Refined ice-flow directions of the Cordilleran Ice Sheet and implications for mineral exploration

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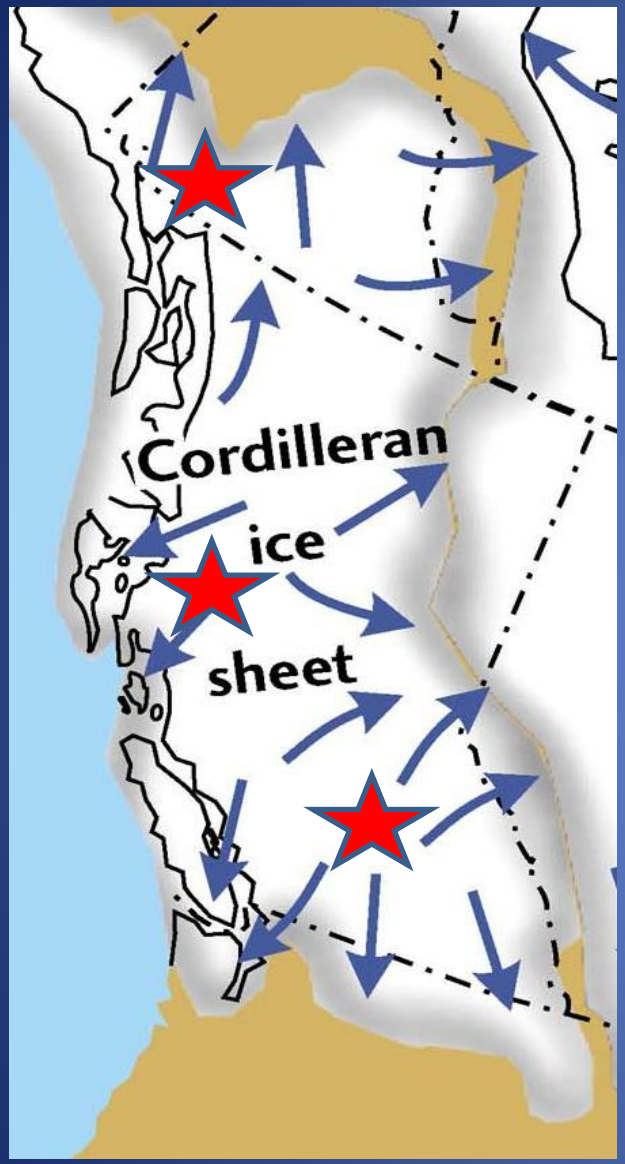
Introduction

- Mineral deposits are often buried by glacial sediments
- Locating them requires a good understanding of ice flow history
- The landform record largely reflects late glacial flow patterns
- Last Glacial Maximum (LGM), and early phase, flow patterns were considerably different



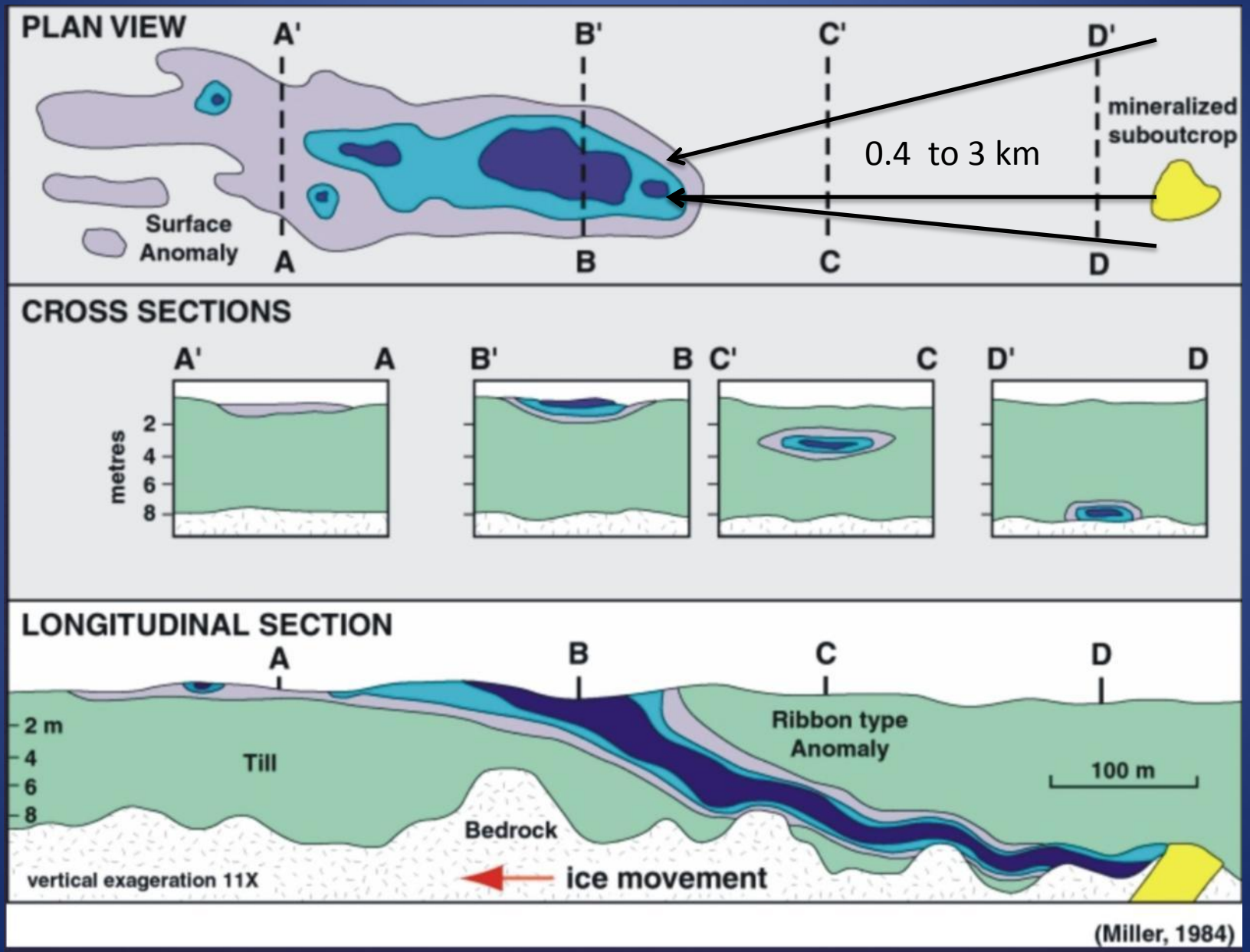
Example study areas:

1. South-central CIS, BC
2. West-central CIS, BC
3. Northern CIS, Yukon

Each area illustrates different ice flow histories and unique mineral dispersal patterns

But first, a little primer on Drift Prospecting

Drift Prospecting – the search for glacially buried and dispersed mineralization



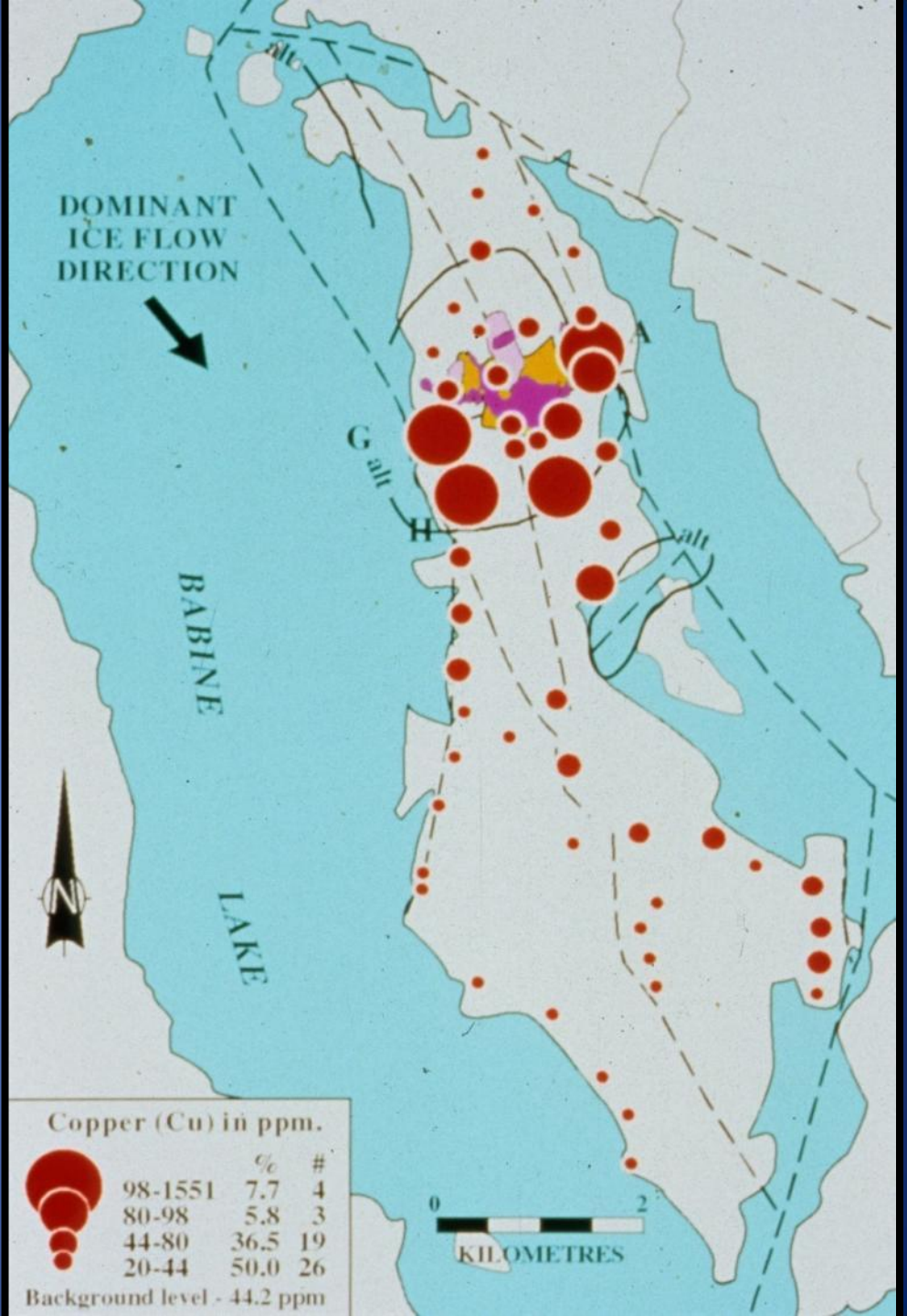
EXAMPLE DISPERSAL PATTERNS

Bell Mine: Babine Lake

- **>95%tile at 0.5 km**
- **> 85%tile at 2 km**
- **50-85%tile to 6 km down-ice**

- widespread glacio-lacustrine cover

Levson (2002)



British Columbia Geological Survey

GeoFile 2011-03

REGIONAL TO PROPERTY-SCALE DRIFT PROSPECTING SURVEYS IN BRITISH COLUMBIA

Compiled by T. Ferbey (PGeo)

DRIFT PROSPECTING DATA

- *Published regional-scale drift prospecting data (references are listed by NTS mapsheet)*
- *Published property-scale till geochemistry data (references are listed by label number)*
- *Regional-scale till geochemistry survey in progress*

INTRODUCTION

Presented here is a geographically referenced list of drift prospecting surveys that have been conducted in British Columbia. A list of topical studies and special volumes that are relevant to drift prospecting in British Columbia have also been included. These studies and geochemical data will be of interest to explorationists and researchers who are assessing the effectiveness of drift prospecting surveys in the context of their own exploration or research program, who are preparing to design and implement their own survey, or who have generated geochemical data on drift samples and are looking for data from orientation surveys for context and comparison.

To be included here, drift prospecting reports and (or) geochemical data must be published and publicly available and have used basal till or glaciofluvial gravels as sample media. These reports and data can be viewed and downloaded from the following websites:

British Columbia Geological Survey
www.empr.gov.bc.ca/Mining/Geoscience/PublicationsCatalogue/Pages/default.aspx

Geological Survey of Canada
ess.nrcan.gc.ca/essi/geoscan_e.php
gdr.nrcan.gc.ca/mirage/index_e.php

Geochemical surveys that used B-horizon soils, lacustrine sediments, or stream sediments as sample media are not included here.

Regional-scale studies listed used geochemical determinations on basal till samples to asses the base and precious metal potential of a particular region. The exception to this is work that was conducted in northeast British Columbia that used glaciofluvial gravels, and to a lesser extent basal till samples, to assess this region's diamond potential. Property-scale surveys were designed to characterise the clastic dispersal of mineralization in basal till from known mineralized bedrock sources. References for property-scale surveys are organized by the mineral deposit type they were conducted over or around. Data from these detailed studies are important as they provide a basis for comparing regional-scale geochemical data to that from known mineralized sources. This comparison is important in assessing which basal till samples in a regional-scale program could be considered elevated and worthy of follow-up work. Till geochemical surveys that are currently in progress are also included here. References for this work will be provided as the surveys are completed.

Also included here is a list of references for studies that may not necessarily have been conducted in British Columbia but that are relevant to drift prospecting surveys regardless of the glaciated region or country they are to be conducted in. These studies have a topical, rather than geographic, focus and can provide invaluable insight into the design, implementation, and interpretation of drift prospecting surveys. References are also presented for the five most recently published volumes on drift prospecting. Papers within these volumes also have a topical focus and can provide important background information on the subtleties of drift prospecting programs, which can vary from one physiographic region to another, using theory and data from case studies. For example, preparation for any drift prospecting program in the Canadian Cordillera would be incomplete without a thorough review of Levson (2001).

This map and list of references is intended to provide a way of quickly identifying drift prospecting studies and data that are either geographically or topically of interest to those working in British Columbia. Any omission in the reference list or on the map should be brought to the attention of the compiler. This publication will be updated on an annual basis.

ACKNOWLEDGEMENTS

A. Plouffe (GSC, Ottawa), B.C. Ward (SFU), and W. Jackaman (Noble Exploration Services Ltd.) are thanked for their comments, suggestions, and improvements to this map and list of references and helping keep it up to date.

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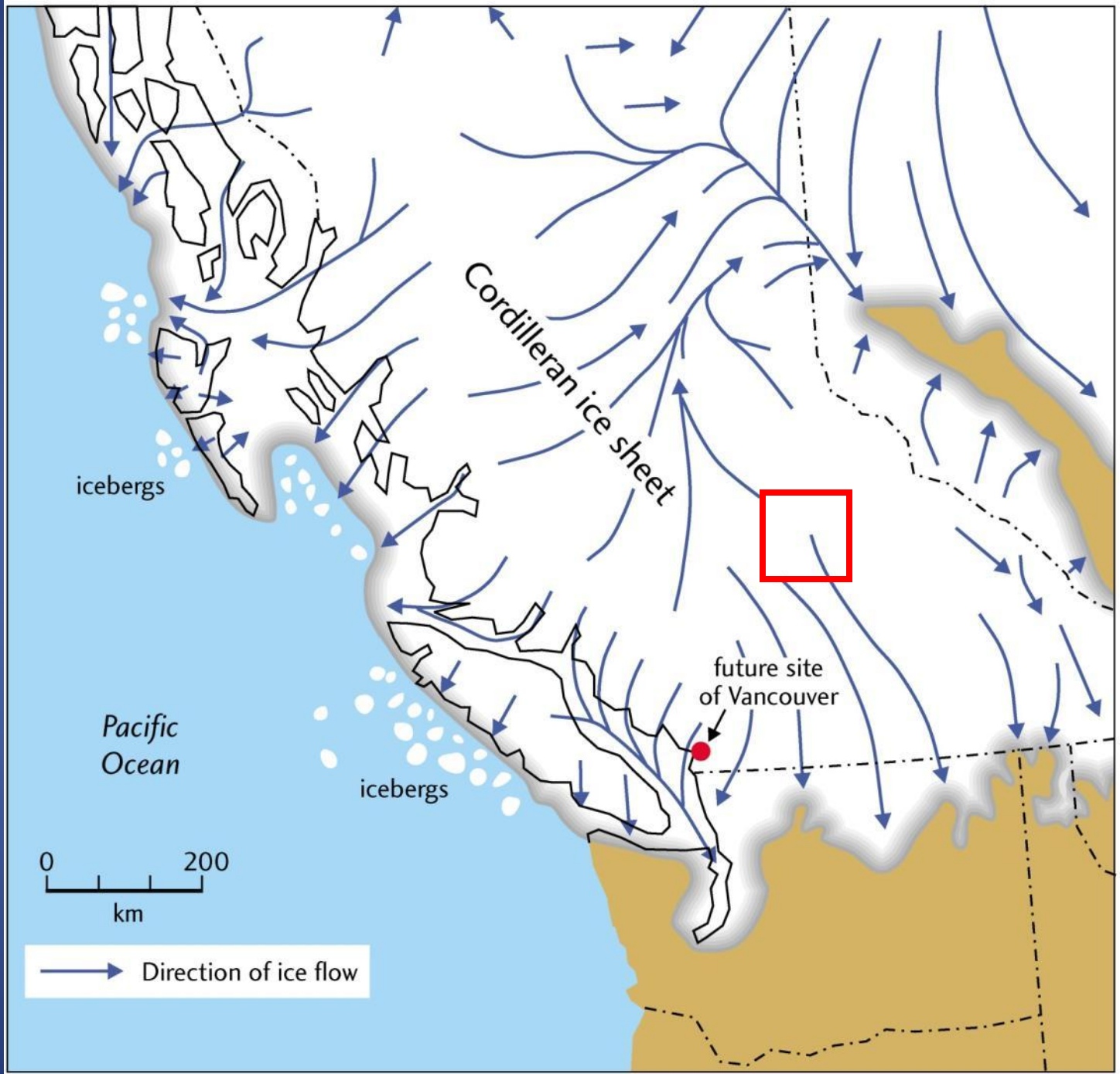
Till geochemical surveys in BC and Yukon with associated mapping programs, GSC, BCGS and YGS

Some recent mineral discoveries with the help of drift prospecting/ till geochemistry in CIS

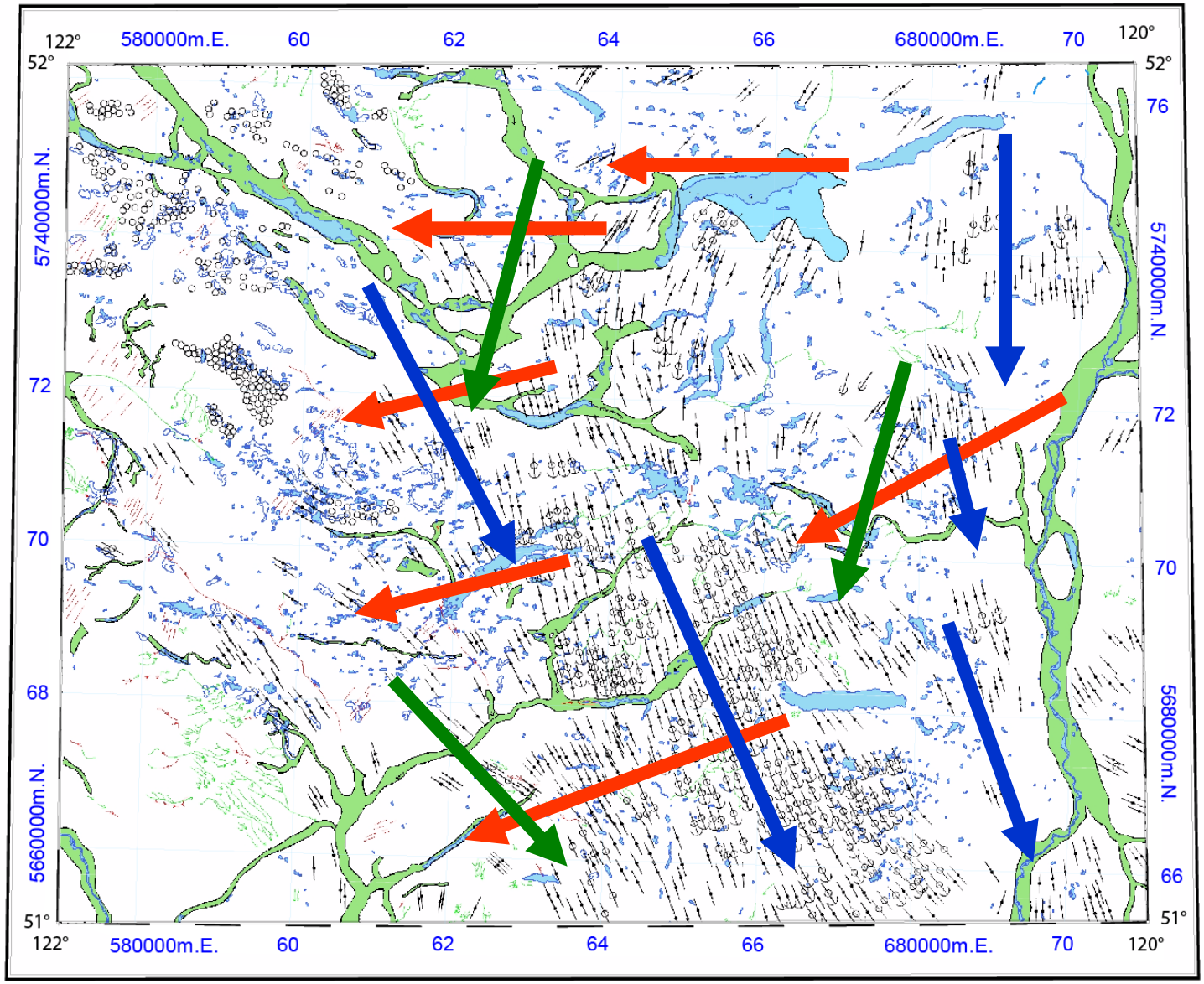
- Boulder tracing of gold mineralization (Plouffe et al. 2011 CJES)
- Red Sky property (Ferbey 2010)
- Potential Cu mineralization north of known mineralization at Huckleberry Mine (Ferbey and Levson 2009)
- East Detour Gold anomaly (Bond and Plouffe 2003; YEG)
- Big Salmon Fault gold anomaly (Bond and Plouffe 2003; YEG)
- Spice Claims (Bond and Plouffe 2002; YEG)
- 3Ts and Cigar anomalies (Levson et al. 1994; Levson, 2001)

BC study area 1:

South-central BC: Bonaparte Lake area

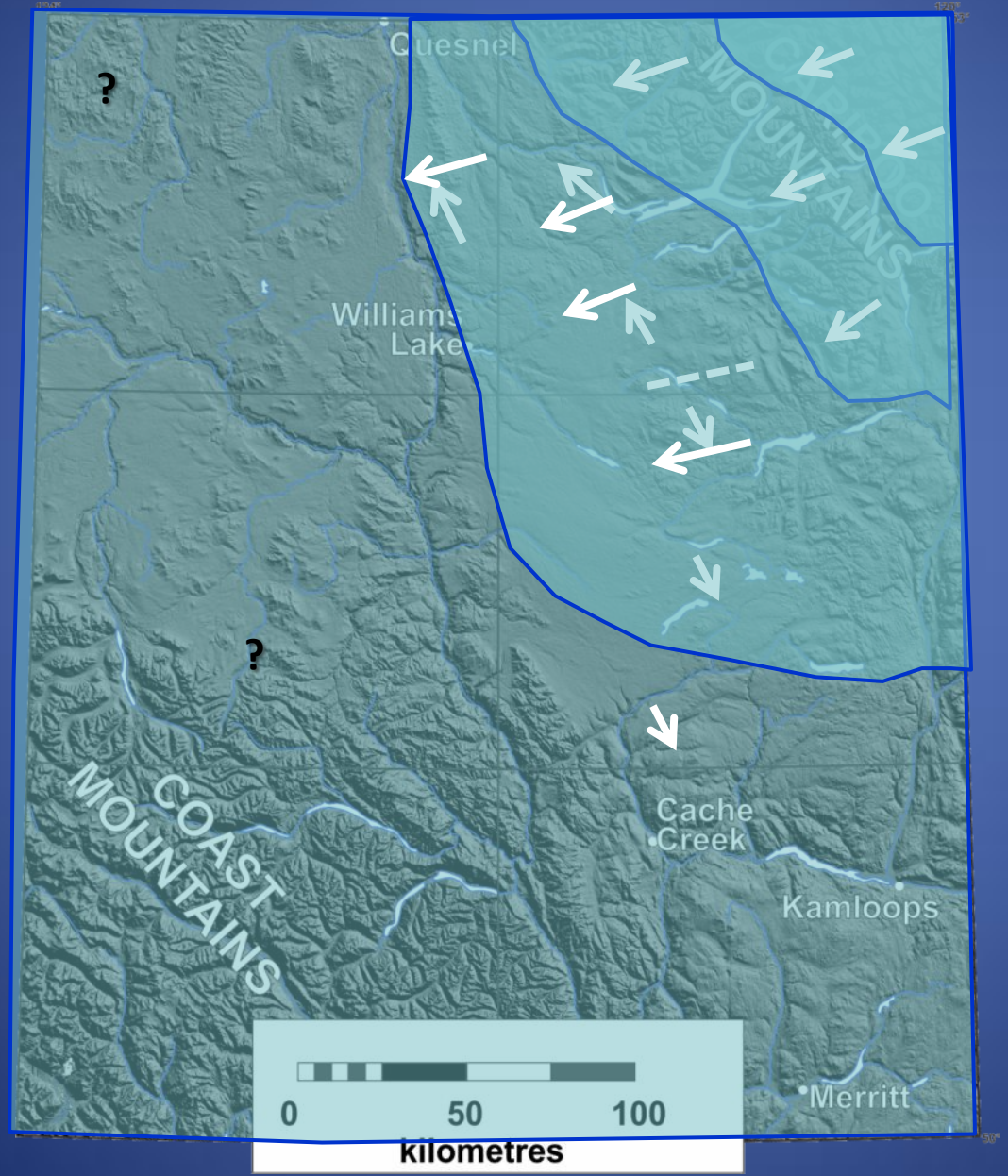


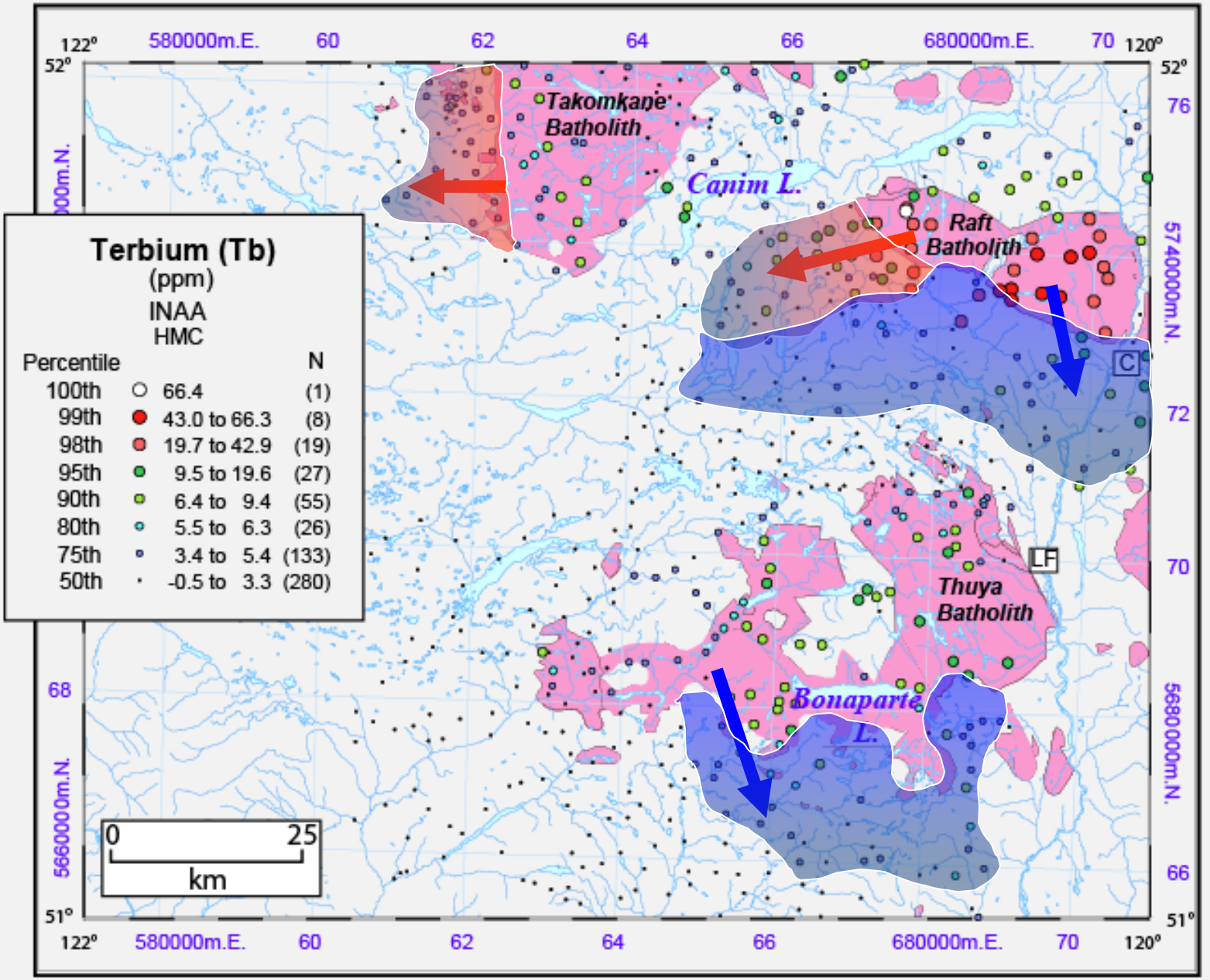
Ice-flow history: south central British Columbia



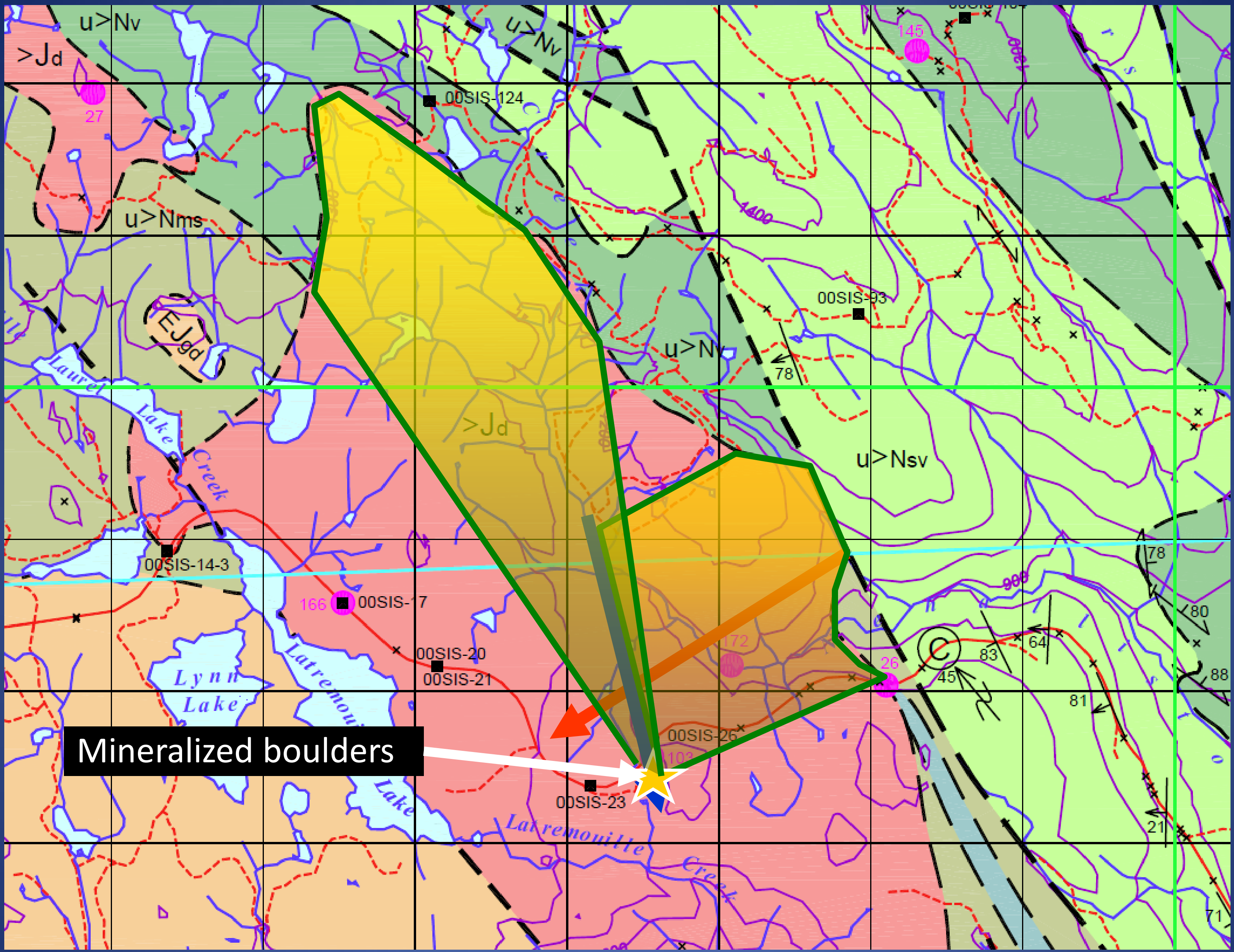
(Plouffe et al., 2011, CJES)

ICE-FLOW HISTORY





(Plouffe et al., 2011, CJES)



Schriazzia et al. (2002; OF 2002-4)

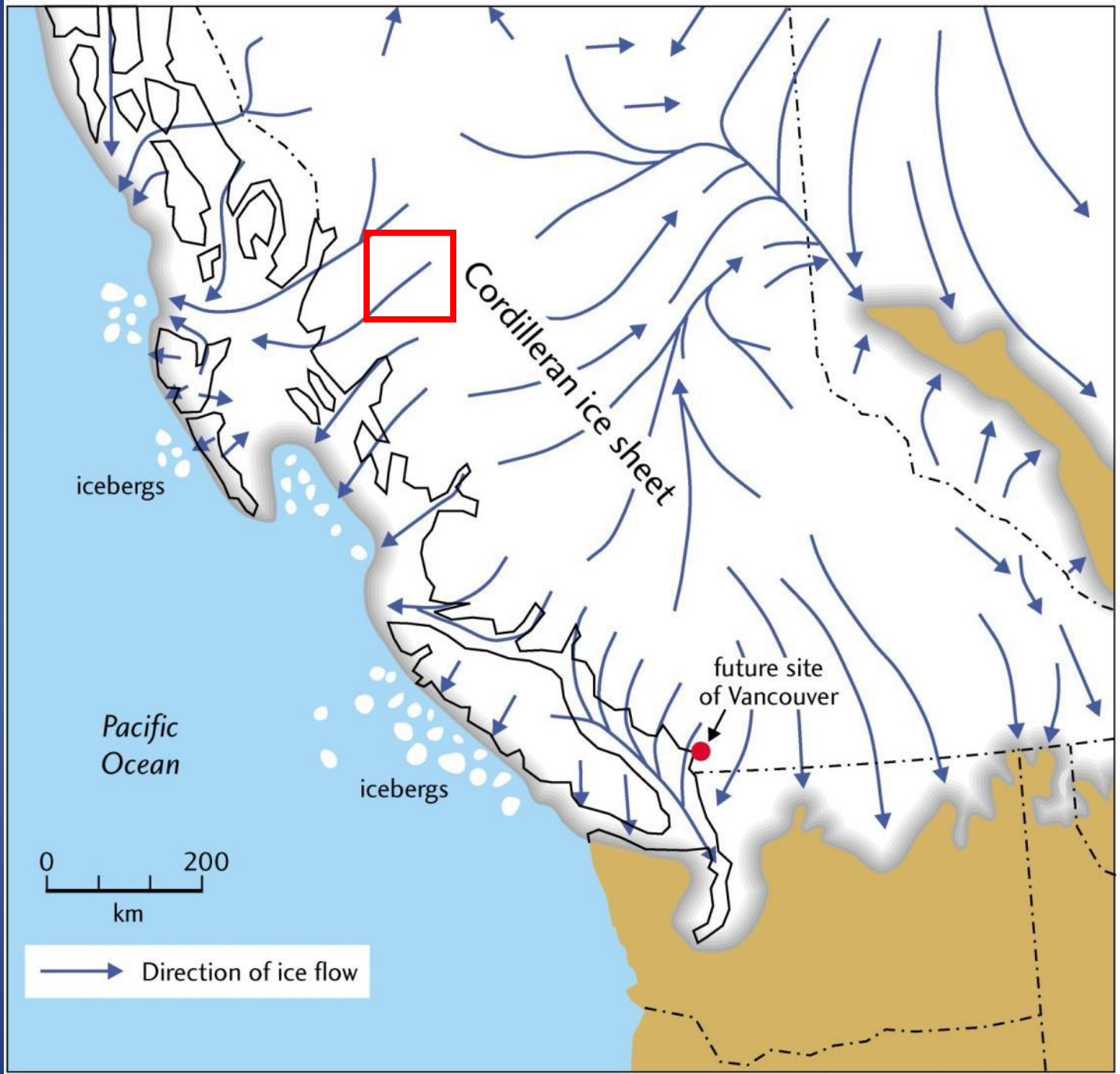
SCALE 1:50 000

0 1 2 3 4 5

Kilometres

BC study area 2:

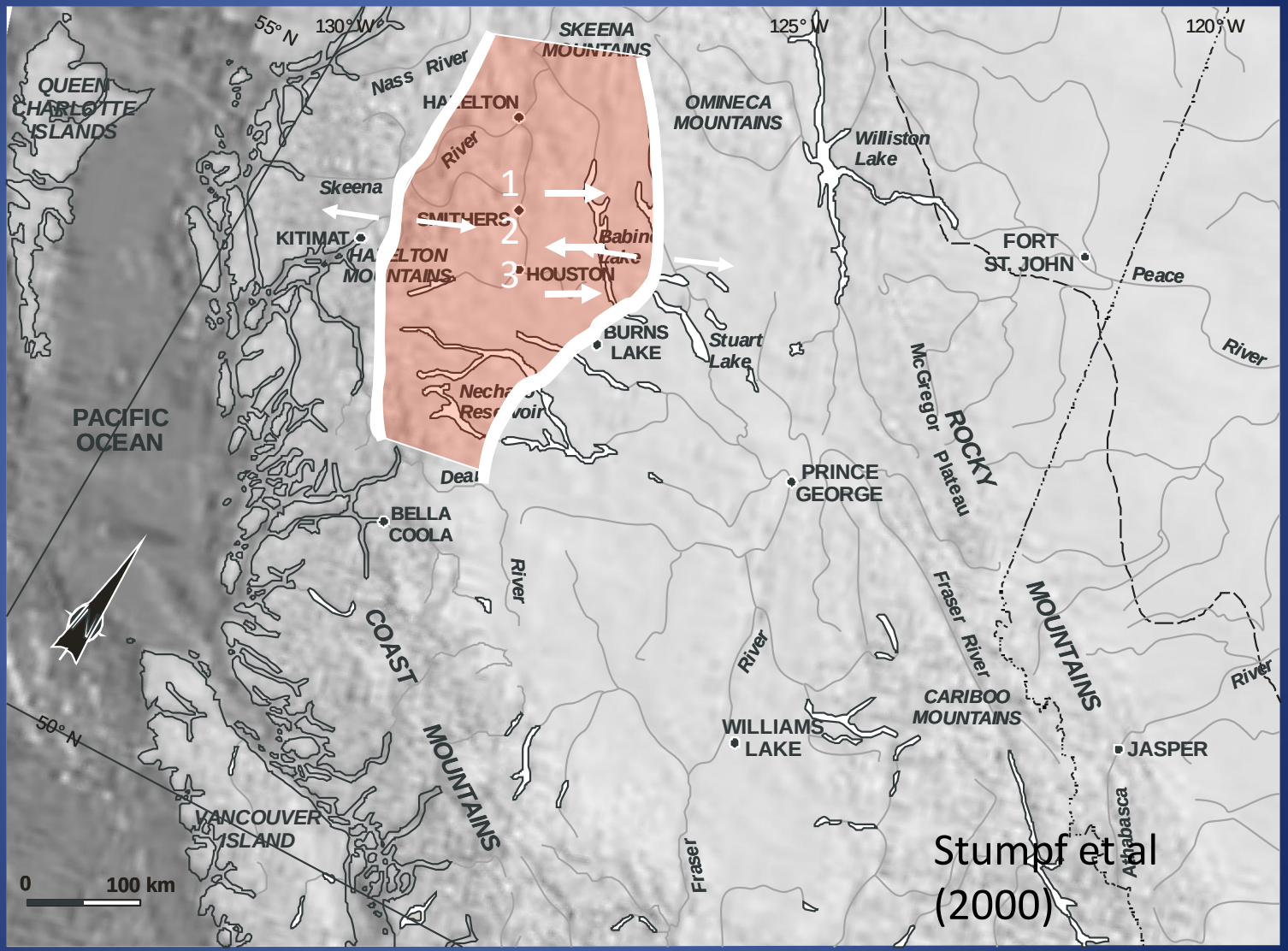
West-central Coast Mtns / Interior Plateau; Huckle-berry mine case study



Well developed streamlined landforms in valleys and Plateau areas – dominates dispersal in areas of relatively thin till

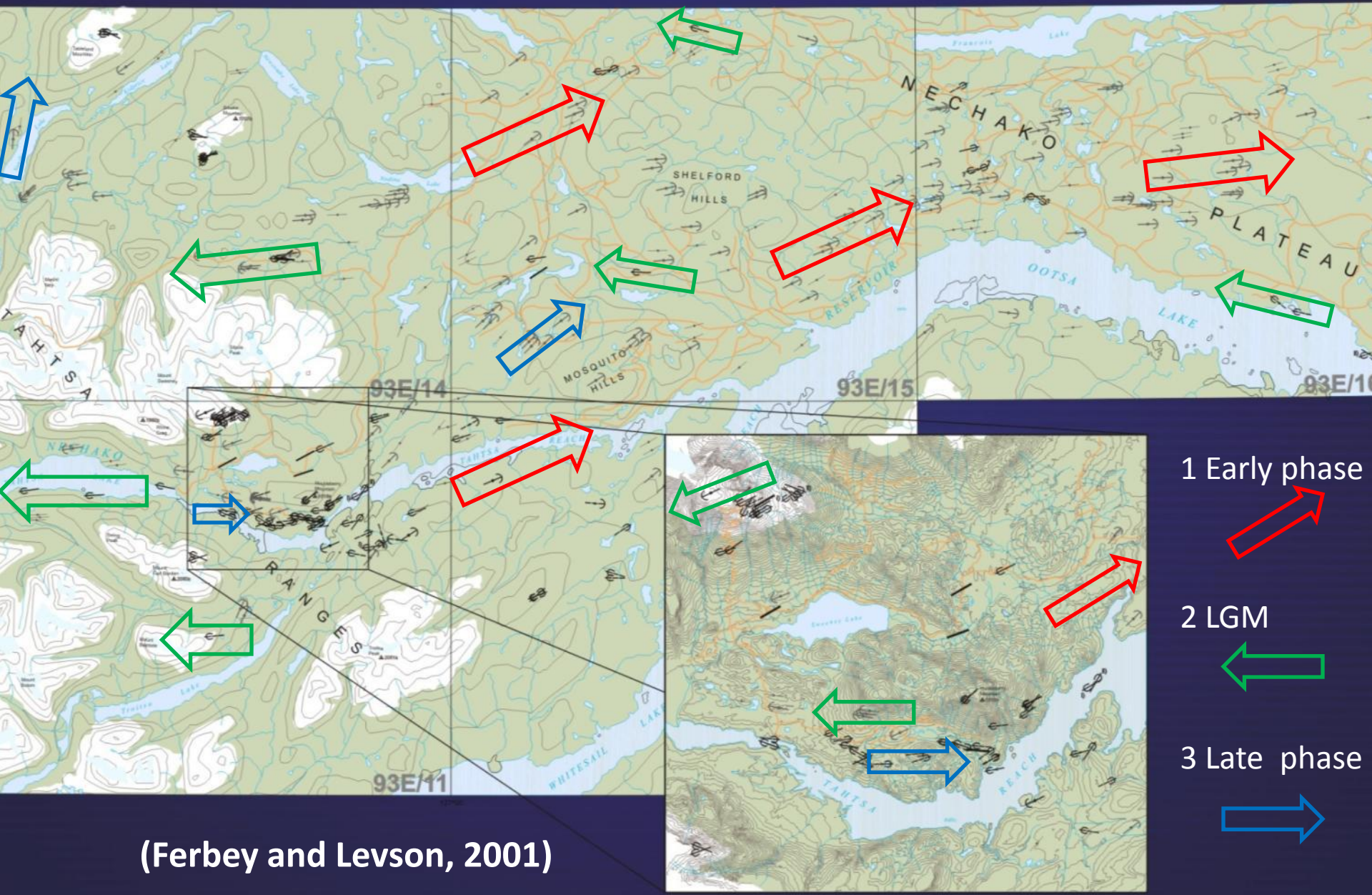
Older LGM flow preserved in striae and erosional rock forms (roche moutonnées) at higher elevations

Migration of ice divide



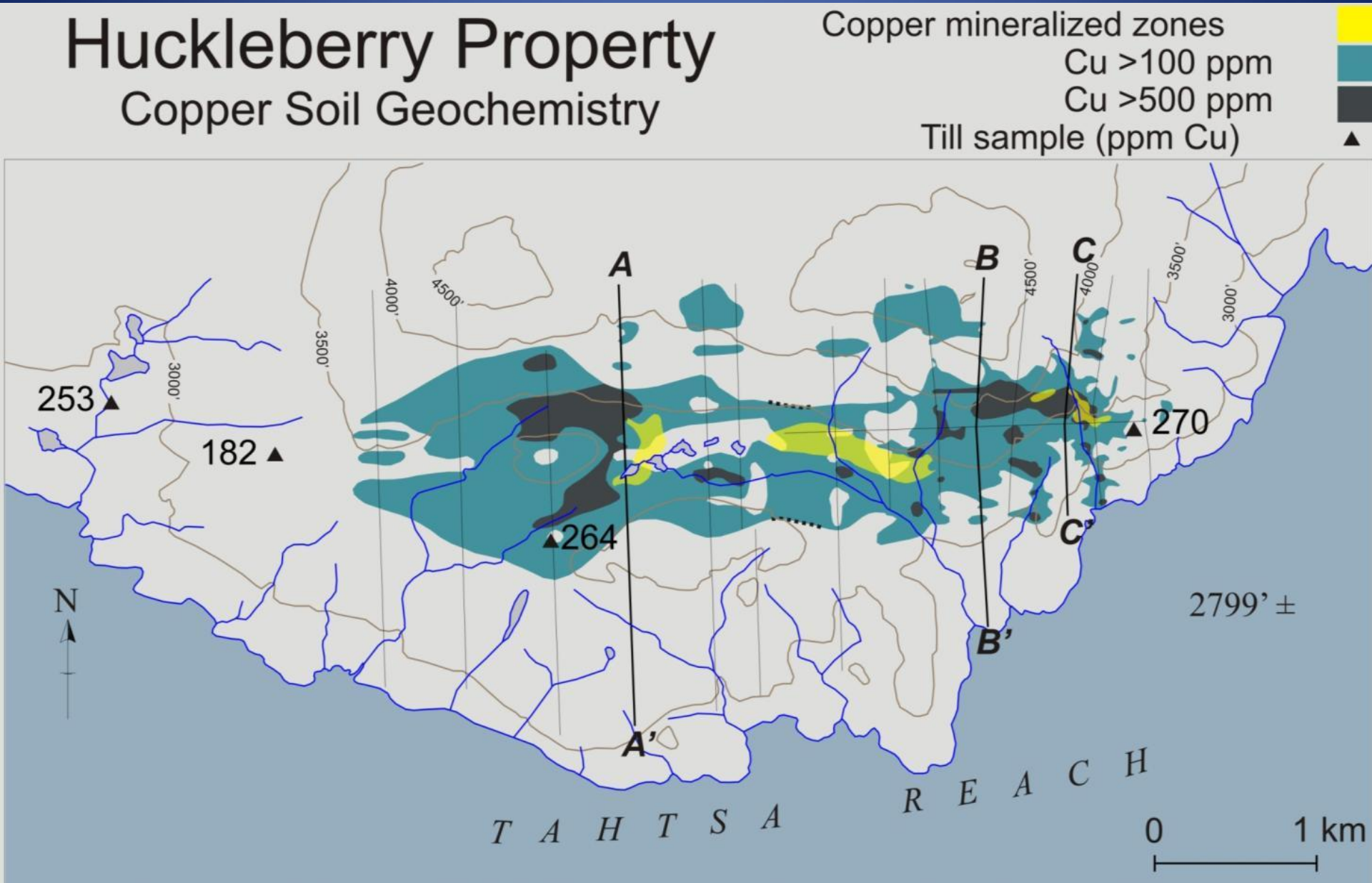
Stumpf et al (2000)

Ice Flow History, Huckleberry Mine Area

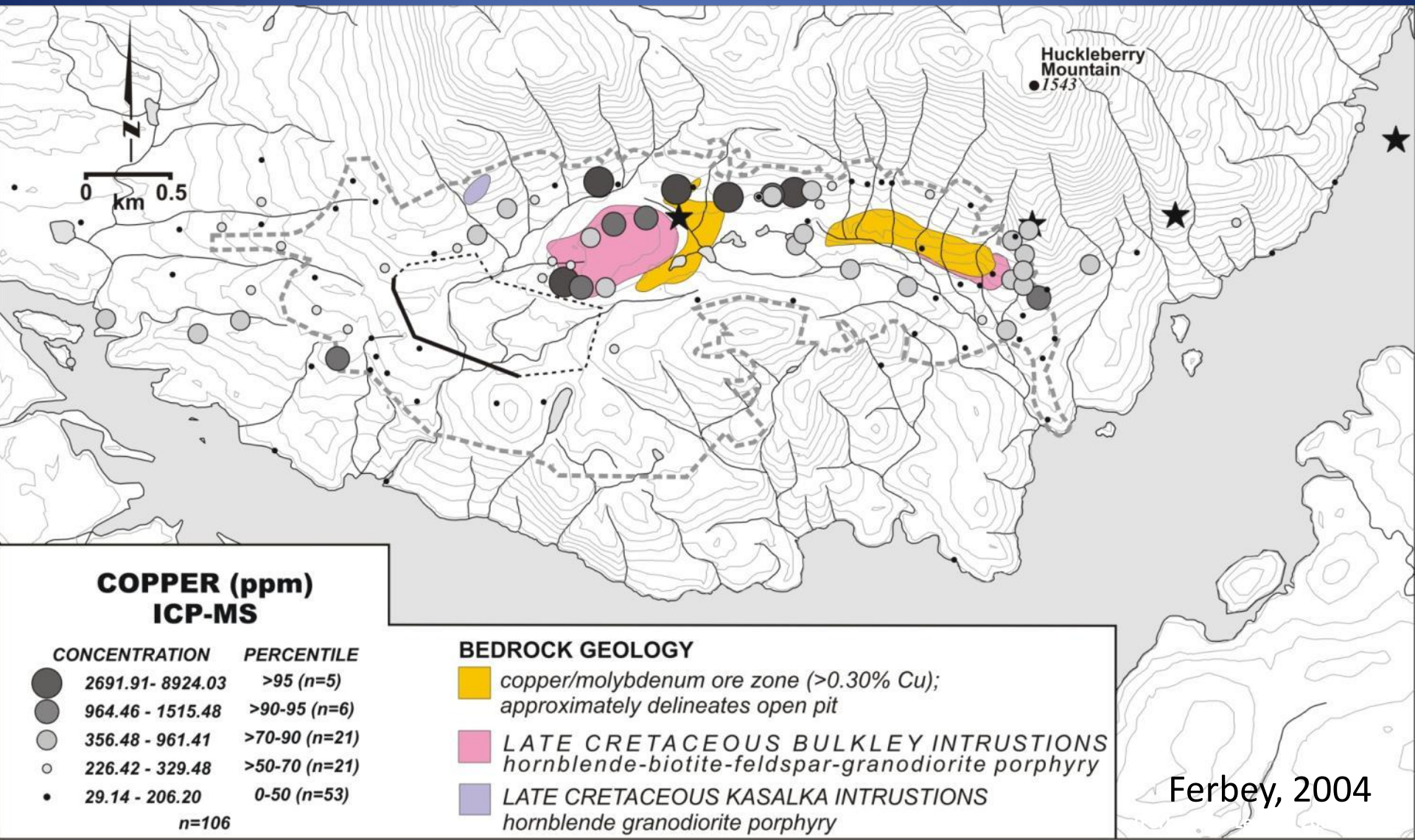


(Ferbey and Levson, 2001)

Soil geochemistry - High copper in soils occurs mainly west of the deposit but multiple ore zones complicate the dispersal patterns.

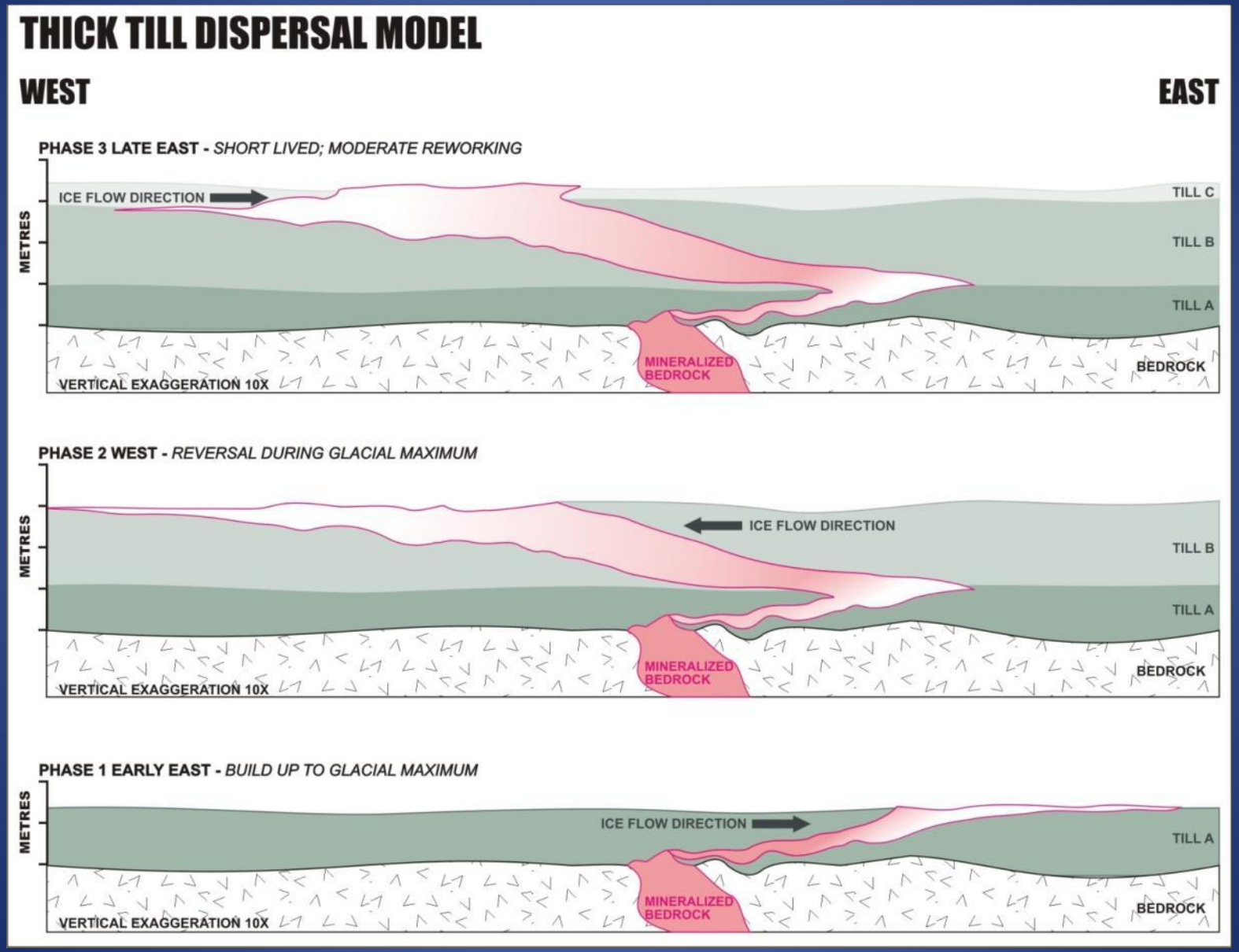


Copper in till: 95$^{\%tile}$ (>2691 ppm) up to 500 m west of deposit; > 90$^{\%tile}$ (>946 ppm) up to 2 km west; extensive early-phase and minor late-phase eastward dispersal



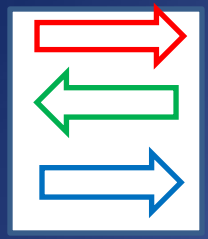
Ferbey, 2004

Migration of ice-divide: impact on glacial dispersal

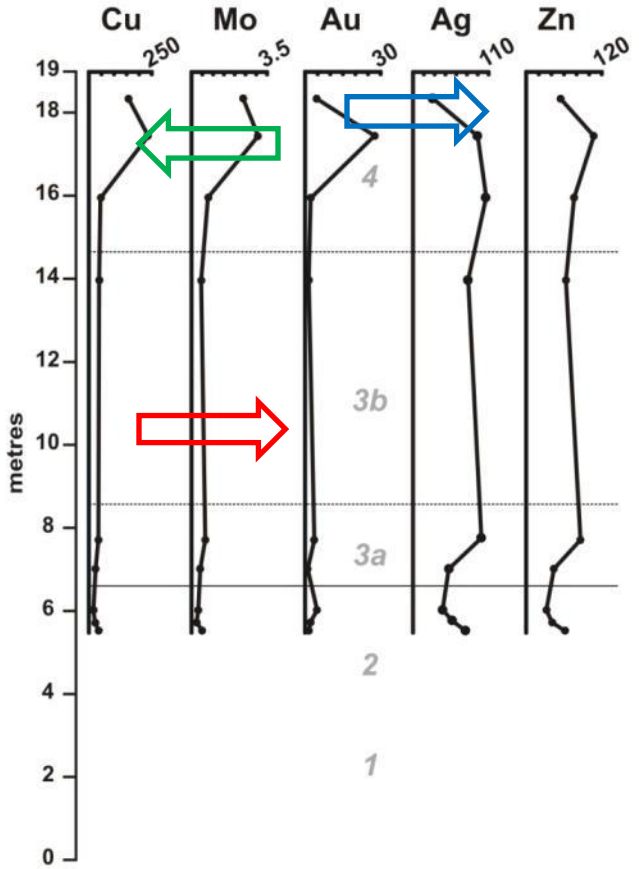


Ferbey et al. (2012; BCGS Open File 2012-02)

The ice flow reversals are recorded in the subsurface till stratigraphy & geochemistry
This site, west of the deposit, shows

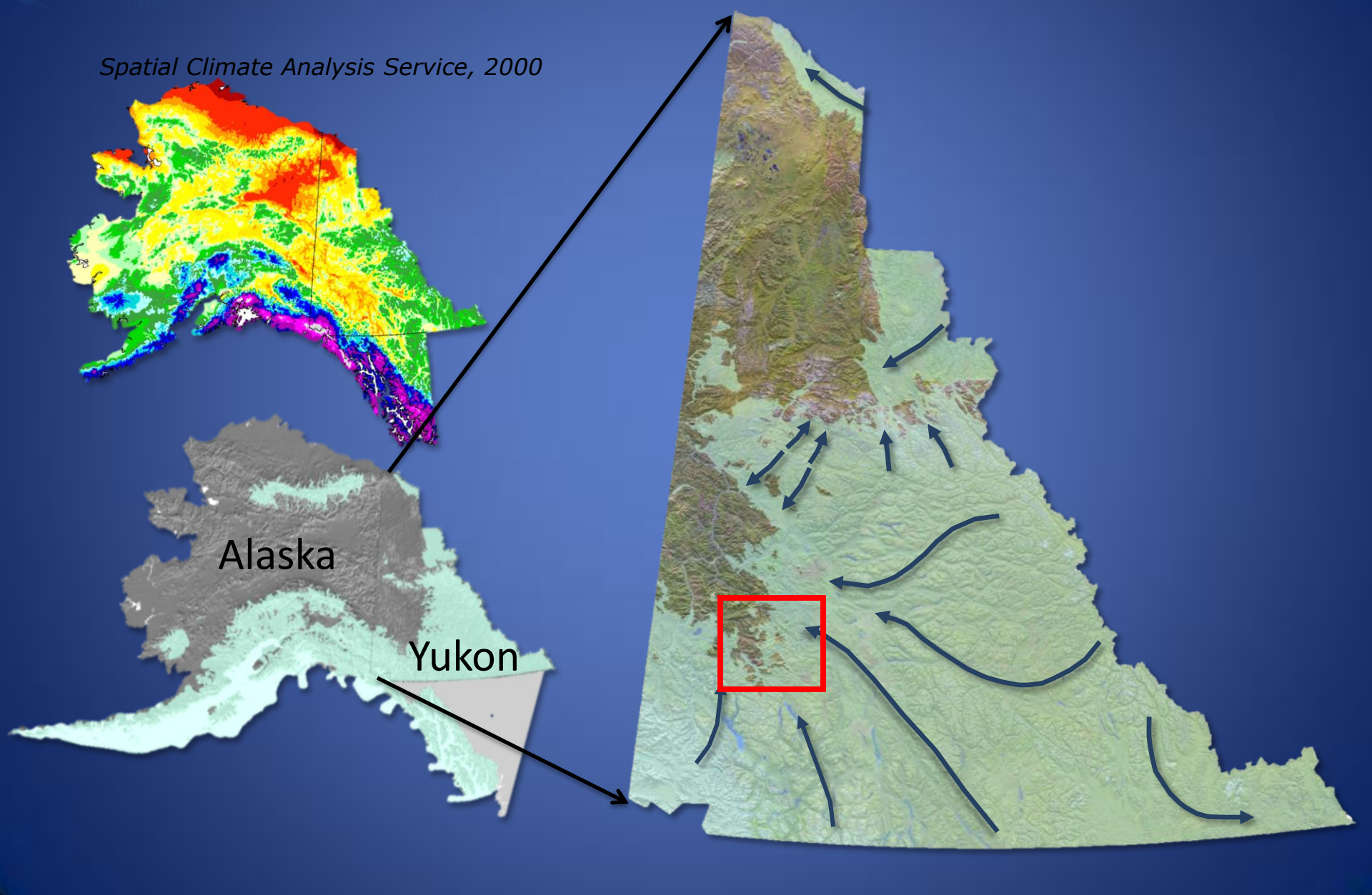


1) extensive early phase eastward dispersal followed by
2) westward transport of mineralized debris and
3) Minor late eastward dispersal

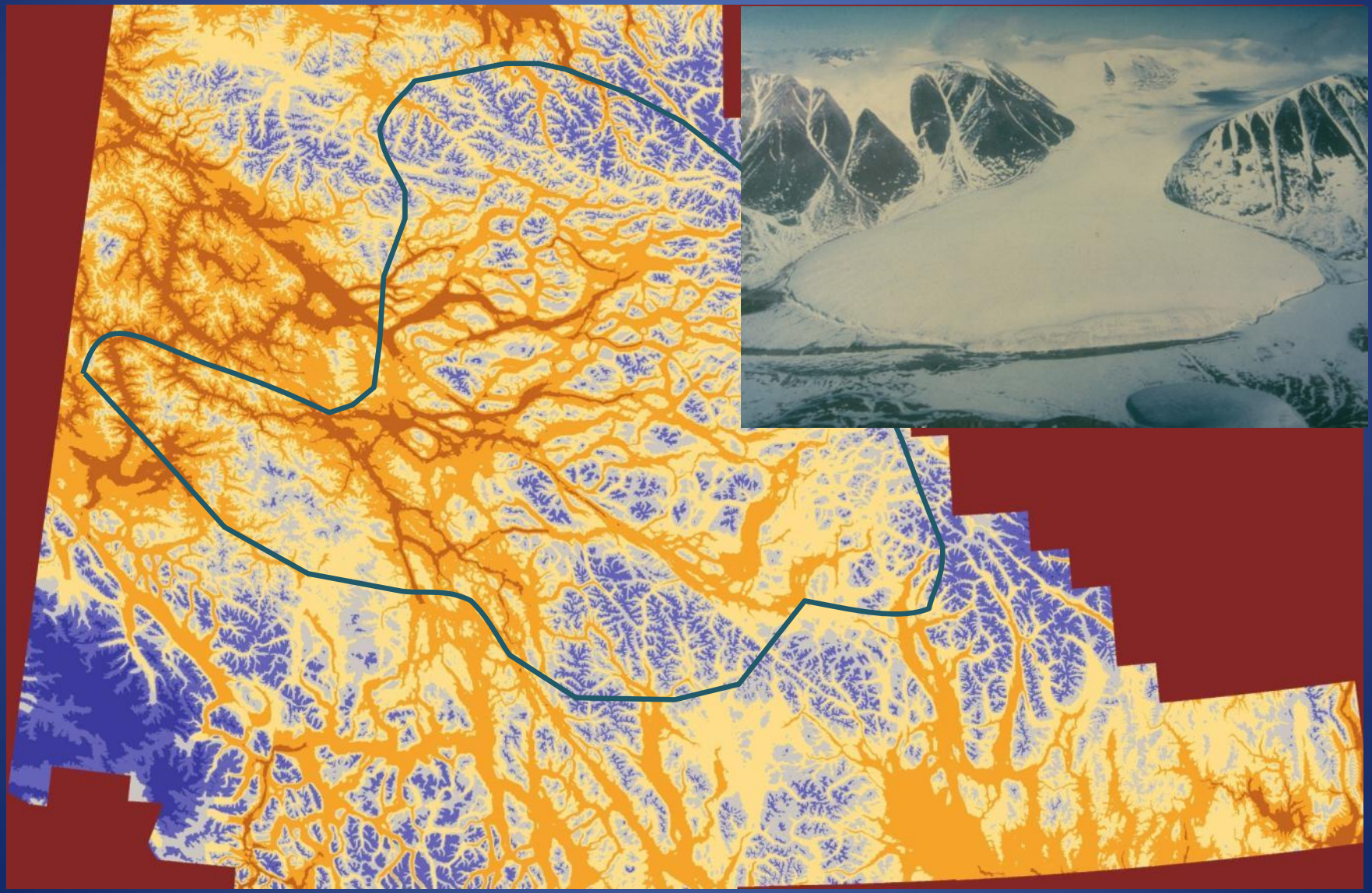


Ferbey, 2004

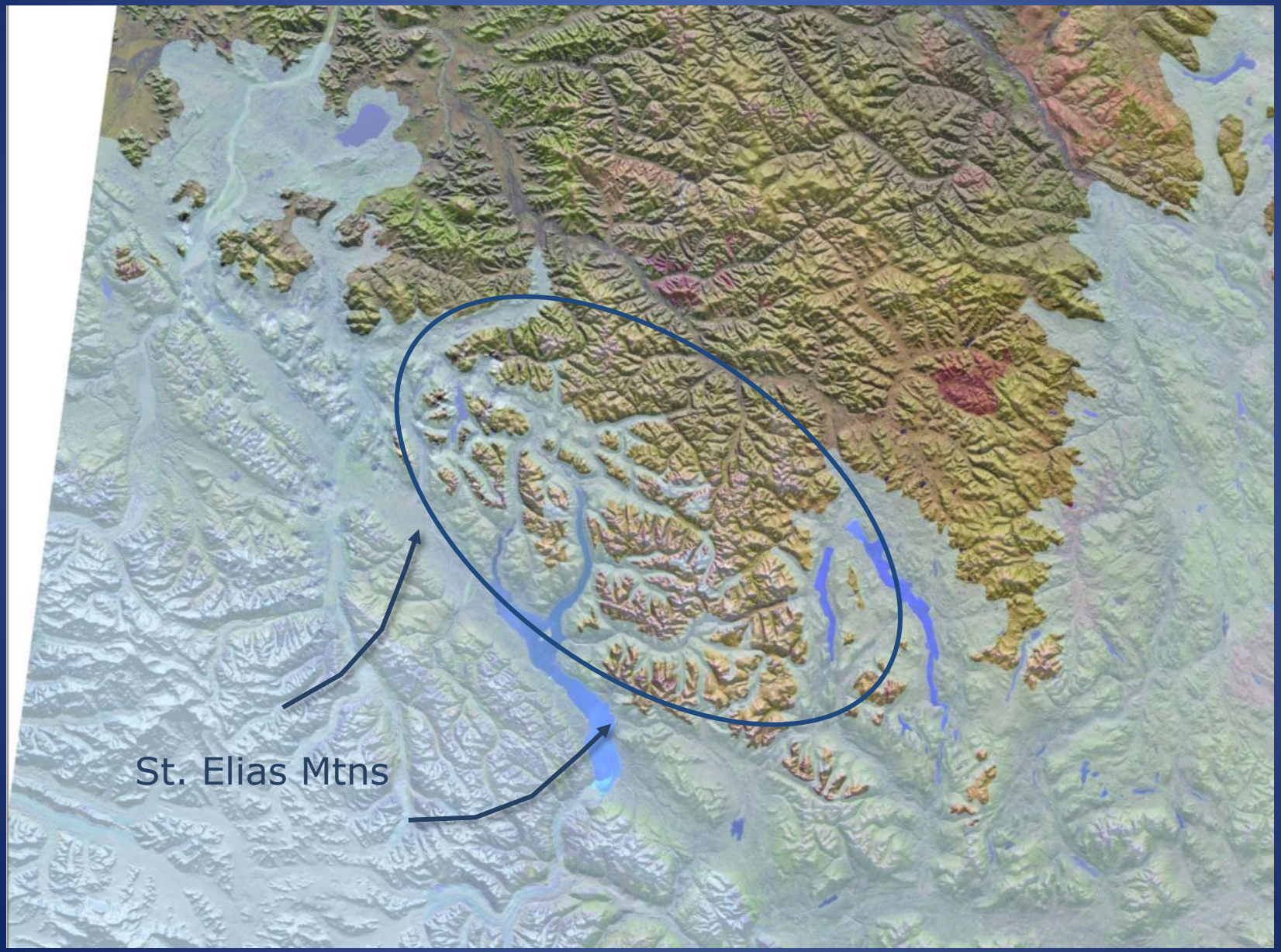
Study area 3: relatively dry interior of Yukon

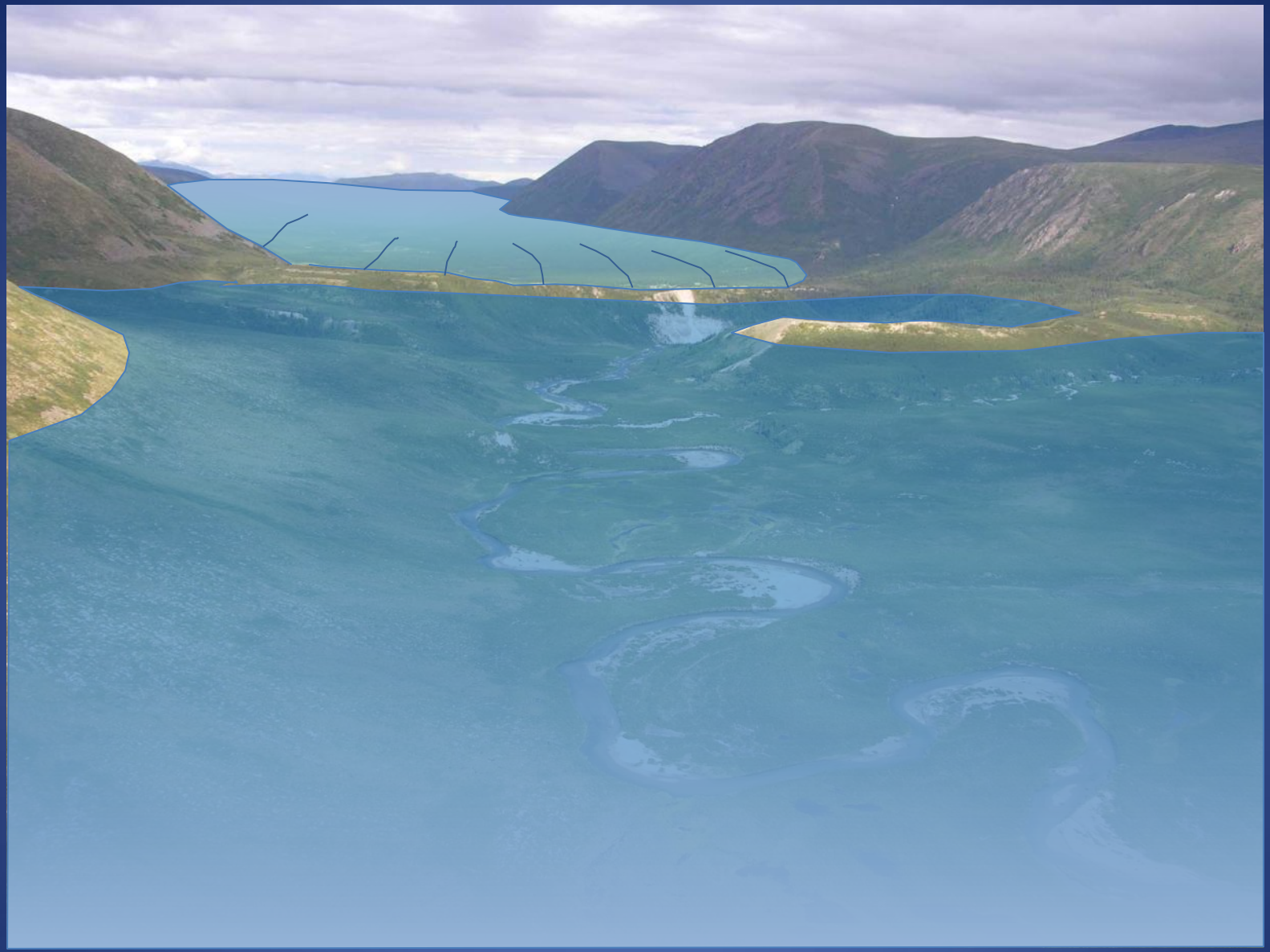


Alpine glaciers locally expanded in the Yukon Interior but ice accumulation was limited by aridity



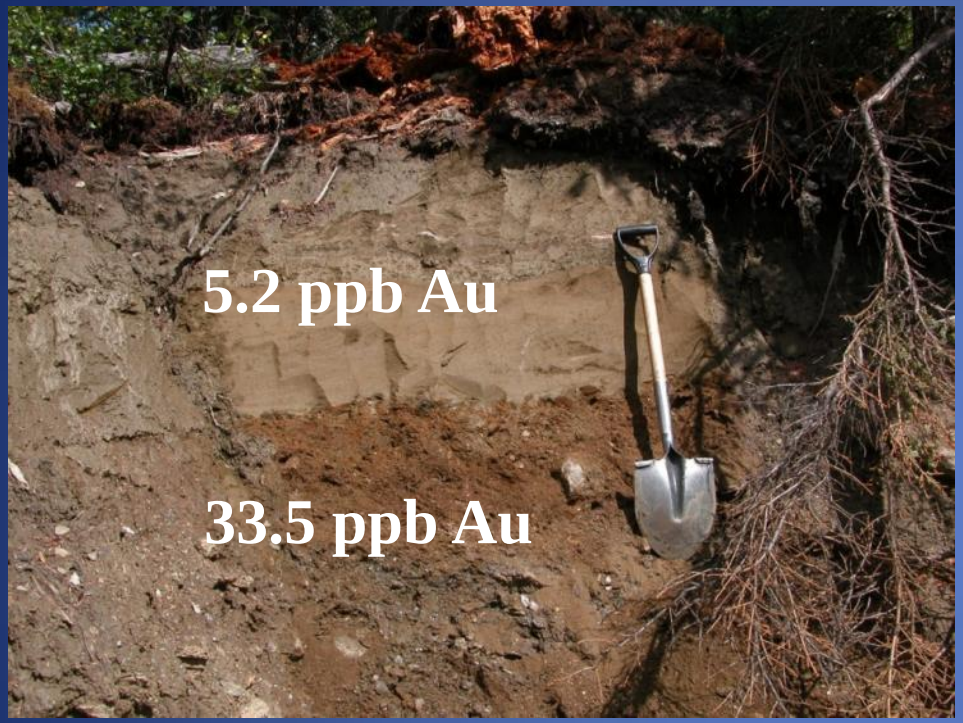
Eventually the CIS invaded the interior; Example shown: CIS invading the Ruby Range from St Elias Mtns

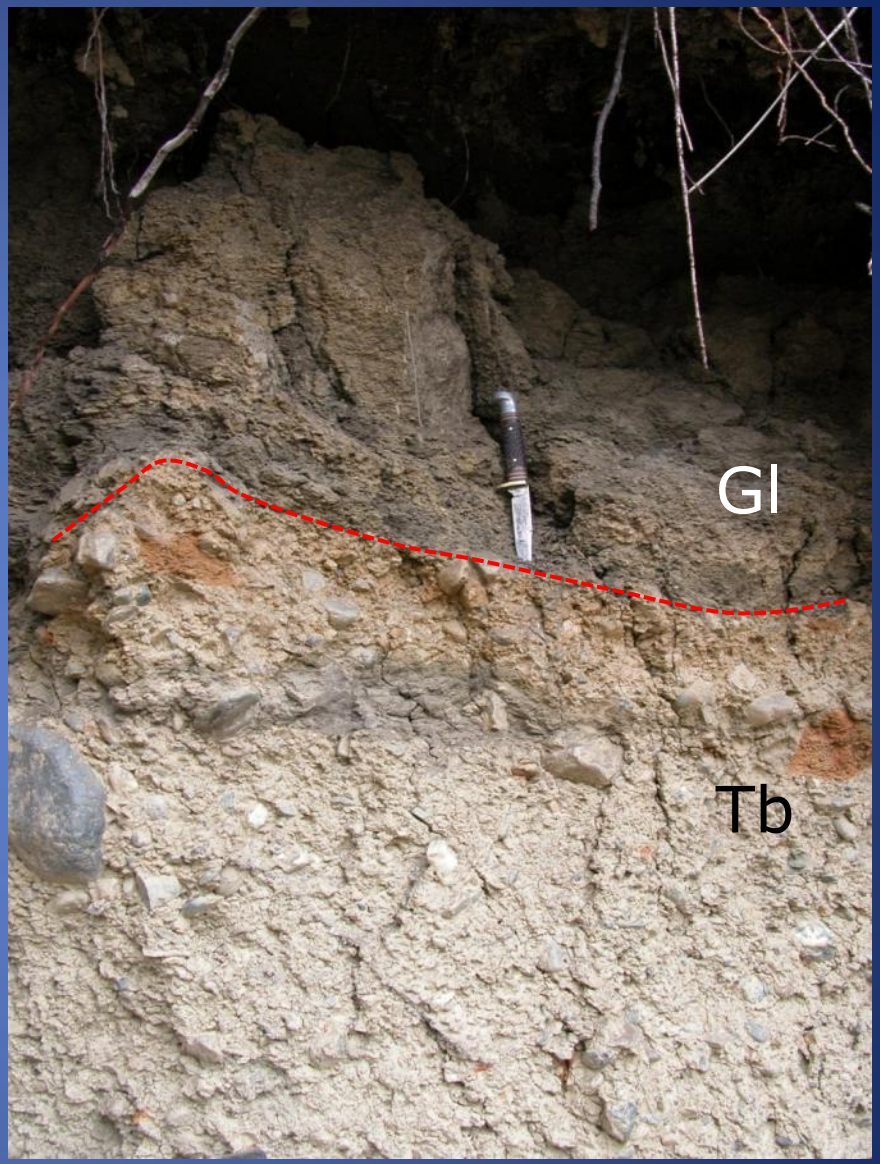




In many areas, CIS ice advanced up valleys and dammed large glacial lakes

Yukon Geological Survey

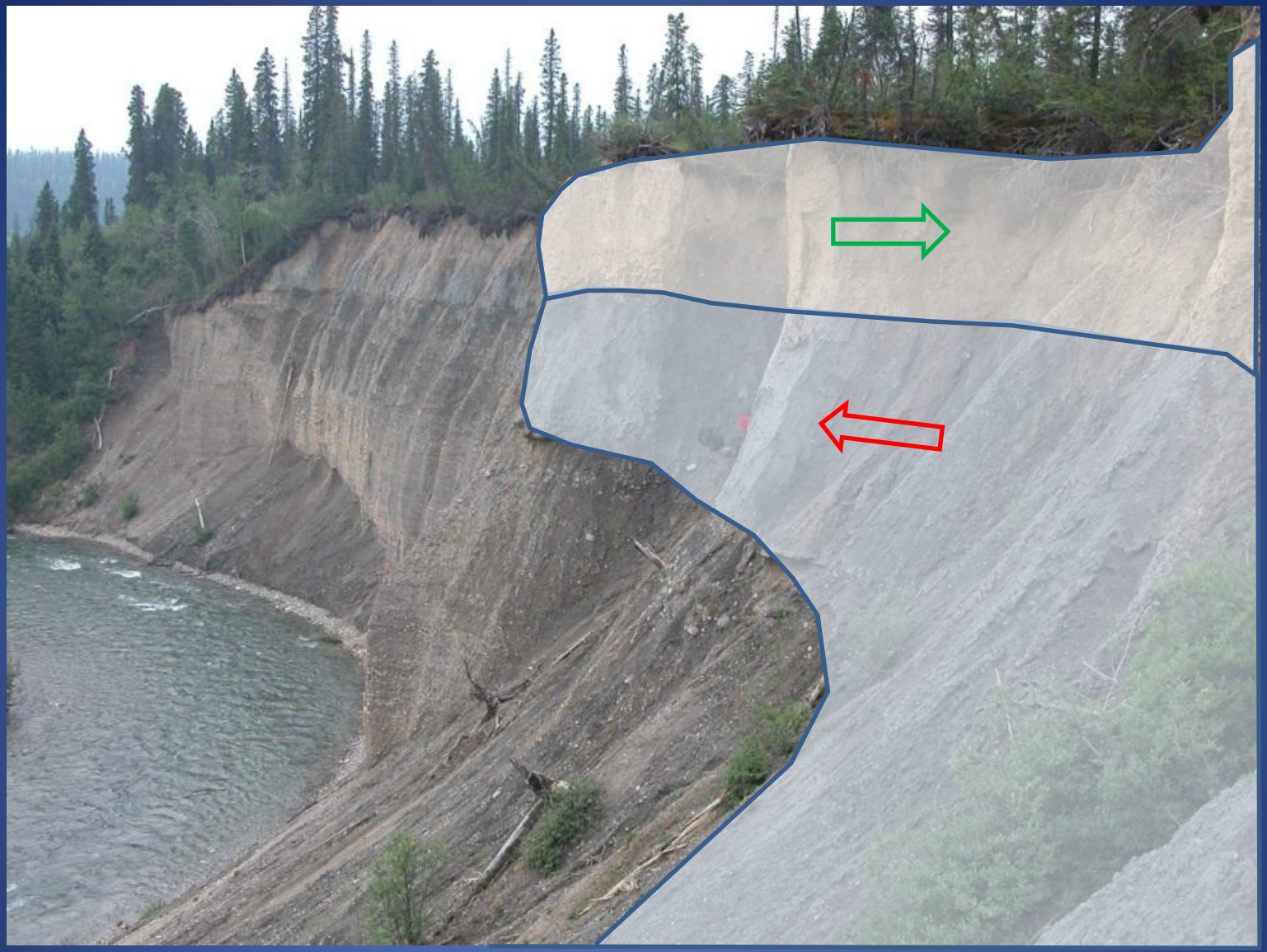




Glaciolacustrine deposits obscure till both geochemically and physically making surface till sampling difficult

The glaciolacustrine sediments can be extremely thick (see person for scale)

Yukon Geological Survey



Shifting ice sources is also resulted in till stratigraphy: lower till from local valley glaciers, upper till from CIS at the LGM flowing up-valley; completely opposite

SUMMARY

- Effective drift prospecting requires a good understanding of the ice flow history
- The landform record largely reflects late glacial flow patterns of the CIS
- LGM (and early phase) flow patterns were considerably different in places as indicated by detailed mapping
- In areas of thin till, dispersal is dominated by the last major flow event and relatively simple patterns prevail
- Multiple phases of ice flow produced complex dispersal patterns and complex till stratigraphy is locally preserved

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