The periglacial landforms of Svalbard

Content
- -) ice-wedges
- -) rock glaciers
- -) pingos
- -) solifluction
- -) avalanches
- -) debris flows
- -) rock falls
- -) nivation
- -) aeolian landforms

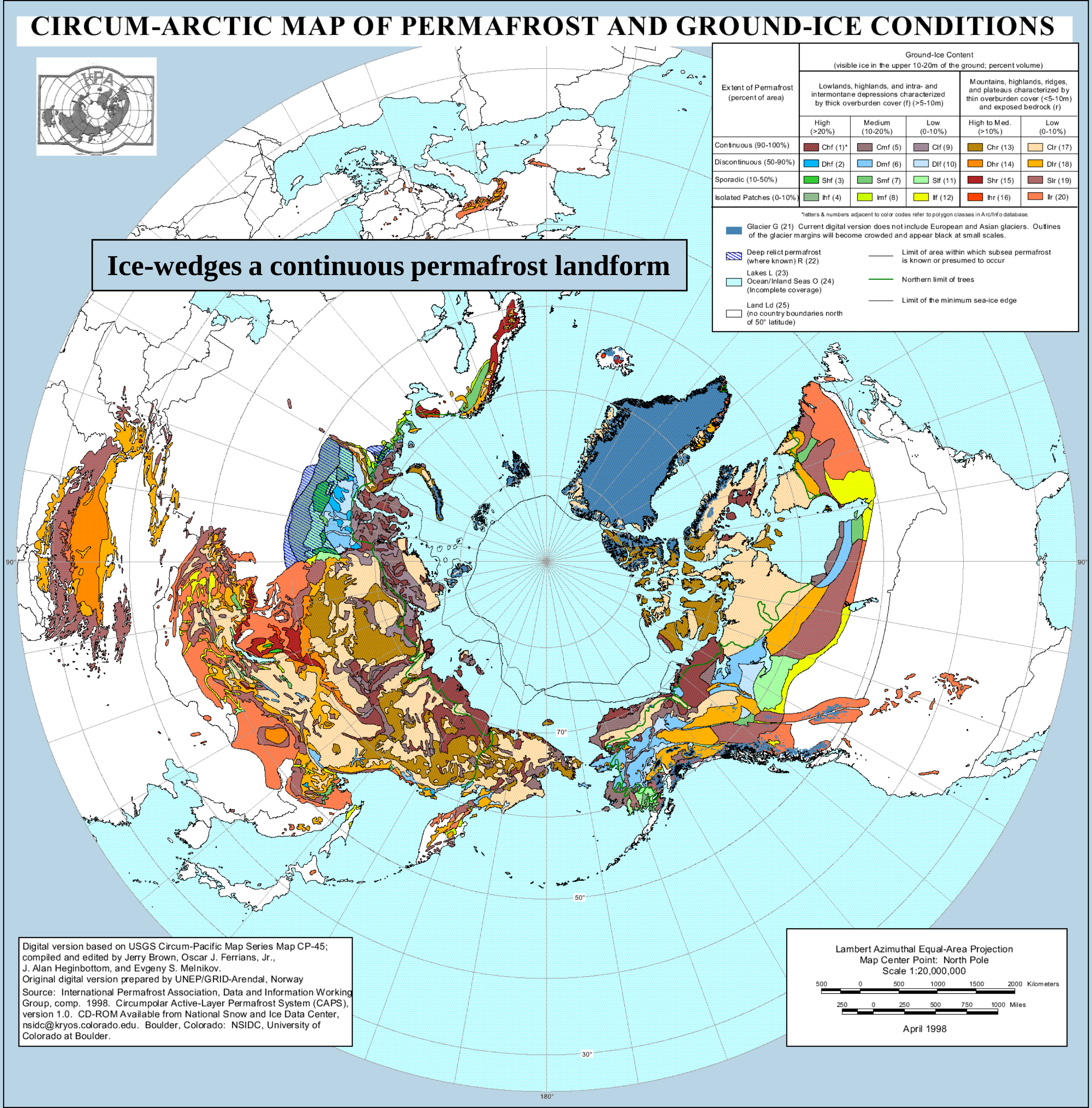
Glacial landforms
- -) surge glaciers

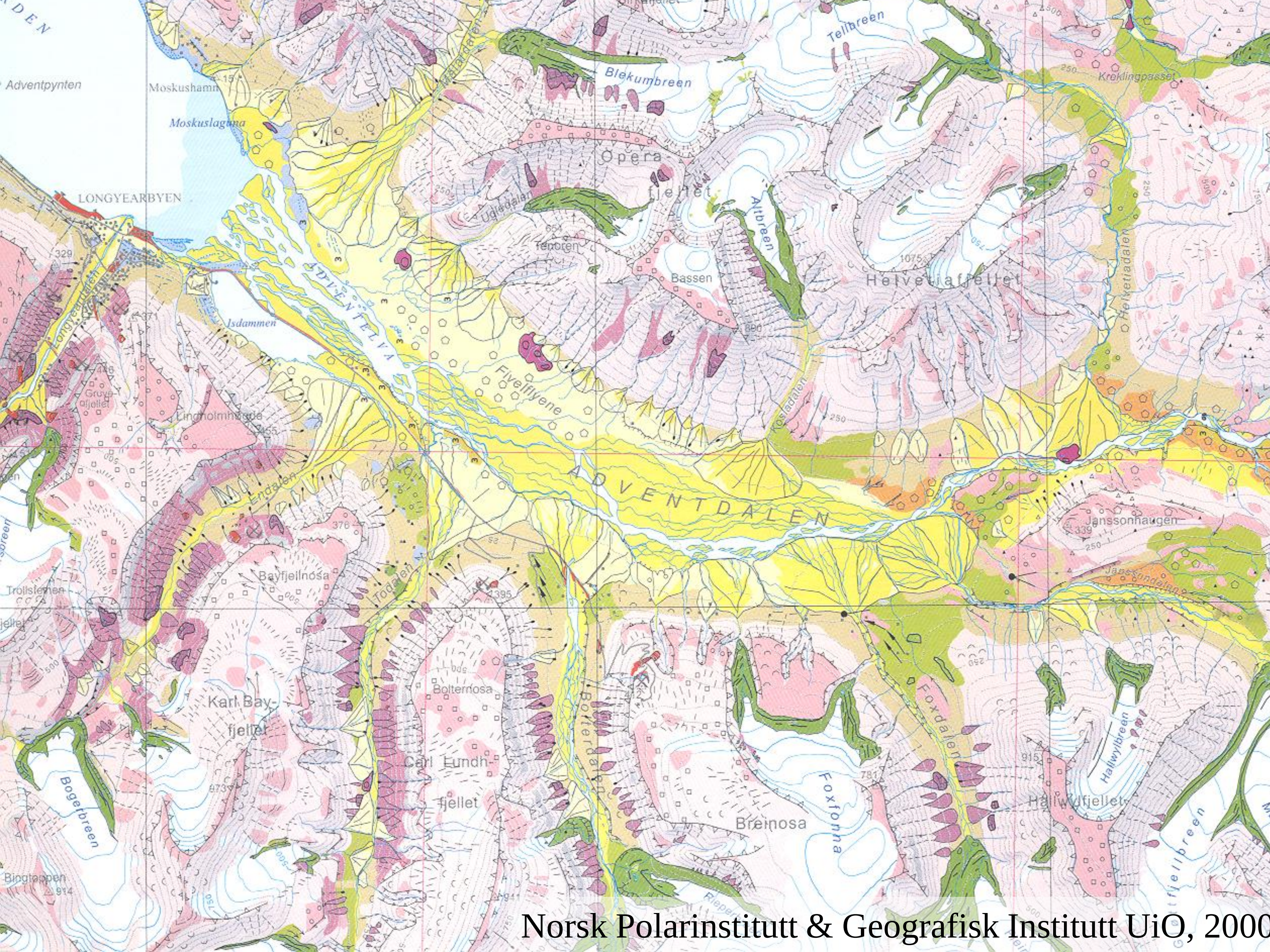
Hanne H. Christiansen
-) Geology Department, The University Centre in Svalbard, UNIS
-) Department of Geosciences, University of Oslo


Polygons – ice-wedges

MAAT:
-6°C

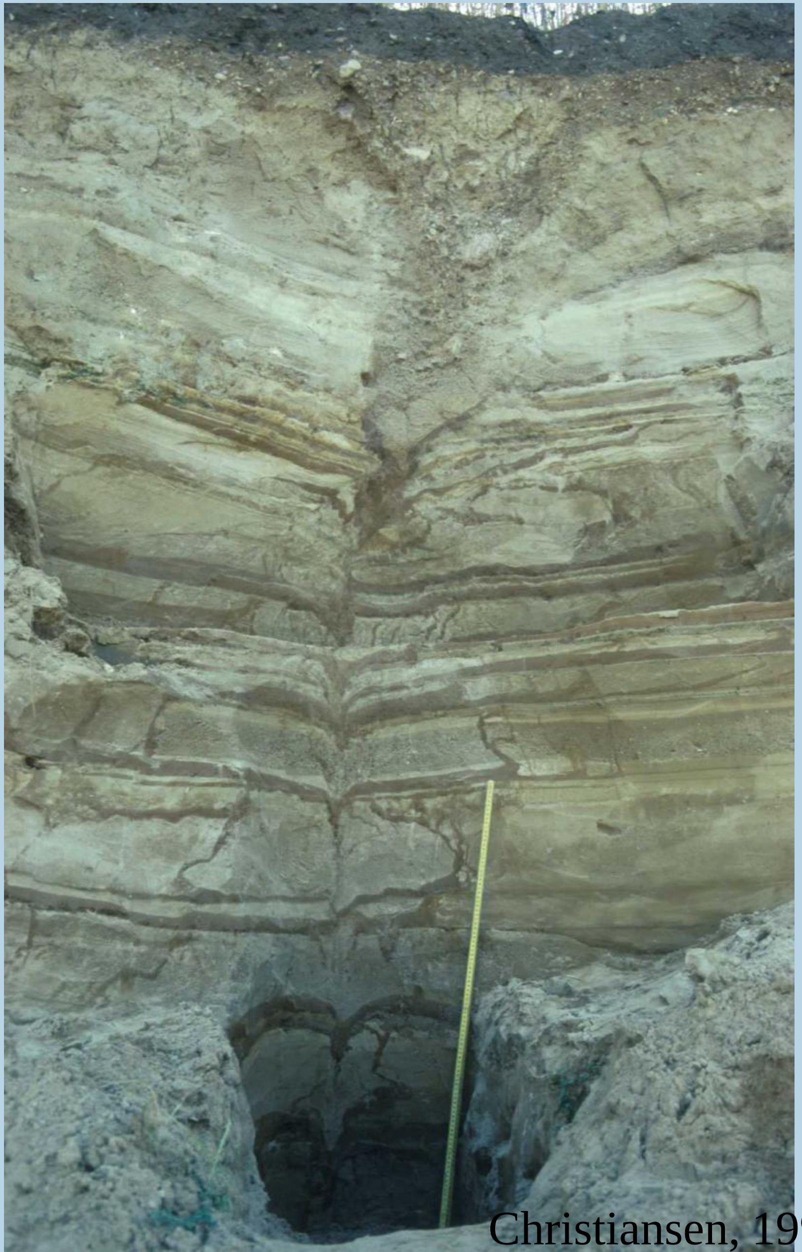
Ice-wedges a continuous permafrost landform



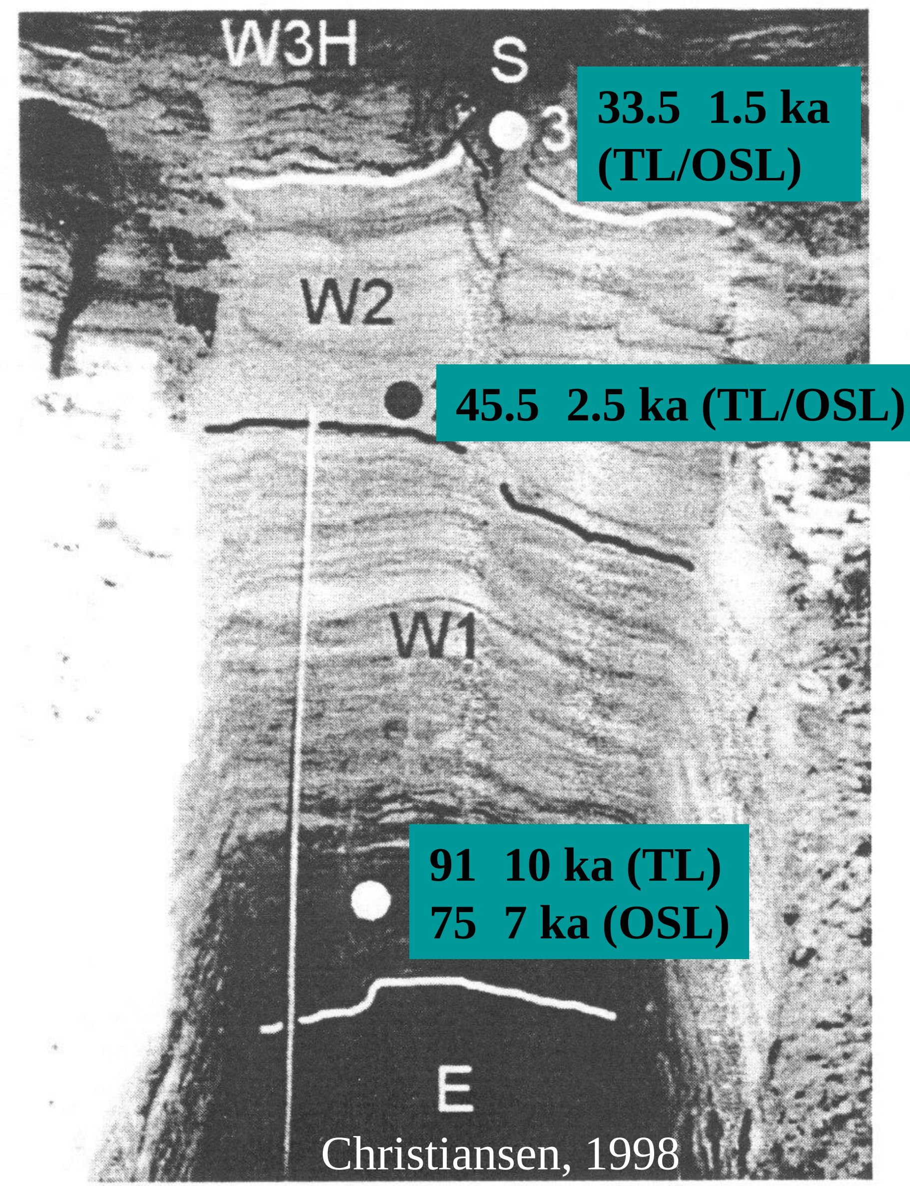


Norsk Polarinstitutt & Geografisk Institutt UiO, 2000

Danish ice-wedge cast and sand-wedge



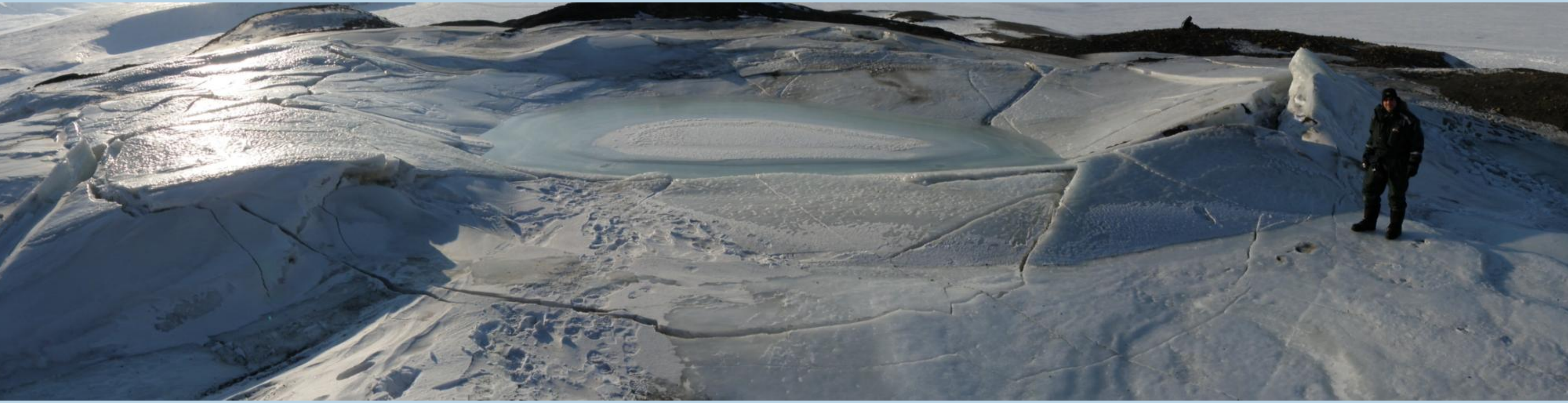
Christiansen, 1993



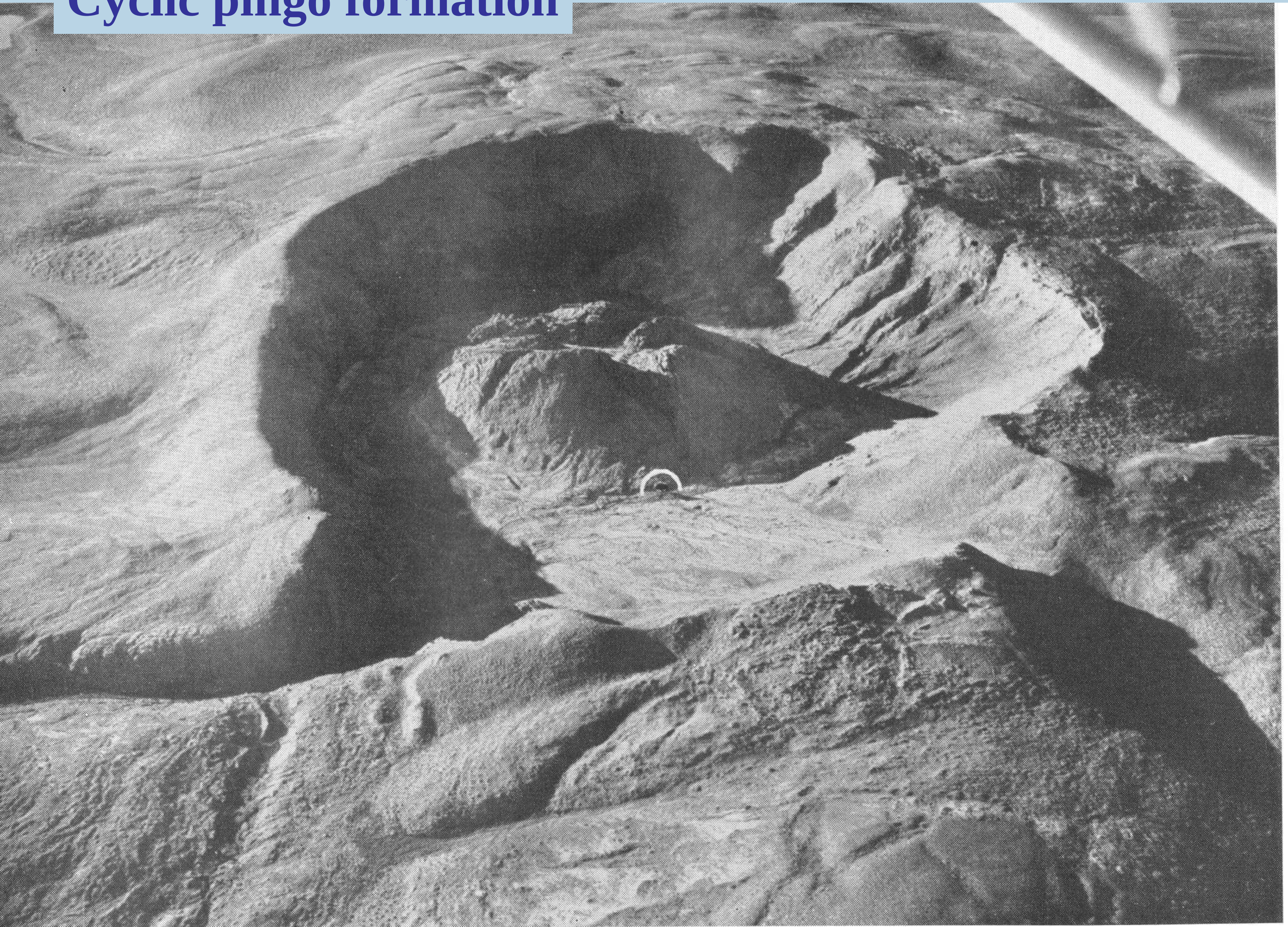
Christiansen, 1998

Pingos

Very active pingo in Adventdalen, Svalbard



Cyclic pingo formation



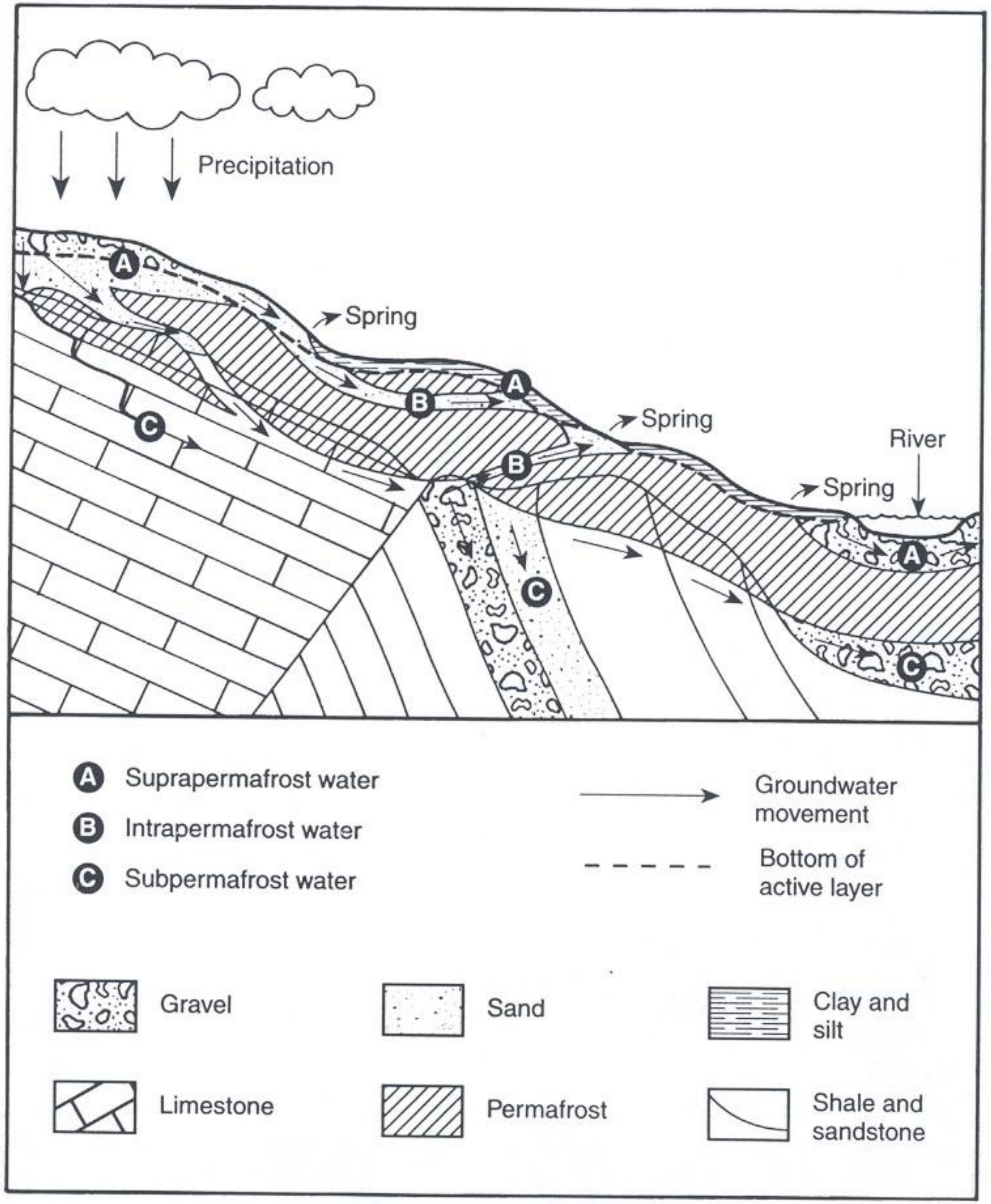


Figure 5.15 Occurrence of groundwater in permafrost areas

Permafrost hydrology

taliks

Open system pingos

This pingo type is usually found in high relief permafrost areas

Growth rate newer measured directly

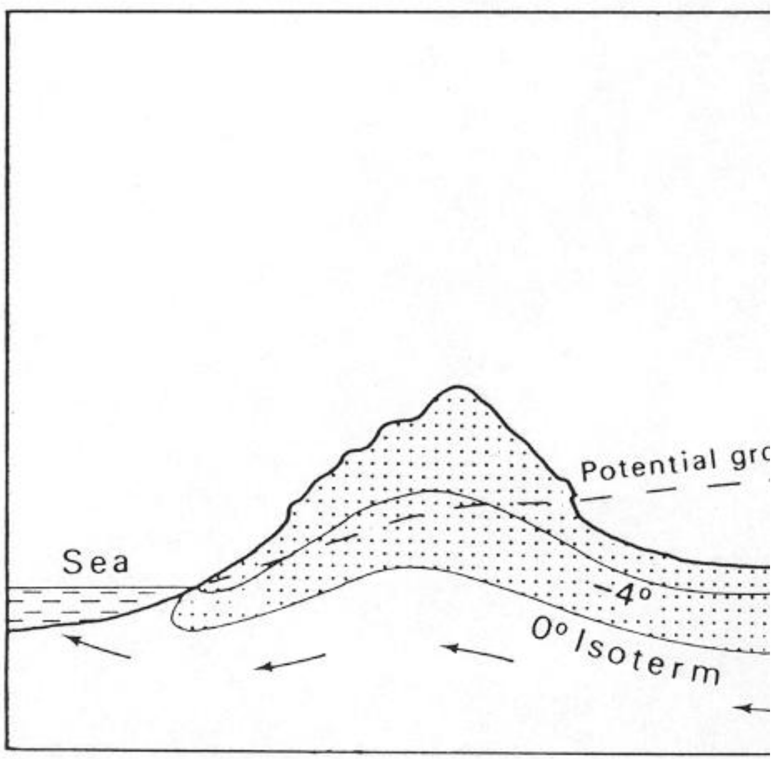
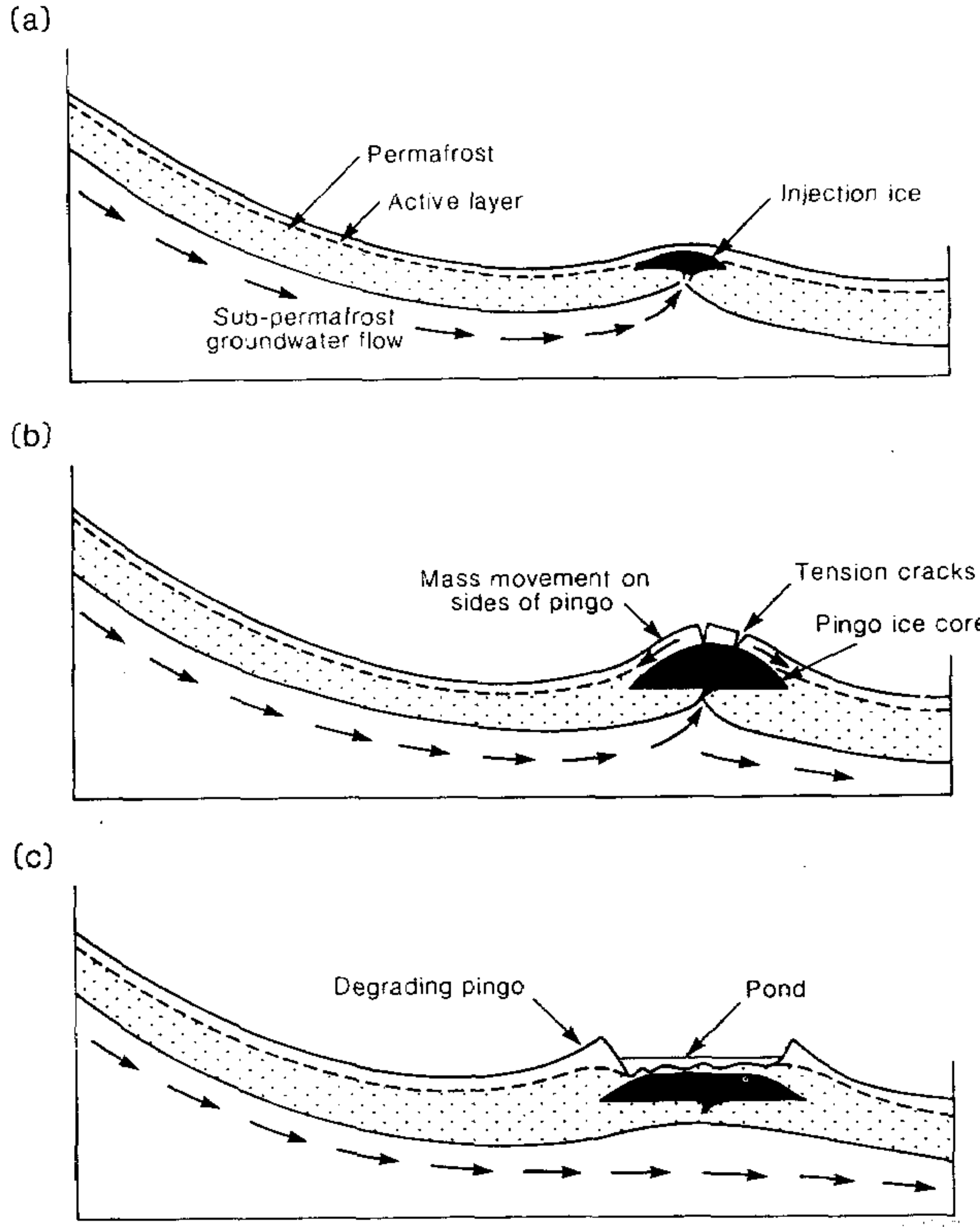


Fig. 2. *Vertical profile of the permafrost layer*
out



Pingo distribution on Svalbard

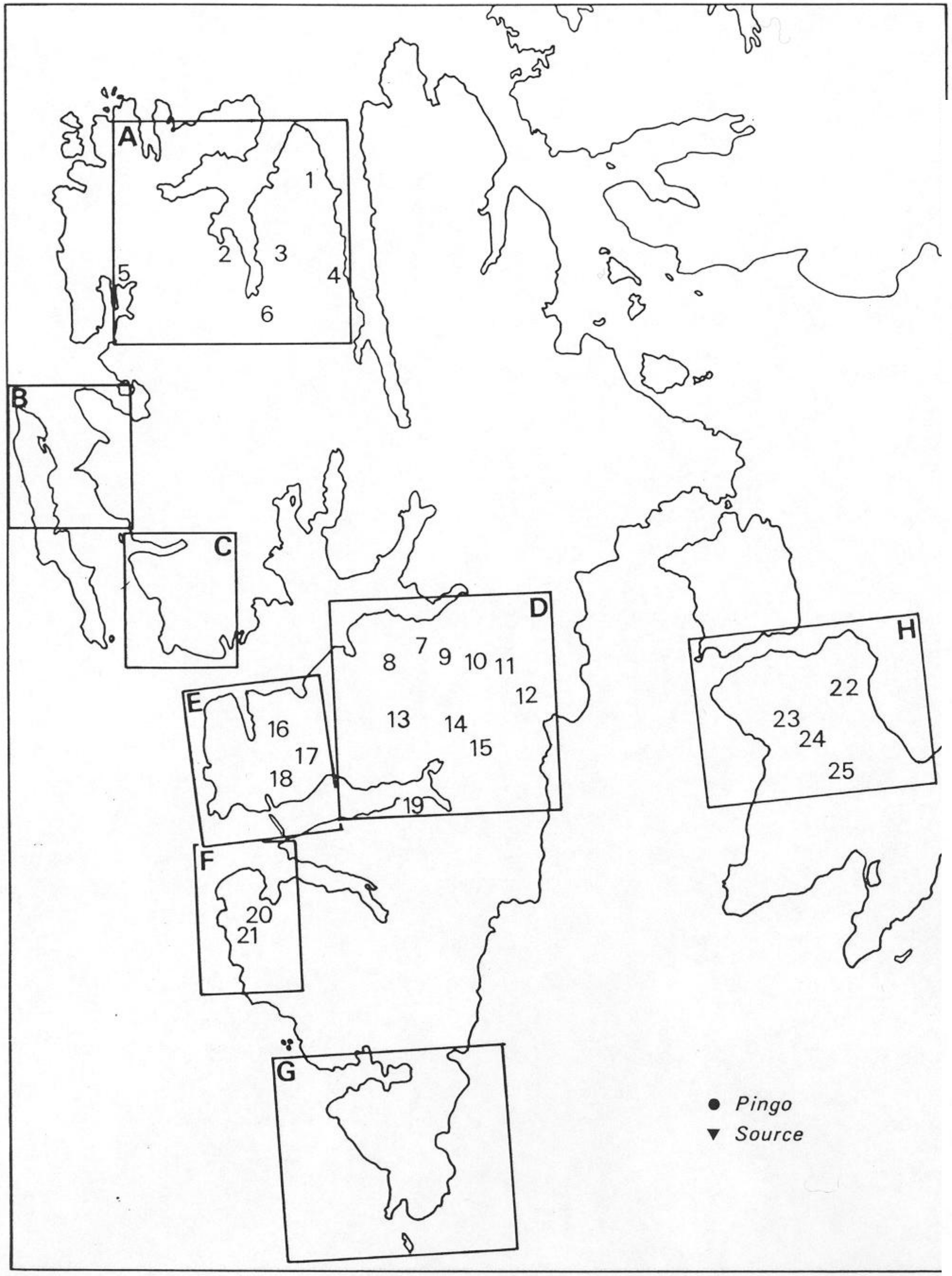


Fig. 4. *Outline map of the more detailed maps showing the site of the different pingos and springs describe*

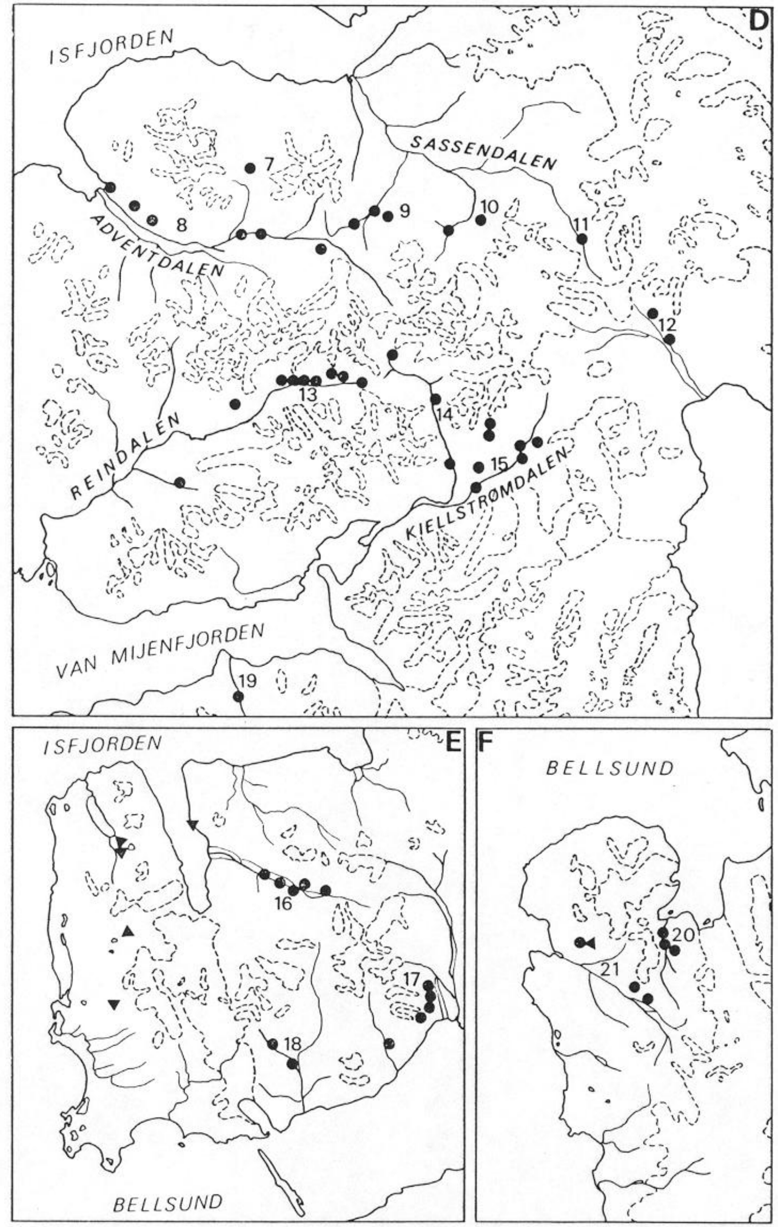


Fig. 8. *Map of the area between Isfjorden, Agardhbukta and Van Mijenfjorden.*

Rock glaciers

Rock glacier: A thick lobate or tongue-shaped body of frozen debris that moves slowly downslope through deformation of internal ice or ice-rich sediment. Moves due to permafrost creep. PF temp. and the amount of ice regulates the speed.

Two types:
Talus rock glaciers (talus-derived or protalus RGs)
Glacigenic rock glaciers /glacier derived rock glaciers (debris or morainic RGs)

Activity status:
Active (mobile) 0.005-2 m/yr.
Inactive (immobile; contains internal ice)
Relict (immobile: no perennial internal ice)

Rock glaciers

Rock glacier characteristics

Steep margins 10-70 m high

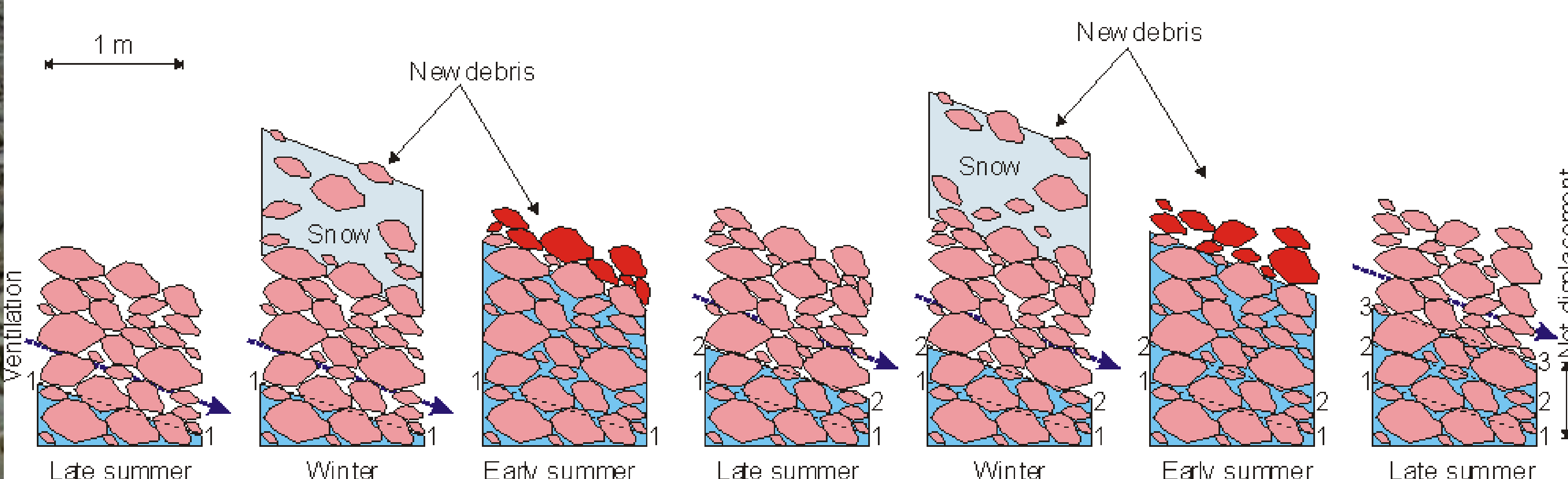
Surface microrelief:

closed depressions
longitudinal ridges & furrows
transverse ridges & depressions.

Surface layer of unfrozen coarse debris 1-5 m thick overlies ice-rich sediment and pure ice.

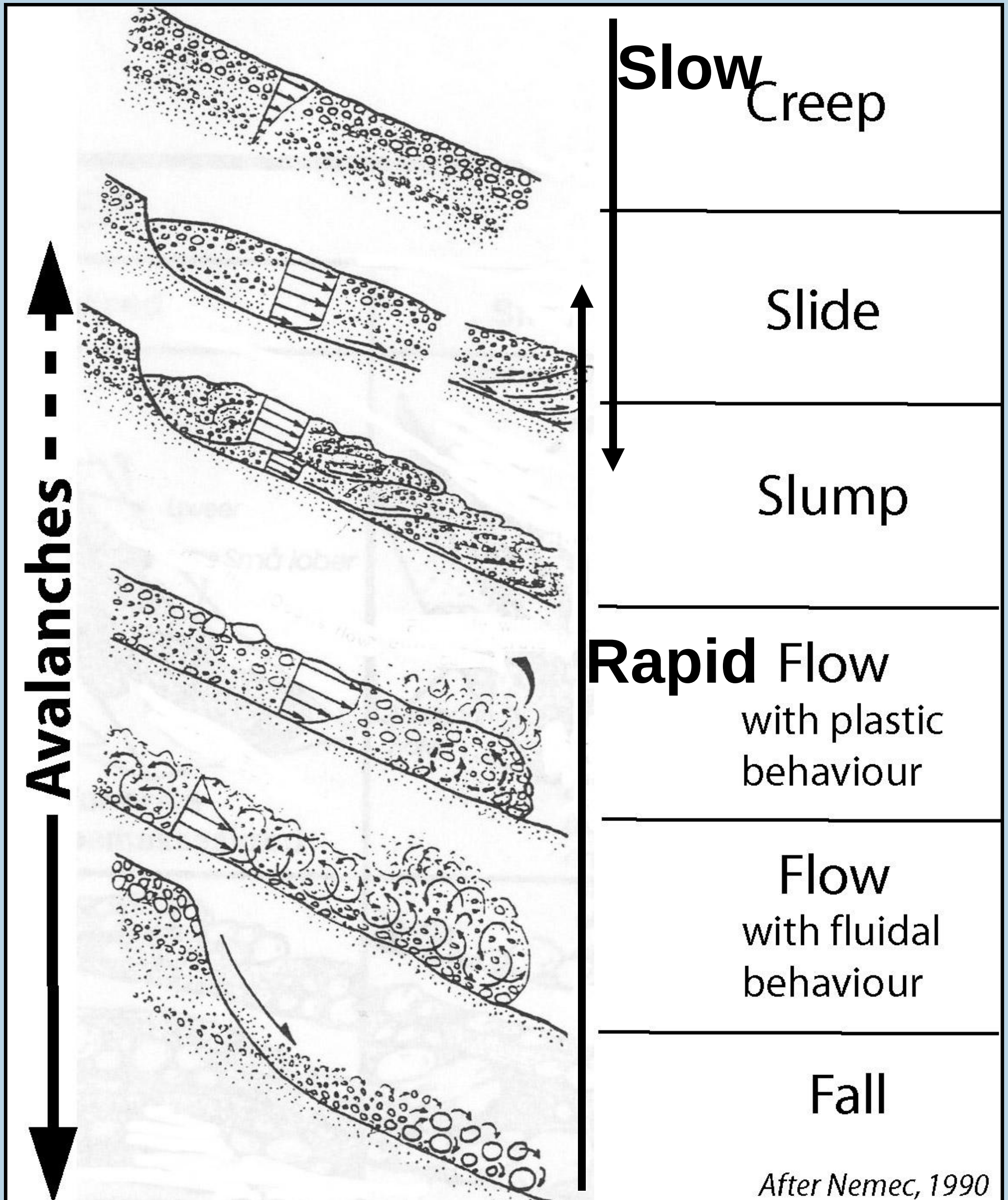
Internal ice: 50-90% of RG volume.
Glacigenic RGs: glacier ice. Talus RGs: ice segregation, burial of surface snow and ice.

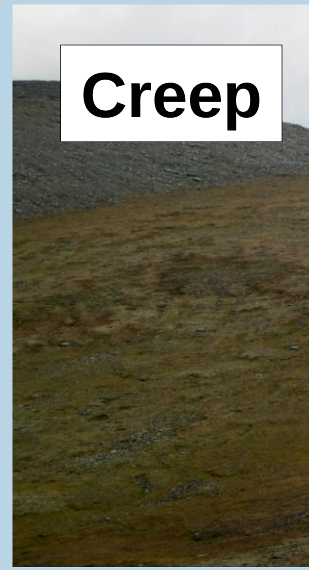
Displacement of active layer and permafrost caused by debris accumulation



Annual permafrost net growth rate: 0-5 cm

Slow and rapid mass movements

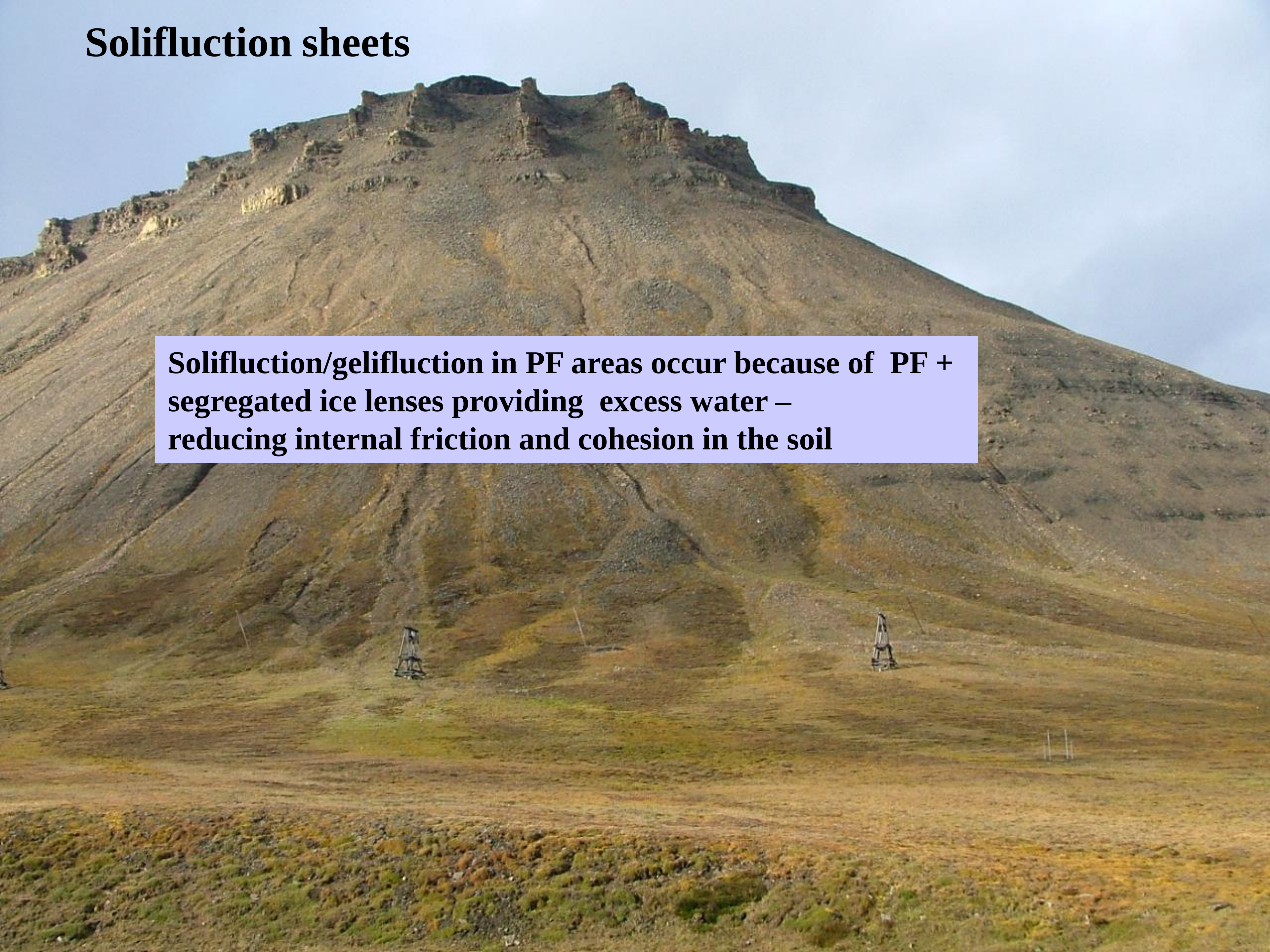




Solifluction lobes


Solifluction small lobes

Solifluction sheets



Solifluction/gelifluction in PF areas occur because of PF + segregated ice lenses providing excess water – reducing internal friction and cohesion in the soil

Taubane towers as solifluction monitoring instruments

Old Longyearbyen house piles (tree trunks) registering solifluction

Creep and gelifluction = solifluction

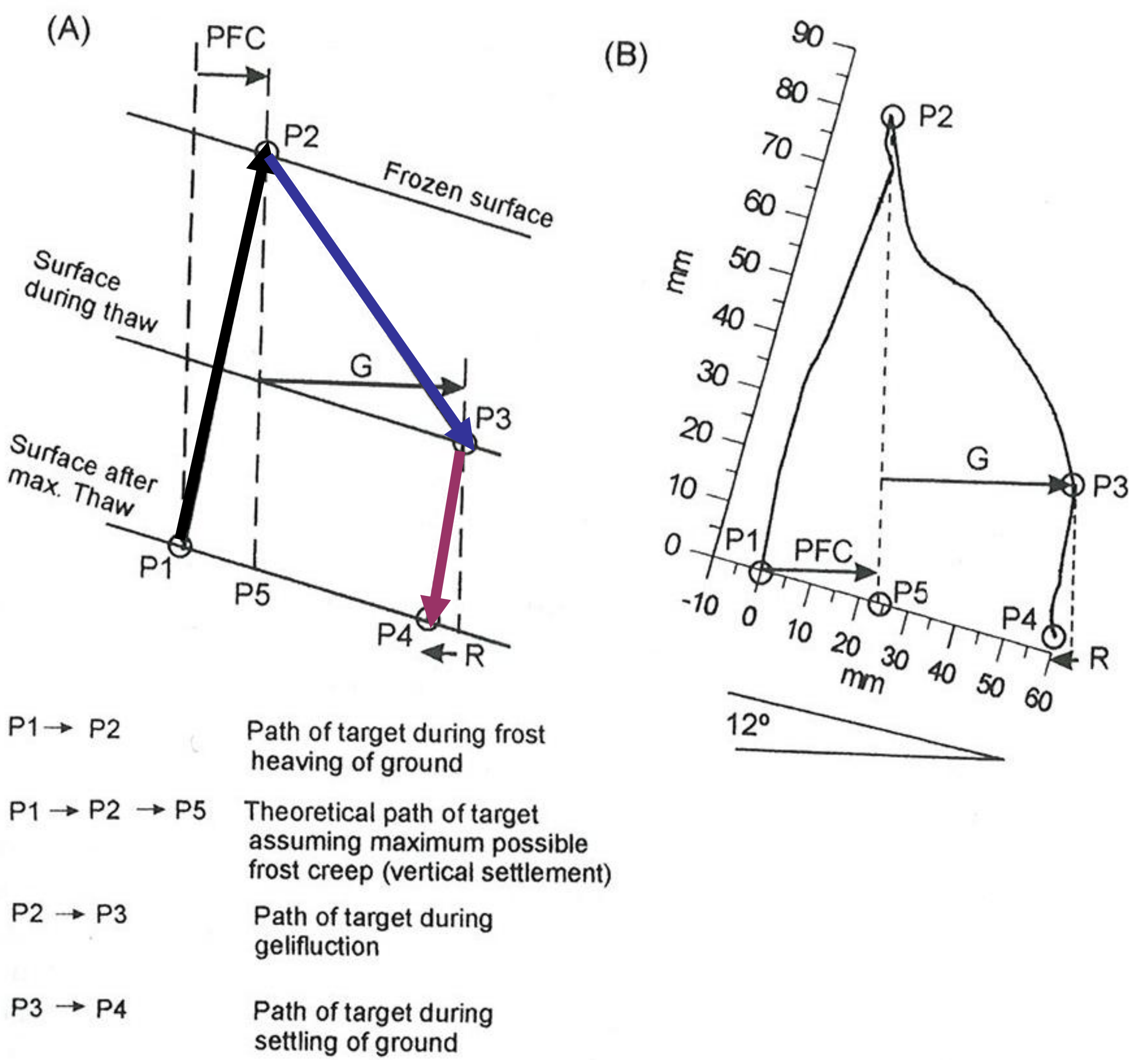


Figure 9.7. The components of solifluction. (A) Theoretical displacements of a soil particle due to potential frost creep (PFC), gelifluction (G), and retrograde movement (R). (B) Interpretation of observed surface movement vector in a controlled large-scale laboratory simulation of gelifluction movement at CNRS, Caen, France. Data from Harris and Davies (2000).

Creep = Heave*tan(slope°)

$\Delta l = h \tan(\sigma)$

Solifluction styles

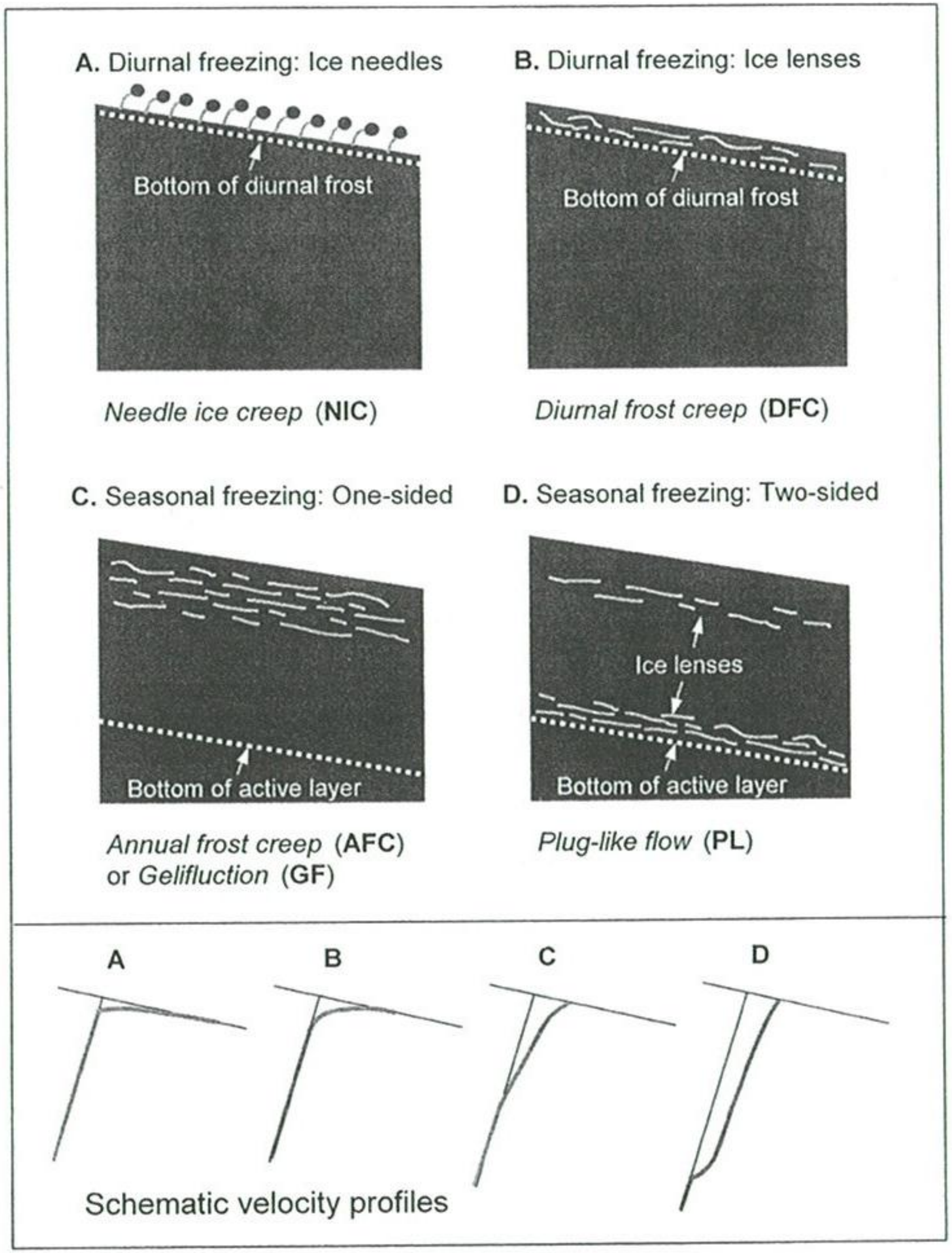


Figure 9.8. Summary of frost heave types and associated velocity-depth profiles of solifluction movement. From Matsuoka (2001c). Reprinted from Earth Science Reviews, with permission from Elsevier.

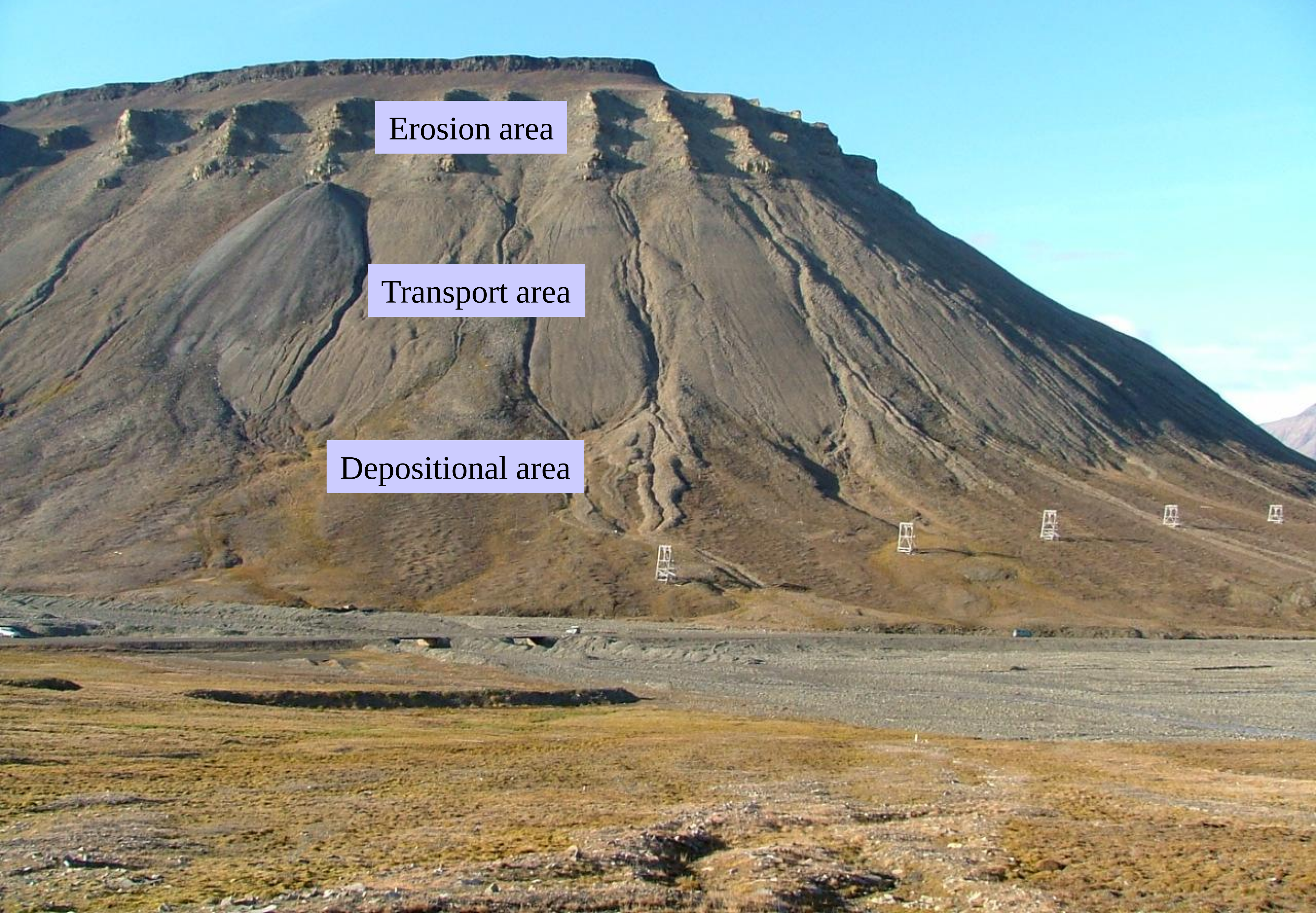
Small-scale slope failures in the active layer, >1 m deep.

**Occur when shear strength is reduced,
because of increased ice/water content.**

Triggers: rapid spring thaw or summer rain

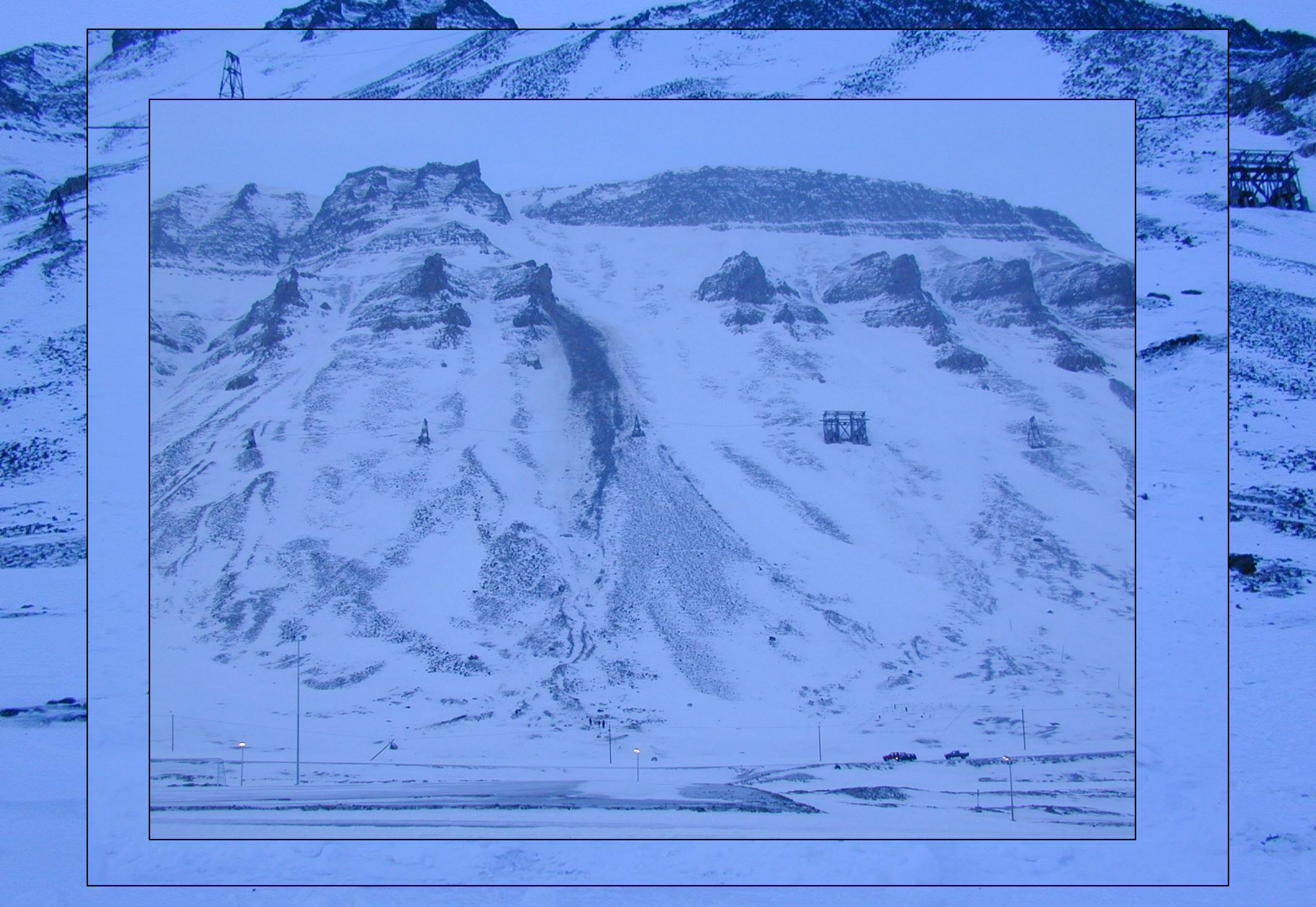
Active layer detachment slides

Debris flows



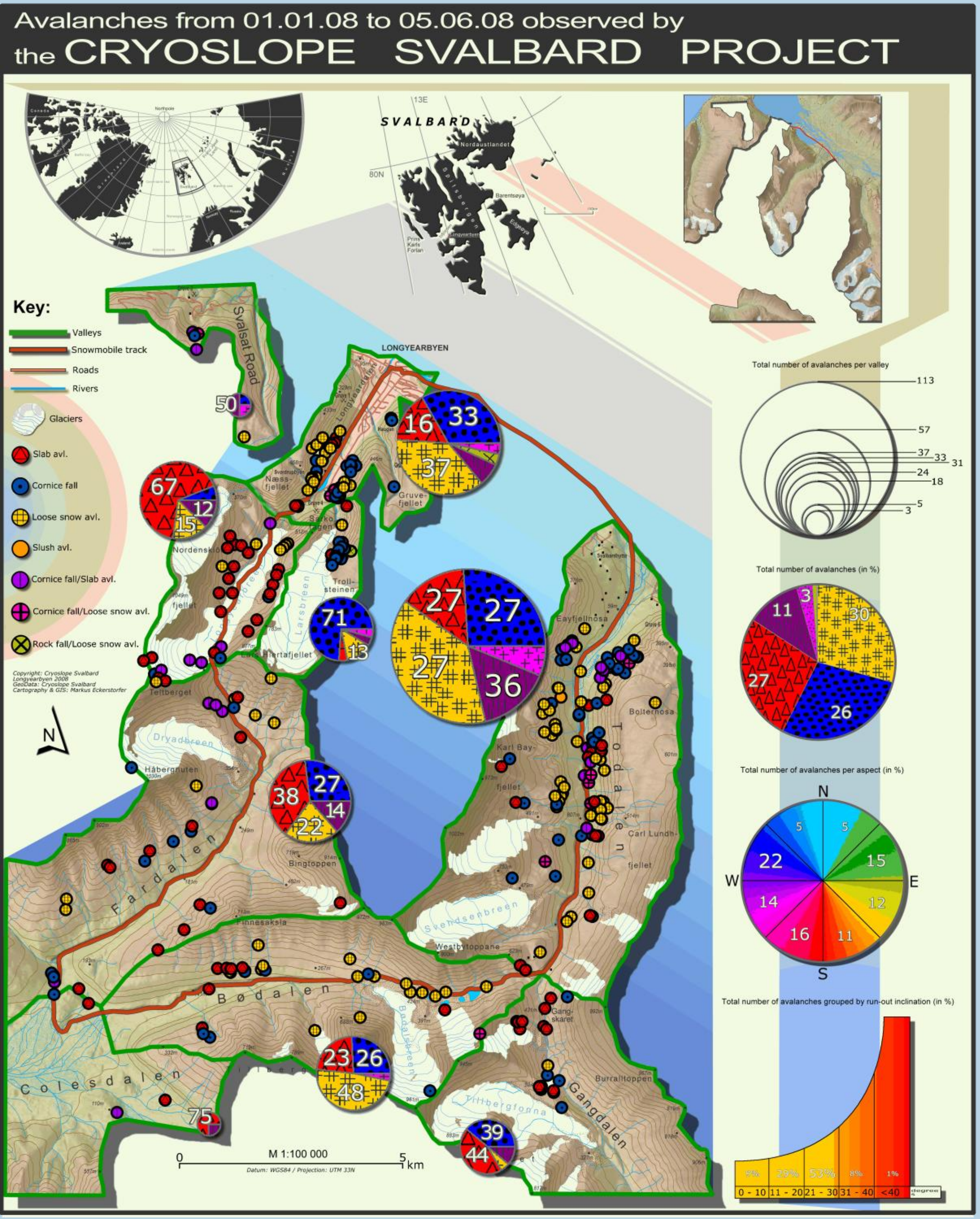
Debris flow June 2003 Longyearbyen

Rockfalls




Free faces
Transport
&
deposition
Weathering:
Thawing of ice or formation of new permafrost
Loosening of rock particles in fractures
Shear strength reduced below stresses from gravity

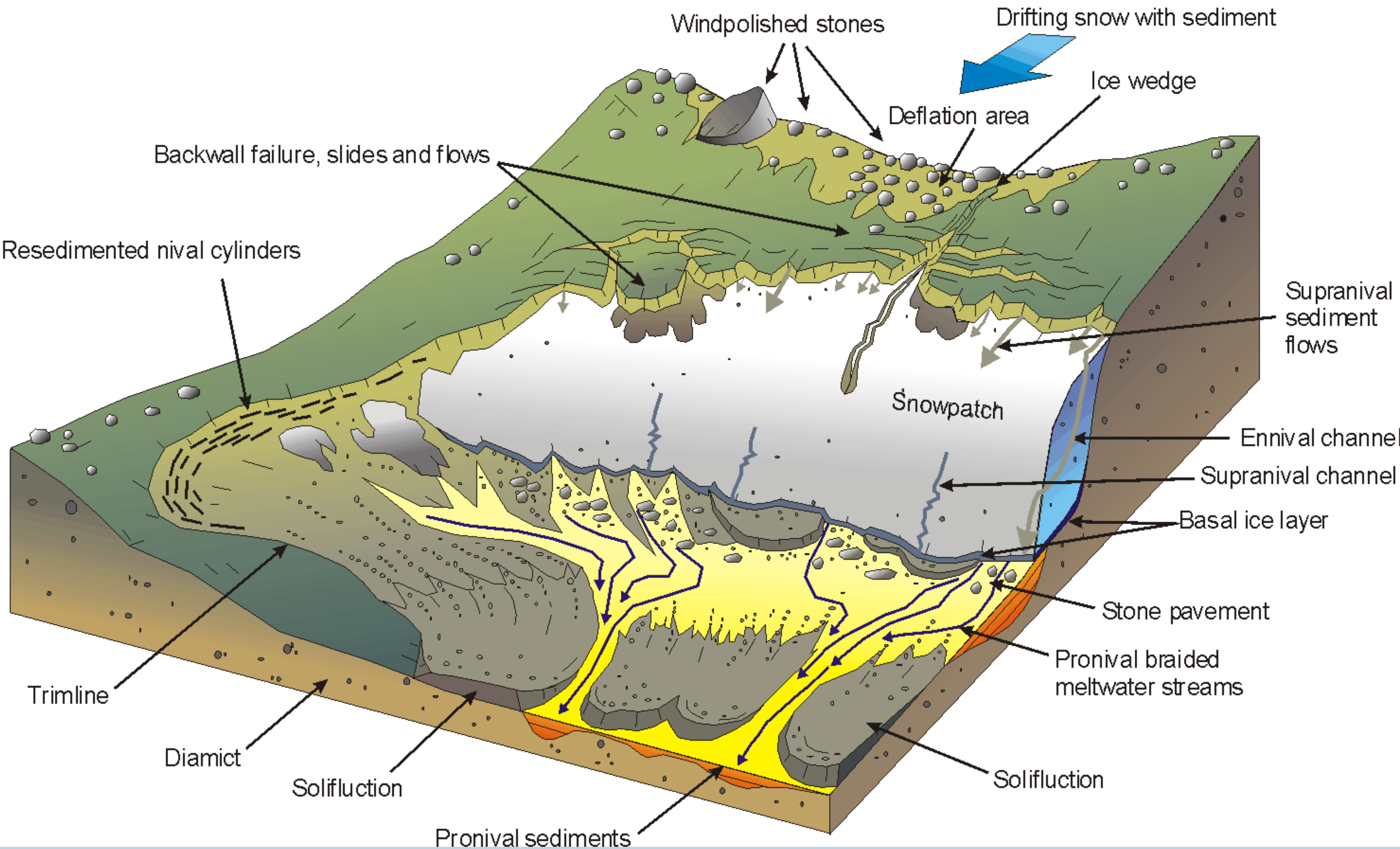
Traffic and snow avalanches

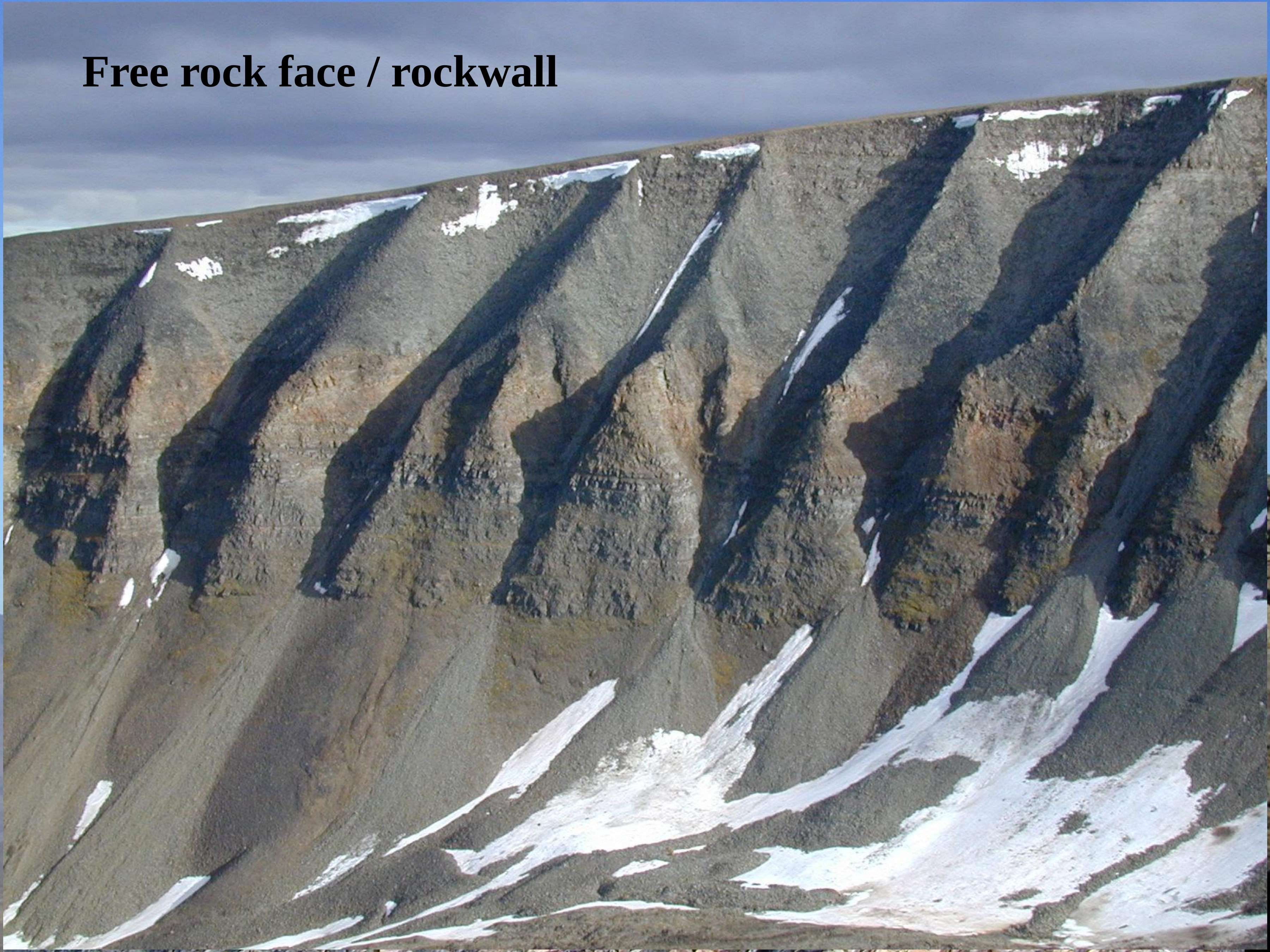


Building the first systematic database with all slope activity to access meteorological control on snow avalanches

Nov more than 600 avalanches since 1 January 2007

High Arctic Nivation Process-Form-Sediment Model



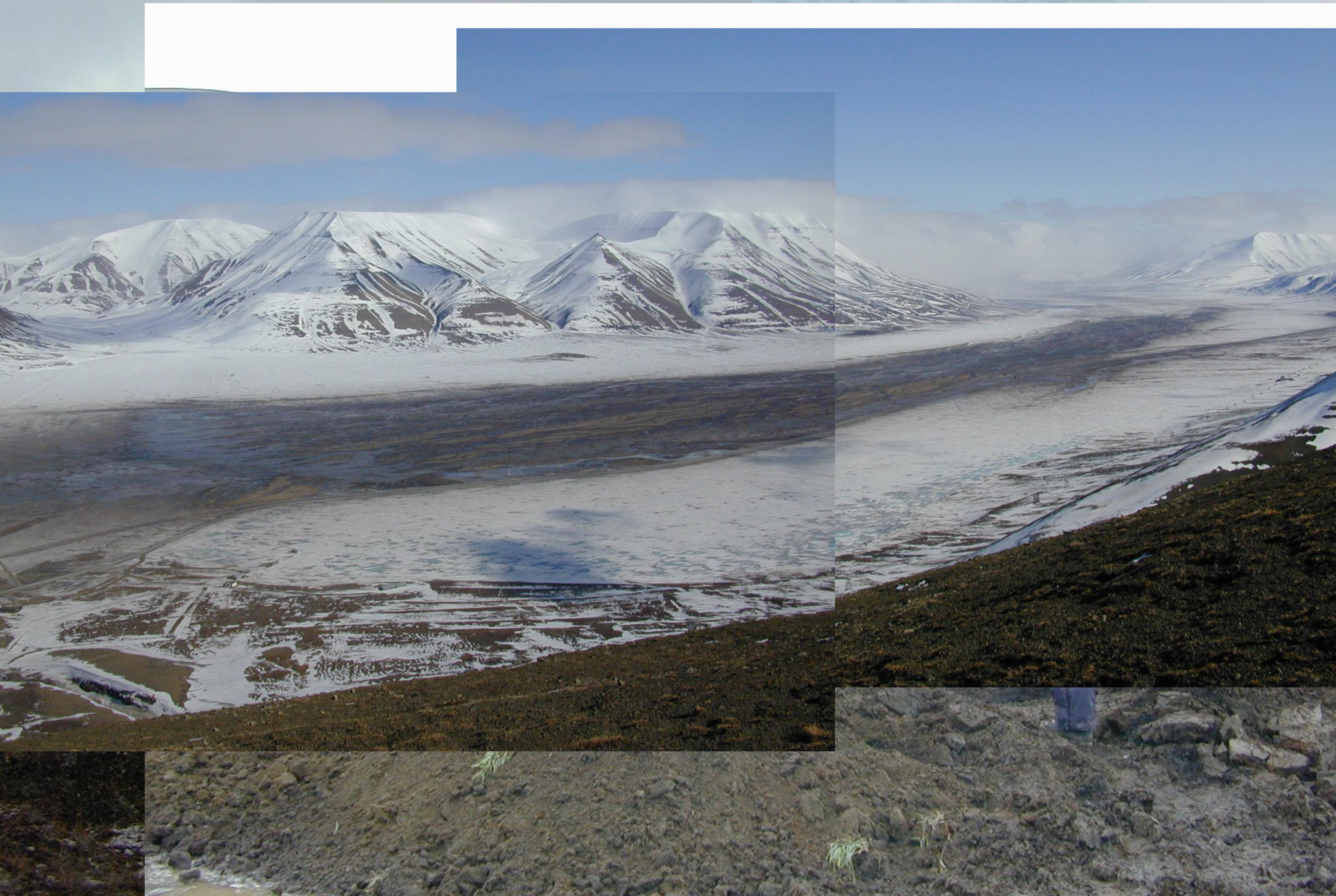


Weathering landforms

Wind – a very important geomorphological factor in Svalbard !

Wind erosion and transport in periglacial landscapes - Svalbard

Wind transport and deposition in periglacial landscapes - Svalbard



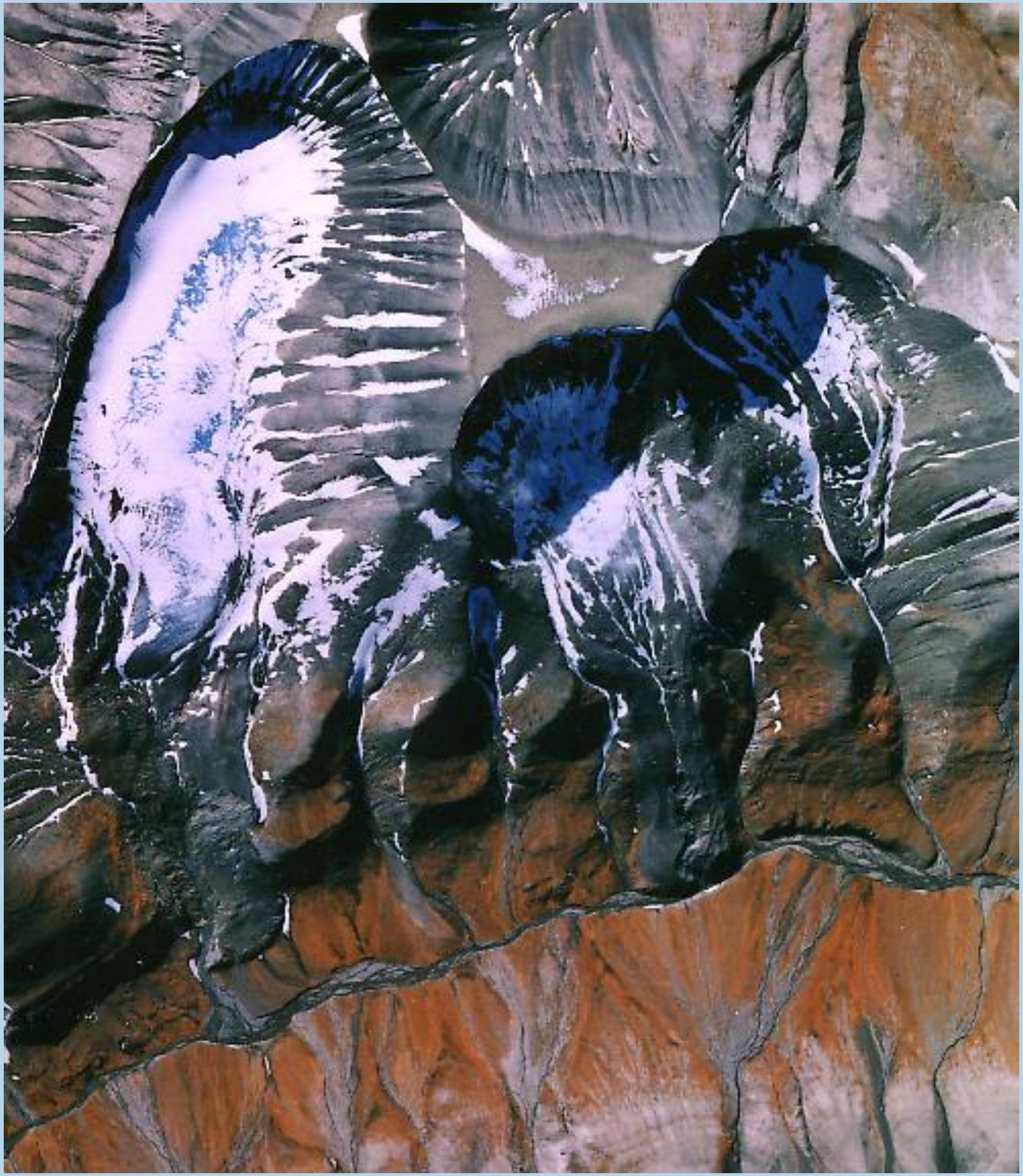
Wind erosion in periglacial landscapes - Svalbard

High geomorphic activity in permafrost regions at altitudes near the ELA

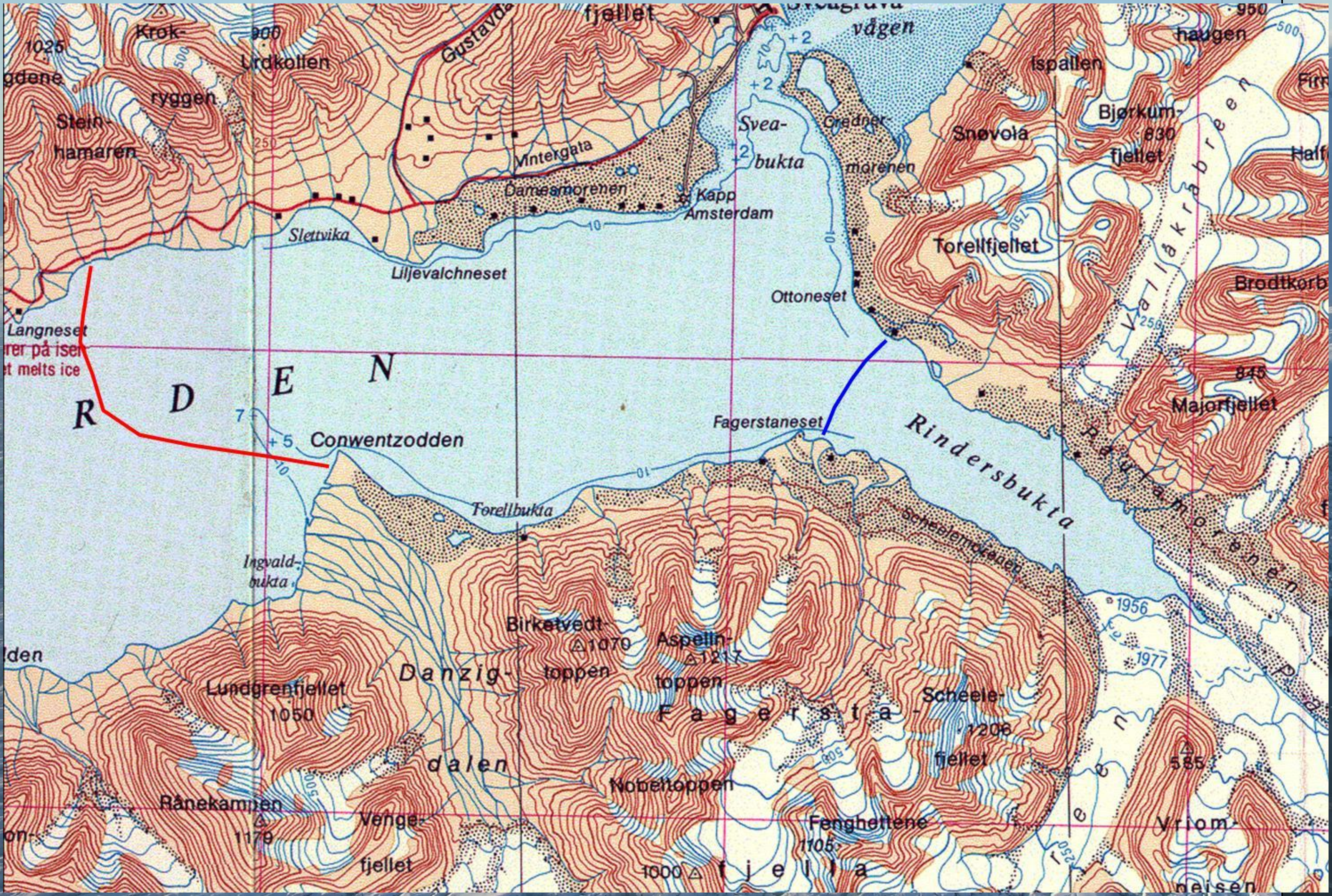
rock falls,
avalanches,
glaciers,
rock glaciers,
snowpatches,
streams,
solifluction,
etc.

Site:
Northern side of Hiorthfjellet, near Longyearbyen, Svalbard. North is towards bottom of figure

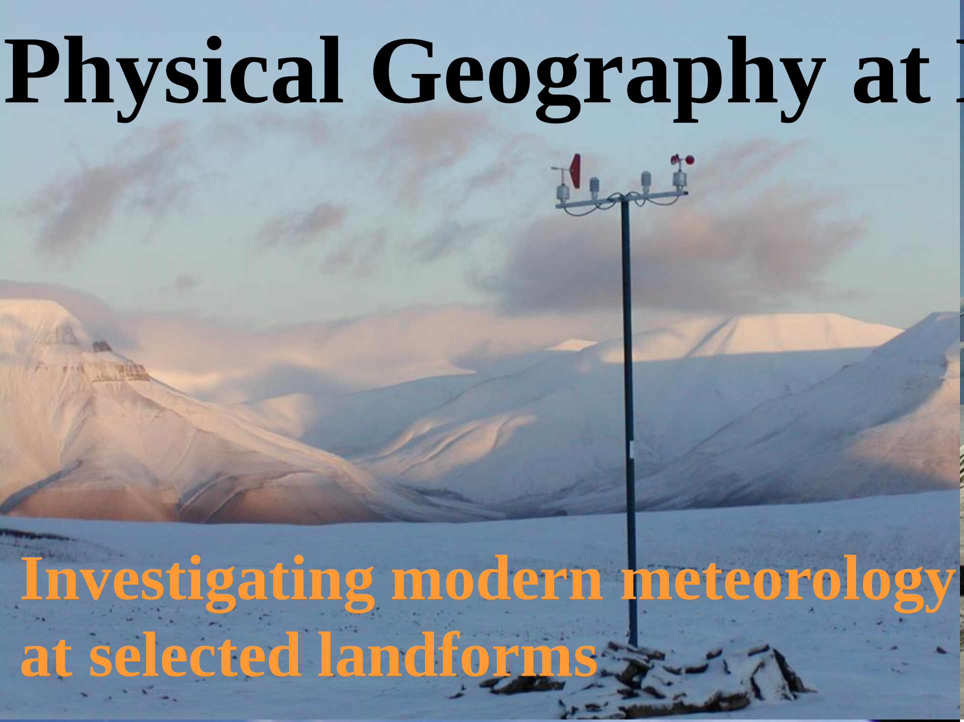
Figure measures 3000 x 2400 m

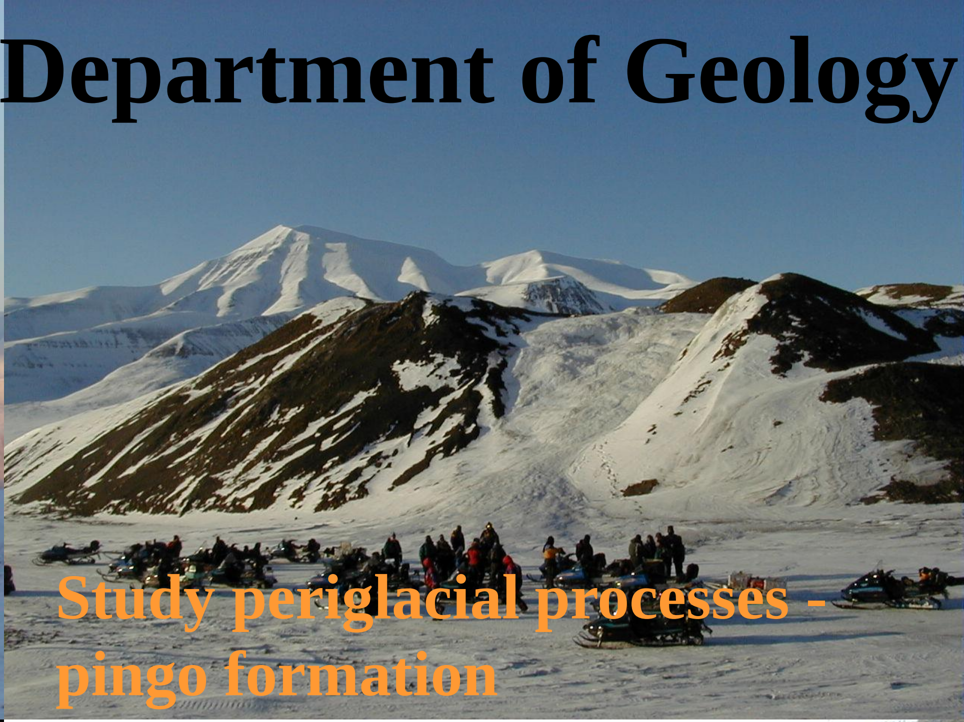


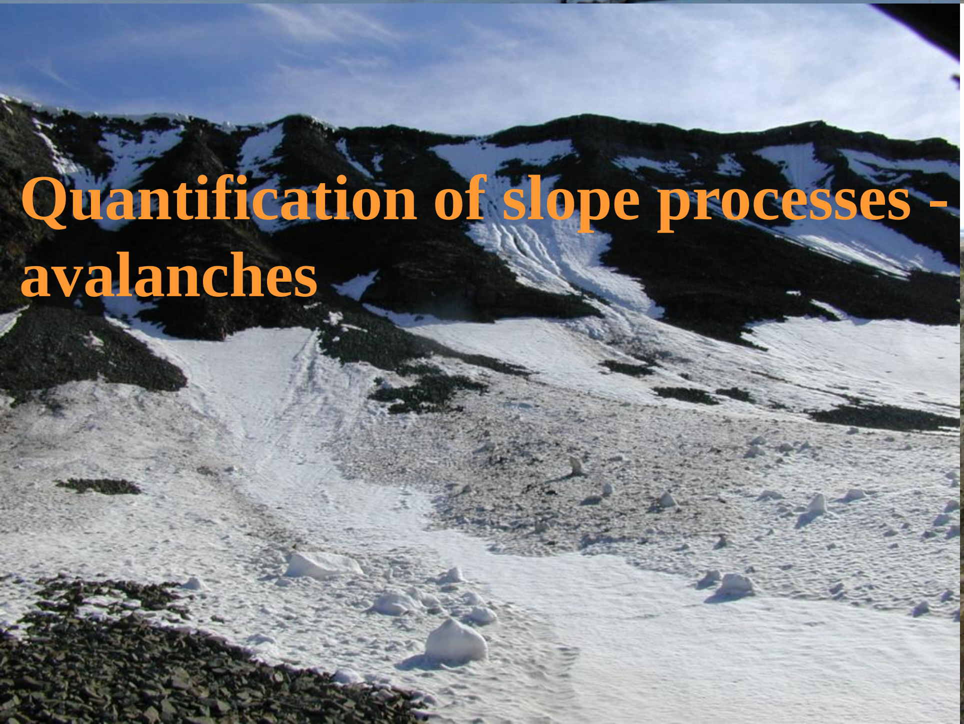
Paulabreen surge 2005



Physical Geography at Department of Geology







Readings

-) H.M. French The Periglacial Environment, Third edition, 2007. Wiley, 458 p.

-) Humlum, O, Christiansen, H.H. & Juliussen, H. 2008. (2007) Avalanche Derived Rock Glaciers in Svalbard. *Permafrost and Periglacial Processes*, 18, 75-88.

-) Christiansen, H.H. (1998) Periglacial sediments in an Eemian - Weichselian succession at Emmerlev Klev, southwestern Jutland, Denmark. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 138, 245-258.

-) Liestøl, O., 1976: Pingos, springs, and permafrost in Spitsbergen. Norsk Polarinstitut Årbok 1975, pp. 7-29.