Drift exploration techniques in the Gillam area - year 4 (NTS 54D, 54C)

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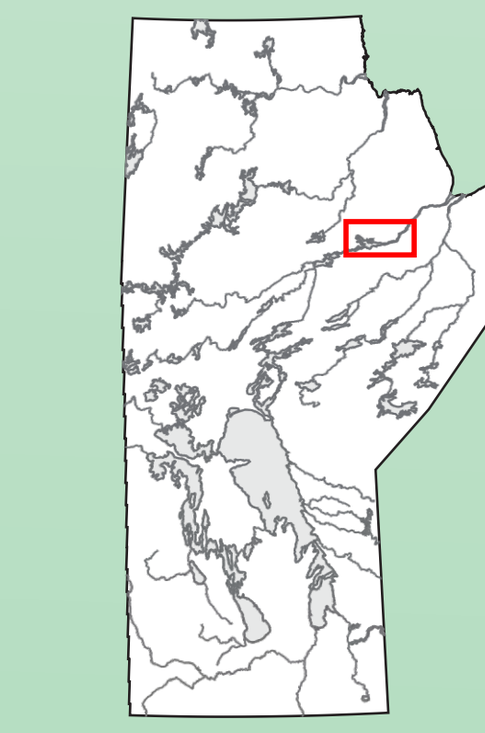
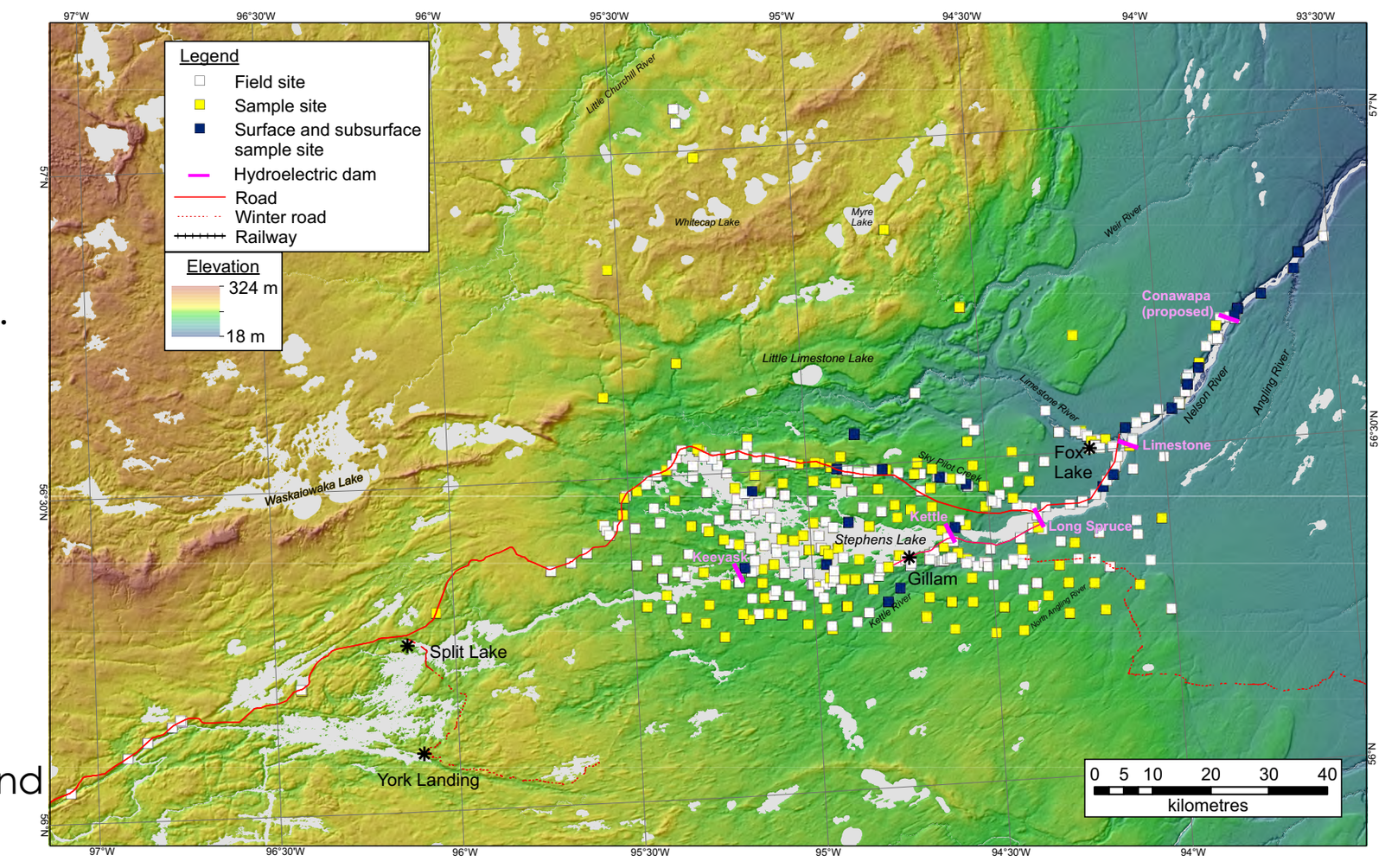


Problem and objectives

Problem

The goal of this work is to determine the effect of multiple glaciations on till deposition, in a zone of transition from a multi-till stratigraphy within the Hudson Bay Lowlands to a single till stratigraphy over the Precambrian Shield.

The study area has access to numerous sections that expose multiple tills, in addition to interglacial and postglacial sediments. The thick tills are not easily separated into different units within the Hudson Bay lowlands, leading to different stratigraphic models. Also, the transition to the thin tills overlying the Precambrian Shield in the west is not well understood. Yet, the two different settings were affected by the same 3+ glacial cycles.



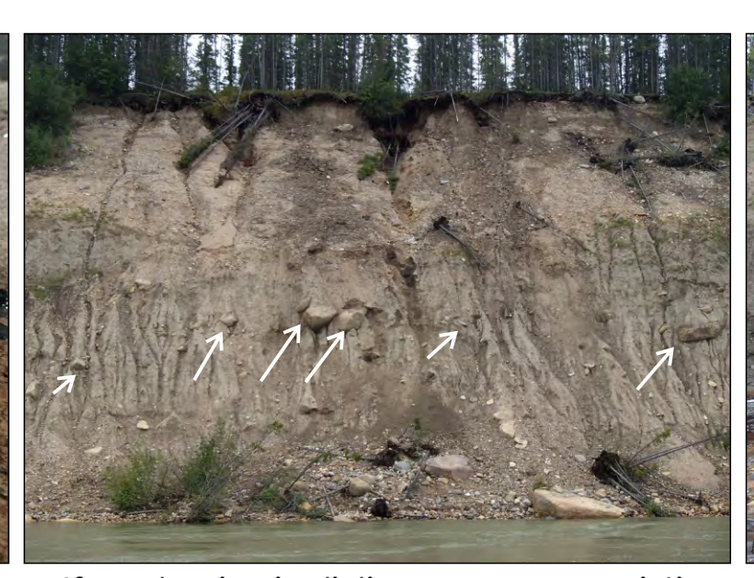
Objectives

1) investigate the surficial geology;
2) investigate the subsurface geology where exposed along river sections;
3) conduct till sampling for analyses of till composition and provenance;
4) develop a new public till-compostion database; and
5) determine till provenance and geochemical assemblages; and their potential implications for drift exploration.

Deposition and erosion during glaciation

Not every ice-flow phase is depositional *and* erosional

If a glacier is sliding along the bed, it can erode by plucking, abrading or striating the bedrock.



If a glacier is sliding over preexisting sediments, it may erode those sediments, and/or deposit lodged boulders at the contact.

..or it may deposit a new till, creating a sharp contact with preexisting sediments.

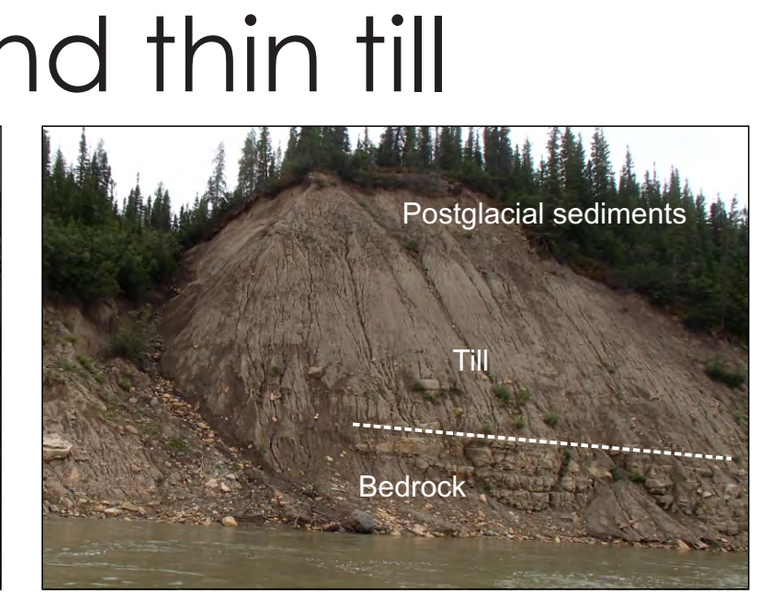
If there is enough sediment supply (from an area "x" distance up ice), deposition can be continuous even though the orientation of ice flow may change over time.

Till deposition could have occurred during older phases or younger phases, or a mix of both; resulting in reworking and removal of older tills (overprinting) and/or minimal reworking and high preservation (inheritance).
...thus we need to figure which phase(s) is/are actually responsible for till composition – in order to figure out up-ice source area.

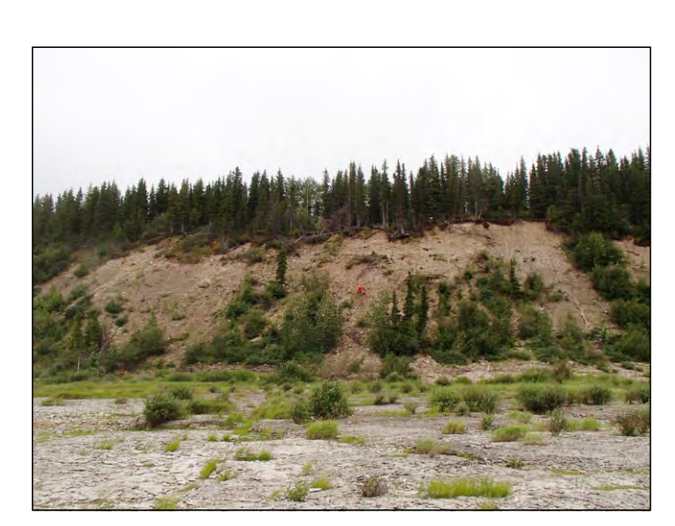
Thick and thin till

Thin till over striated outcrops of paragneiss.

2-3 m of till over diorite

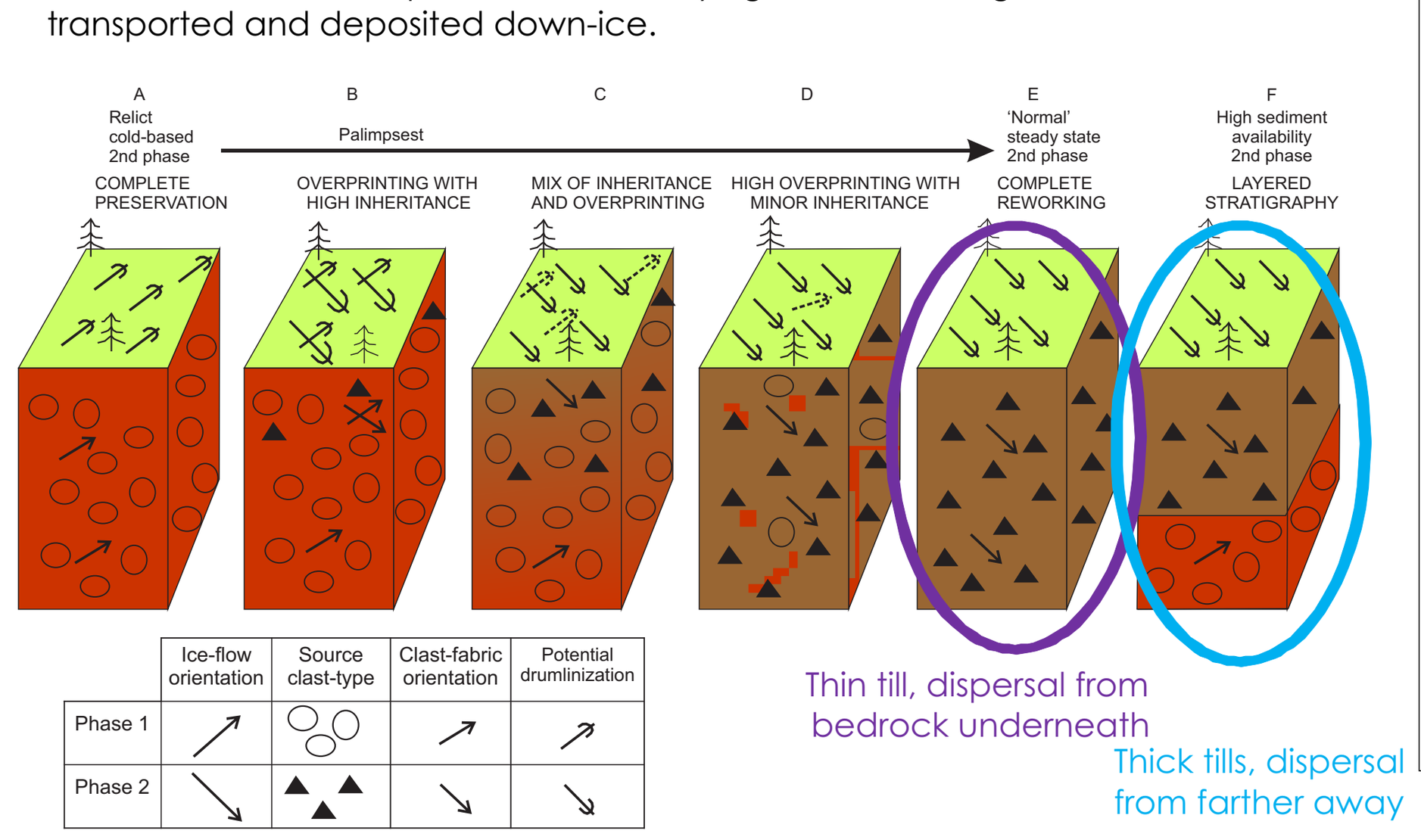


Thick till over limestone bedrock.



A section with at least 3 different till units, separated by nonglacial sediments, over limestone bedrock.

Why does this matter?
Because we assume uptake from underlying bedrock into glacier/base, where it is transported and deposited down-ice.



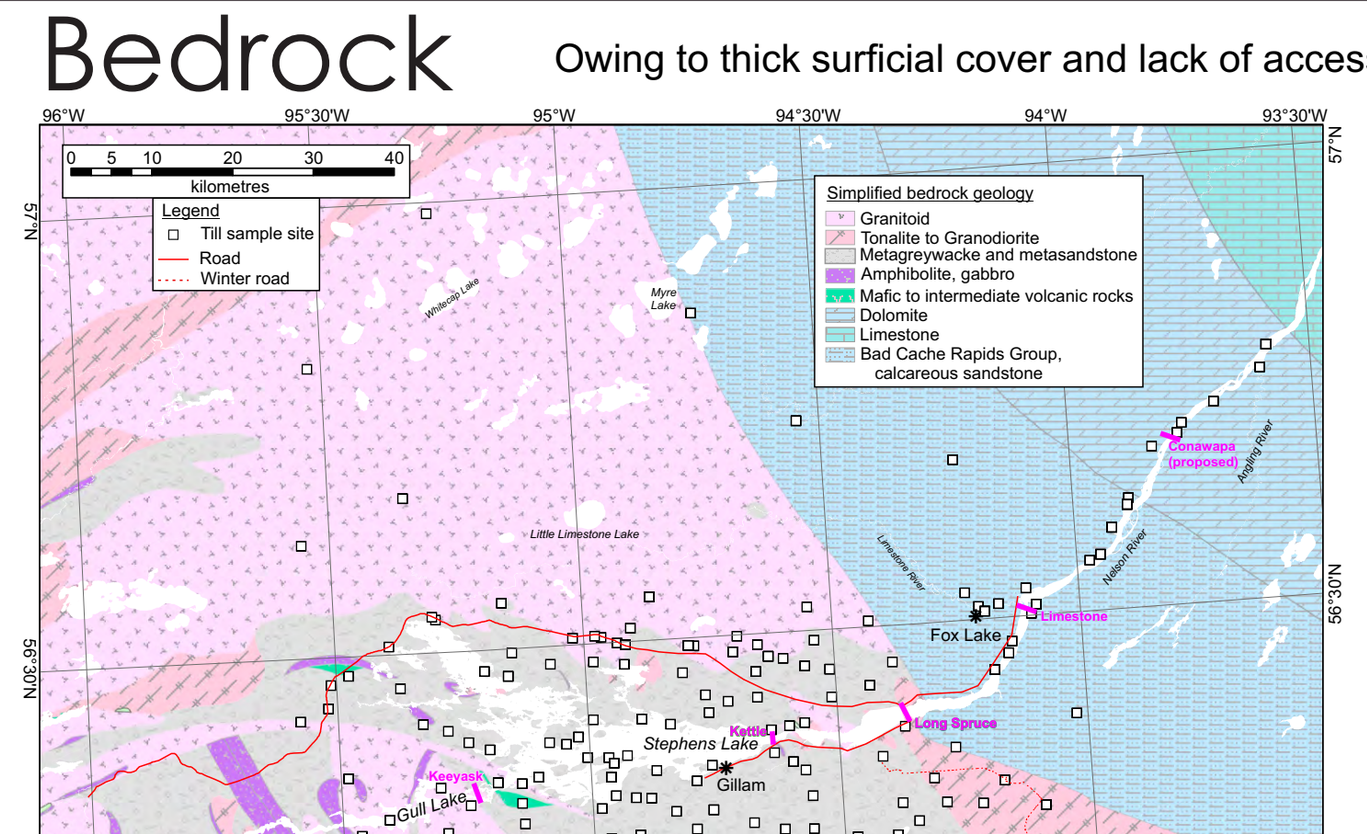
Trommelen et al. 2013 Boreas, v. 42, p. 693-713

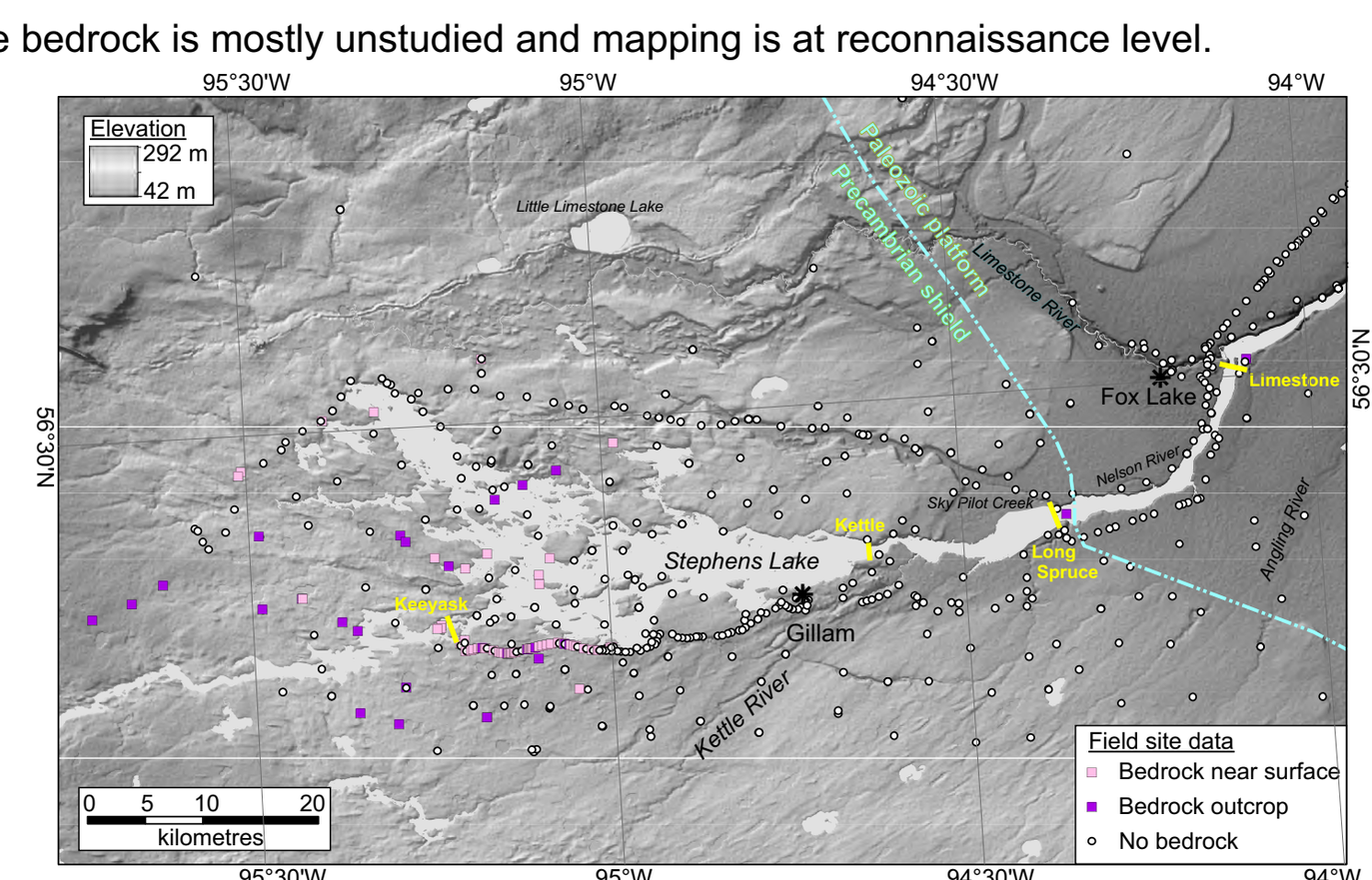
So we need to know:
- Which direction was the sediment transported from? (**'provenance' or 'source area'**)
- How far was it transported? (**'transport distance'**)

And, in the case of multiple ice-flow events or phases over time:
- Were earlier events completely removed? (**'overprinted'**)
  *In which case only the last ice-flow event is important.
- Were earlier events only partially removed? (**'inherited'**)
  *In which case all ice-flow events, or perhaps just the older ones, are more likely to answer the two questions above.

Bedrock

Owing to thick surficial cover and lack of access, the bedrock is mostly unstudied and mapping is at reconnaissance level.



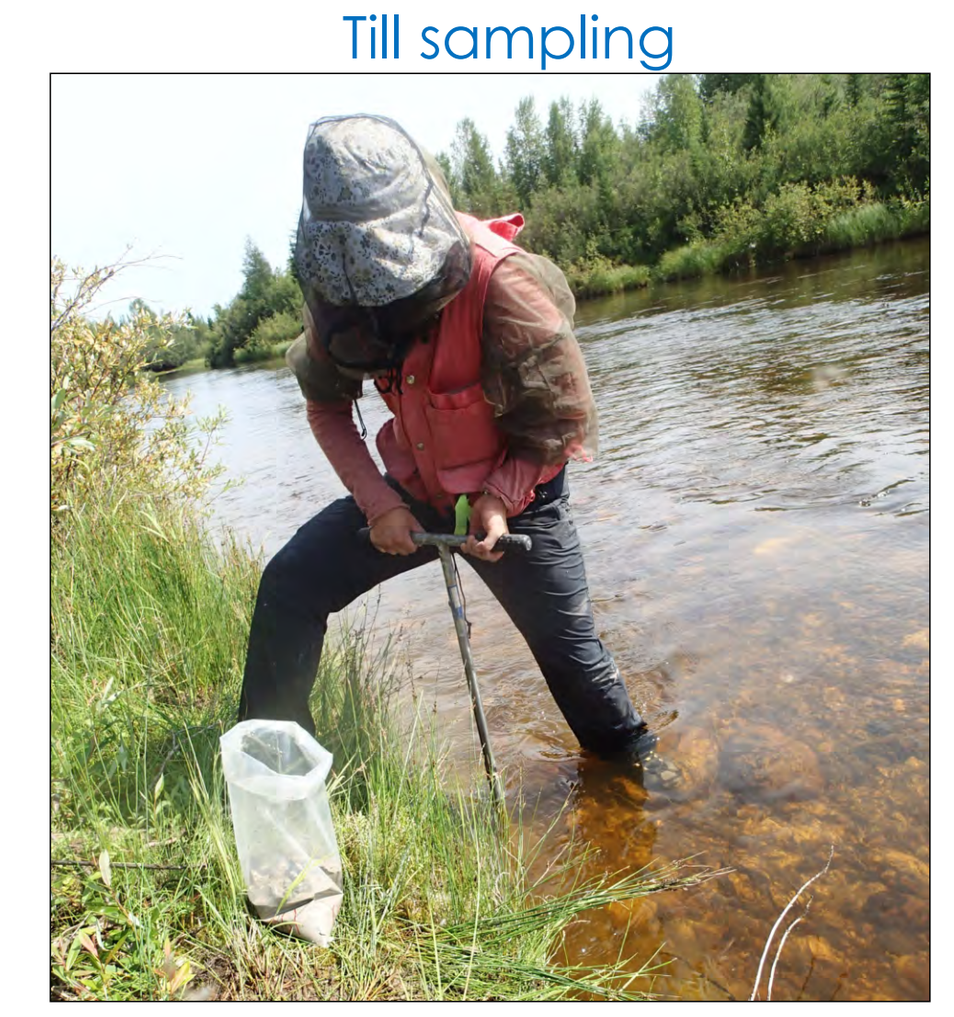


Methods: multi-proxy data analysis

Field mapping

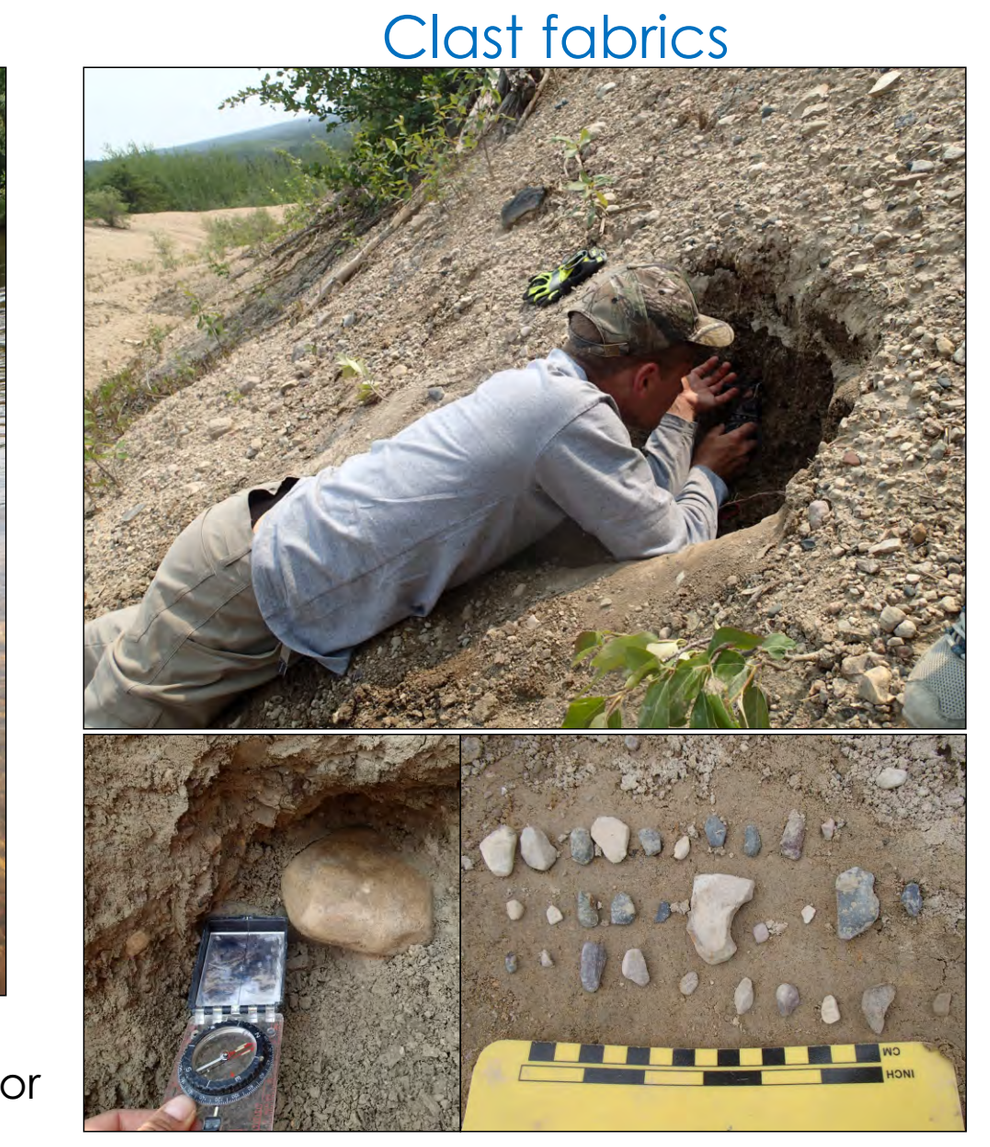
Augering into a hole that was dug by hand allows us to reach depths of up to 2.5 metres.

Till sampling



Collected 244 samples of till for further analyses. Due to cover by thick organics or glaciolacustrine sediment, sometimes it's necessary to sample till from where water has eroded the surface material.

Clast fabrics



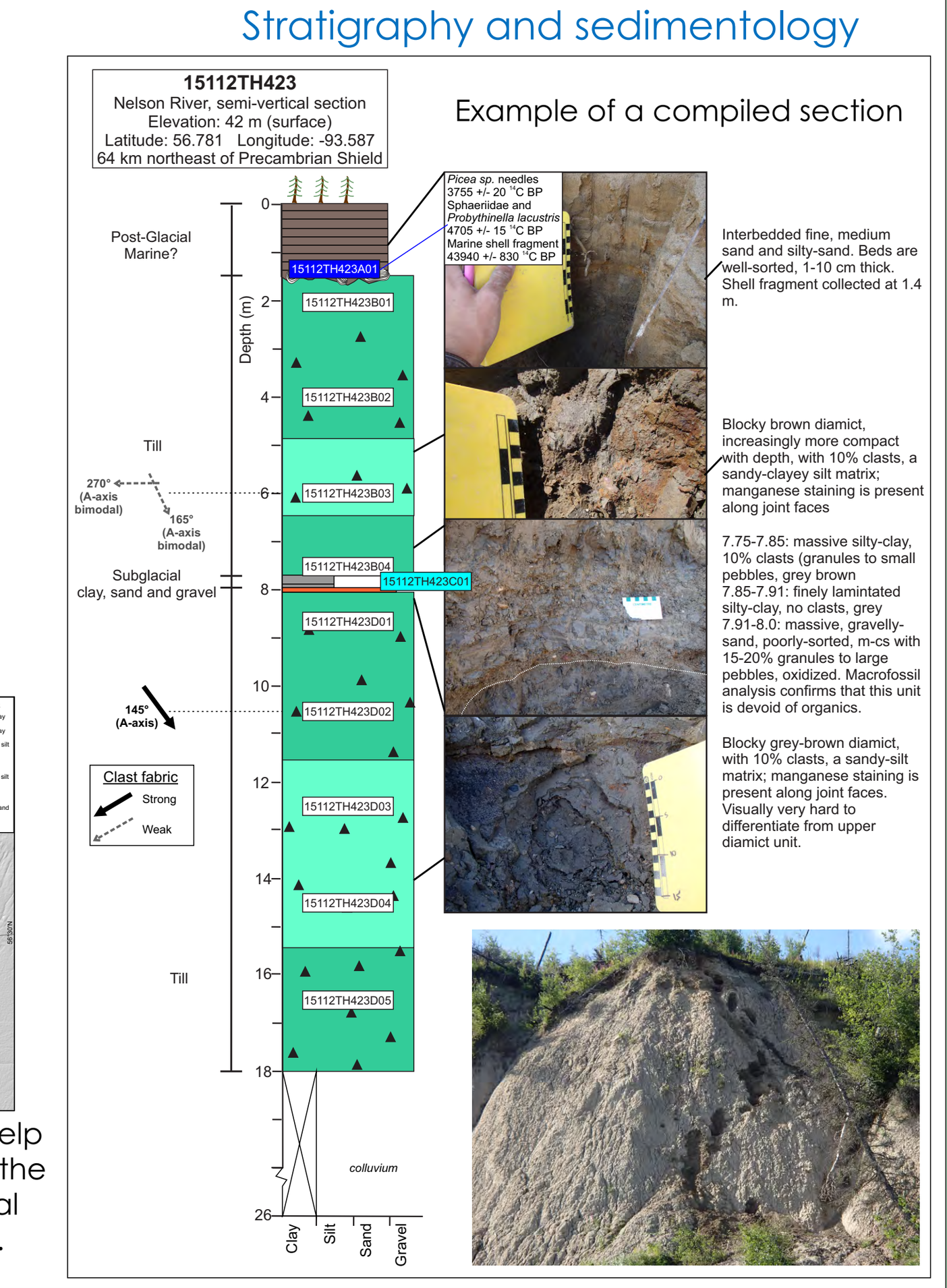
Measuring the orientation of elongated clasts within till allows us to approximate the stress orientation during deposition and hence the ice-flow orientation.

Mapping of erratics

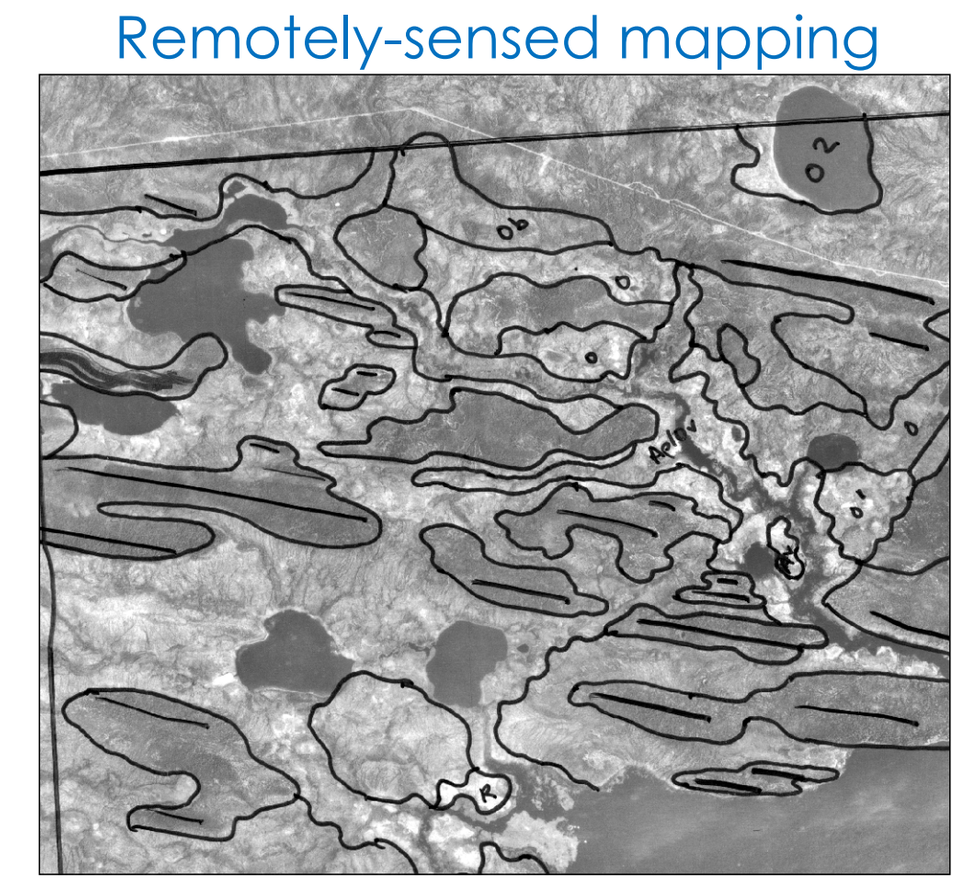
Likely sourced from the Omarolluk formation, outcropping in the Belcher islands of eastern Hudson Bay.

Likely sourced from the Dubawnt Supergroup, outcropping in Nunavut.

Stratigraphy and sedimentology



Remotely-sensed mapping

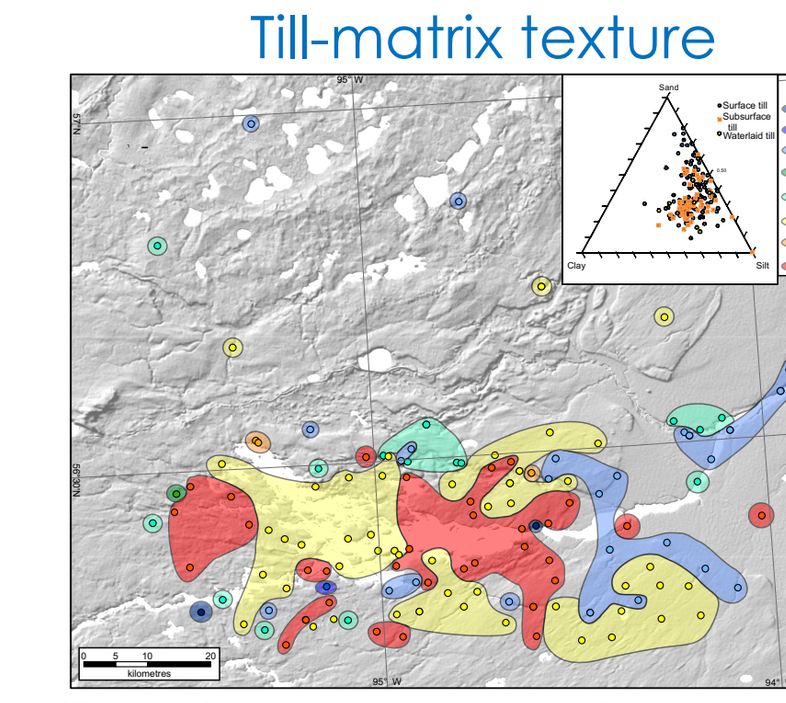


Surficial geology maps are made using the field information, combined with aerial photography and digital elevation models.

Till-clast lithology

The composition of the till is used to determine where the sediment-source area is. For example, most of the till in the study area is carbonate-rich (left), and has been deposited by ice flowing west to southwest from the Hudson platform. Some areas though, are granitoid-rich (right), and have been deposited by ice flowing from the north and northwest.

Till-matrix texture

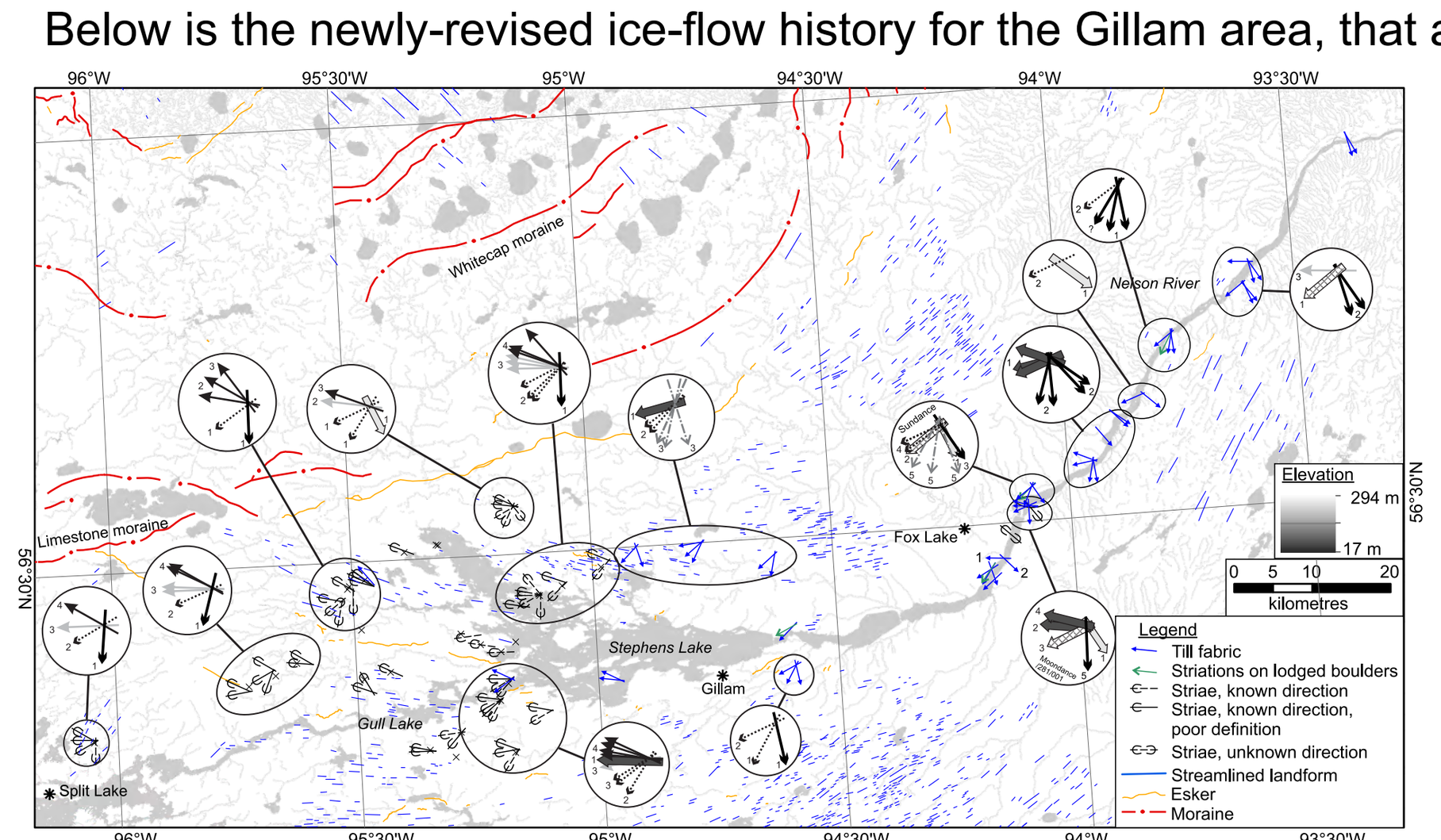


Till-matrix texture can also be used to help determine where till is sourced from. In the Gillam area, however, there is no spatial or stratigraphic correlation with texture.

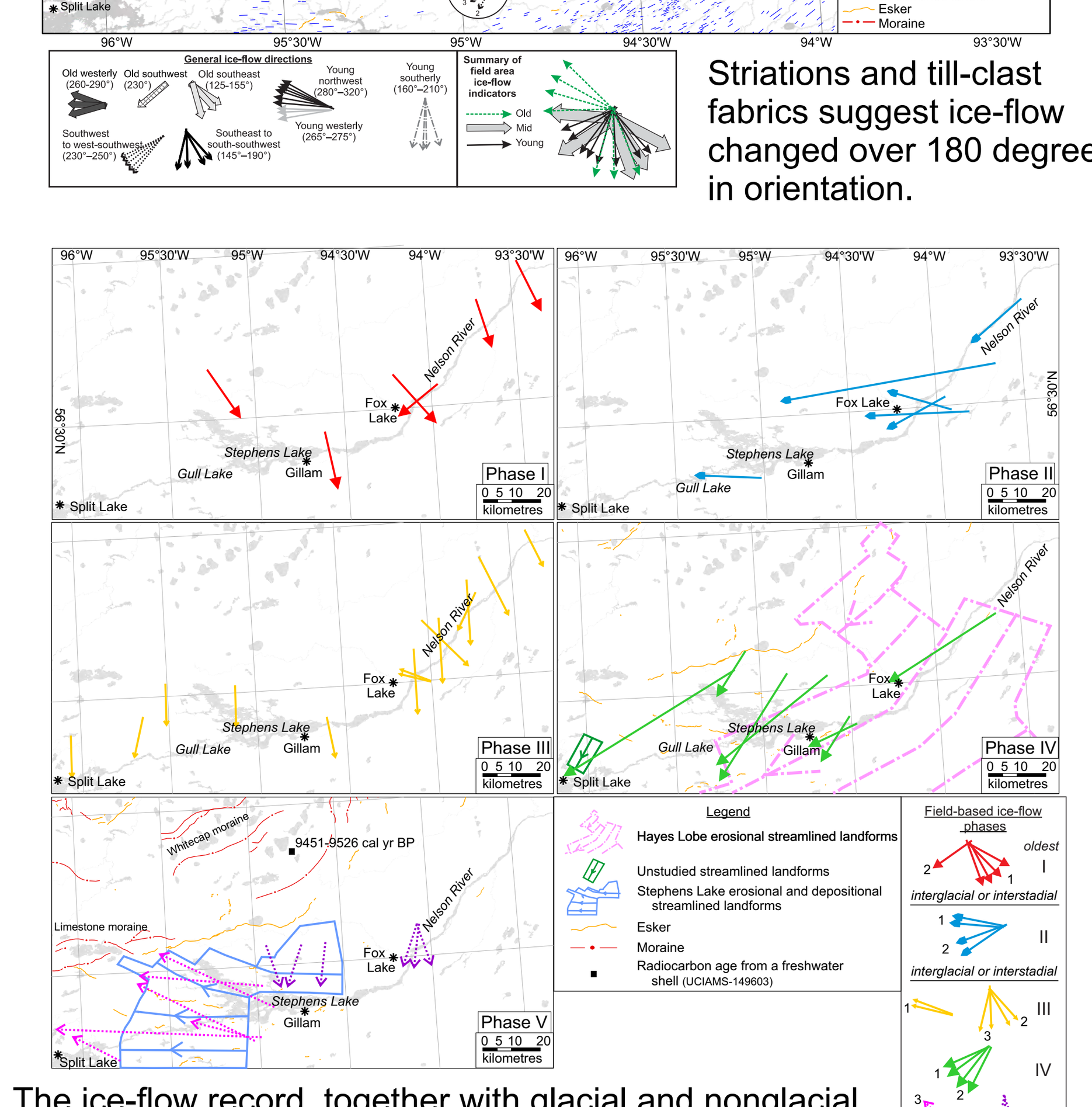
Ice-flow history

During our 4 summers of fieldwork in Gillam, we collected striation measurements from 24 sites, conducted till-clast fabric analyses at 41 sites from 18 sections, and completed magnetic fabrics on till matrix at 6 sites. We have also compiled similar work from other studies in the area.

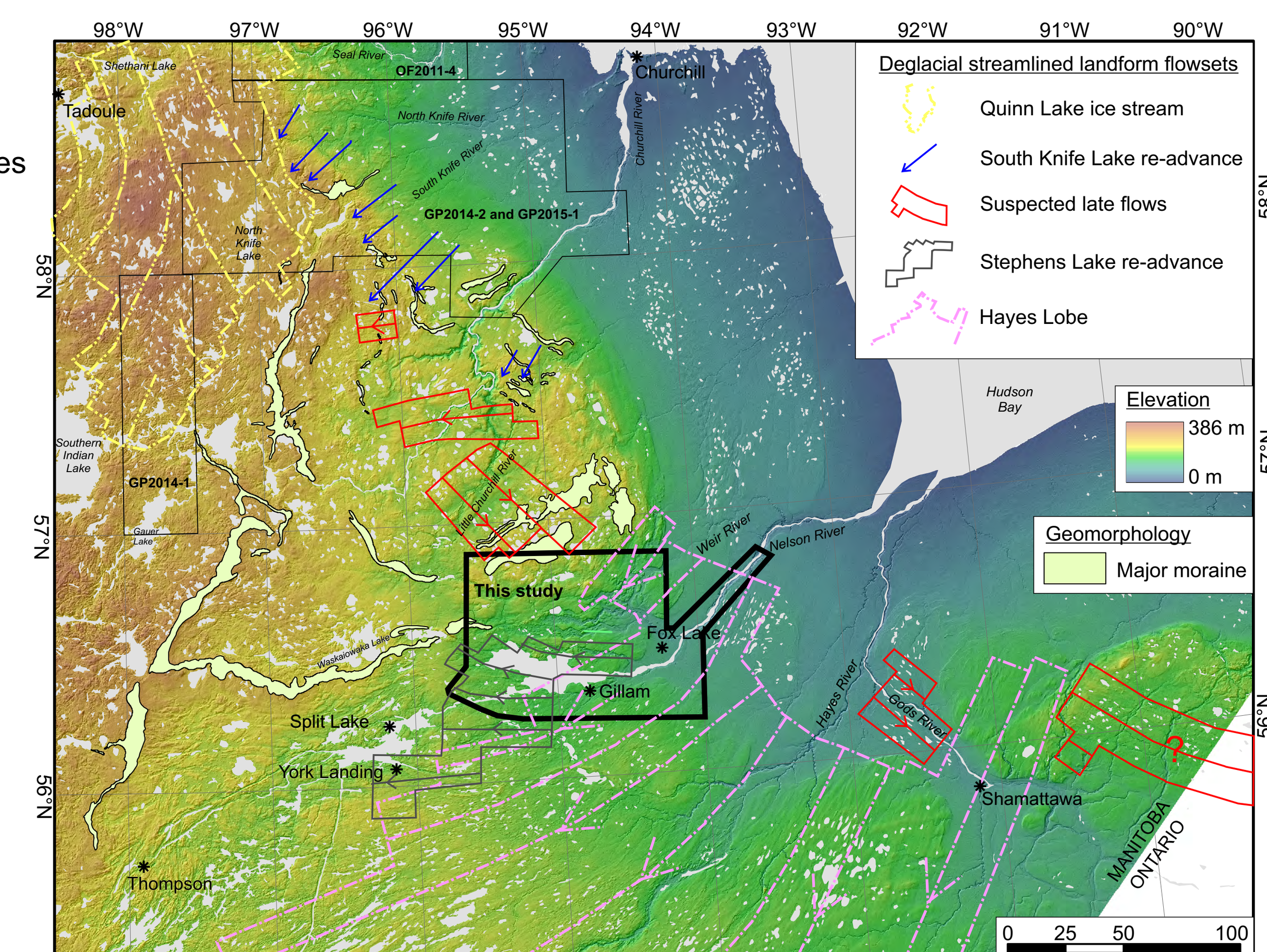
Below is the newly-revised ice-flow history for the Gillam area, that also takes into account till composition and stratigraphy.



Striations and till-clast fabrics suggest ice-flow changed over 180 degrees in orientation.

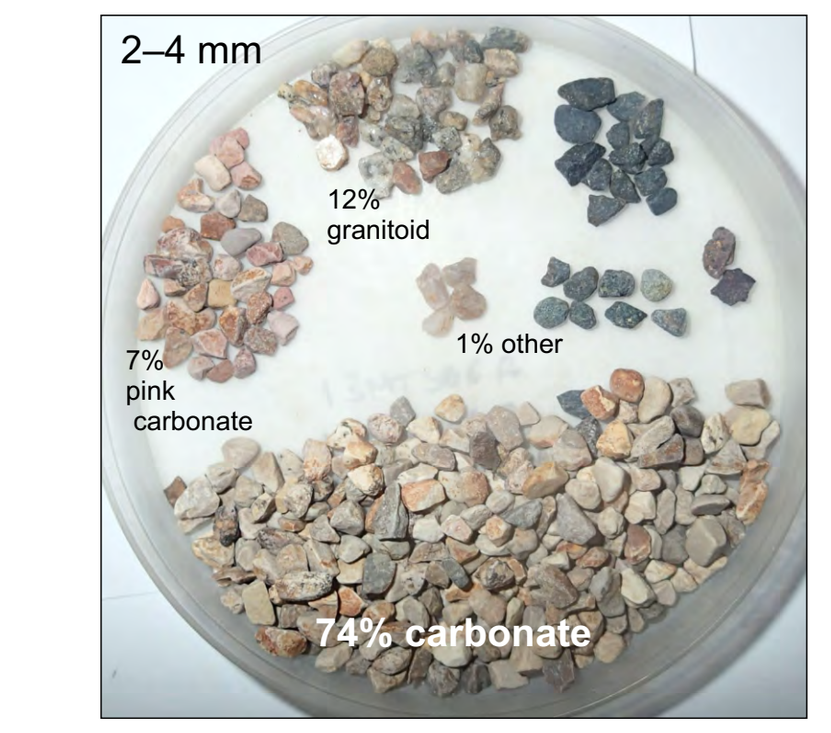


The ice-flow record, together with glacial and nonglacial stratigraphy along the Nelson River, suggests there were at least 3 glacial cycles that influenced the area.

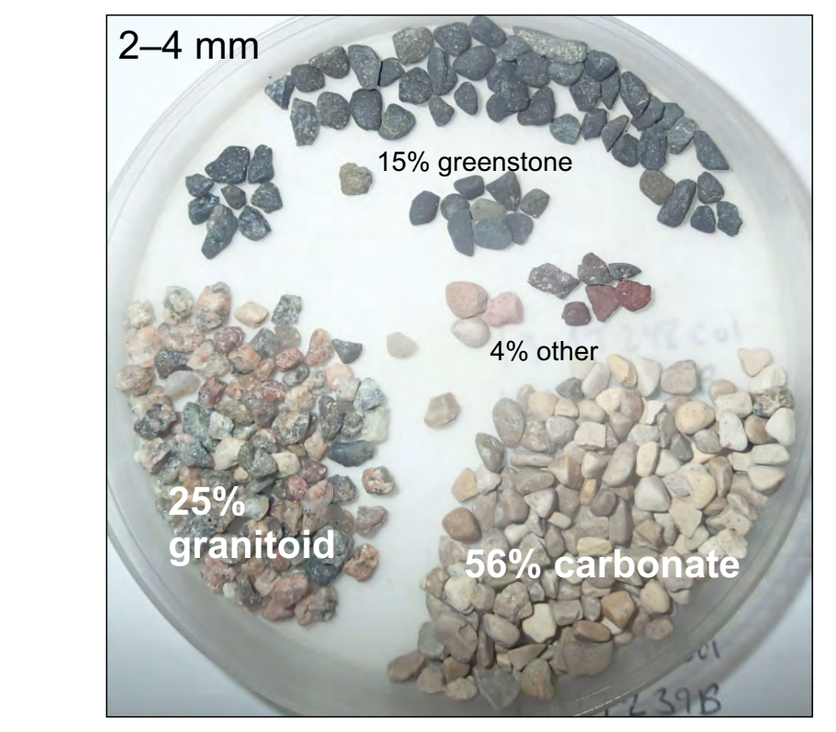


2 streamlined landform flowsets cross the study area. The Hayes Lobe was erosional, while the Stephens Lake re-advance was erosional and depositional.

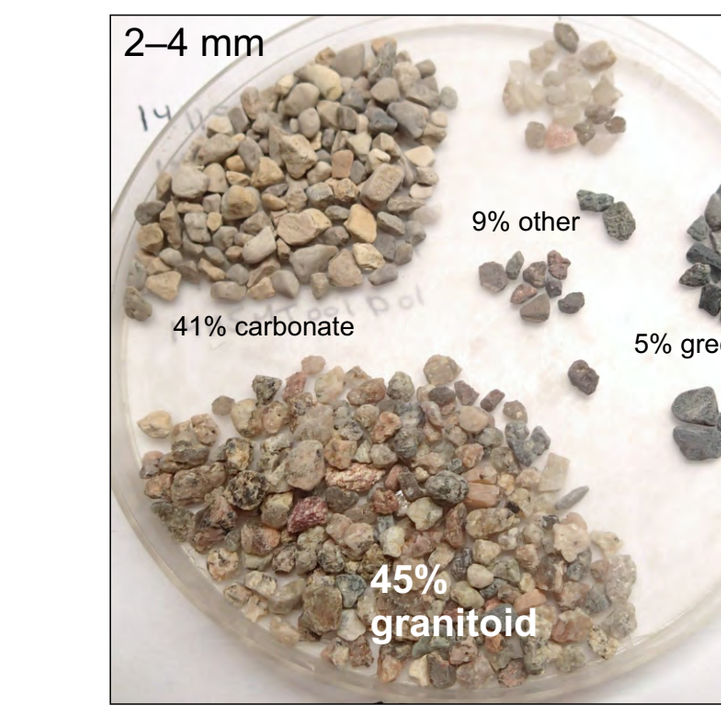
Till-clast lithology



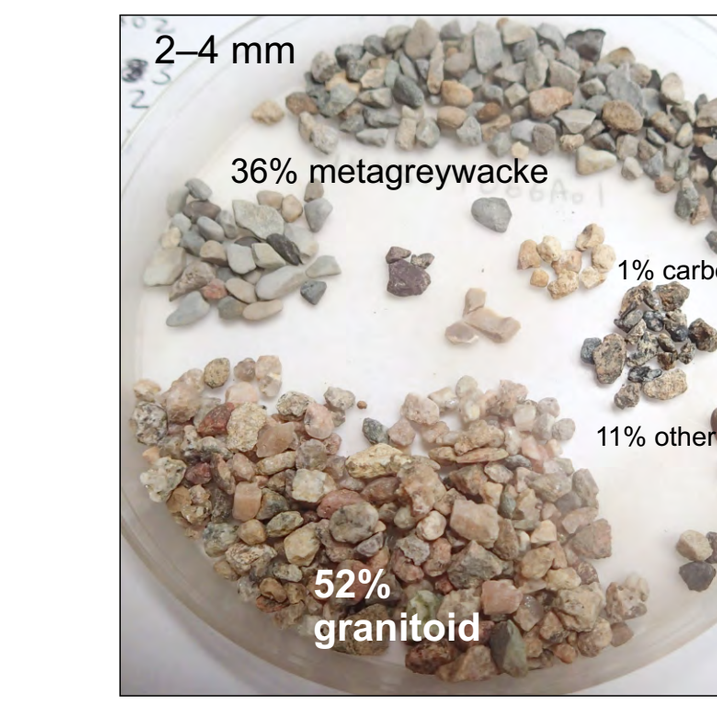
Highly calcareous carbonate-rich till, with elevated concentration of pink carbonate clasts.



Hybrid (mixed) calcareous till with grantoids (70th percentile) and greenstones (70th percentile).



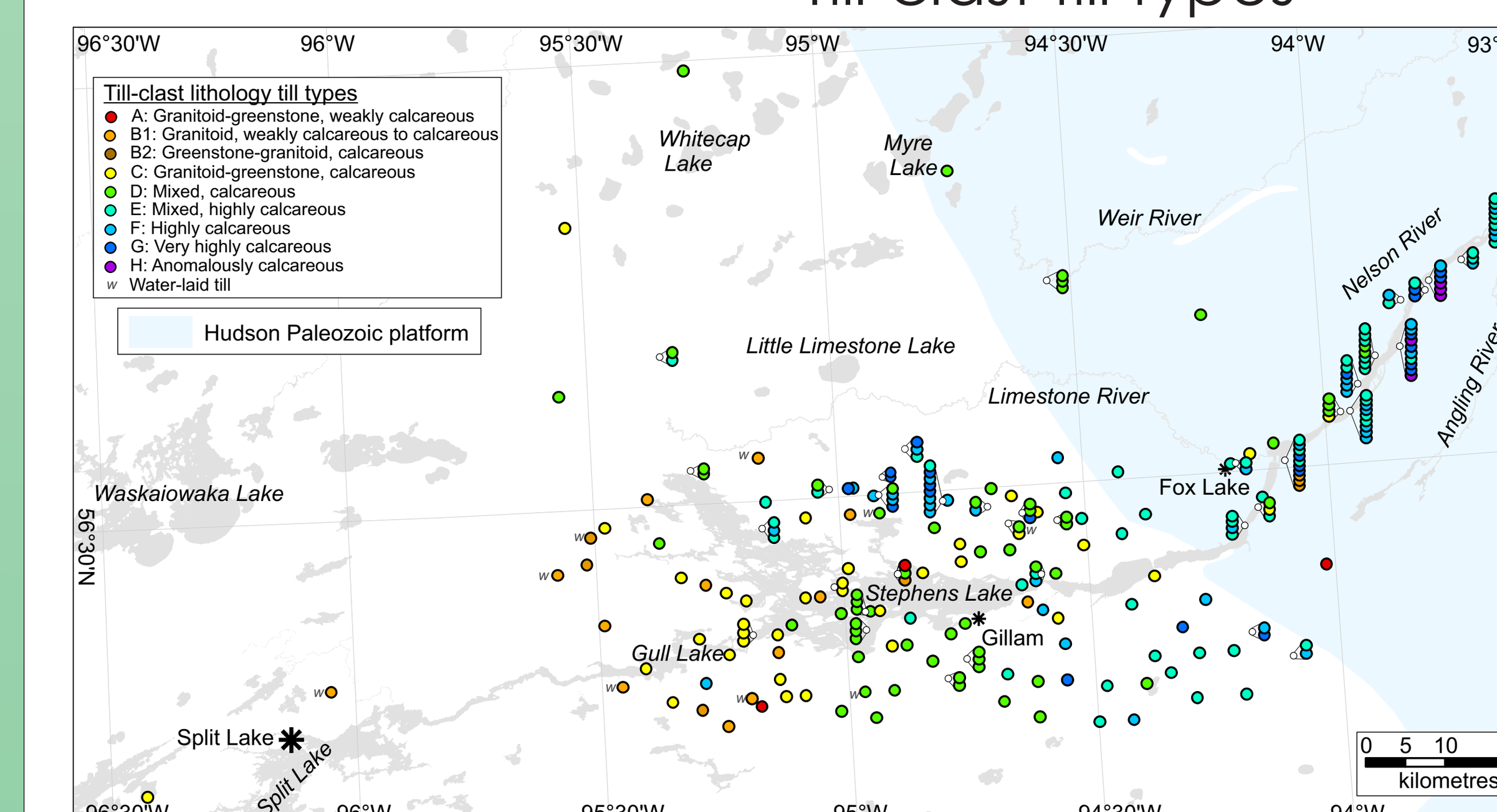
Hybrid (mixed) calcareous till with elevated (>95th percentile) grantoid concentration and a lower concentration of greenstones.

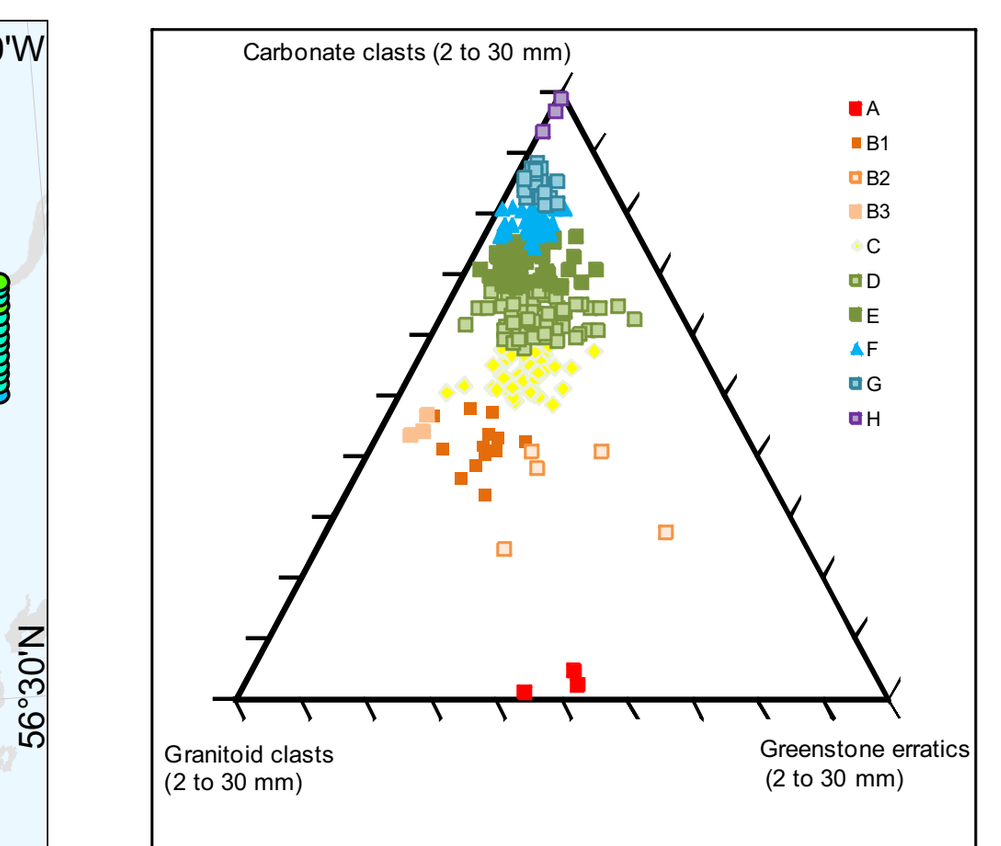


Weakly calcareous till with elevated (>99th percentile) grantoid concentration and greenstone (>95th percentile) concentration.

The wide range in eastern- and/or northeastern-sourced calcareous, and 'locally'-sourced greenstone clast concentrations, combined with the variable concentrations of northern-sourced clasts, suggests that the **regional tills are hybrids that contains different mixes of inheritance and overprinting.**

Till-clast till types

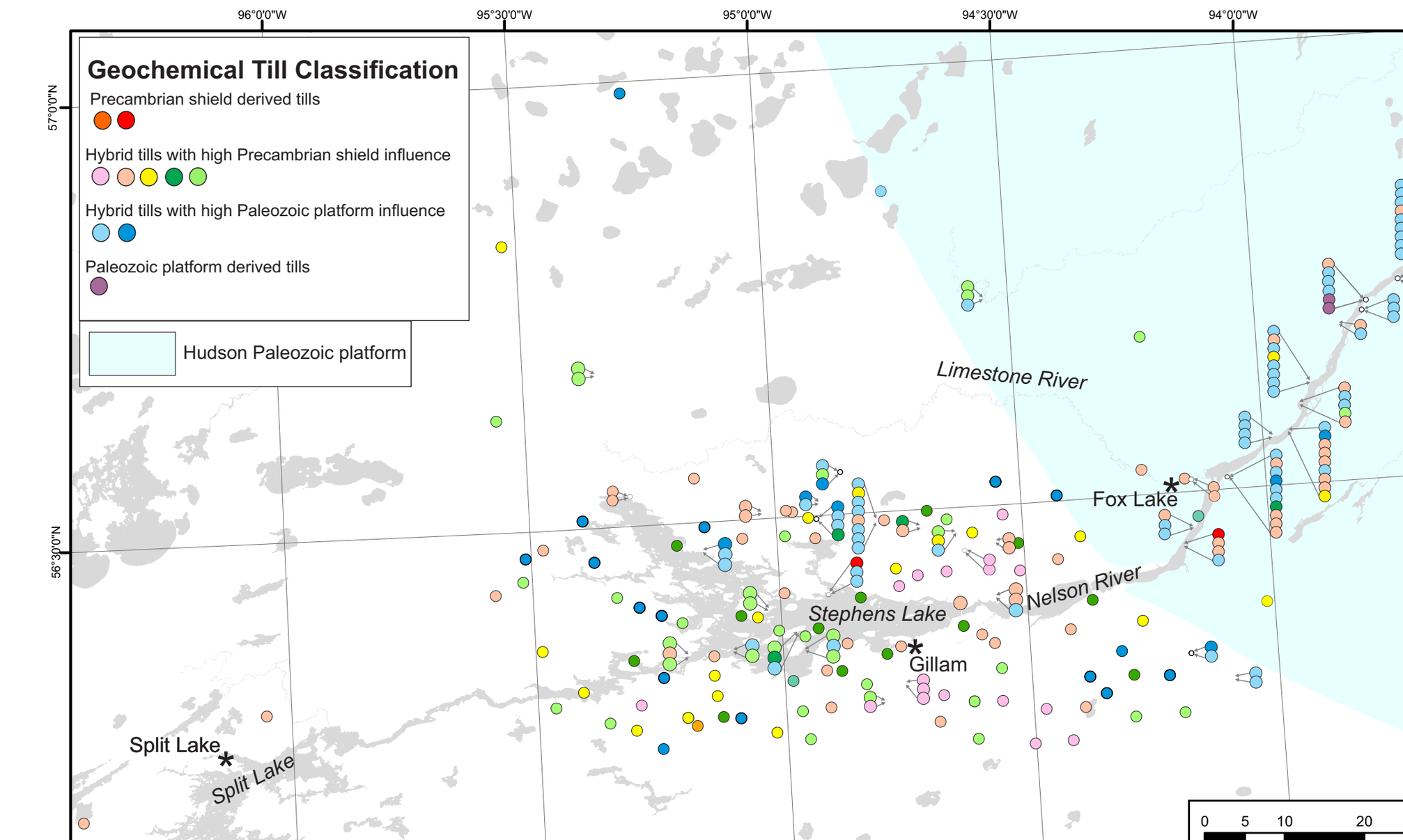




Using the till-clast lithologies, we have separated the till into 8 till types. Spatially, there appears to be a relationship between lowered carbonate-clast content and the western half of Stephens Lake.

Importantly, this area (till-types A to C) correlate with the Stephens Lake flowset (phase V ice flow).

Till-matrix geochemistry till types



Using till matrix geochemical data, comprising analysis of 251 samples for 10 major oxides and 39 trace elements, we have used multivariate statistics to examine compositional relationships between the tills in the Gillam region.

Our statistical method, known as a k-mean classification, examines all the available geochemical data, and classifies the samples into groups based on their geochemical similarities.

We are still working on analysing the similarities and differences between this classification based on till-matrix geochemistry, and the classification described above based on clast-lithology.

Future work

Final work is progressing, and we hope to provide a new till stratigraphy for the Hudson Bay Lowland. We will test our stratigraphy by correlating with sections along the Hayes and God`s rivers, as well as in the Kaskattama highlands.

Locally, three 1:50 000 surficial geology maps will be produced, and all section and sample data will be released.

Acknowledgements

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