

A LiDAR-based glacial landform map of the Kebnekaise massif, northern Sweden



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Aim and Objectives

Aim

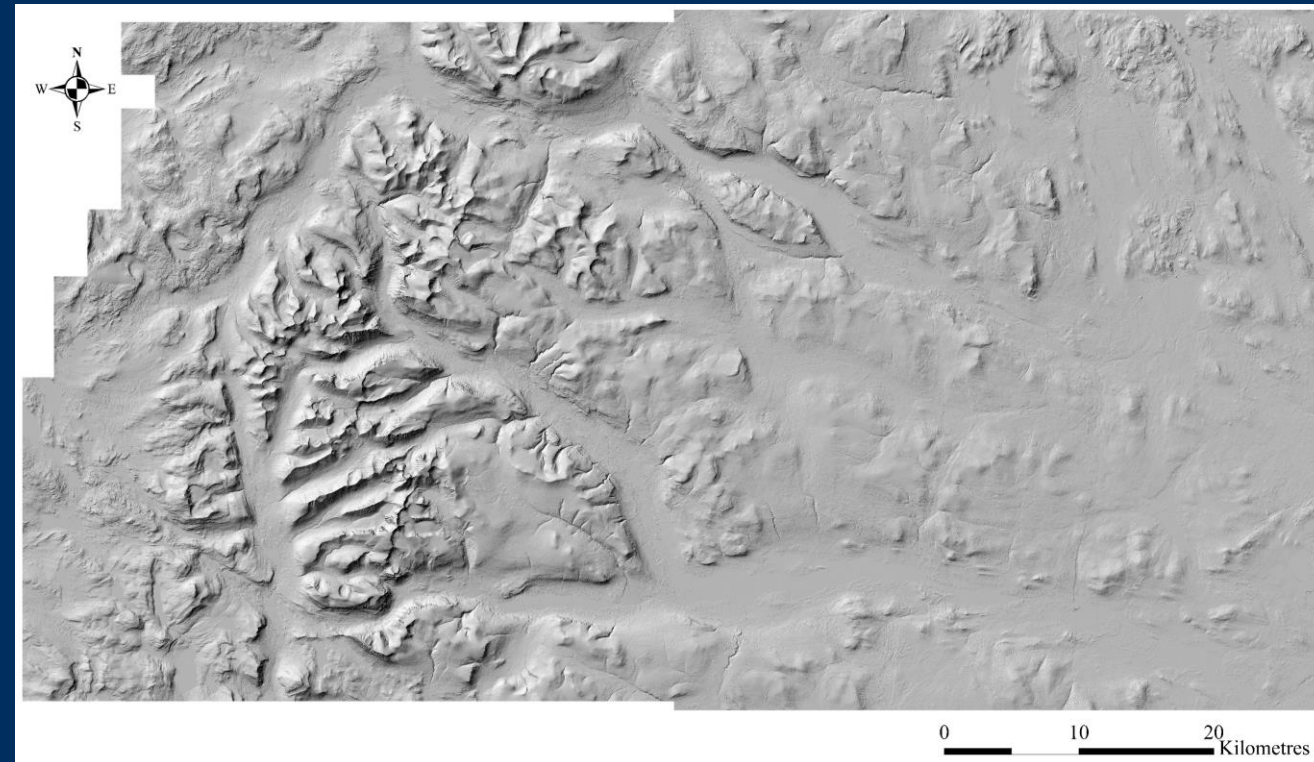
To produce an updated geomorphological map and to reconstruct the deglacial history of the area surrounding the Kebnekaise region of the northern Swedish mountains.

Objectives

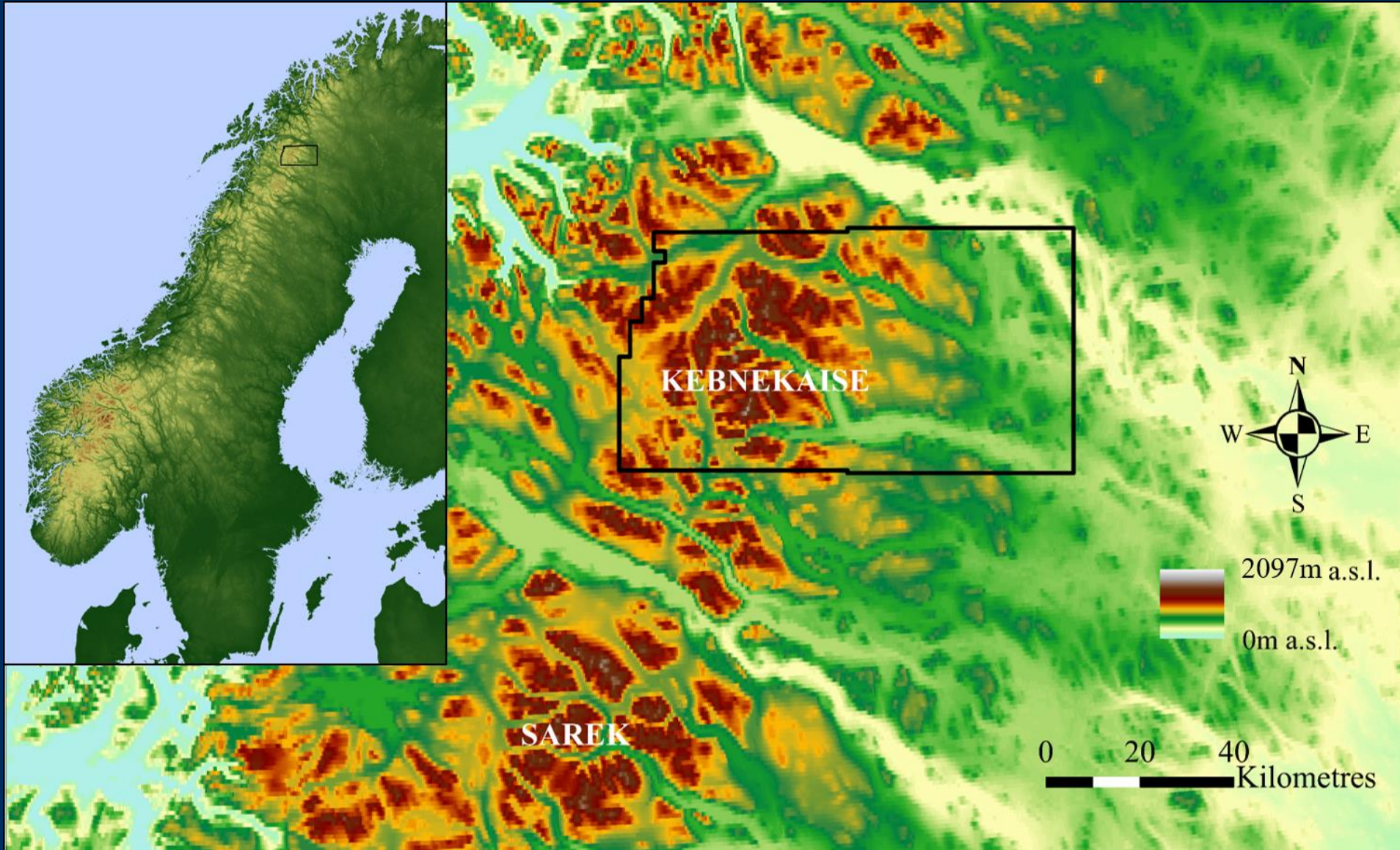
- To produce an updated geomorphological map of the Kebnekaise region, using a combination of field- and remotely sensed mapping of newly available LiDAR elevation data.
- To reconstruct the pattern of retreat during the final deglaciation using palaeoglaciological inversion methodologies, and to test such a regional-scale reconstruction against ice-sheet-scale reconstructions suggested in previous works.
- To evaluate LiDAR-based mapping robustness, and compare to previous mapping studies.

Methods

- 2x2 metre resolution Swedish LiDAR-based terrain model
- GIS-produced hillshade models used for remote landform mapping
- Ground-truthing of geomorphological mapping



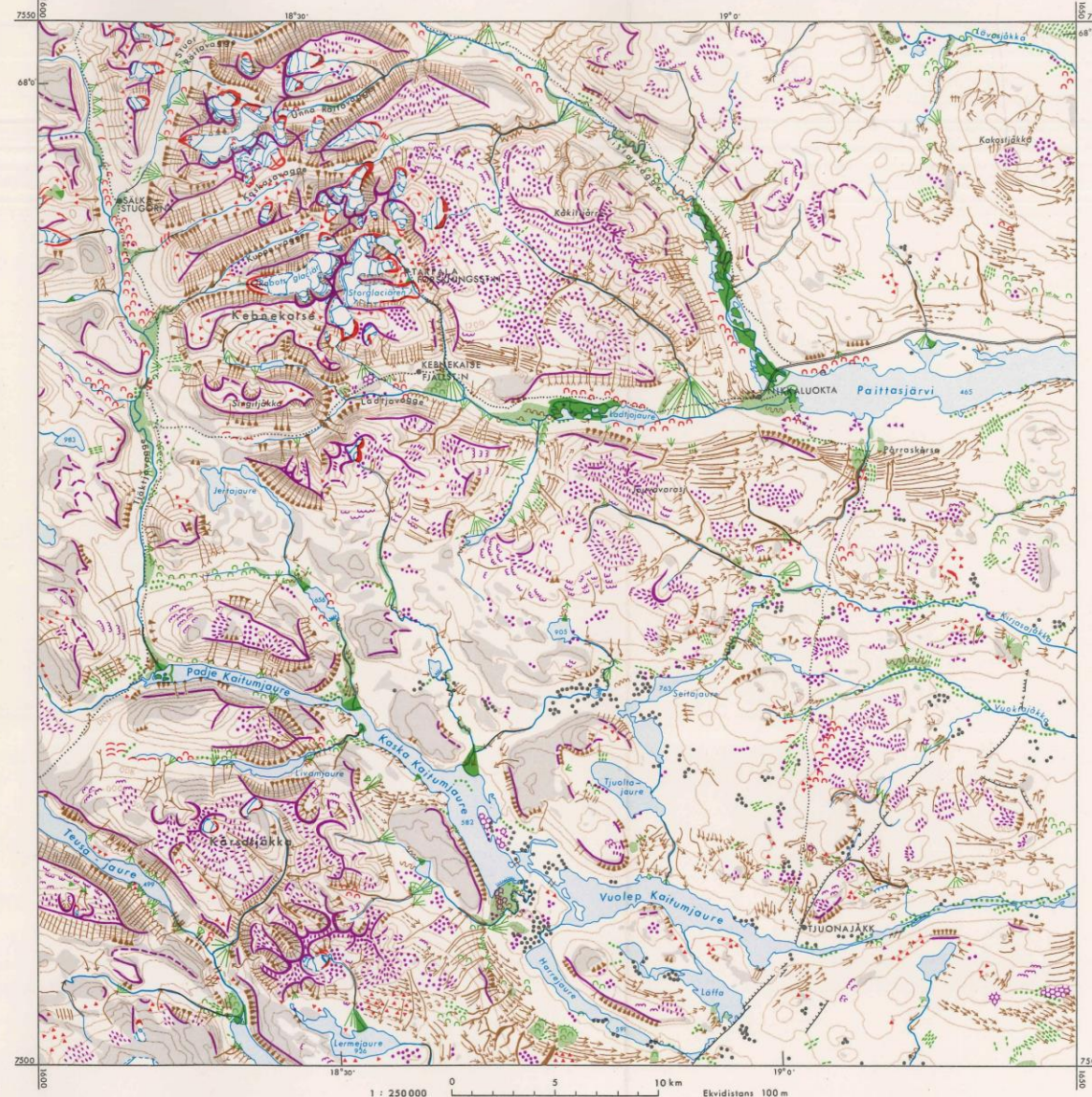
Research area in northern Swedish mountains



Updated geomorphological map provides a somewhat successional map for the region to that of Melander (1975), produced from interpretation of aerial photographs.

GEOMORFOLOGISKA KARTBLADET 29 I KEBNEKAISE GEOMORPHOLOGICAL MAP

Utarbetad vid Naturgeografiska Institutionen
Stockholms Universitet av OLLE MELANDER

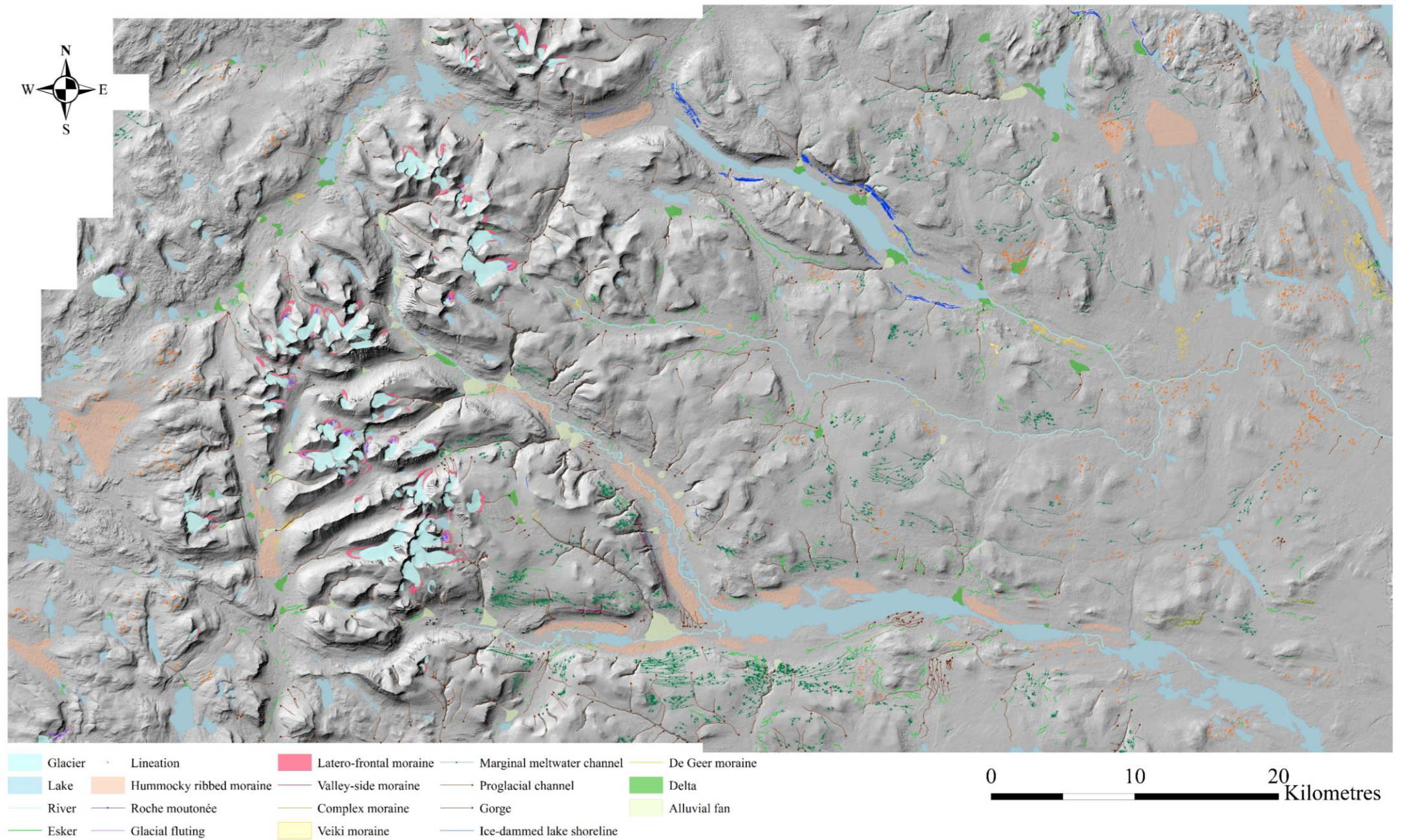


Karthörnens koordinater i Rikets nät
Godkänd ur sekretesssynpunkt för spridning.
Rikets allmänna kartverk 1974-04-29

Kartritningen utförd av Sigrd Bergfeldt

Tryckt vid AB KARTOGRAFISKA INSTITUTET, STOCKHOLM 1974

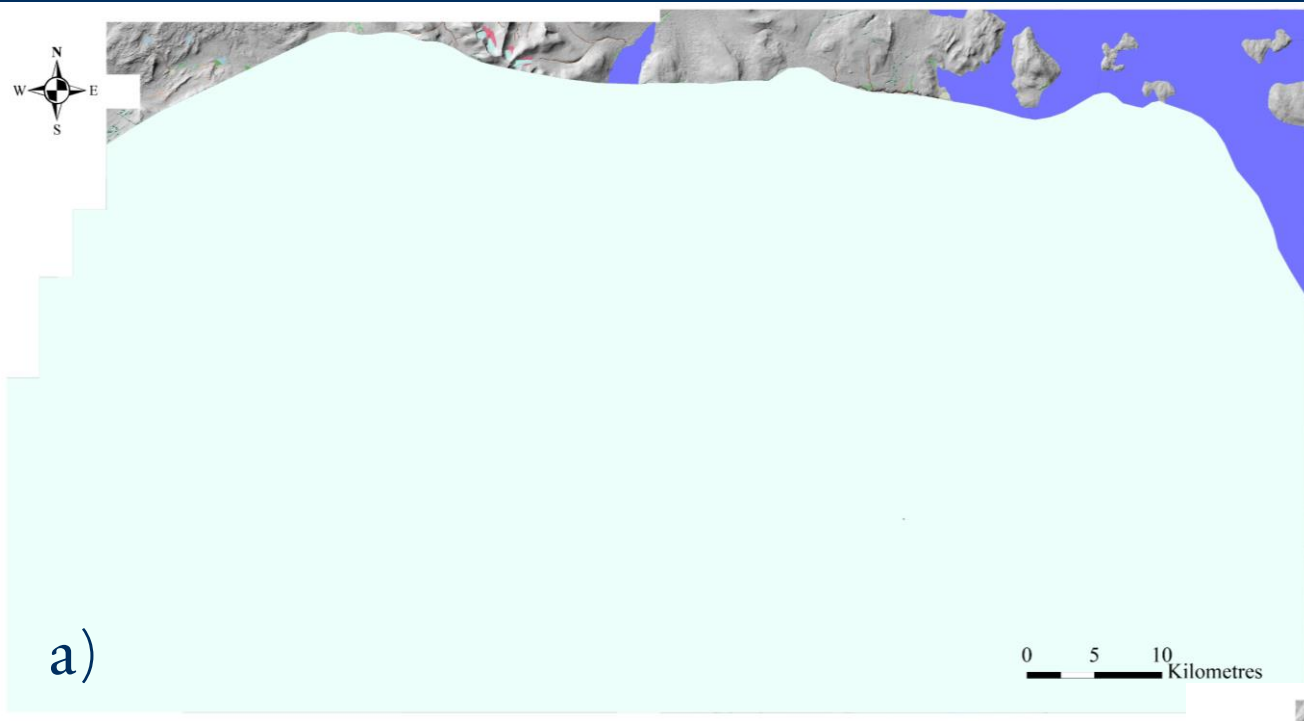
- Kalt berg Bedrock outcrops
- Glaciellt präglad kantlinje Glacially eroded trough edge, well developed
- Glaciellt svagt präglad kantlinje Glacially eroded trough edge, poorly developed
- Glaciärnisch Cirque, well developed
- Glaciärnisch, otydlig Cirque, poorly developed
- Solifluktsvalkar Solifluction lobes
- Strukturmark i plan terräng Patterned ground on flat terrain
- Strukturmark i lutande terräng Patterned ground on slopes
- Tundrapolygoner Tundra polygons
- Blocksänkor Boulder depressions
- Småkuperad moränterräng (i regel nivåskillnader < 5 m) Hummocky moraine (normally with relative heights < 5 m)
- Kuperad moränterräng (i regel nivåskillnader > 5 m) Hummocky moraine (normally with relative heights > 5 m)
- Änd- och sidomorän End moraine and lateral moraine
- Svag drumlinisering inkl. "fluting" Weak "drumlinisation" and fluting in drift
- Rik- och storblockiga områden Blockfields and other blocky areas
- Diffusa glaciofluviala erosionsspår Traces of glaciofluvial erosion
- Rännor av glaciofluvialt/fluvialt ursprung (vanligen torrdalar) Glaciofluvial/fluvial channels (normally dry)
- Större glaciofluvial/fluvial ränna, ofta inskuren i fast berg Large glaciofluvial/fluvial channel in bedrock
- Tydlig glaciofluvial/fluvial erosionskant Distinct glaciofluvial/fluvial erosion scarp
- Meandrande flodlopp Meandering river
- Avskuren meander, korvsjö Abandoned meander loop (oxbow lake)
- Vattenfall eller fors Waterfall or rapids
- Rullstensås Esker
- Slukåsar och liknande Subglacially-engorged eskers and similar features
- Kuperade glaciofluviala akkumulationer Kames and other hummocky glaciofluvial accumulations
- Glaciofluvial terrass Glaciofluvial terrace
- Fossilt delta Fossil delta
- Recent delta, mindre Small recent delta
- Recent delta, större (deltafronten markerad) Large recent delta (with marked delta front)
- Svämkgäla Alluvial fan
- Annan glaciofluvial/fluvial avlagring Other glaciofluvial/fluvial accumulation
- Issjöstrandlinje Shoreline of ice dammed lake
- Recenta strandformer Recent minor shoreline features
- Rasränna Rockfall chute
- Lavinblocktunga Avalanche boulder tongue
- Talus Talus
- Slamström Mudflow
- Protalus-vall Protalus rampart
- Ravin Gully or channel in deposits
- Palsområde Palsas
- Förkastning Fault line

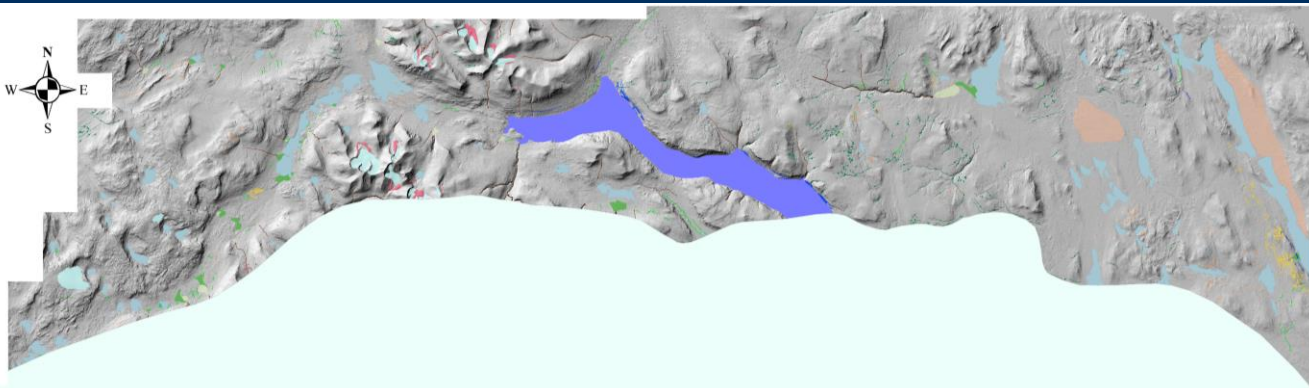


Geomorphological map of Kebnekaise (1:90,000).

Deglaciation reconstruction

Proposed (provisional) deglaciation time slices of relative ice margin retreat and ice dammed lakes from interpretation of deglacial landforms (marginal/proglacial meltwater channels, eskers, ice-dammed lake shorelines, De Geer moraines and glacial lineations).

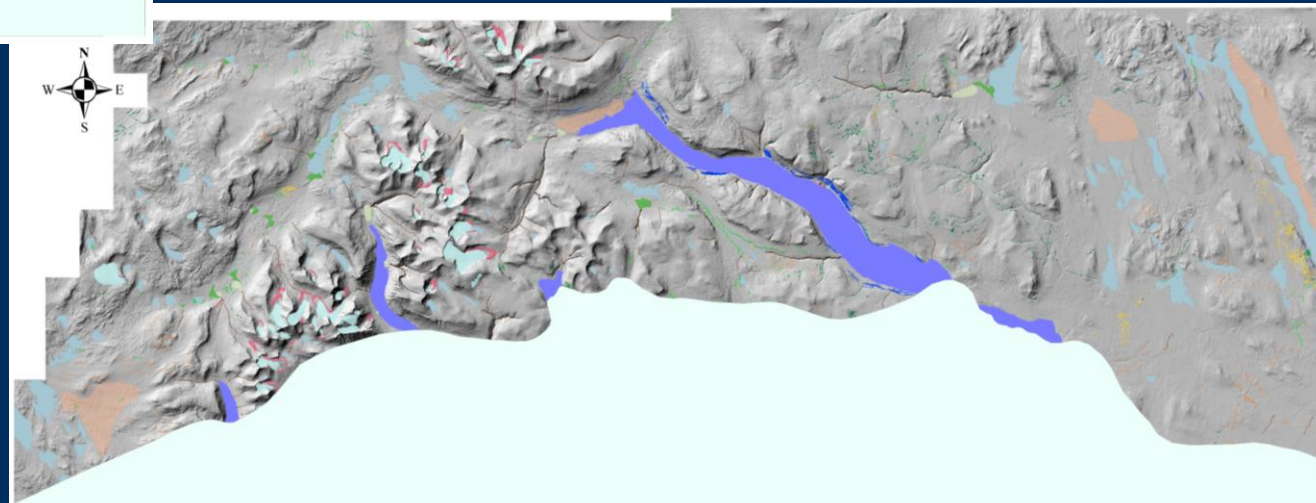




c)

0 5 10
Kilometres

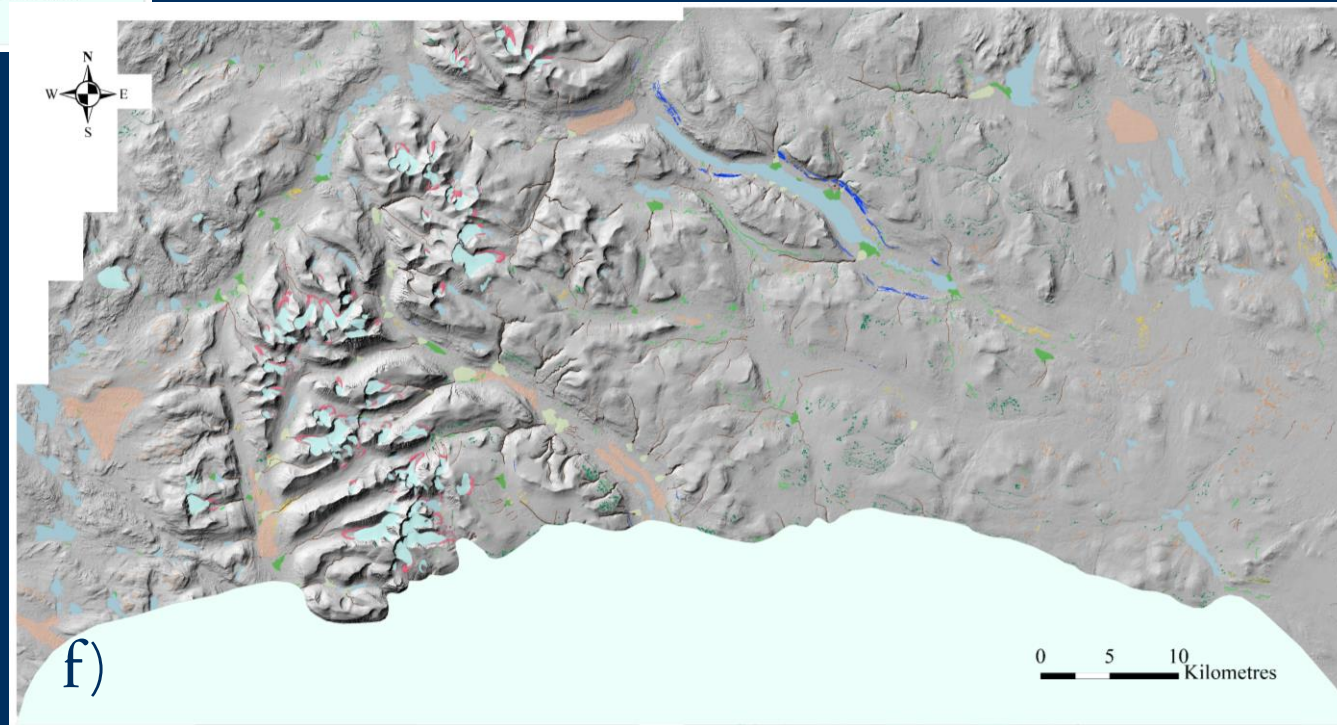
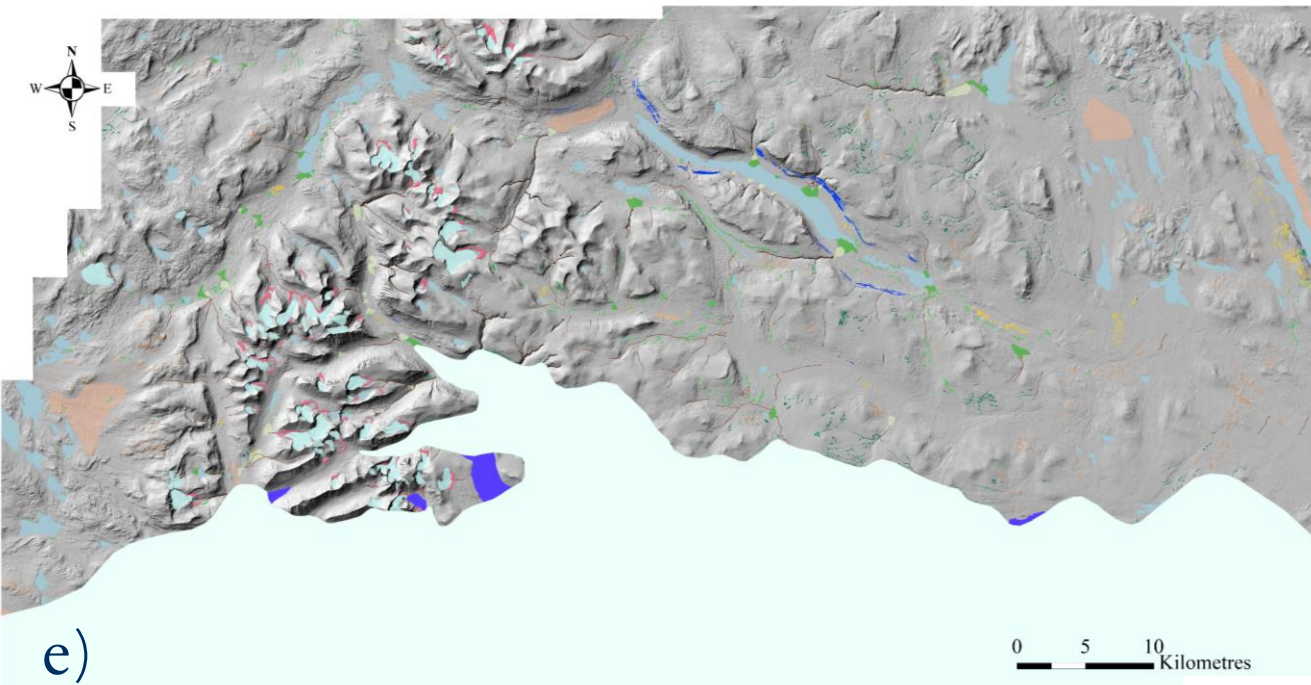
Evidence of previously undocumented ice-dammed lakes identified, most prominently in Rautasjaure valley, suggesting position of southerly-retreating ice margin. Findings complement those of Regnéll et al. (2019).

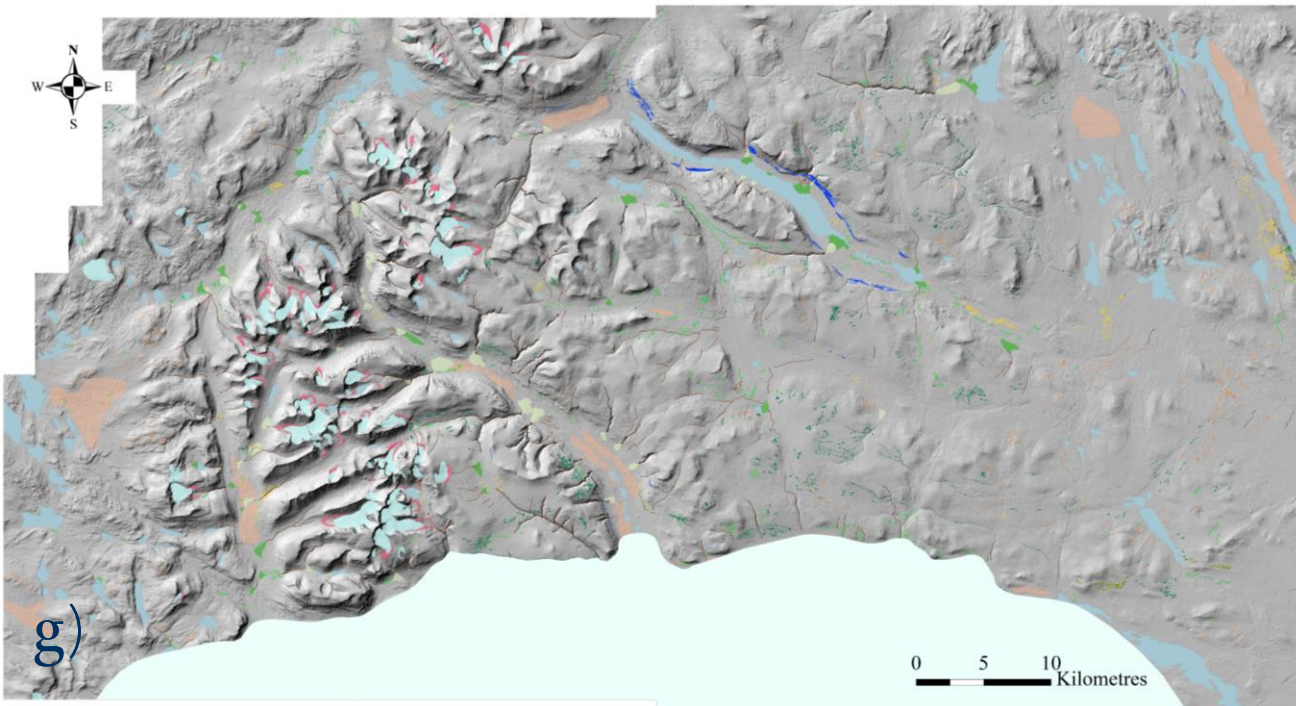


d)

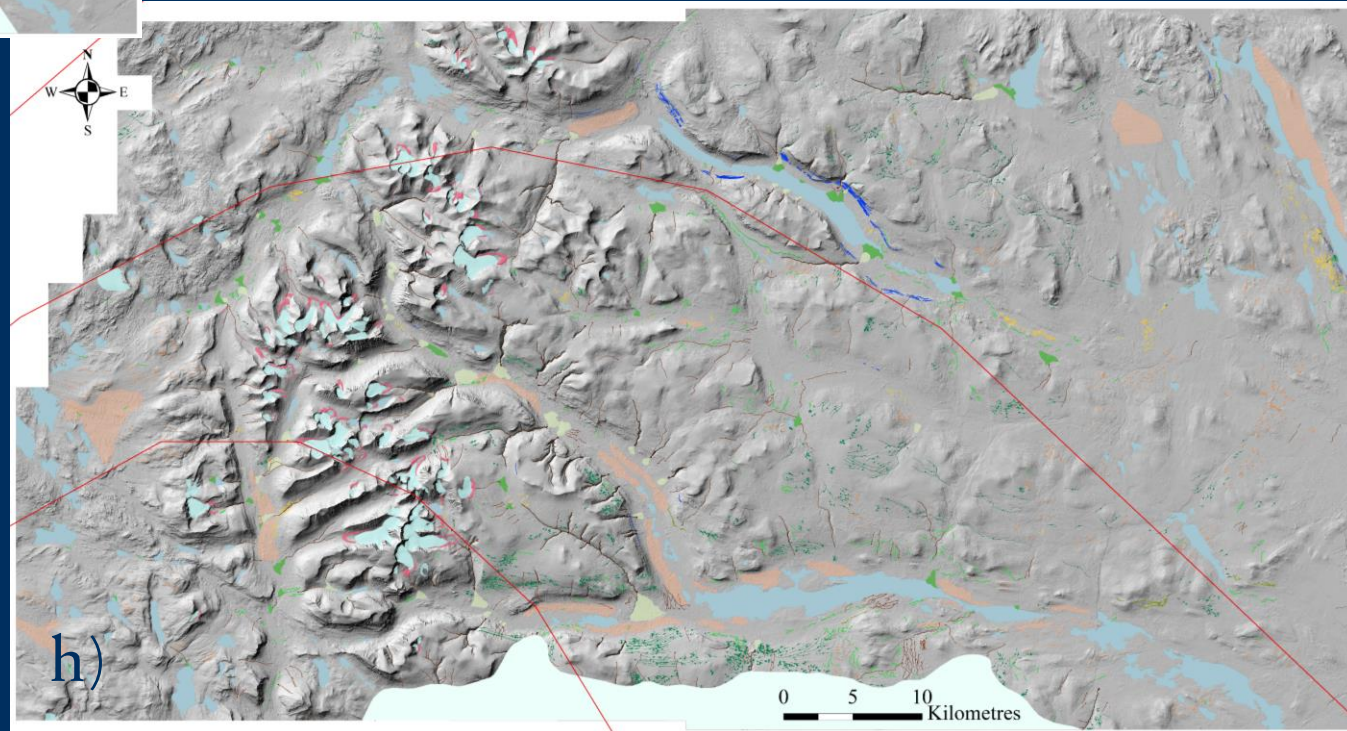
0 5 10
Kilometres

Small ice-dammed lakes in Kaskasavagge, Tarfala, Tjeuralako and Salvujohka. (e)





Final ice retreat time slice (h) shown with Stroeven et al. (2016)'s deglaciation isochrons (top to bottom: 10, 9.9 and 9.8 ka B.P) included for comparison.



Key findings

- Local-scale, detailed ice margin retreat during last deglaciation.
- Previously undocumented ice-dammed lake shorelines identified, most prominently in Rautasjaure valley (highest ~840m a.s.l.).
- Suggested southerly final ice remnant retreat, rather than retreat to final remnant mountain glaciers.
- Geomorphological features identified from 2x2 metre resolution LiDAR-based terrain model that would not be identifiable to the same degree from field observations, satellite images and/or aerial photographs.

References

- Melander, O., (1975). *The geomorphological map 29 I Kebnekaise - Description and assessment of nature value*. Statens Naturvårdsverk, PM 540, 77.
- Regnéll, C., Mangerud, J. and Svendsen, J.I., (2019). *Tracing the last remnants of the Scandinavian Ice Sheet: ice-dammed lakes and a catastrophic outburst flood in northern Sweden*. Quaternary Science Reviews 221, 105862.
- Stroeve, A.P., Hättestrand, C., Kleman, J., Heyman, J., Fabel, D., Fredin, O., Goodfellow, B.W., Harbor, J.M., Jansen, J.D., Olsen, L., Caffee, M.W., Fink, D., Lundqvist, J., Rosqvist, G.C., Strömberg, B. and Jansson, K.N., (2016). *Deglaciation of Fennoscandia*. Quaternary Science Reviews, 147, pp.91-121.