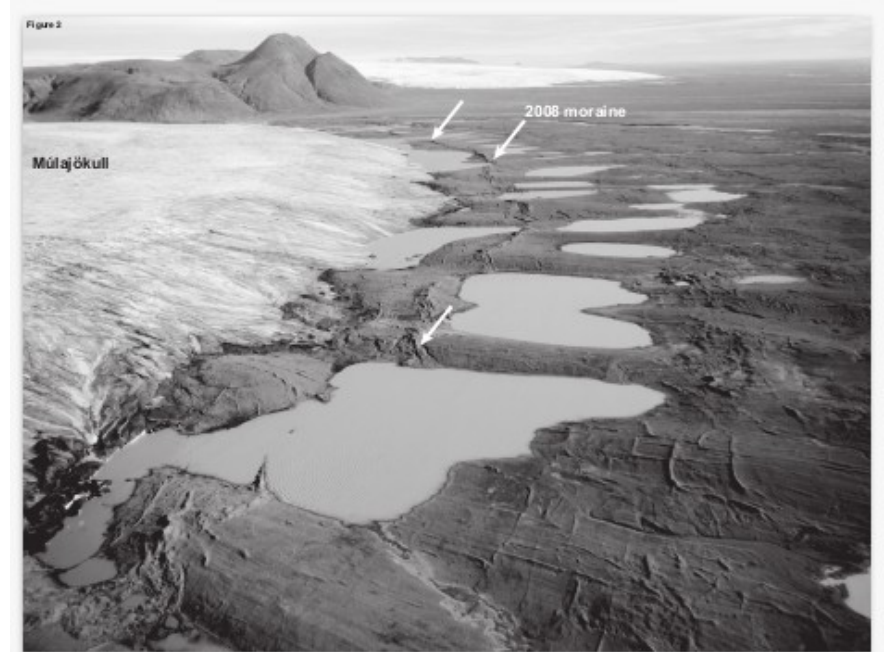
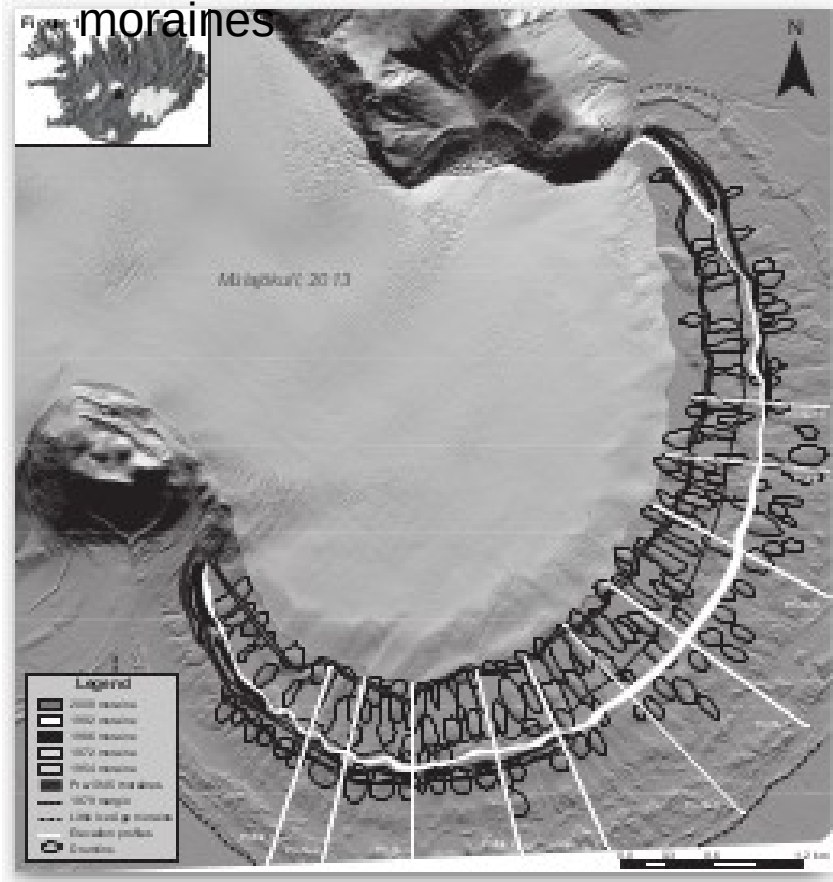
In Nova Scotia they occur mainly in the south





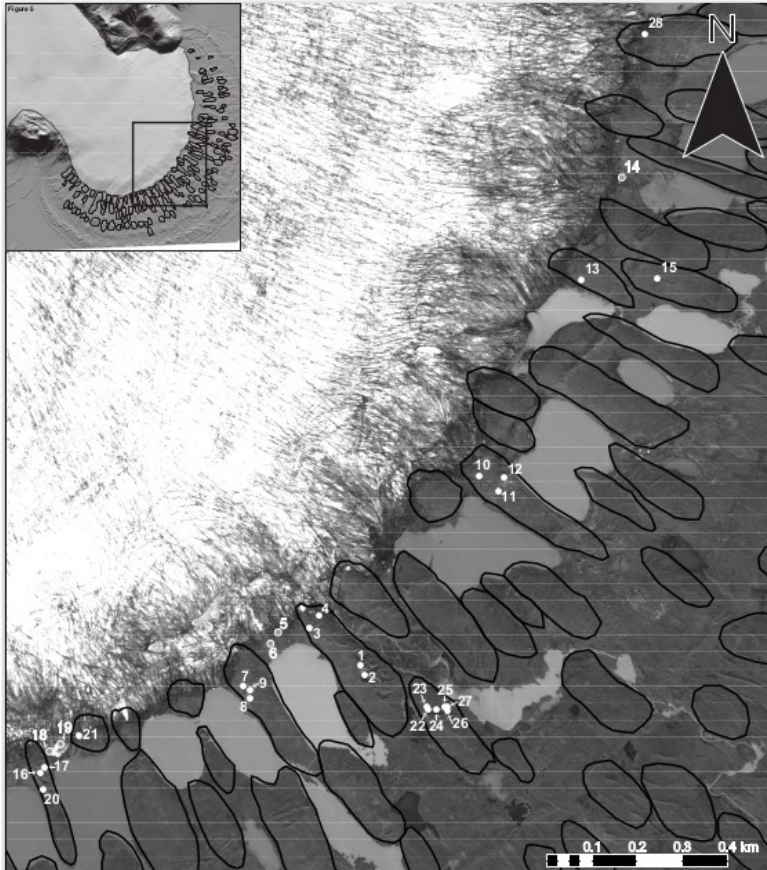
Drumlins in Grand Pre area (southern part of image)
produced during the last phase of the Cenozoic Ice
Age

Iceland: ice margin, fringing drumlins and sequentially regressive moraines



McCracken+2016, Origin of the active drumlin field at Múljökull, Iceland: new insights from till shear and consolidation patterns

<http://www.elsevier.com/open-access/userlicense/1.0/>



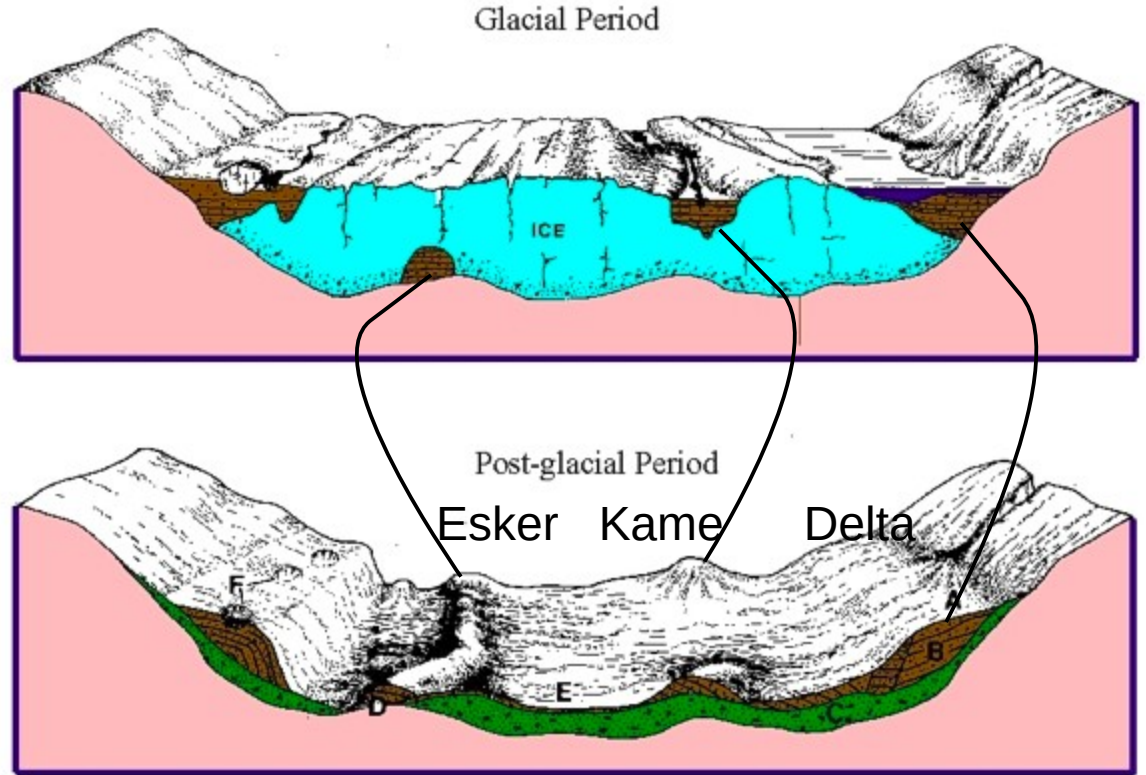
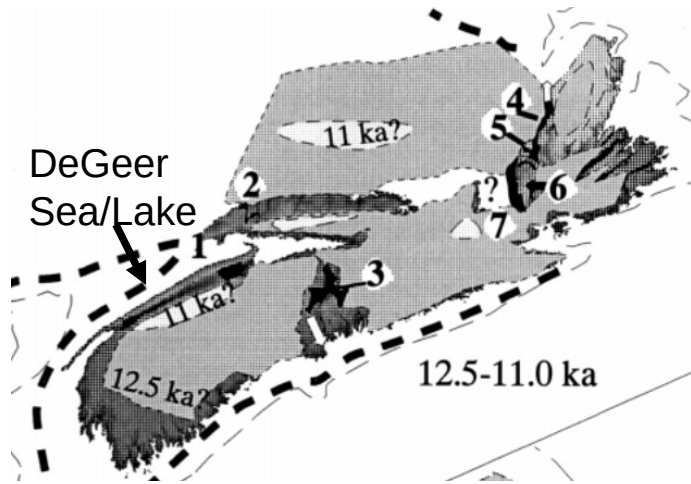
Ice margin and drumlins radiating outwards



Cross-section of a drumlin showing layers in the boulder clay

McCracken+2016

Annapolis Valley (NS) during and after the Cenozoic Ice Age showing origin of eskers, kames and deltas



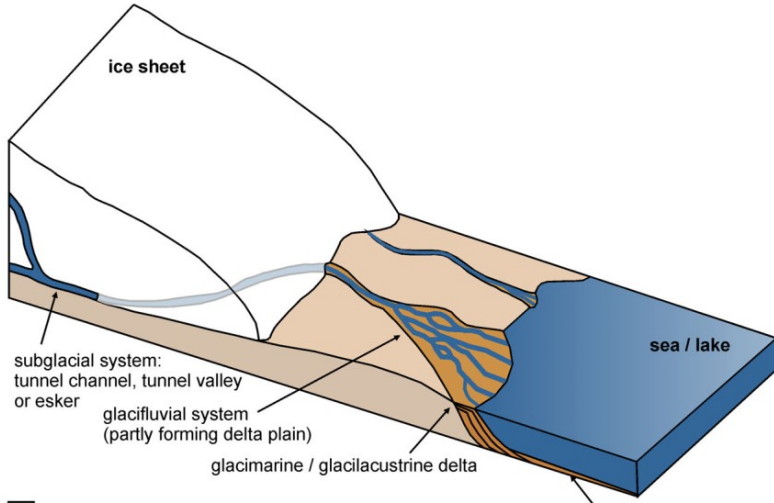
N.B. deltas likely formed at an Ice-Lake margin named the DeGeer Sea/Lake.

Stea & Mott 1998 Géographie physique et Quaternaire, v 52, n° 1,

<https://novascotia.ca/natr/meb/fieldtrip/vista2.asp>

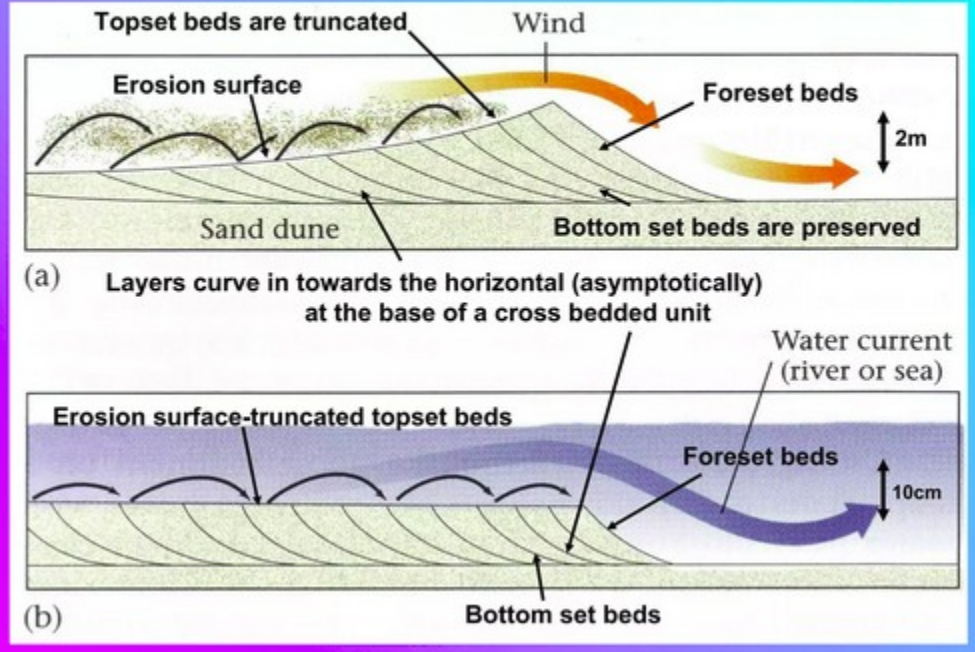
Deltas at ice margin, cross bedding produced by wind and

A Terrestrial ice margin with meltwater discharging into the sea or a lake



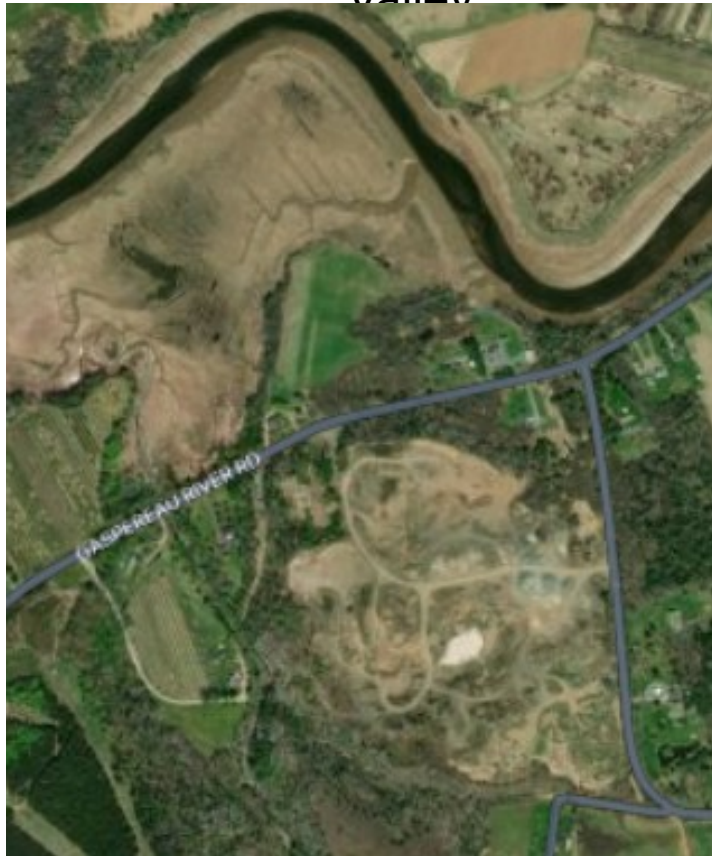
Lang+2020
Sedimentology
doi: 10.1111/sed.12776

The Formation of Cross Bedding



<https://www.slideshare.net/angelabentley/sedimentary-structures-smallas-12734617>

Ice margin delta: Duncanson Brook, Gaspereau Valley



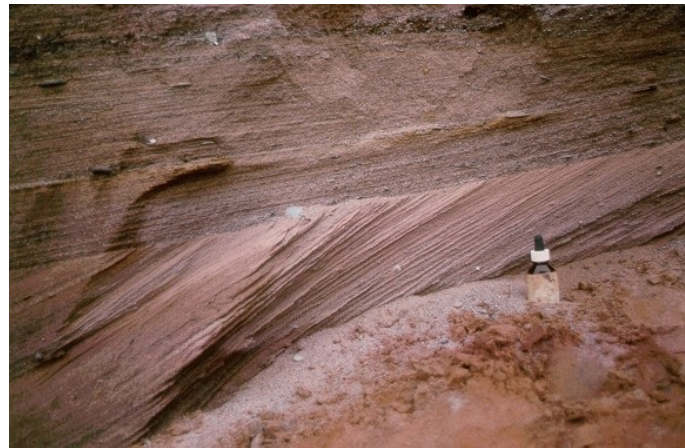
Glacial
features

New Minas
esker



[https://novascotia.ca/natr/meb/
/fieldtrip/vista2.asp](https://novascotia.ca/natr/meb/fieldtrip/vista2.asp)

Esker near
Kejimakujick



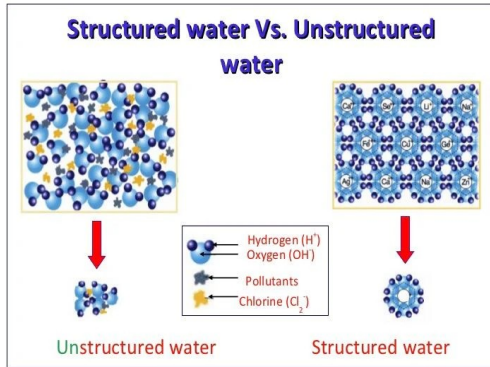
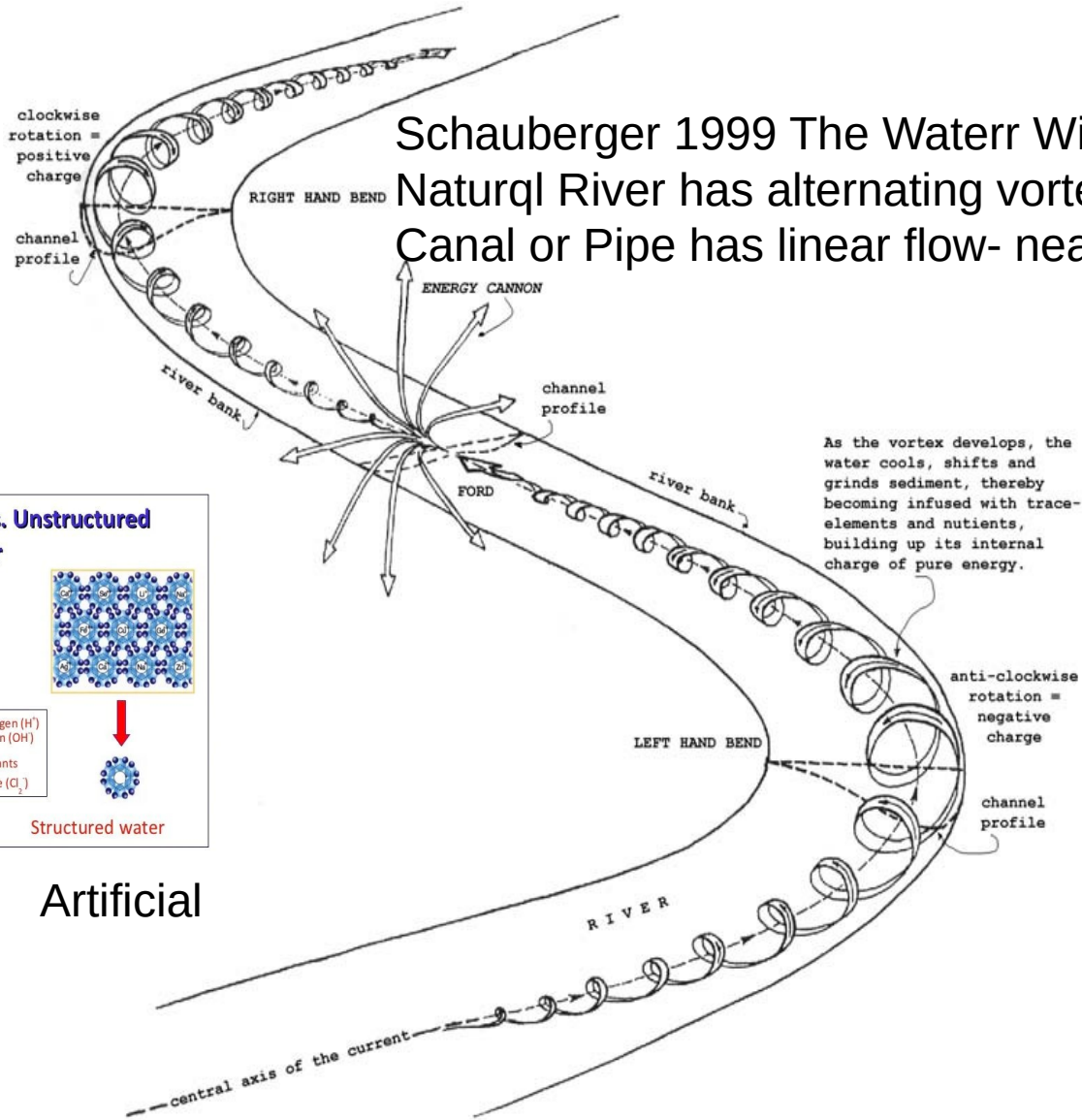
Delta: Minas Basin North
Shore

River History



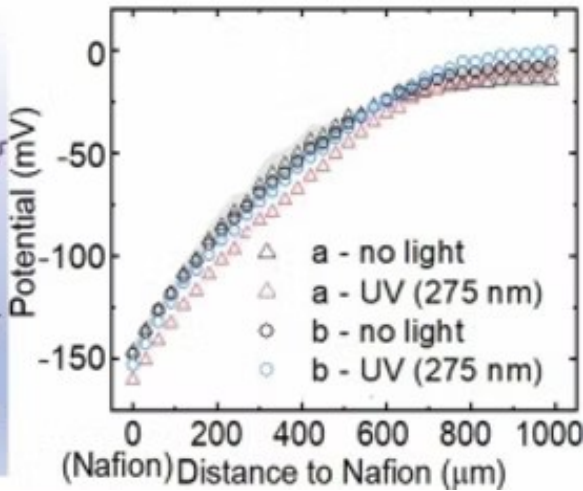
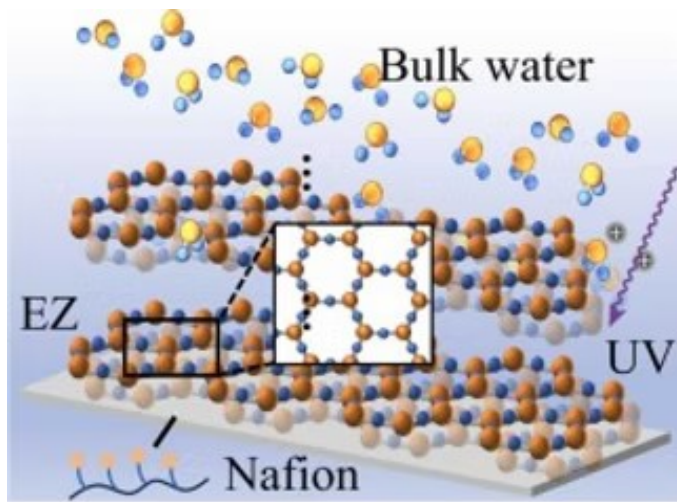
1. S>N rivers draining South Mountain Ice centre
2. W>E rivers: Gaspereau that beheads Deep Hollow River at White Rock
3. Human intervention> Hydro dams and canals on Back and Gaspereau rivers

Schauberger 1999 The Water Wizard
 Natural River has alternating vortex flow: alive
 Canal or Pipe has linear flow- nearly dead



Natural

Artificial



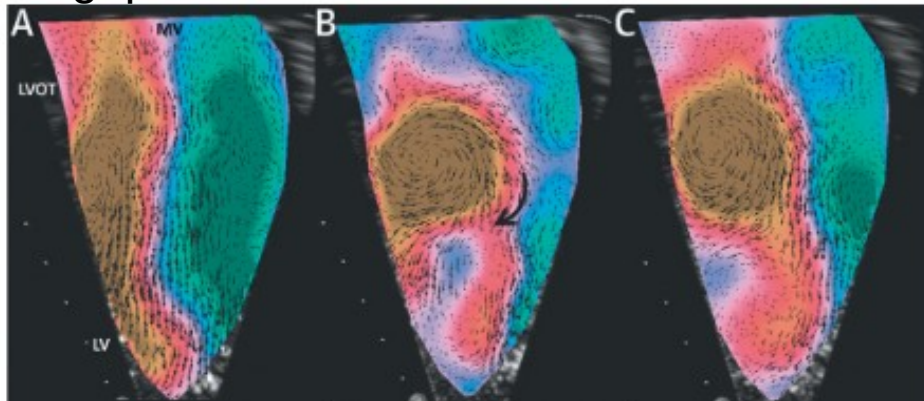
VOTICES
IN
RIVER

EZ water adjacent to Nafion and blood vessel lining enhances flow

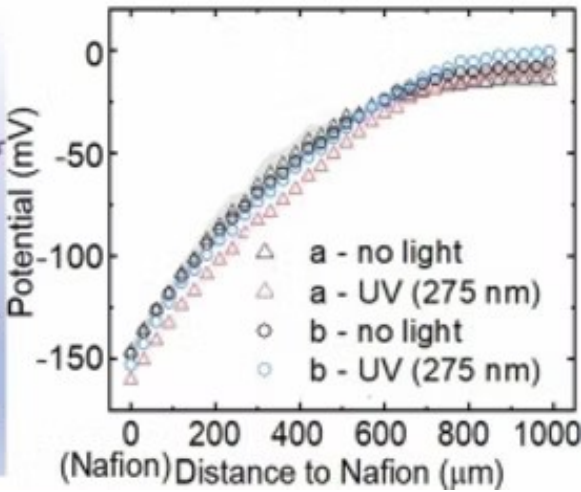
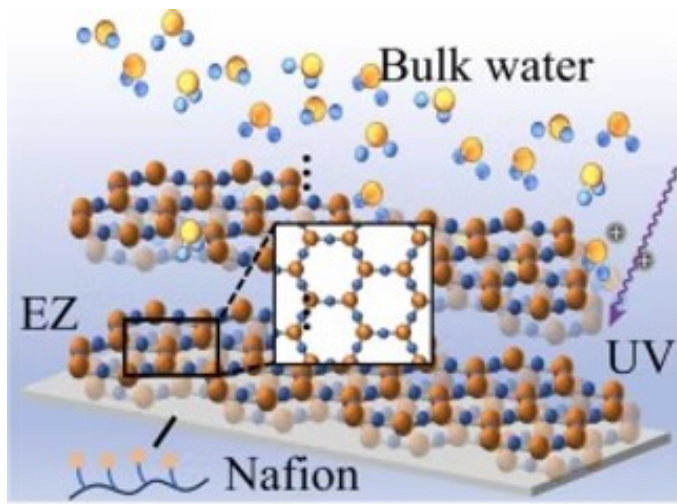
<https://www.pollacklab.org/publications>

Heart Vessels and Transplantation
2/4):113 DOI:[10.24969/hvt.2018.83](https://doi.org/10.24969/hvt.2018.83)

Sengupta et al 2014 PACC Volume 64, /16



VOTEX IN HUMAN HEART



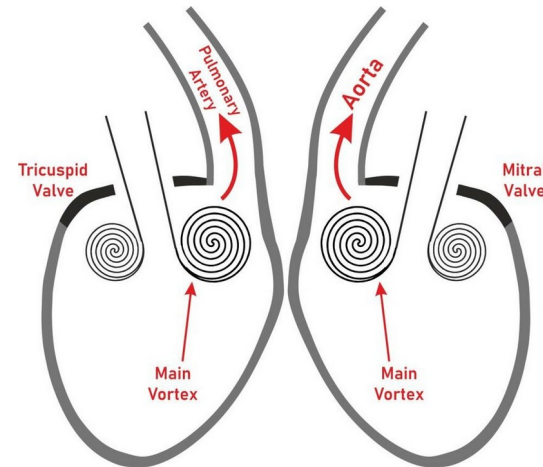
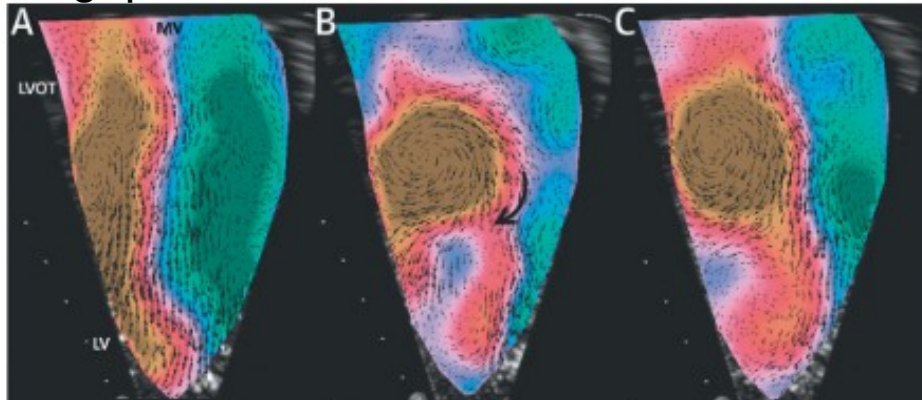
VORTICES IN
RIVER AND
HUMAN HEART

EZ water adjacent to Nafion and blood vessel lining enhances flow

<https://www.pollacklab.org/publications>

[Heart Vessels and Transplantation](#) 2/4

Sengupta et al 2014 PACC Volume 64, /16



Ice age
animals



<https://www.mikmaweydebert.ca/ancestors-live-here/debert/an-ice-age-world/>

Time scale, climate, land and sea in Nova Scotia

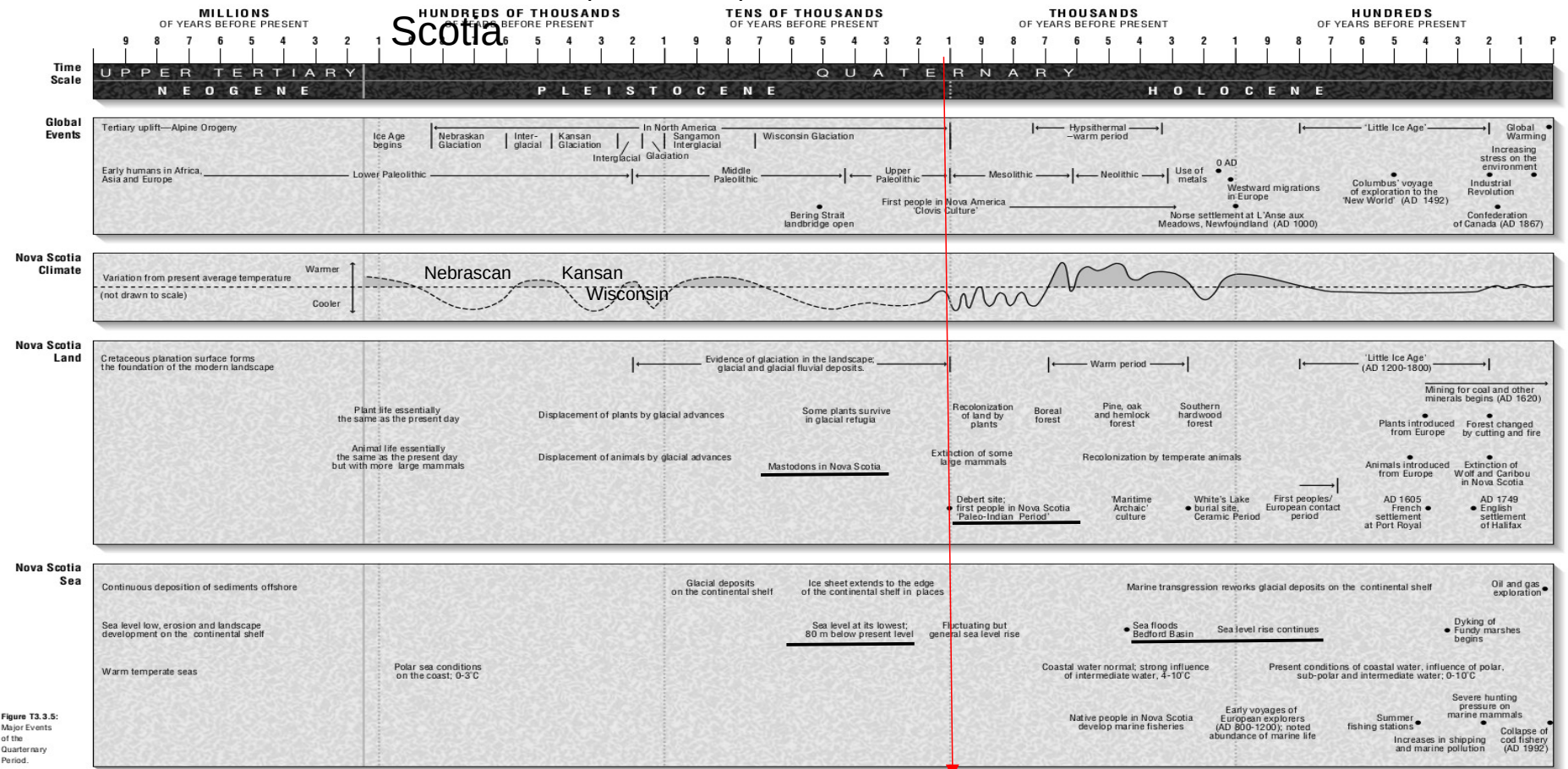


Figure T3.3.5: Major Events of the Quaternary Period.

Earliest humans in NS

Possible causes of glaciations

Milankovich cycles: Insolation (INcoming SOLar radiATION)

Are three main factors:

1. **ECCENTRICITY** that Varies Between an ellipse and a circle – it takes 100,000 years.
2. **TILT** or wobble varies between 24.5° and 22.5° and takes 41,000 years.
3. **PRECESSION** is the gyroscopic rotation of the axis of rotation.

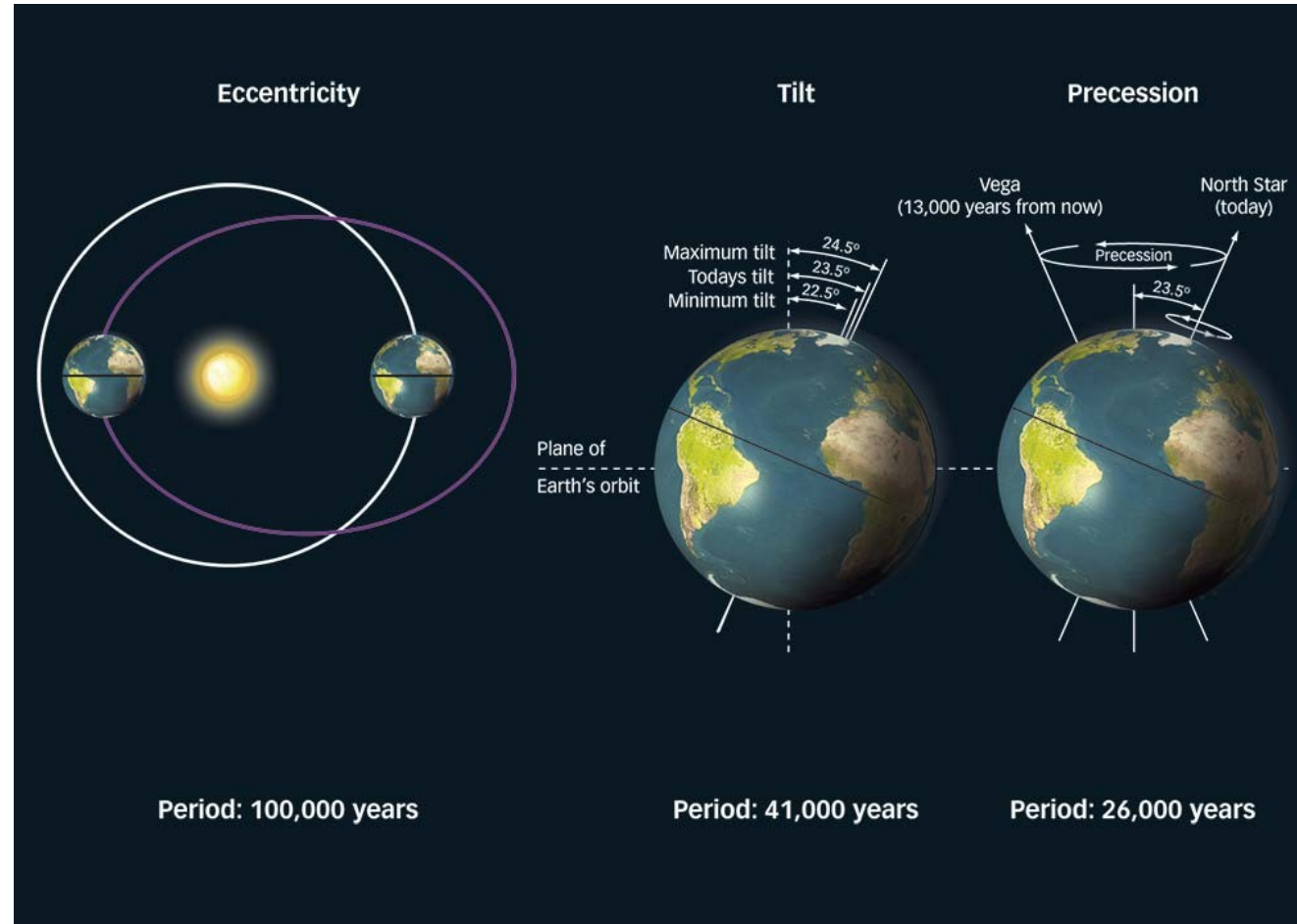
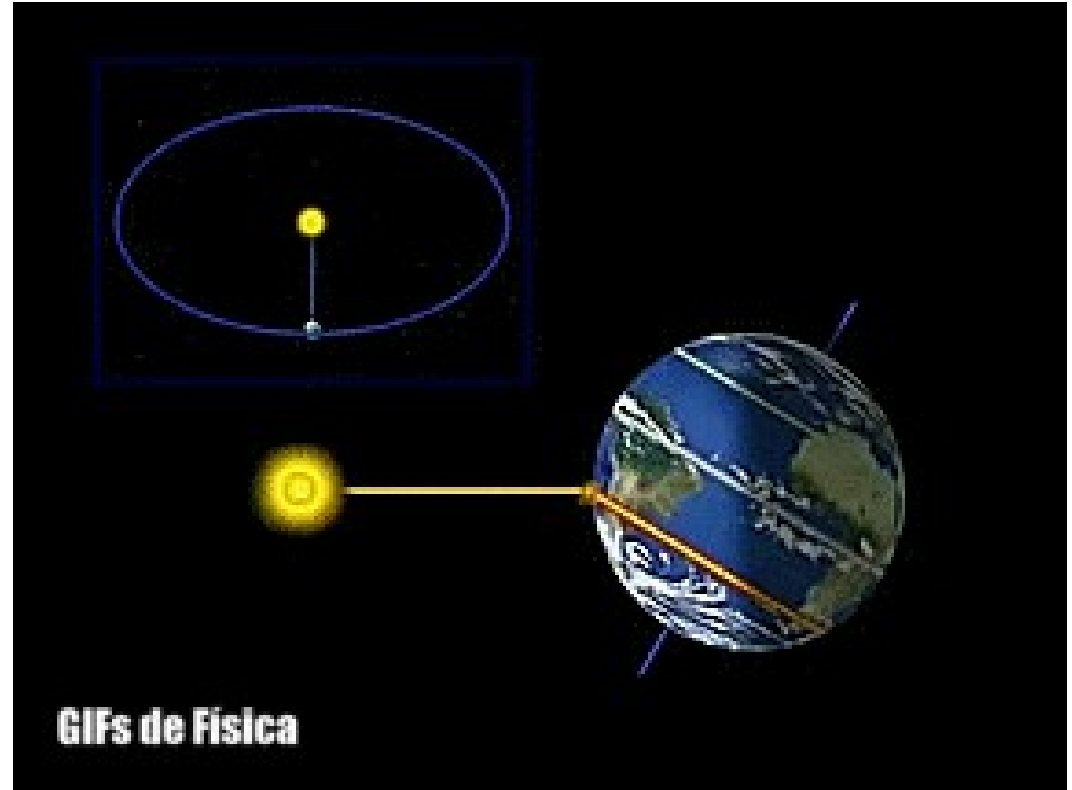
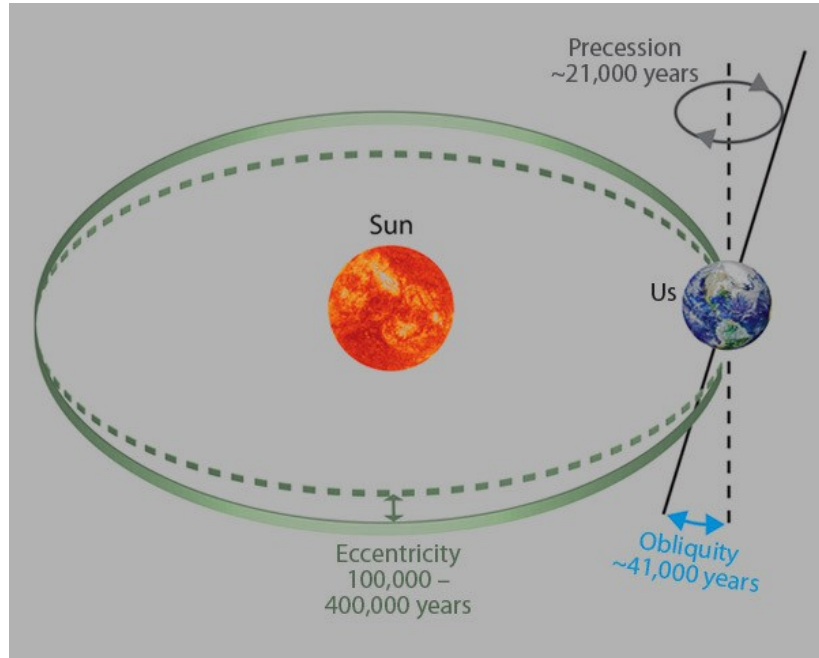
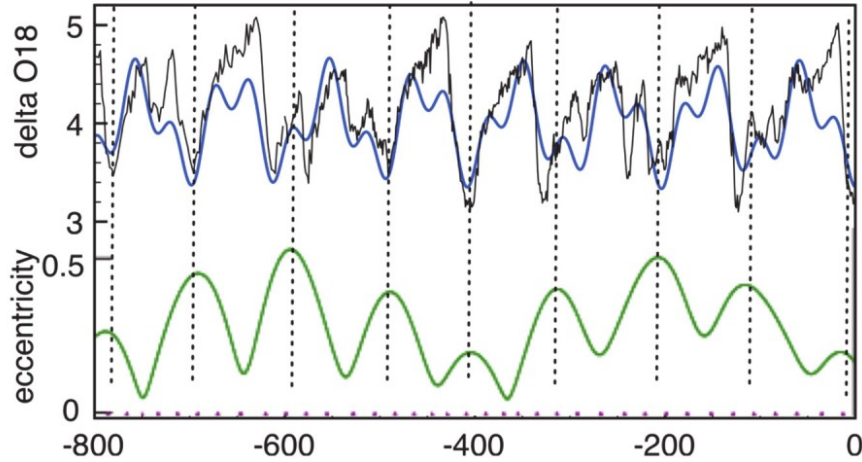


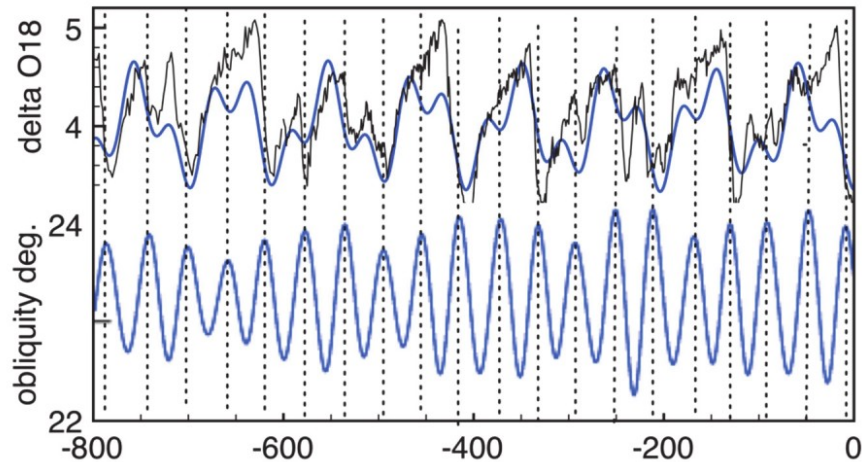
Illustration and video of Precession



a) Correlation of interglacials with orbital eccentricity



b) Correlation of interglacials with obliquity



$\delta\text{O-18}$ in shells changes directly as a result of temperature fluctuations, so it provides a very good record of the climate. Oceanic $\delta\text{O-18}$ values that are high represent cold climates, while lower values indicate a warm climate.

The graphs plot delta O18 versus Time in thousands of years, and show that delta O18 peaks correlate with delta O18 minima for both Eccentricity (100,000 years) and Obliquity (tilt - 42,000 years). There are also small, shorter duration Minima – are these related to 26,000 year Precession cycles?

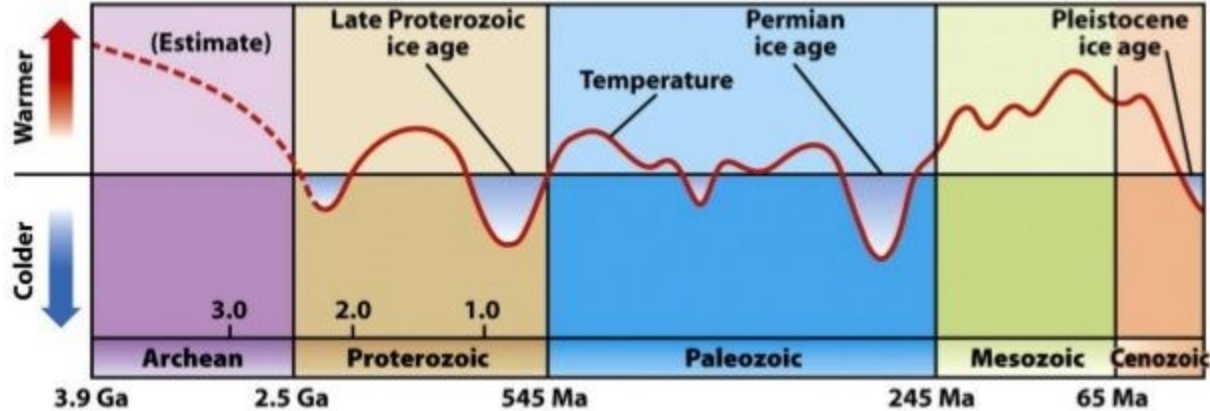
Are these repetitive cycles due to resonance?

Earlier Glaciations

Glaciation recurs across Earth history.

Evidence? Fossil til (tillite), striated bedrock

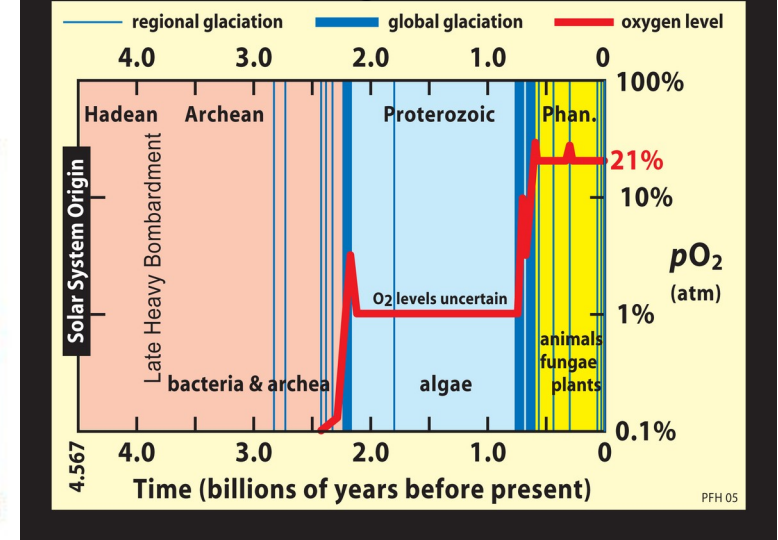
Tillite at equatorial latitudes suggest an ice-covered world:
Snowball Earth



Warmer pre-2.5 Ga Earth precludes Ice Ages
Ma = millions of years, Ga = billions of years
<https://slideplayer.com/slide/4204422/>

Composition of Atmosphere
could

Influence Ice Age occurrences



Graph of Time versus %Oxygen (red) in Atmosphere. Ice ages (blue), Eons, and Life forms P.F. Hoffman116
(SnowballEarth.org; accessed Dec 2017).