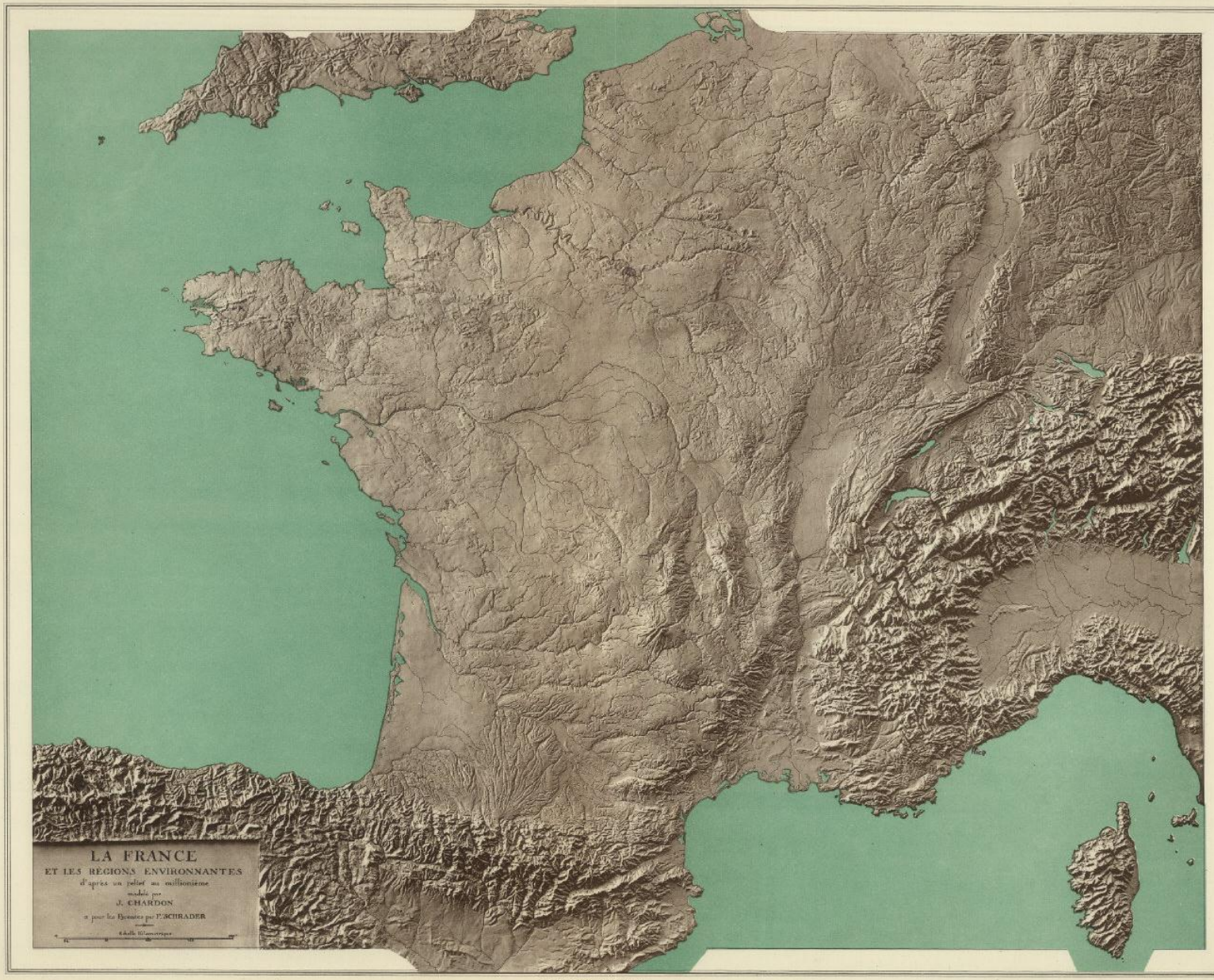
O Permafrost, where art thou?

Fabrice Calmels

Northern Climate ExChange,

Yukon Research Centre

FRANCE EN RELIEF















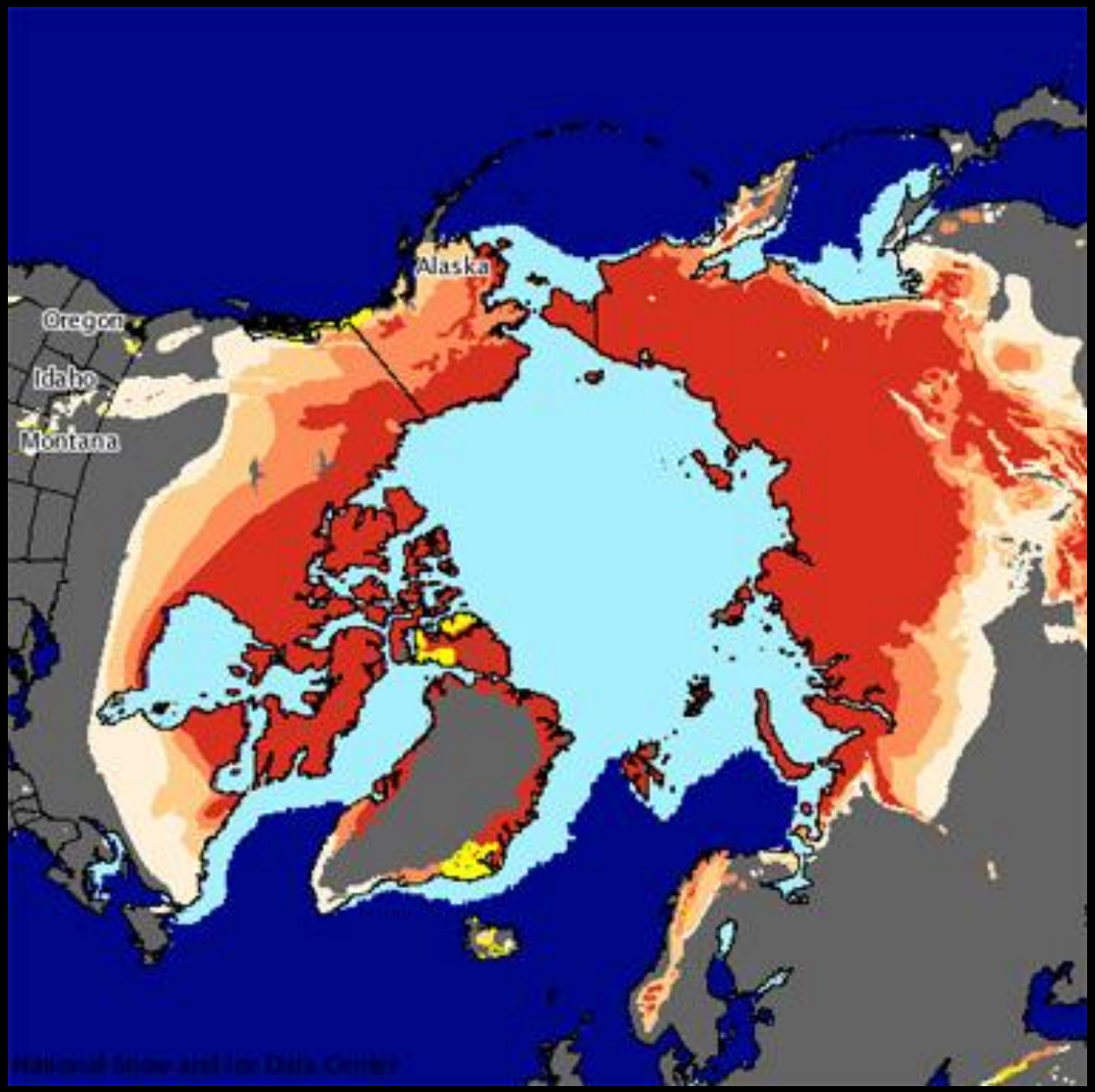



O Permafrost, where art thou?

- What is permafrost?
- How does permafrost shape the landscape?
- Why is permafrost a problem?
- What can we do about it?

What is permafrost?

Permafrost = Ground (soil, rock, ice and organic material) that remains at or below 0°C for at least two consecutive years.

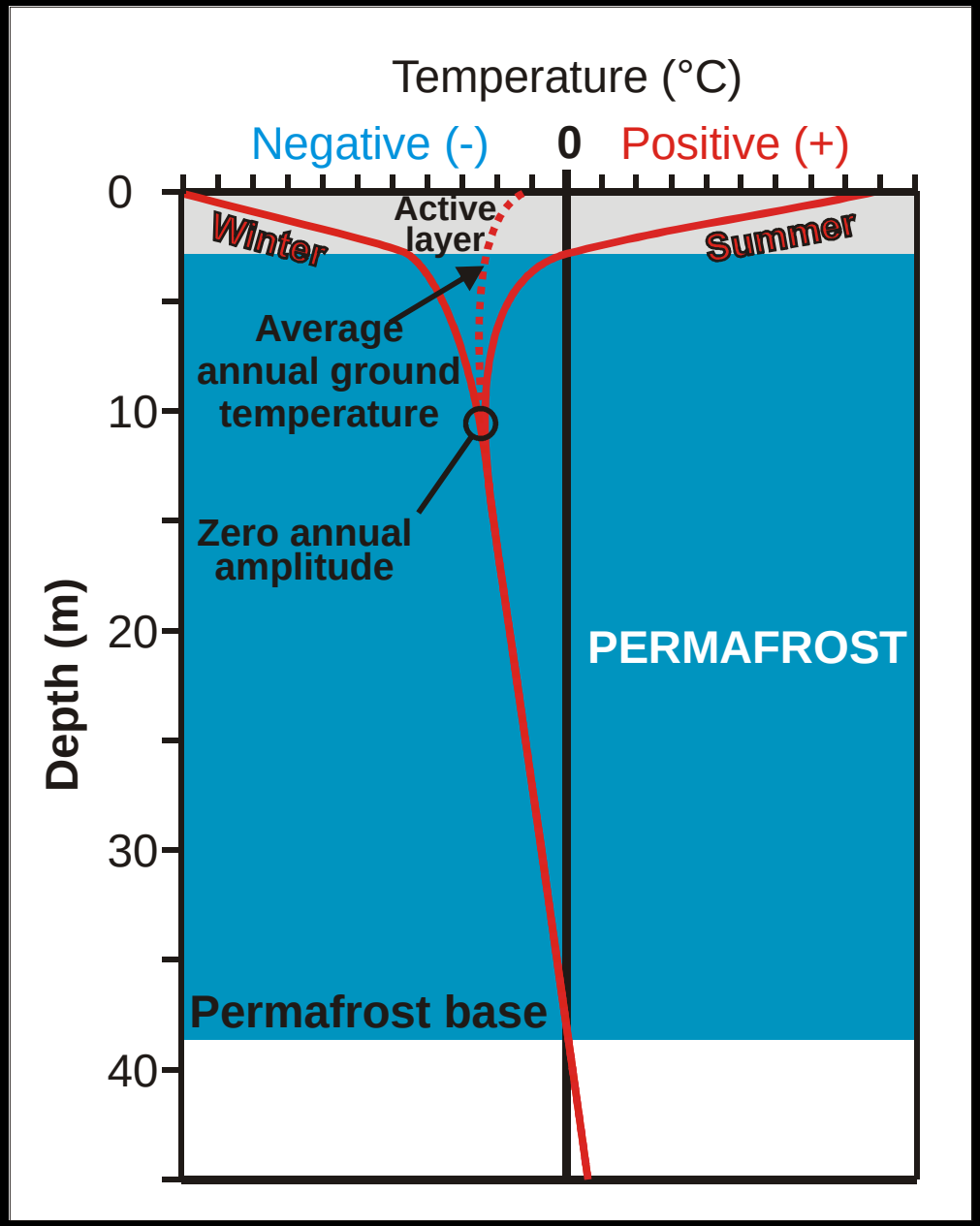


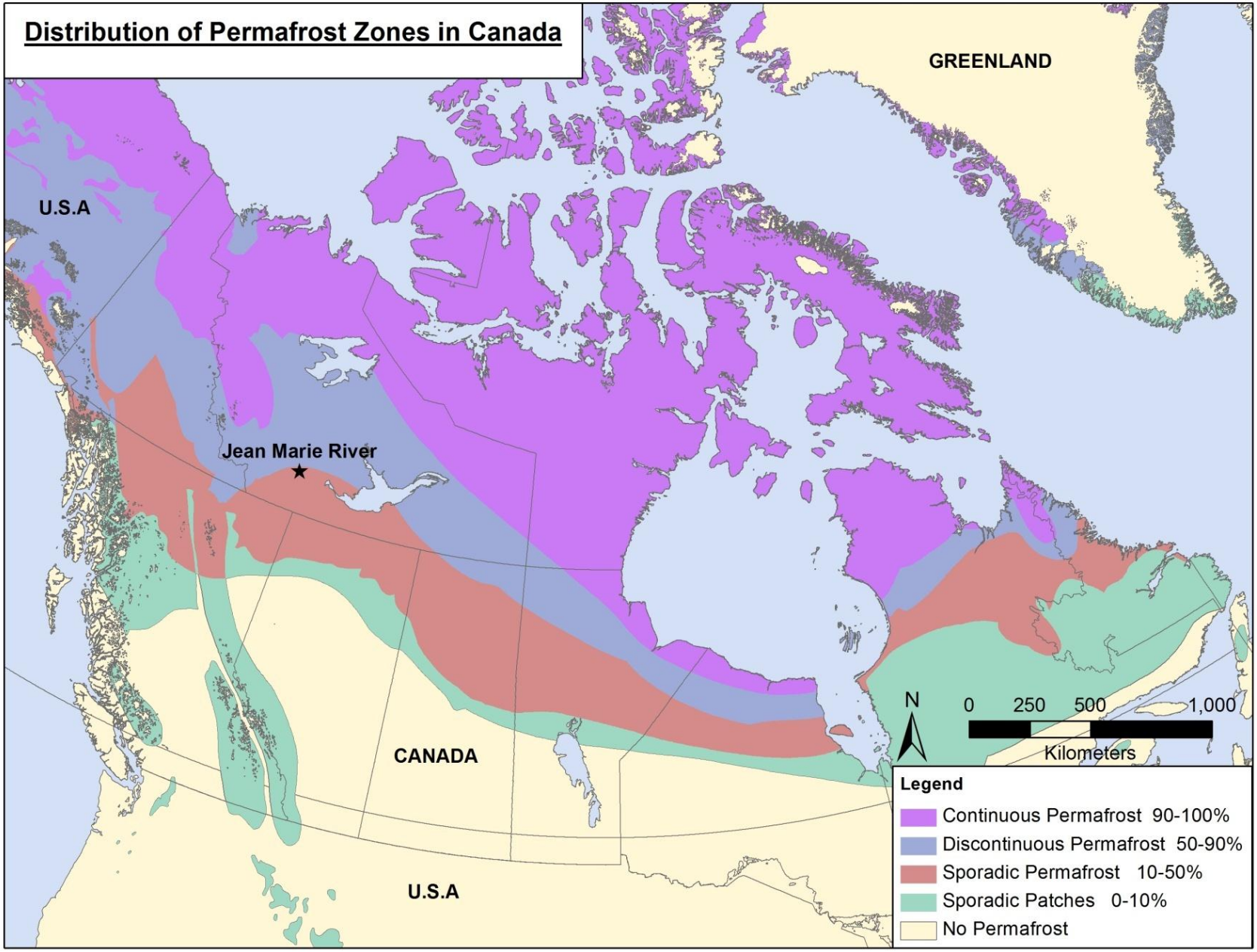
- one half (1/2) of Canada's land,

- one quarter (1/4) of northern hemisphere,

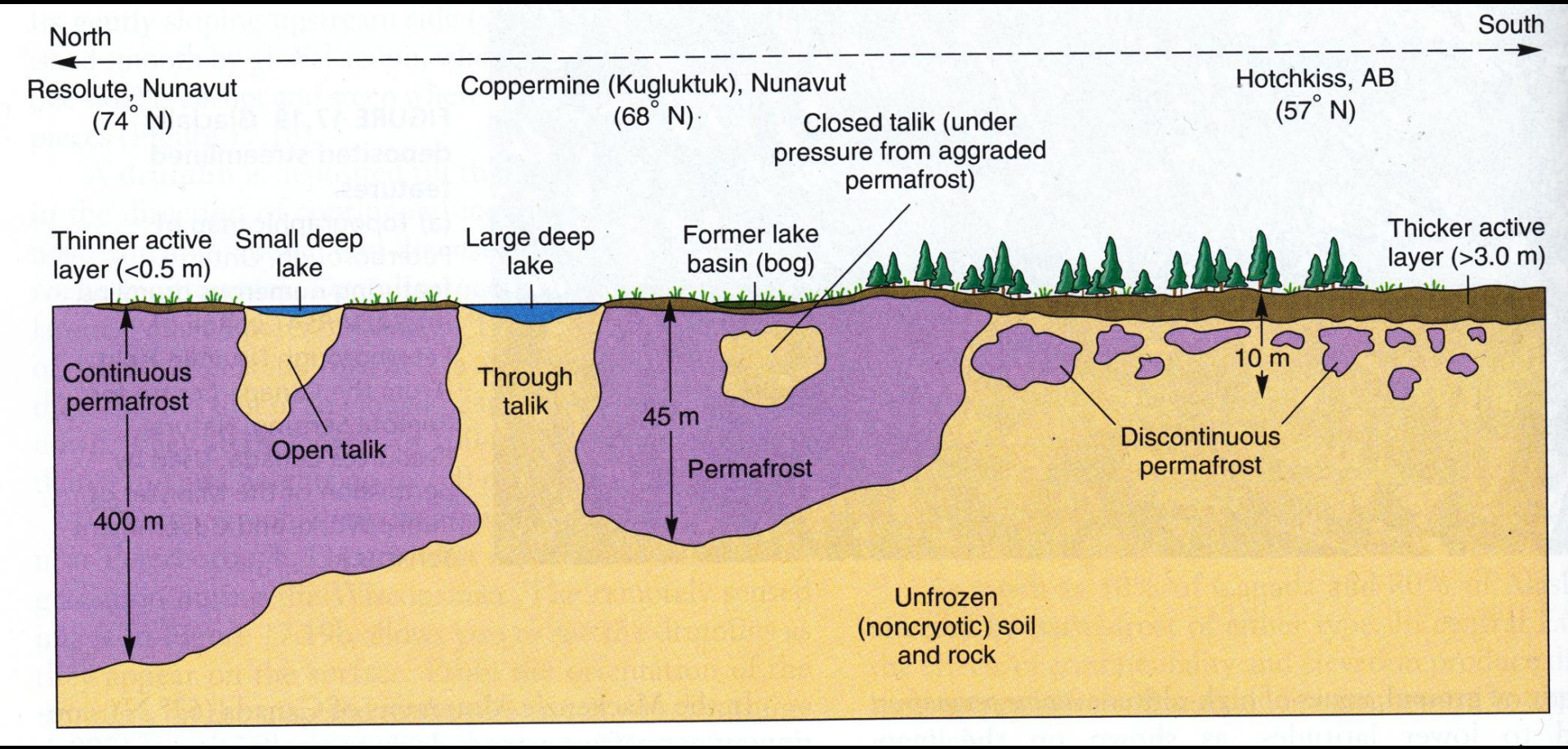
- One fifth (1/5) of the surface of the earth

Ground temperature



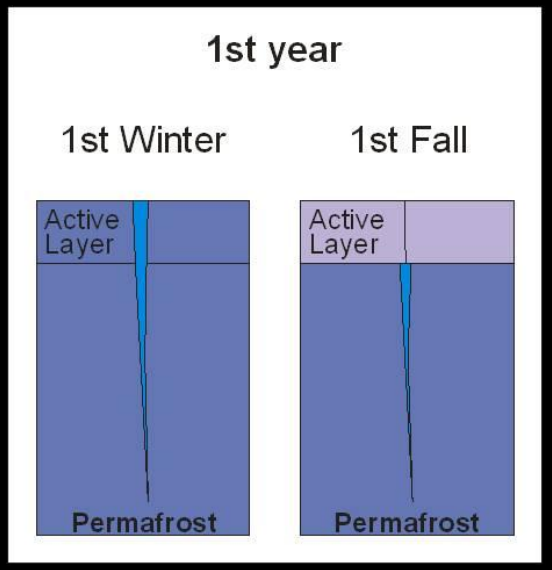

Distribution of Permafrost Zones in Canada
GREENLAND
U.S.A
Jean Marie River
CANADA
U.S.A
N
0 250 500 1,000
Kilometers
Legend
Continuous Permafrost 90-100%
Discontinuous Permafrost 50-90%
Sporadic Permafrost 10-50%
Sporadic Patches 0-10%
No Permafrost

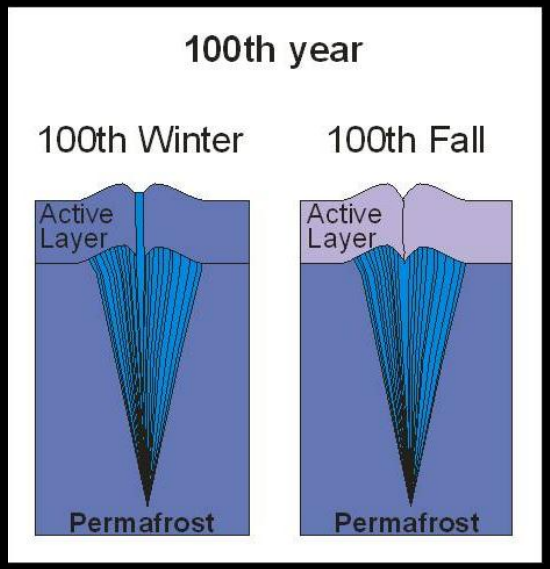
Permafrost zones



How does permafrost shape the landscape?

Ice wedges





How does permafrost impact the landscape?

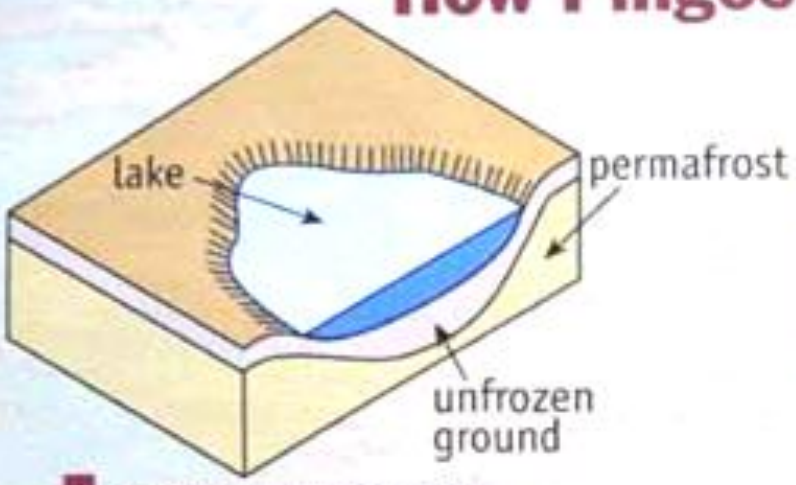
Polygon field

Thermokarst lakes

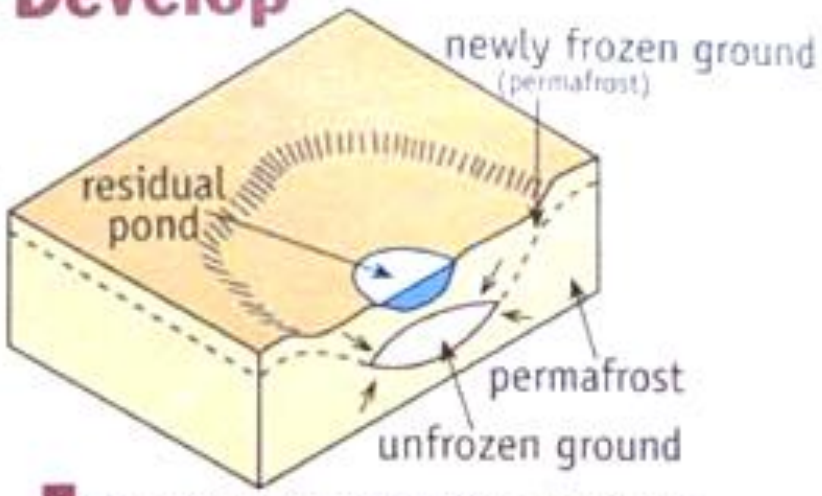
How does permafrost shape the landscape?

Pingo

How Pingos Develop

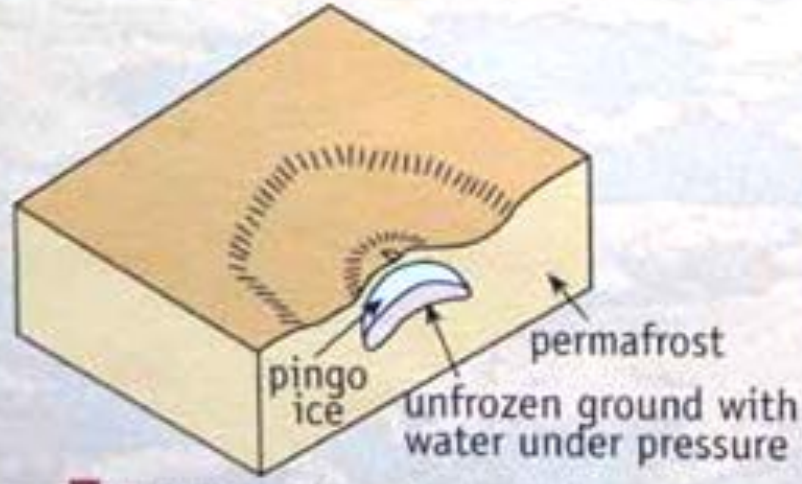


1. There is a layer of unfrozen ground beneath most arctic lakes because they are too deep to freeze to the bottom in winter and the year-round presence of water thaws the surrounding permafrost.

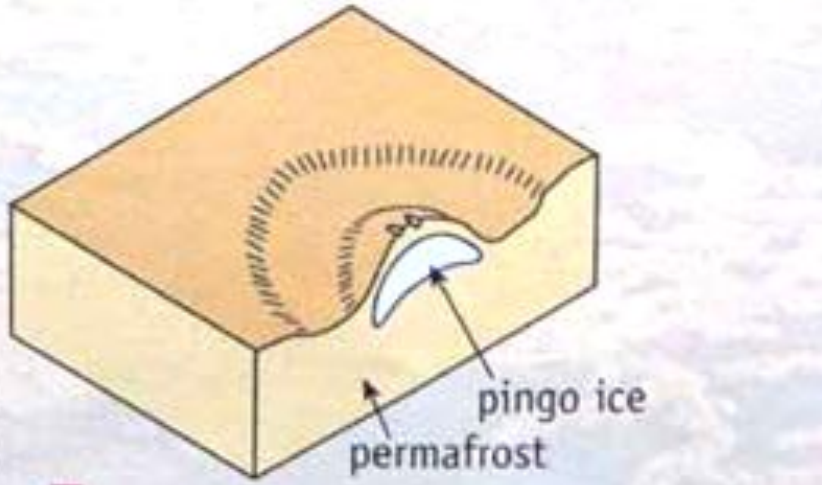


2. When a lake drains, a shallow residual pond is often left behind. The former lake bed begins to freeze, but the pond slows the development of permafrost beneath it.

As the lake bed freezes, the water in the ground turns to ice and expands. The extra water cannot escape, so it is pushed inward toward the centre, ahead of the freezing front (see arrows).



3. The freezing frontadvances inward, placingthe encapsulated "lens"of water under pressure. The thin layer ofpermafrost above the lensis pushed upward, andthe pingo begins to grow.



4. The pingo is fully formed (stops growing) when it is frozen solid–the unfrozen ground becomes permafrost and the pingo has a core of almost pure ice.

How does permafrost shape the landscape?

Frost heave mounds

And there is ice…

Segregated ice

Wedge Ice

Buried ice

Injection ice

Why is permafrost an issue for northern communities and infrastructure?

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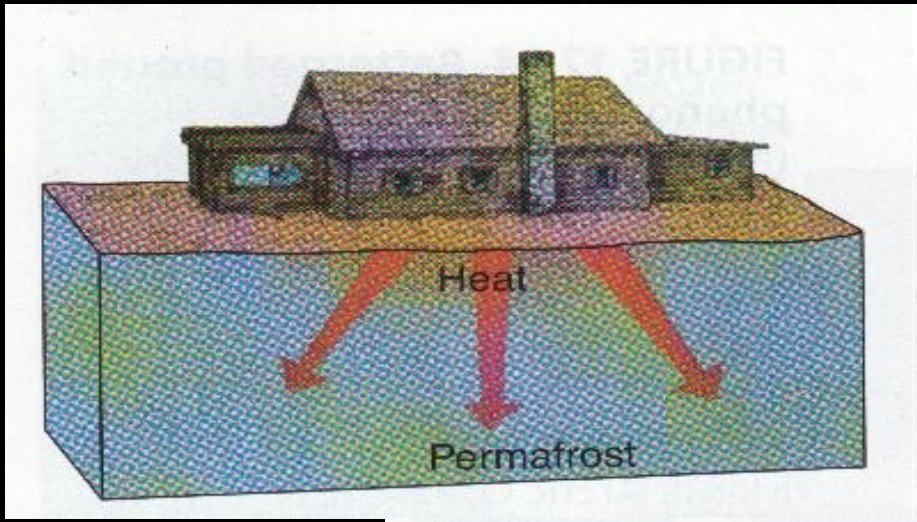
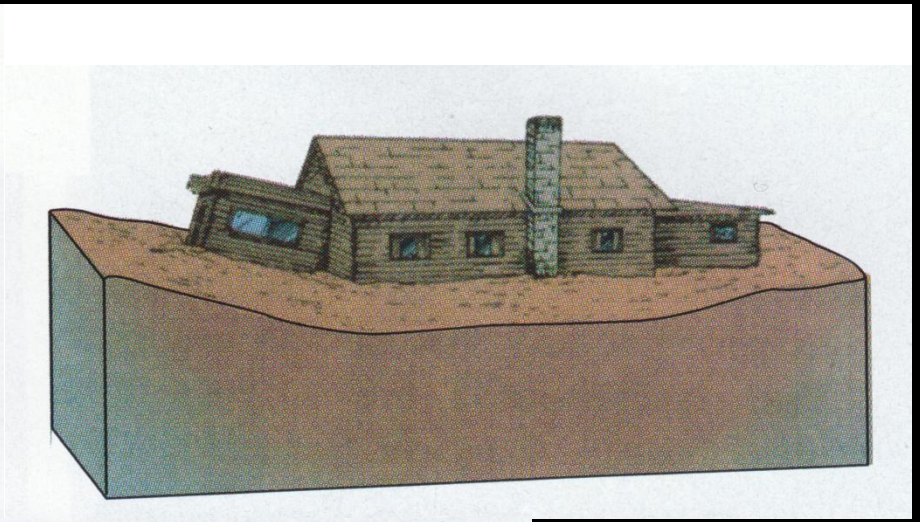


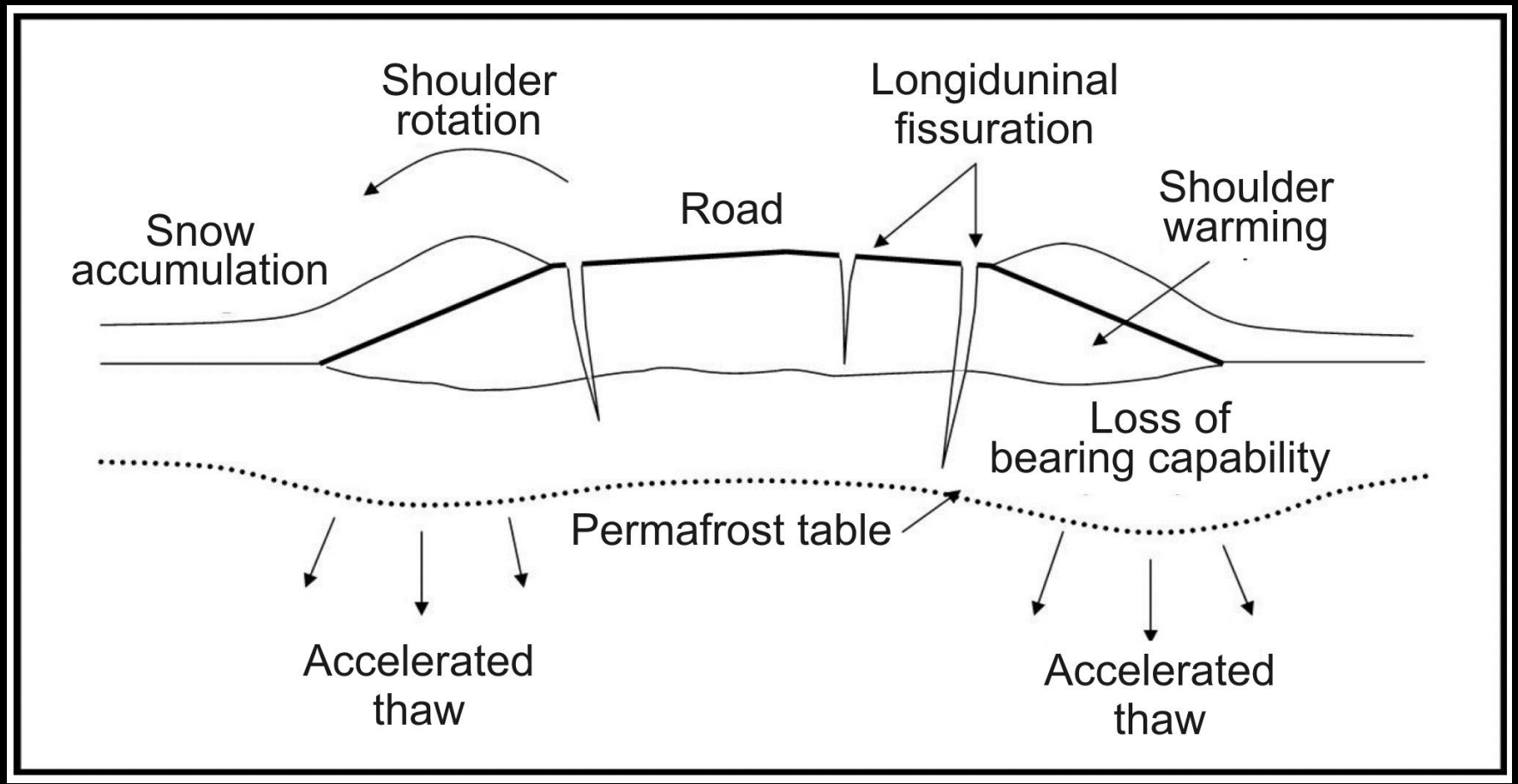


Why is permafrost an issue for northern communities and infrastructure?

Roads

Why is permafrost an issue for northern communities and infrastructure?

Snow and water



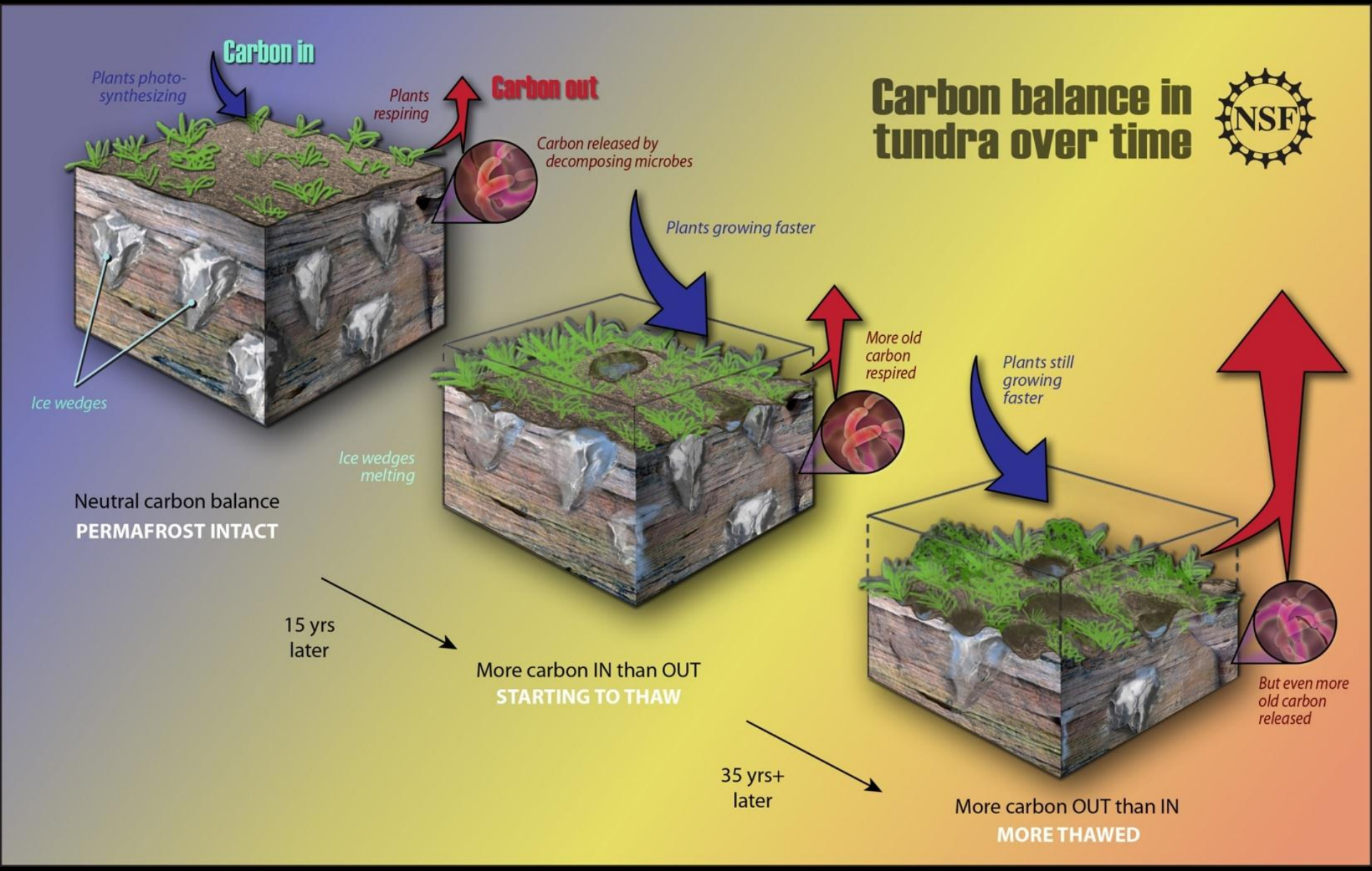
Overall, impact on society and economy

Impact on society and economy

Examples of remediation techniques

Examples of remediation techniques?

Permafrost and Climate changes



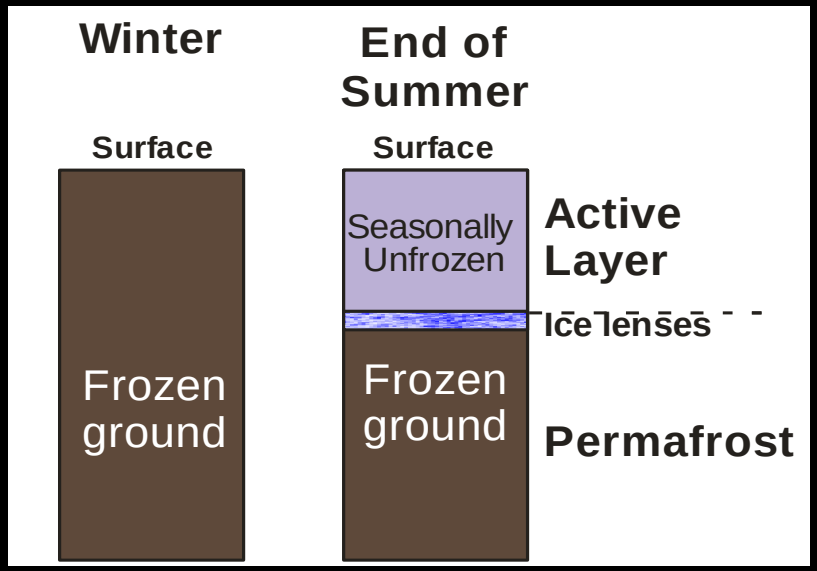
Permafrost and Climate changes

Eventually…

Mapping permafrost distribution and characteristics:

Forecasting the impact of climate change and developing a strategy of adaption.

Where is Permafrost? - active layer survey



Digging

Probing

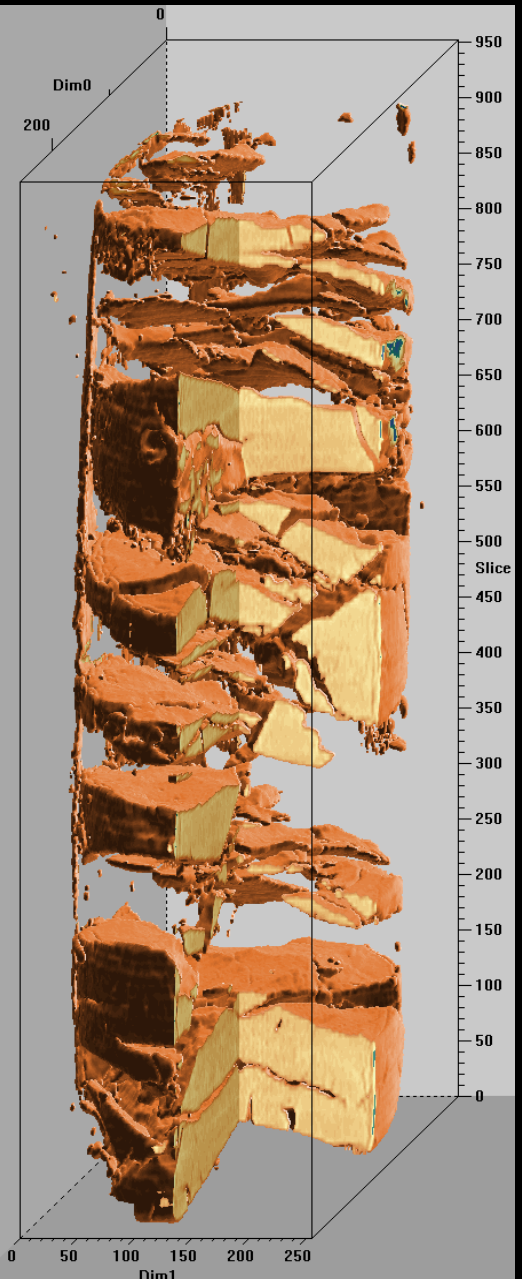
Excavation

What does permafrost look like?

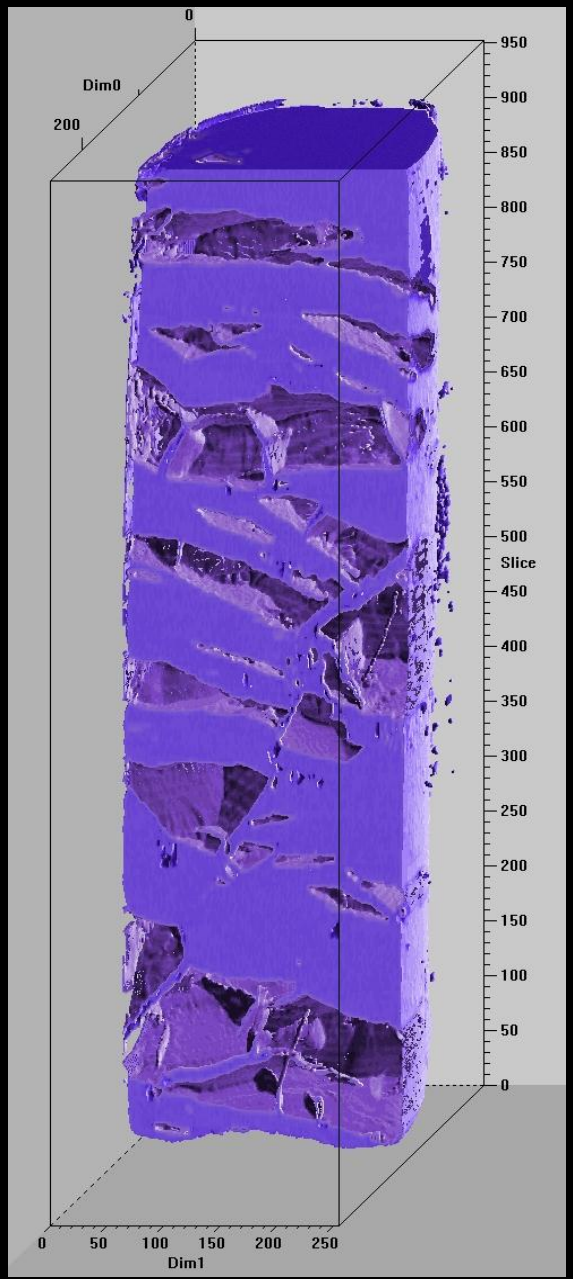
Drilling and sampling

Permafrost cores

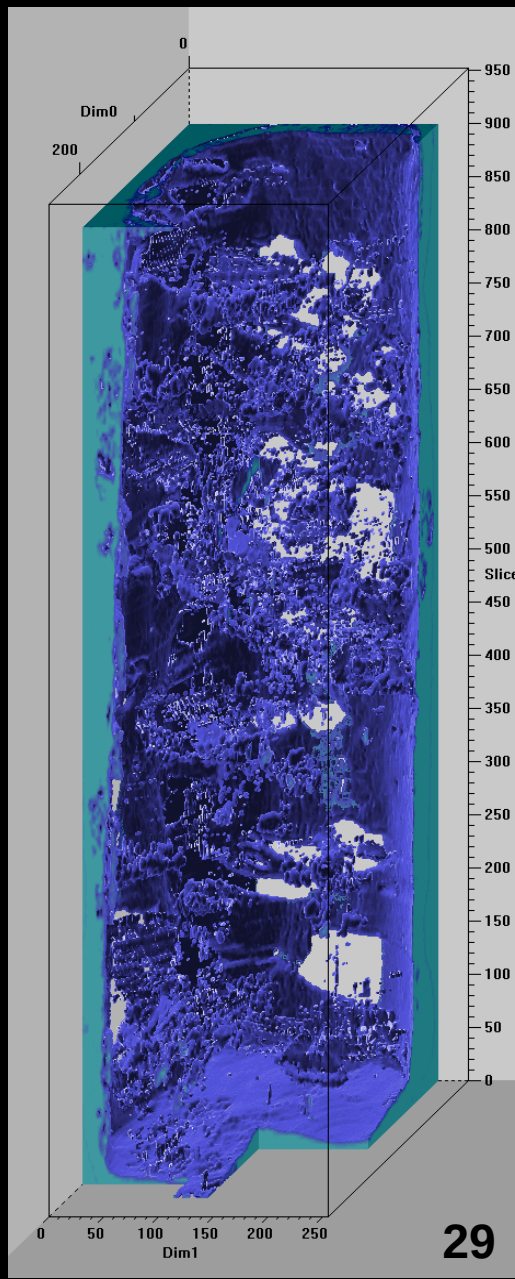
Sediment



Ice

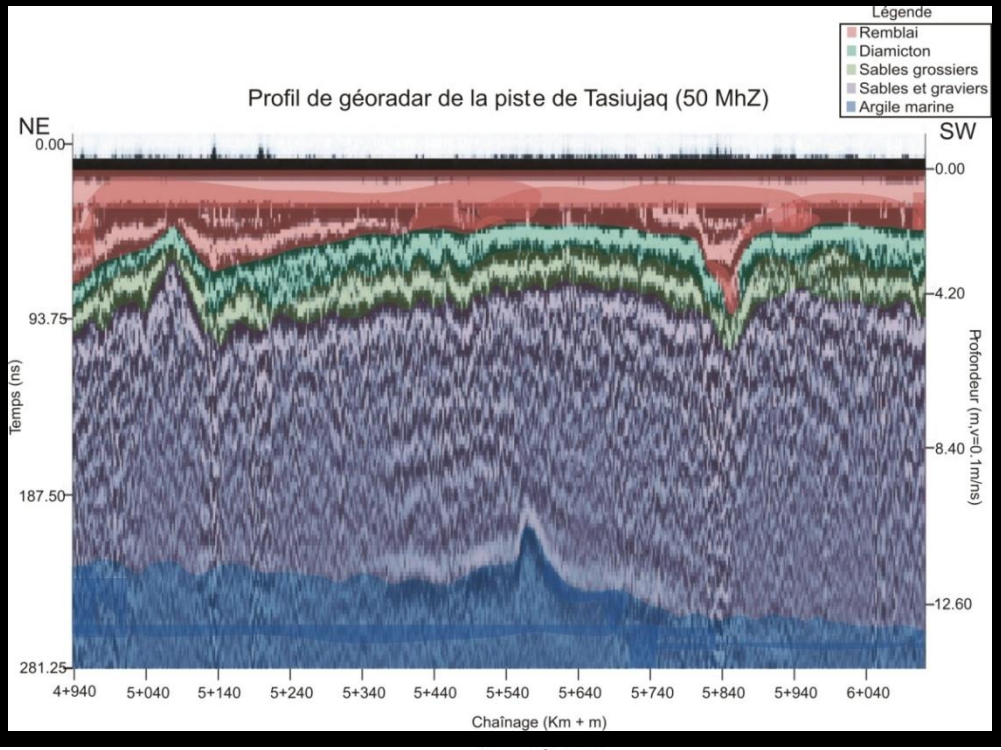


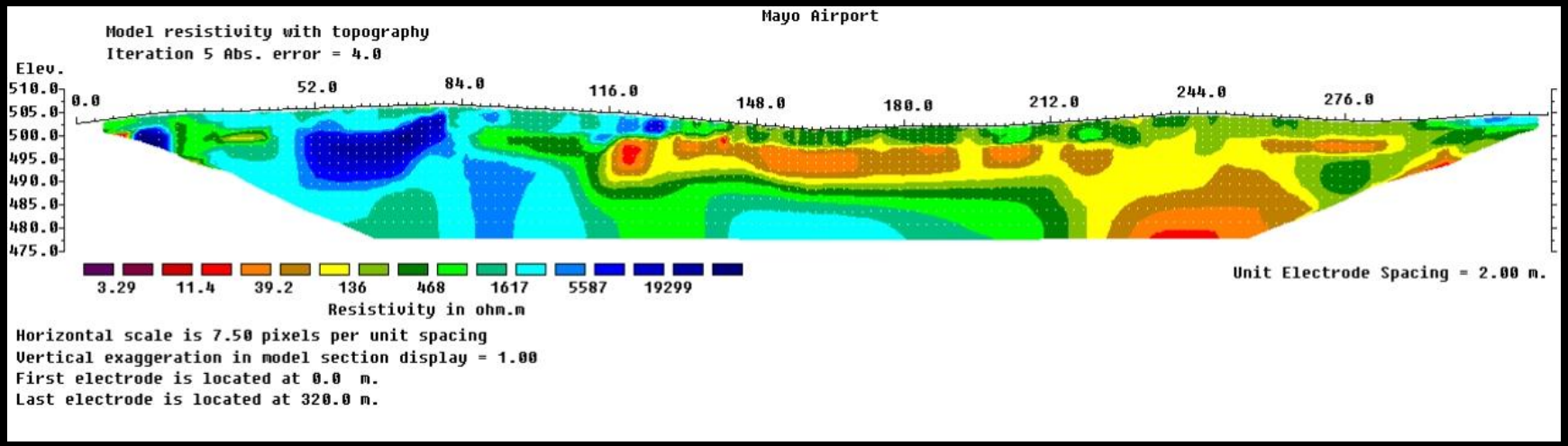
Gas



Geophysical survey

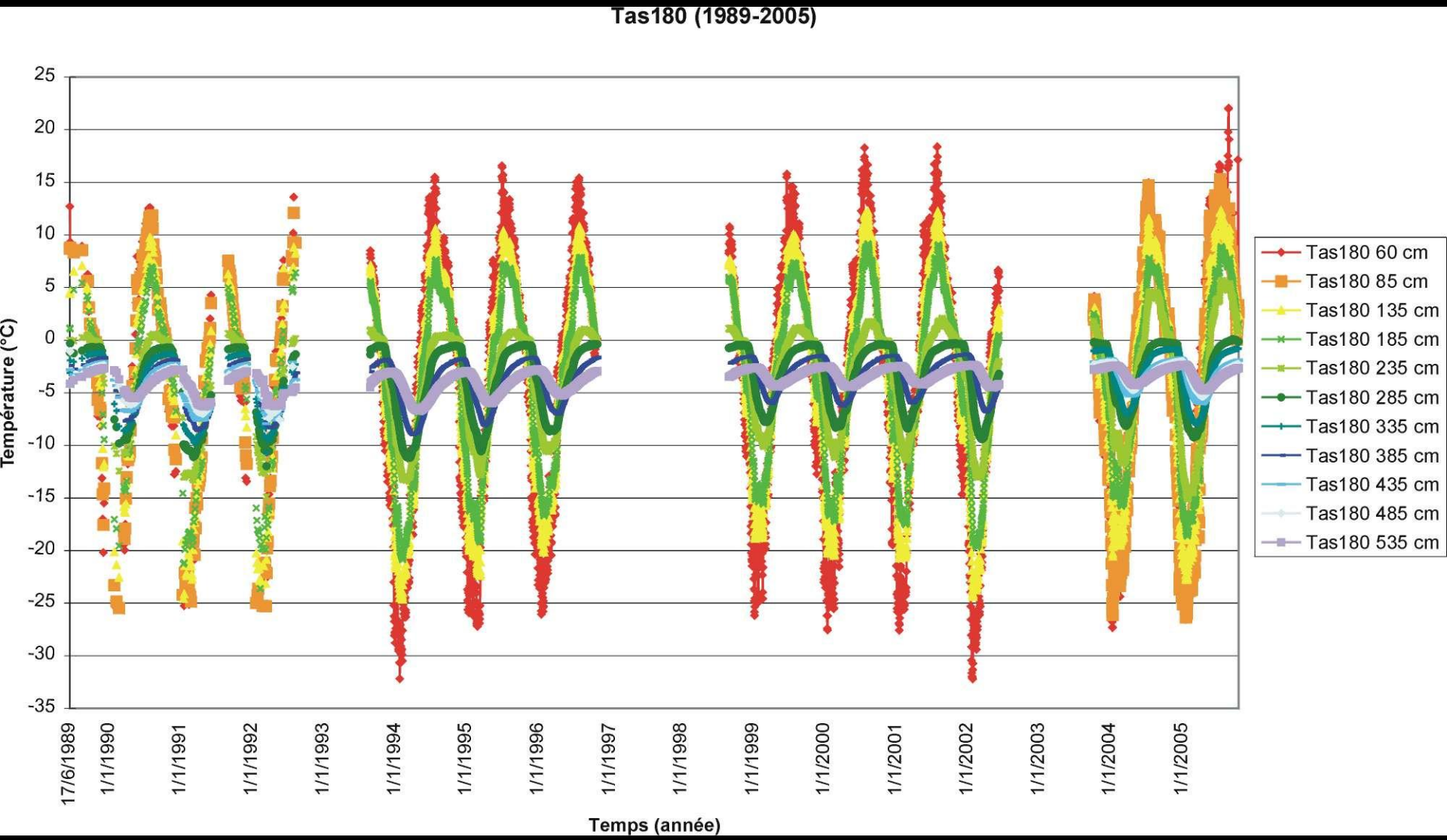
Geophysical survey



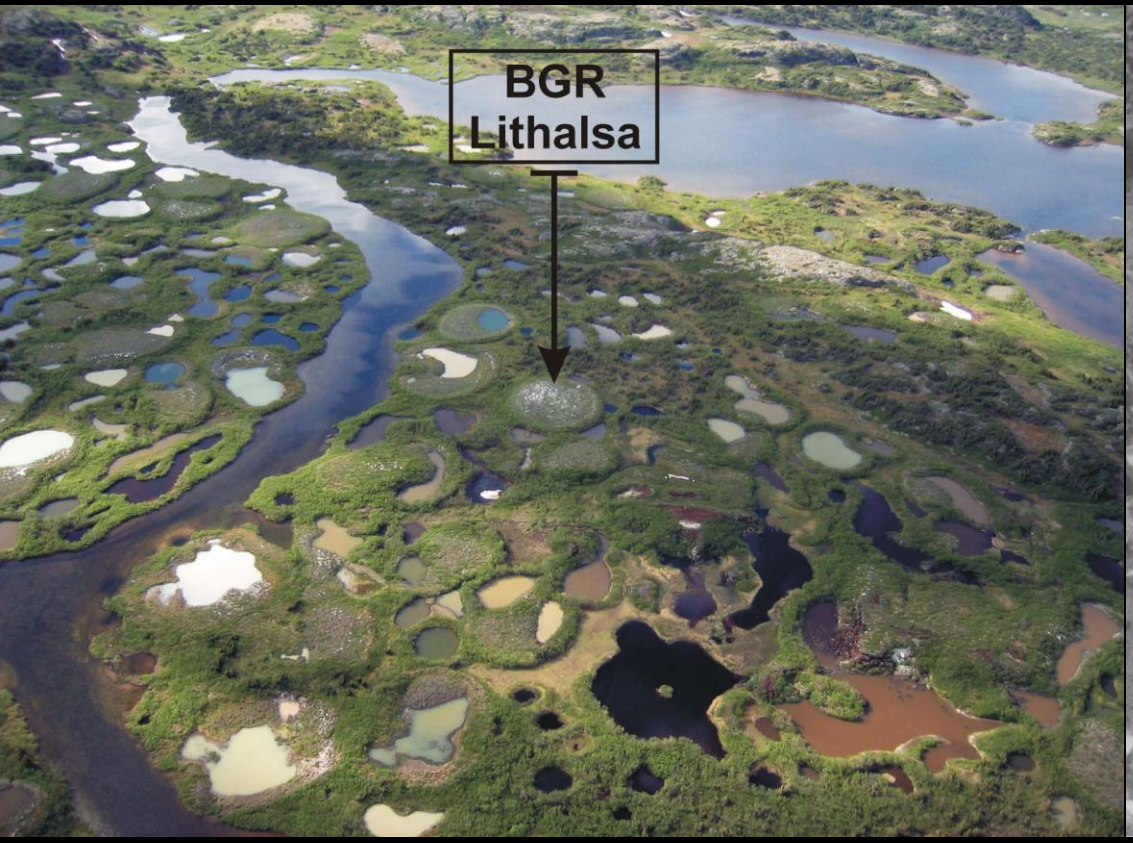


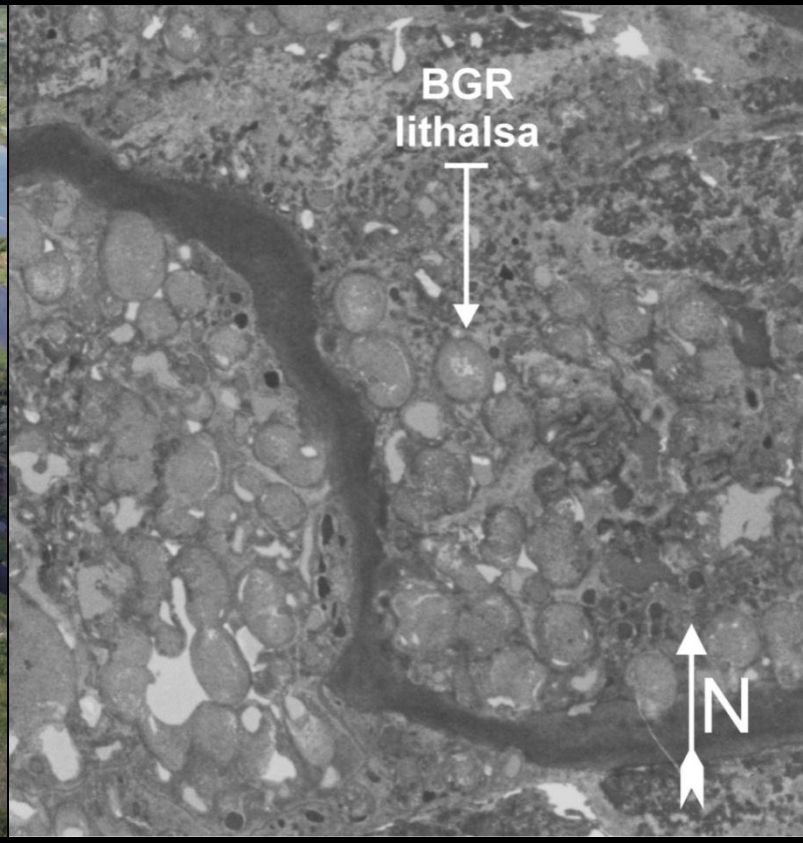
Climate and ground temperature

Climate and ground temperature



Air photo survey

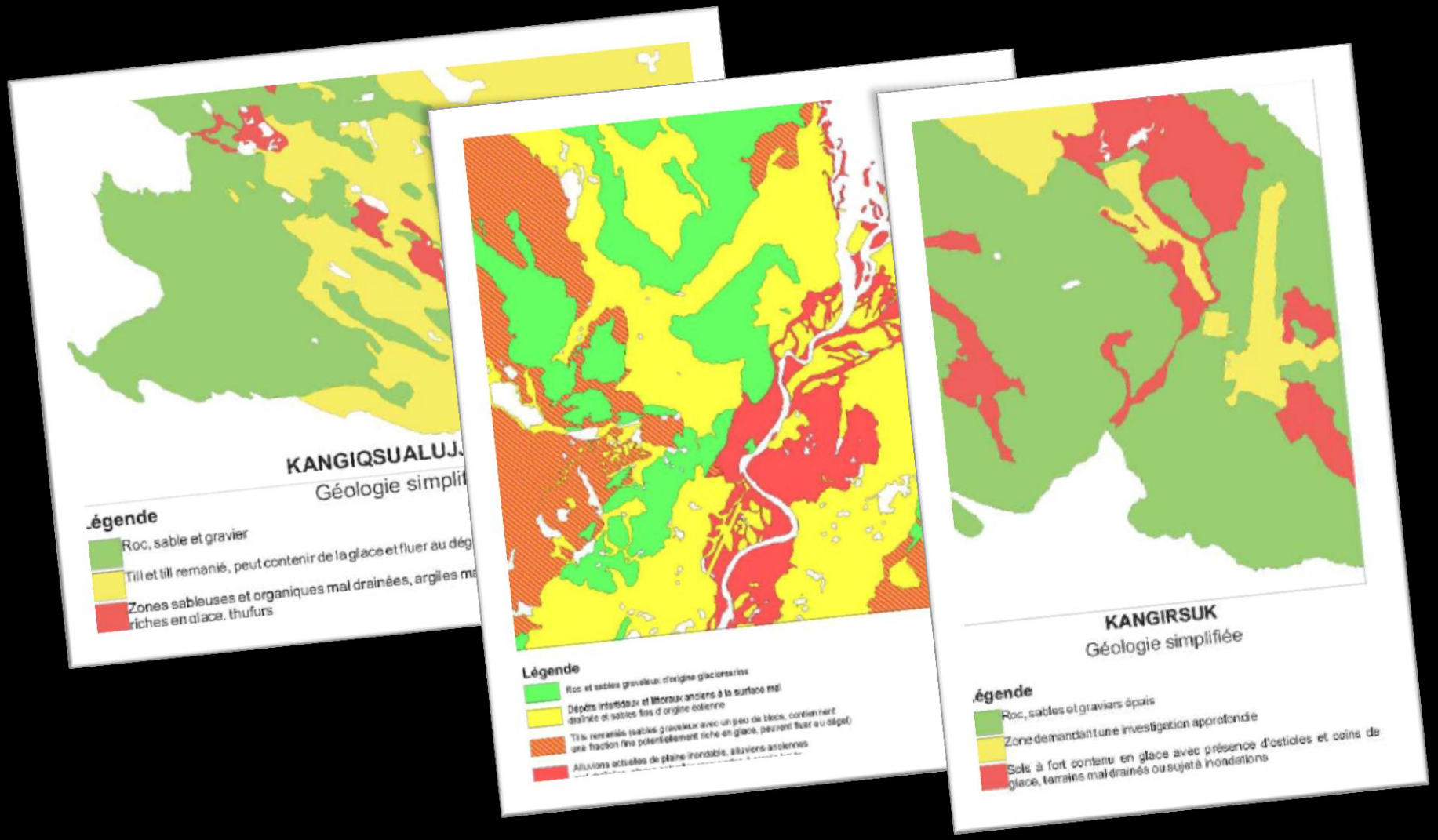


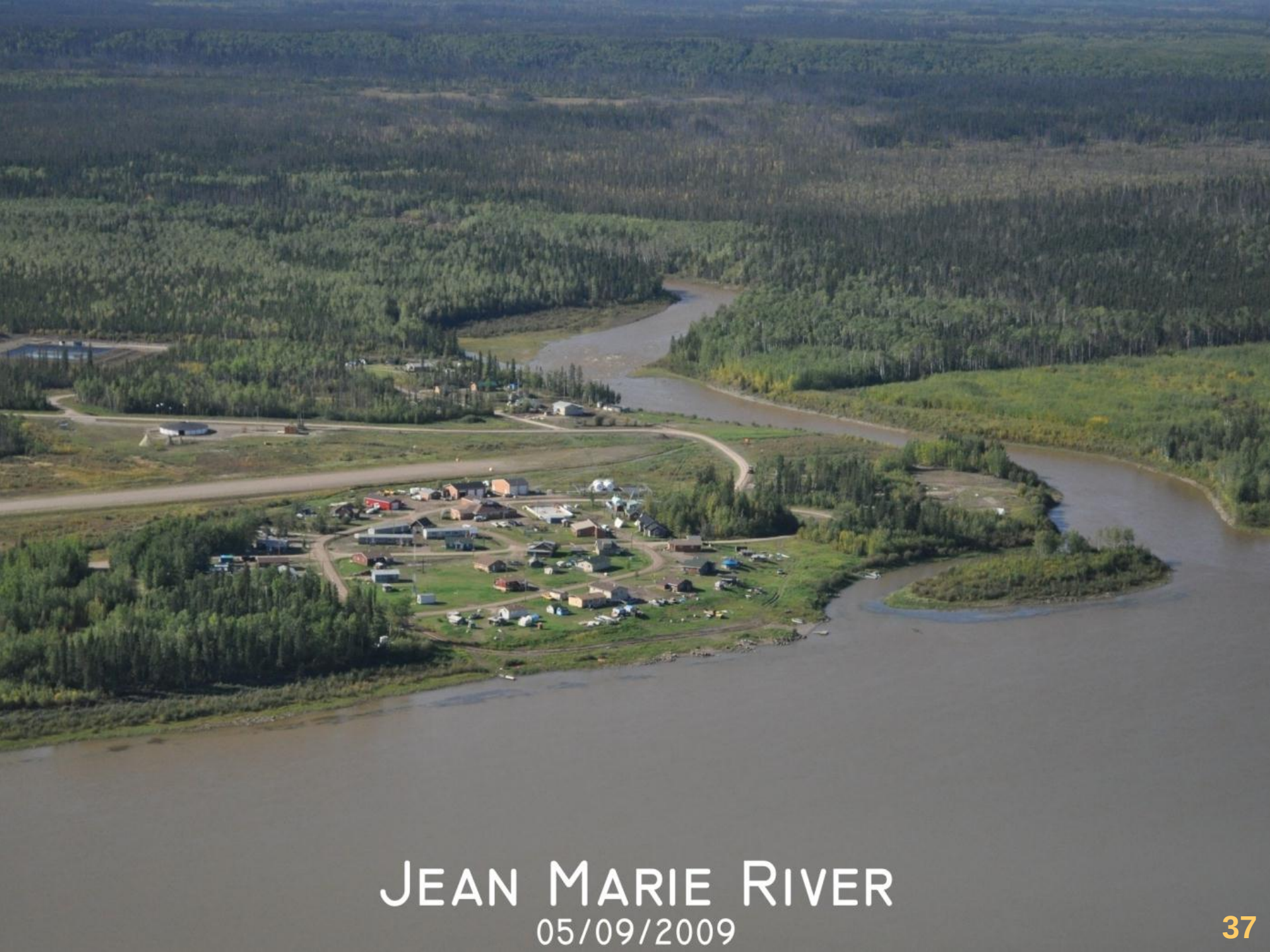


And many other things…

Developing a strategy of adaption:

Vulnerability map featuring three levels of vulnerability: low, moderate, high.




JEAN MARIE RIVER
05/09/2009

Jean-Marie River: Permafrost in peatland

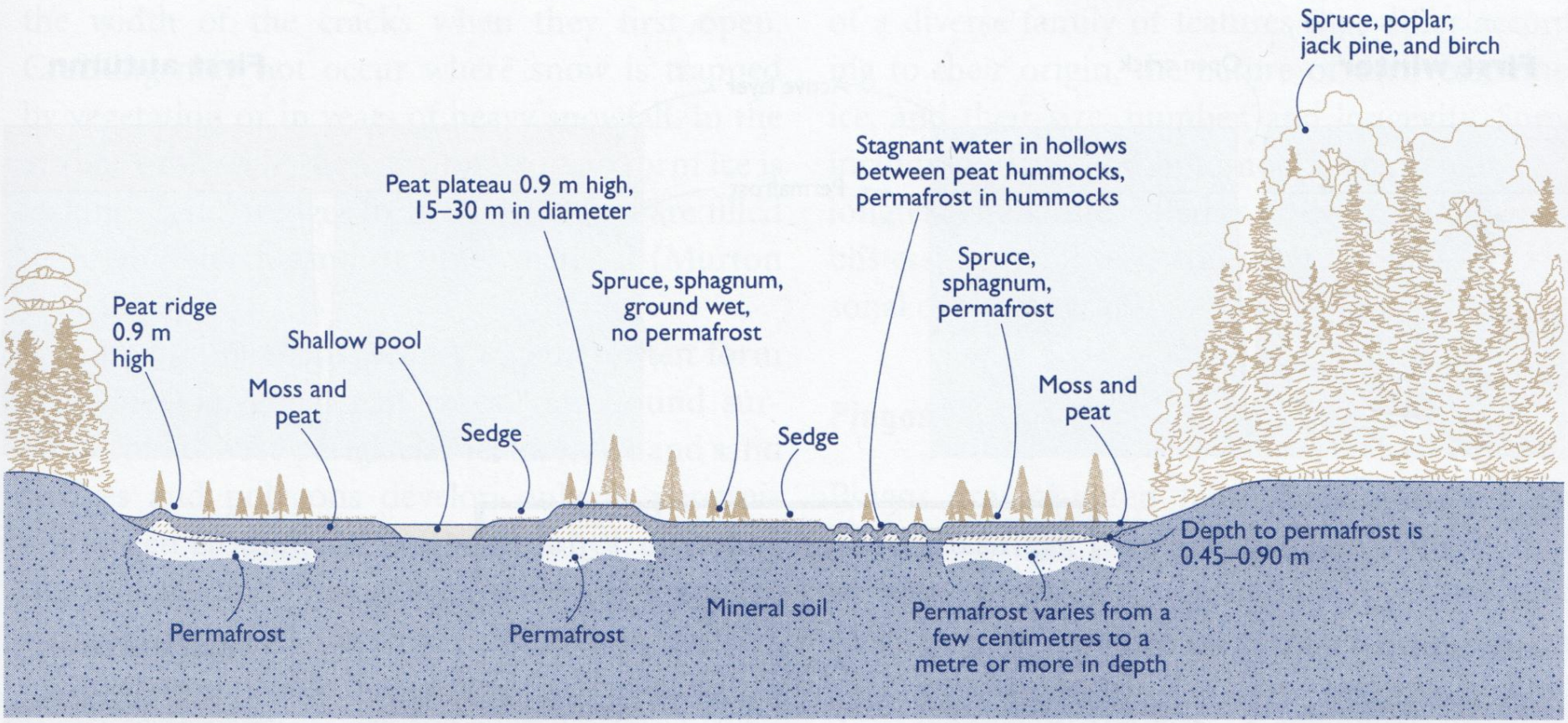


Figure 9.6 The effect of vegetation and terrain on the distribution of permafrost in the peatland of the southern fringe of the discontinuous zone (Brown 1970)

Discontinuous zone: Permafrost in peatland


2-8
32
2-9
33
2-10
0 1 2 3 4 5 6

Jean-Marie River:

Buildings and infrastructure of the community will be safe, but not important areas of their traditional lands.

They use those lands for:

- •Trapping,
- •Hutting
- •Berries/plants gathering, etc.

The extensive degradation of permafrost may affect:

1- The food security, by the lost of land used for hunting, trapping and/or gathering;

2- Drinking water, as well as fish resources, might be contaminated because heavy metals, such as mercury, tends to be trapped and concentrated in organic soils. Thaw of frozen peat may release the pollutants in the enviroment, contaminating water and fishes.

The usual suspect