



# ISOPERM: Reconstructing permafrost dynamics using stable & clumped Isotopes

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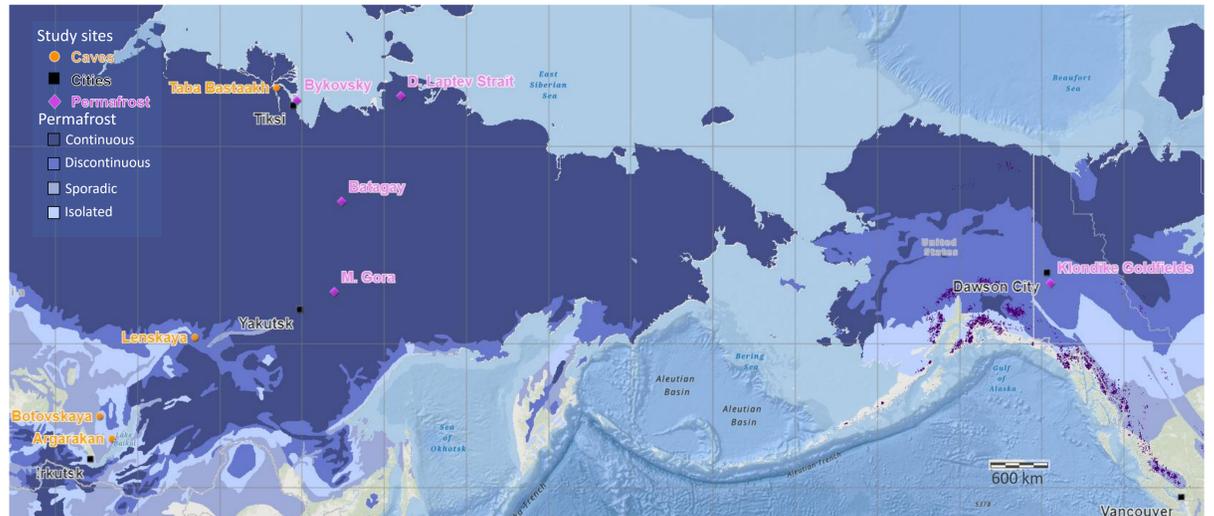
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Permafrost contains approximately twice as much carbon as today's atmosphere<sup>1</sup>. Improved understanding of environmental controls on permafrost stability is vital for estimating future vulnerability of this key climate tipping element.

The ISOPERM project applies multiple cave and permafrost derived proxies to infer palaeo-environmental controls on permafrost stability throughout the Quaternary.



**Study sites:** East Siberian sites traverse a North-South transect from the Arctic Ocean to Lake Baikal, with caves situated on the discontinuous southern boundary. Siberian sites will be complemented with new Canadian permafrost sites.

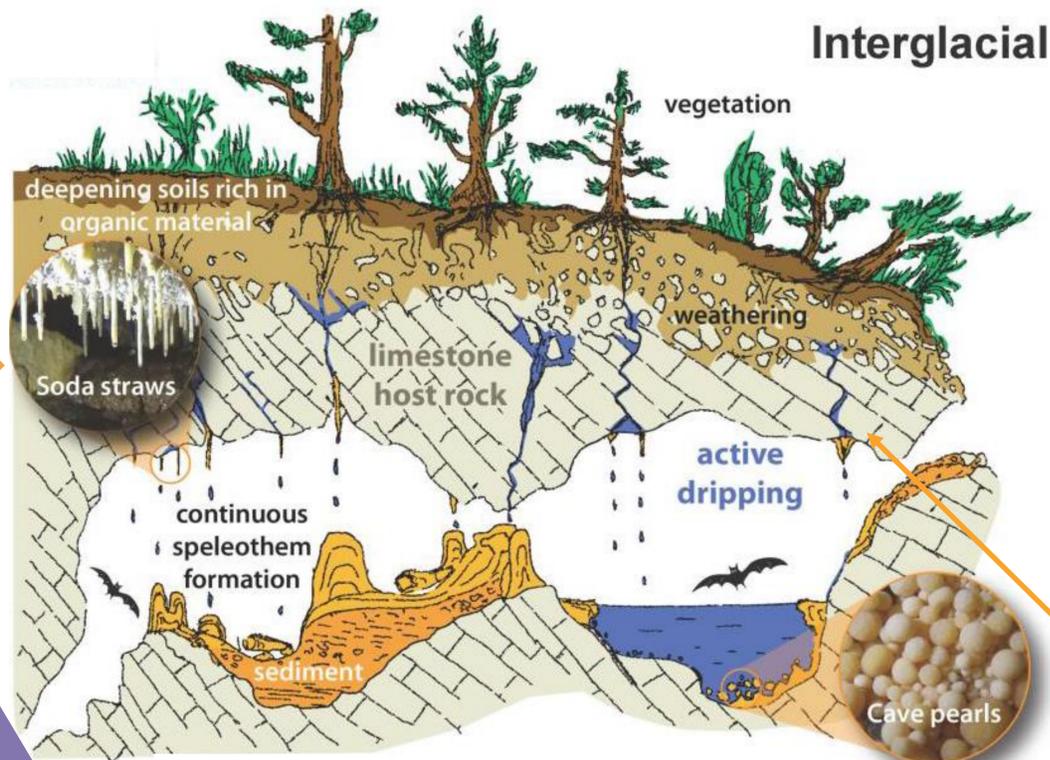
## What do caves tell us about permafrost stability?

**Speleothems** (cave deposits, e.g. stalagmites, cave pearls) precipitate from liquid water.

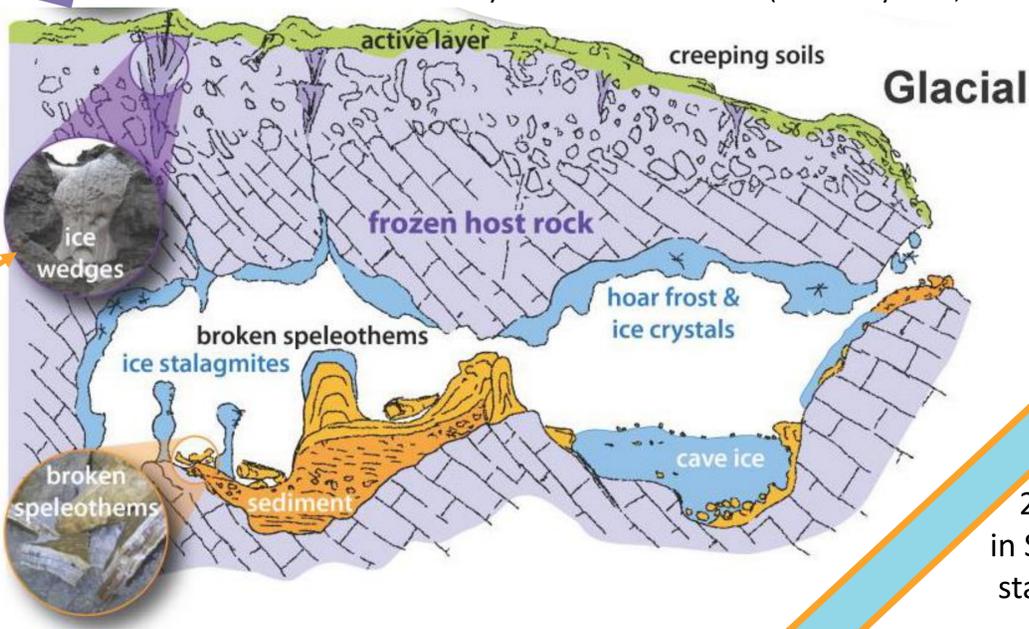
During and after permafrost thaw, drip water enters the cave, precipitating speleothems.

When permafrost is stable, water remains frozen and speleothem growth ceases.

U-series dated speleothems help establish a chronology of local palaeo-permafrost thawing.



Study site schematic: Note, permafrost sampling sites are rarely so conveniently located next to caves (See study sites, above)



## Permafrost measurements

Seasonal precipitation and relative temperatures are inferred from water stable isotopes of ice wedges and intra-sedimental ice.

Ice wedges arise from snow meltwater entering thermal contraction cracks, preserving cold season information<sup>2</sup>.

Intra-sedimental ice arises from soil moisture, preserving summer to annual information.

## Palaeo-temperatures from carbonates

Clumped isotope thermometry<sup>4</sup> of speleothems allows us to estimate multi-annual mean temperatures.



Fossil ostracods and mollusks from polygonal pools and thermokarst lakes give summer palaeo-temperatures.

## Vegetation regimes

We reconstruct vegetation changes using speleothem-derived biomarkers and fossil pollen. These are transported through the overlying epikarst by dripwaters and incorporated into the speleothem as it grows.



## Wildfires

2021 saw unprecedented wildfires in Siberia. The impact on permafrost stability remains unclear<sup>5</sup>.

IsoPerm measures palaeo-wildfires during periods of permafrost thaw using levoglucosan – a biomarker produced only by combustion of cellulose and transported to caves in dripwaters where it is incorporated into speleothem calcite.



## References

Scan the QR code or visit [www.isoperm.net/uk-arctic-science-conference-2022](http://www.isoperm.net/uk-arctic-science-conference-2022)