Landforms of Glacial Deposition

Castle Creek Glacier (BC Rockies)

Landforms of terrestrial glacial depositional

	Ice-marginal	Subglacial
Glacial	Glaciotectonic* moraines	Flutes, megaflutes
	Dump moraines	Drumlins
	Ablation moraines	Rogen moraine
		Mega-scale glacial lineaments
Glaciofluvial	Outwash fans/plains	Eskers
	Kames, kame terraces	
	Kame-kettle topography	

Glaciotectonic: deformation of sediment or rock by moving ice

After Bennett and Glasser, 2009

Glaciotectonic moraines

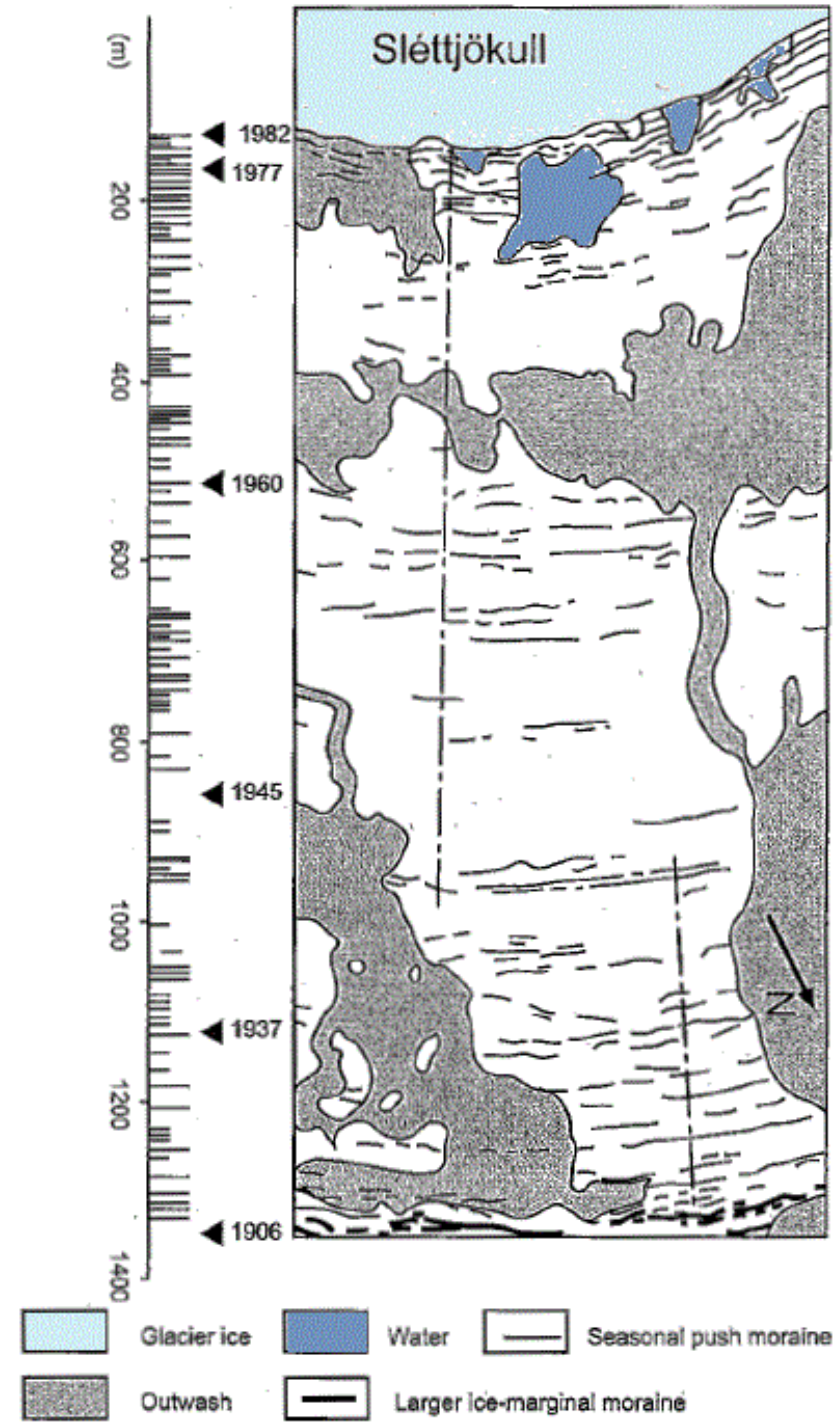
Seasonal push moraines

- Associated with receding glaciers that have significant seasonal melting
- In some cases small annual moraines can be traced across a pro-glacial plain
- Limited glaciotectonic deformation

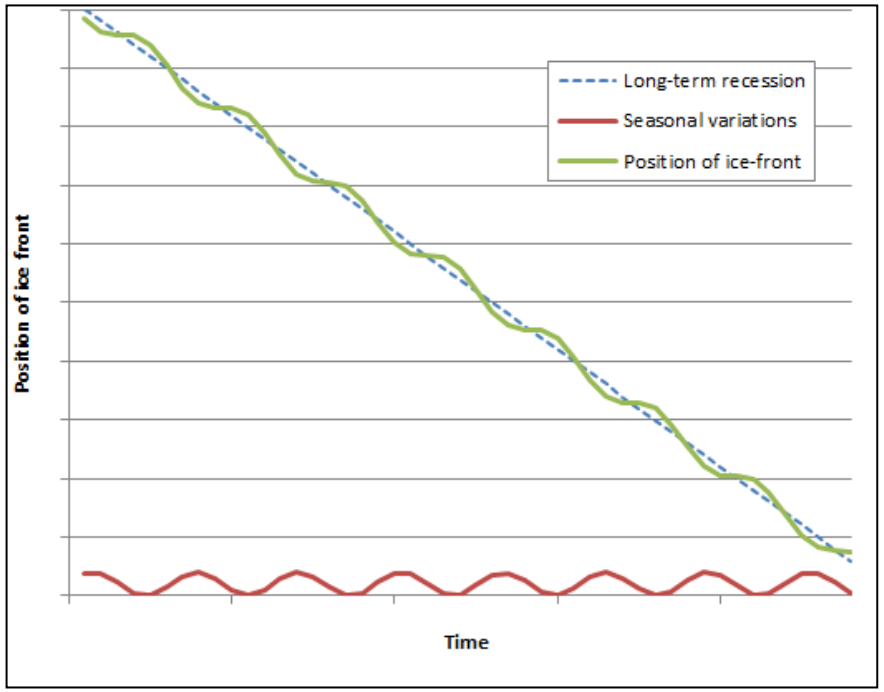
Surge and sustained-advance moraines

- Associated with glaciers that are either surging or advancing in a sustained way
- Often involve significant glaciotectonic deformation of pre-exisiting pro-glacial bed materials (e.g, ground moraine or glaciofluvial deposits)

Seasonal push moraines at Sléttjökull



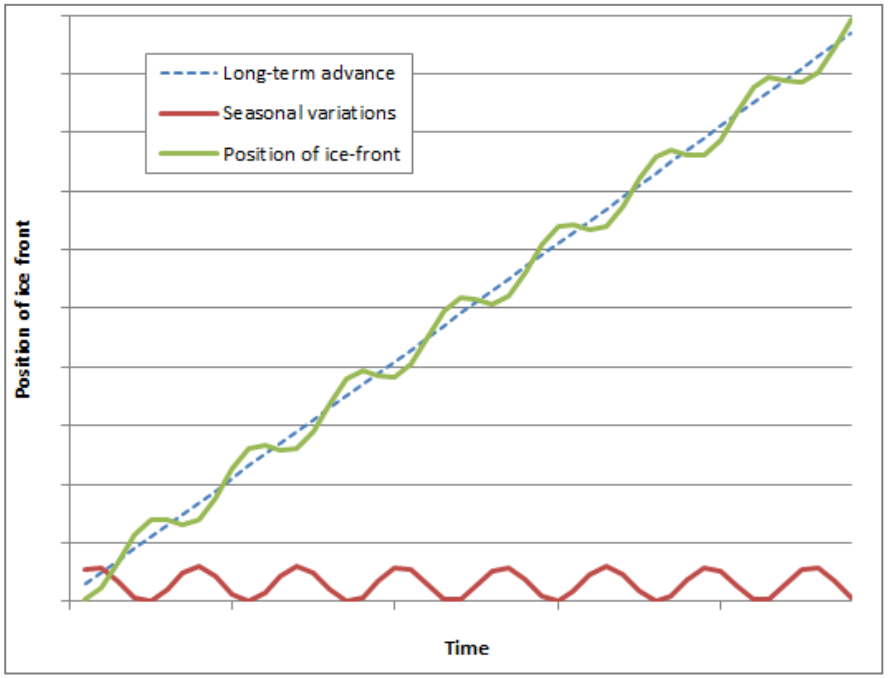
After Bennett and Glasser, 2009

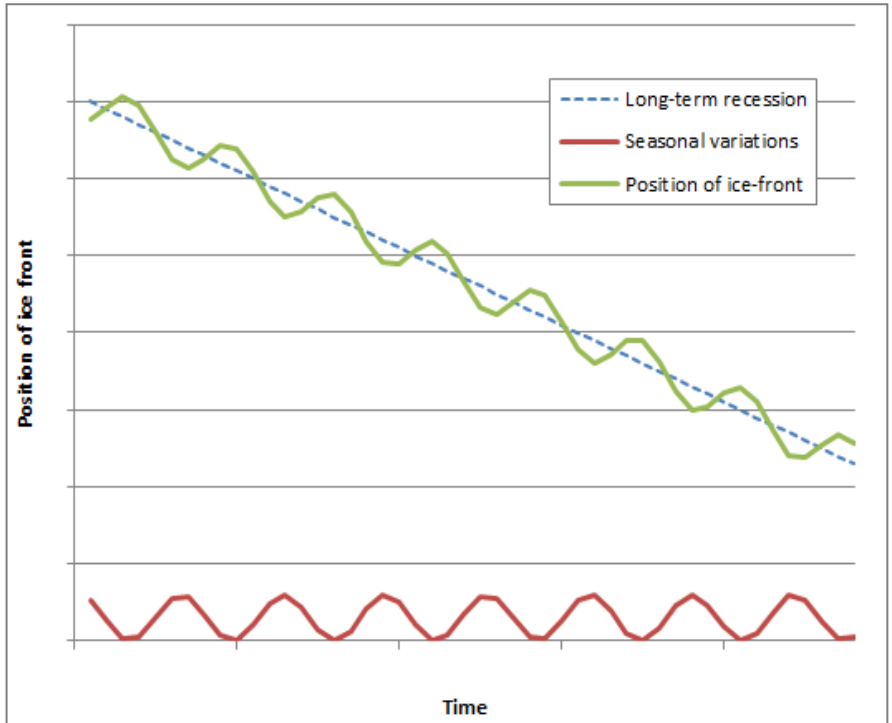


Fast net recession, low seasonal variation:
No seasonal push moraines

Seasonal push moraines

Net advance: No seasonal push moraines



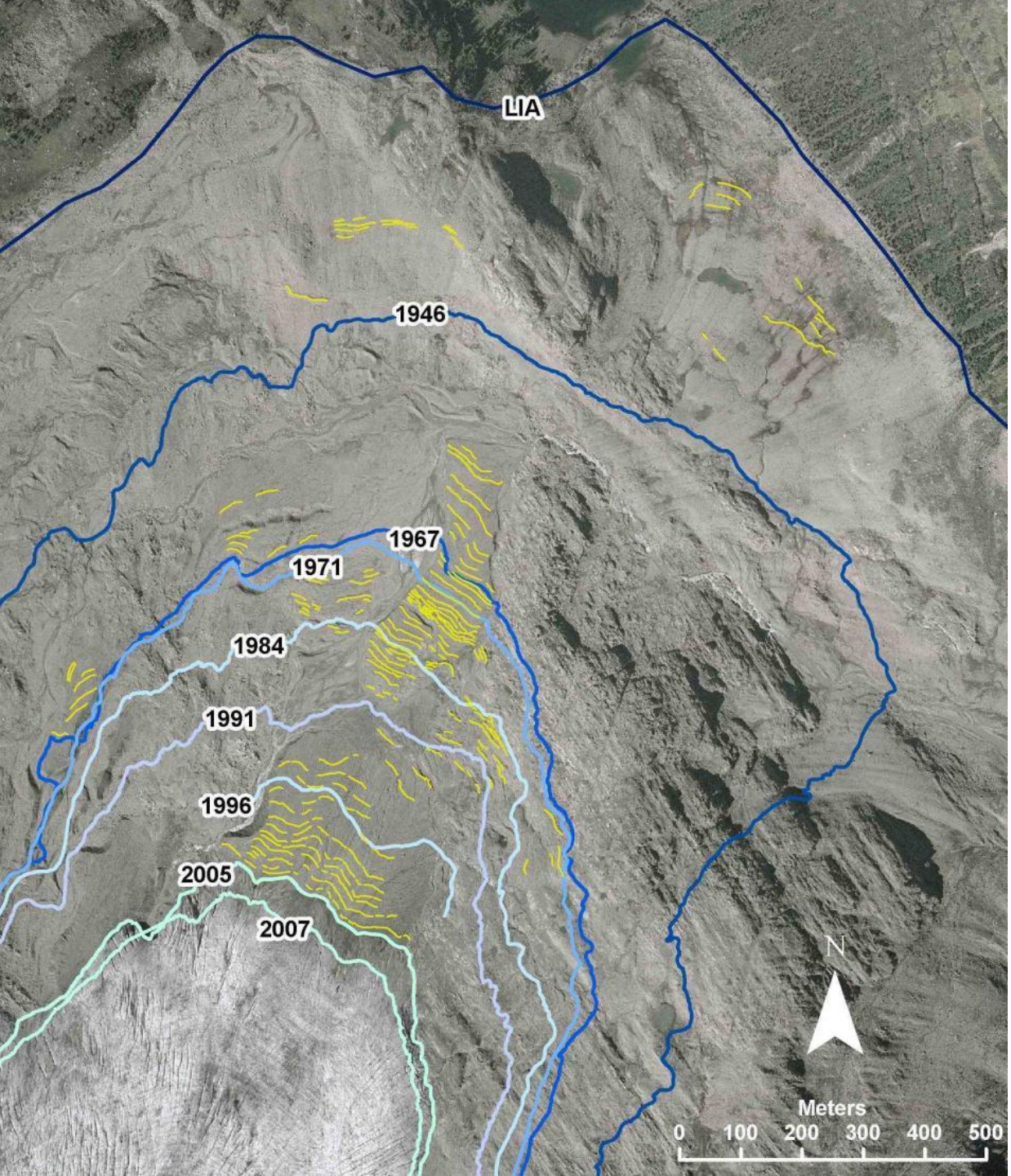


Slower net recession or high seasonal variation:
Seasonal push moraines

Castle Creek Glacier (BC Rockies), M. Beedle, UNBC, http://web.unbc.ca/~beedlem/castle_cr_glacier.html

Castle Creek glacier – development of a push moraine

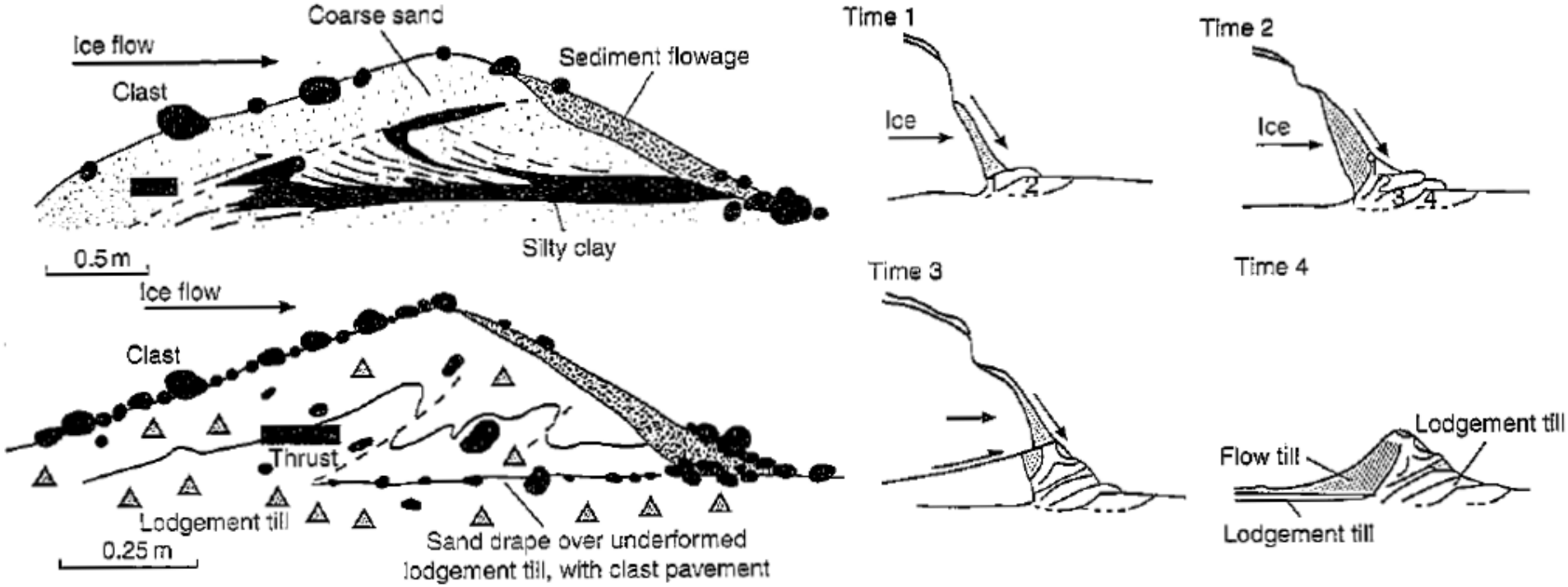
M. Beedle, UNBC



Castle Creek glacier – push moraine history

M. Beedle, UNBC

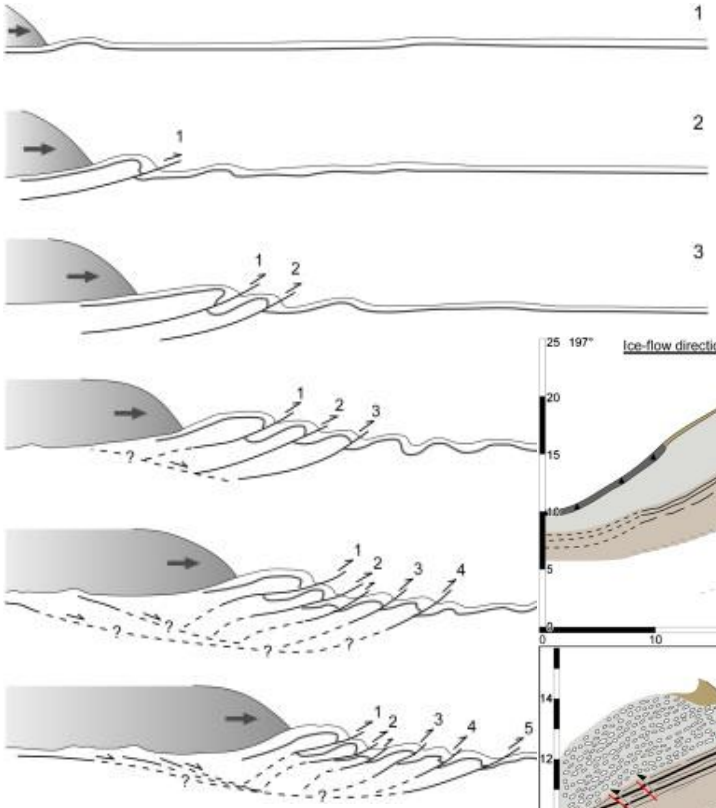
Structure of seasonal push moraines

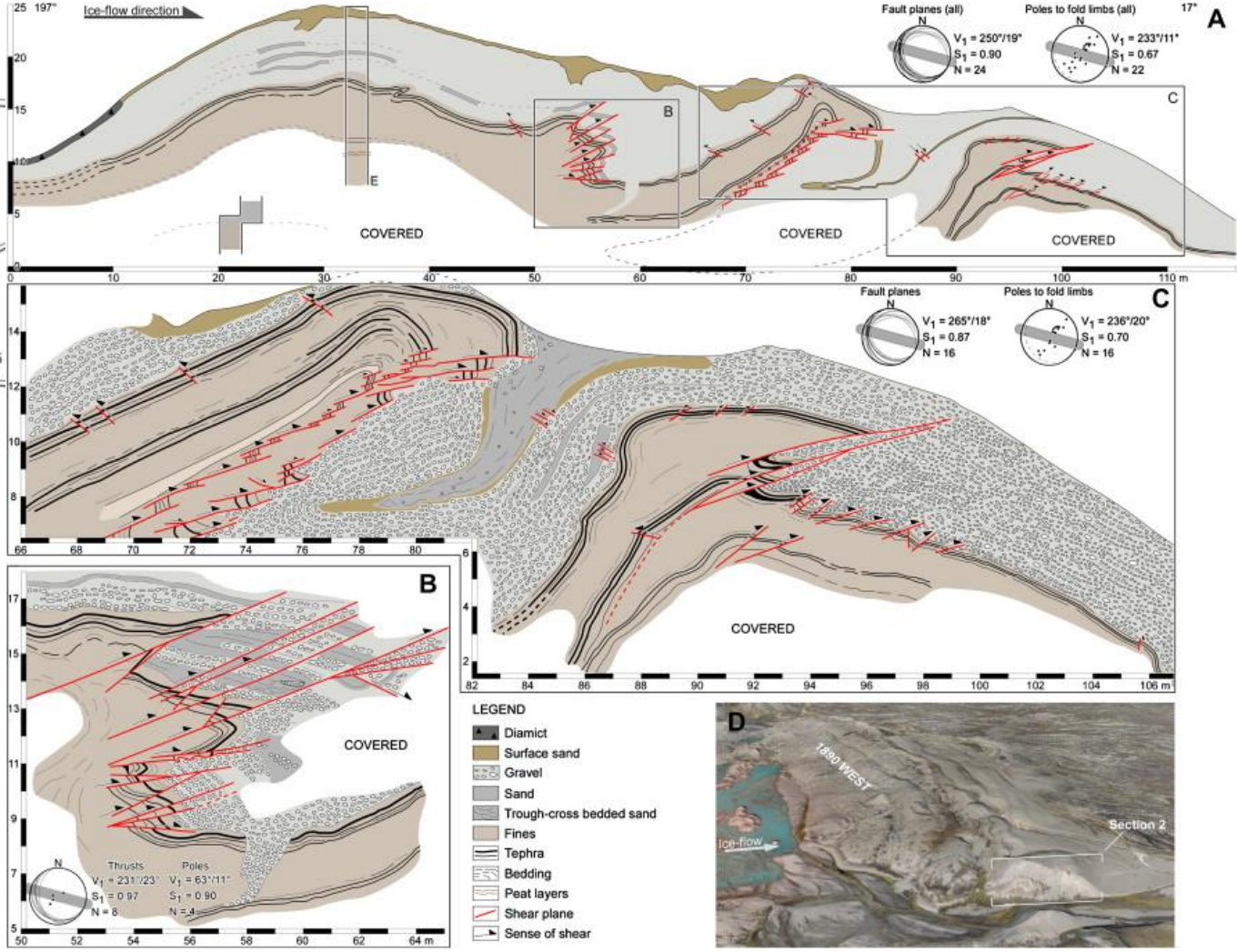


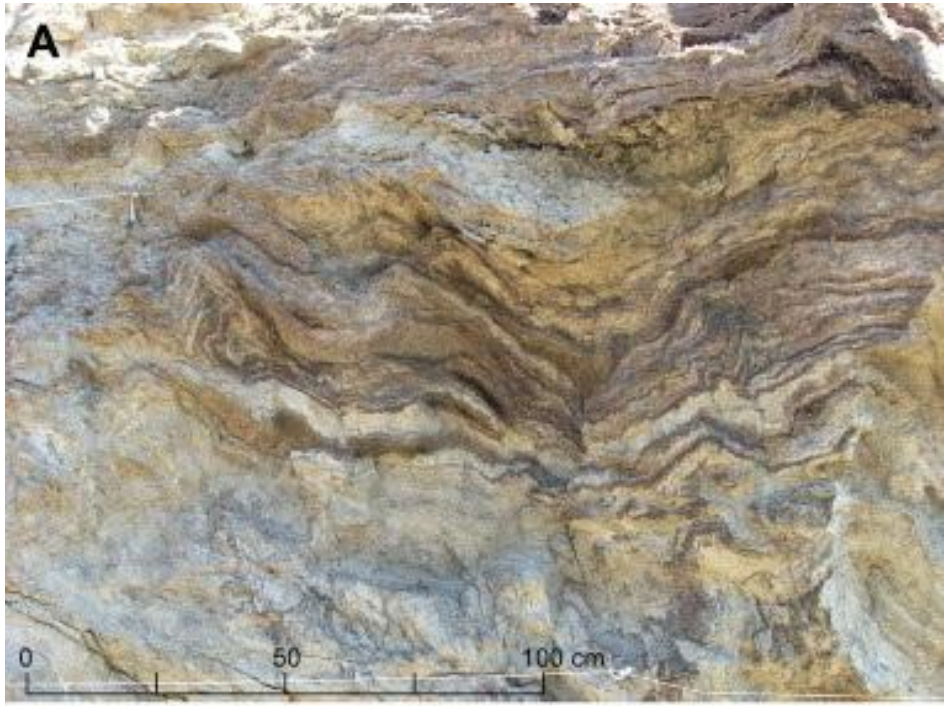
After Bennett and Glasser, 2009

Surge-related push moraine in front of Usherbreen, Svalbard, August 1985

Push moraine from the 1980 surge of
Eyjabakkajökull, Iceland
(Benediktsson, et al., 2009)







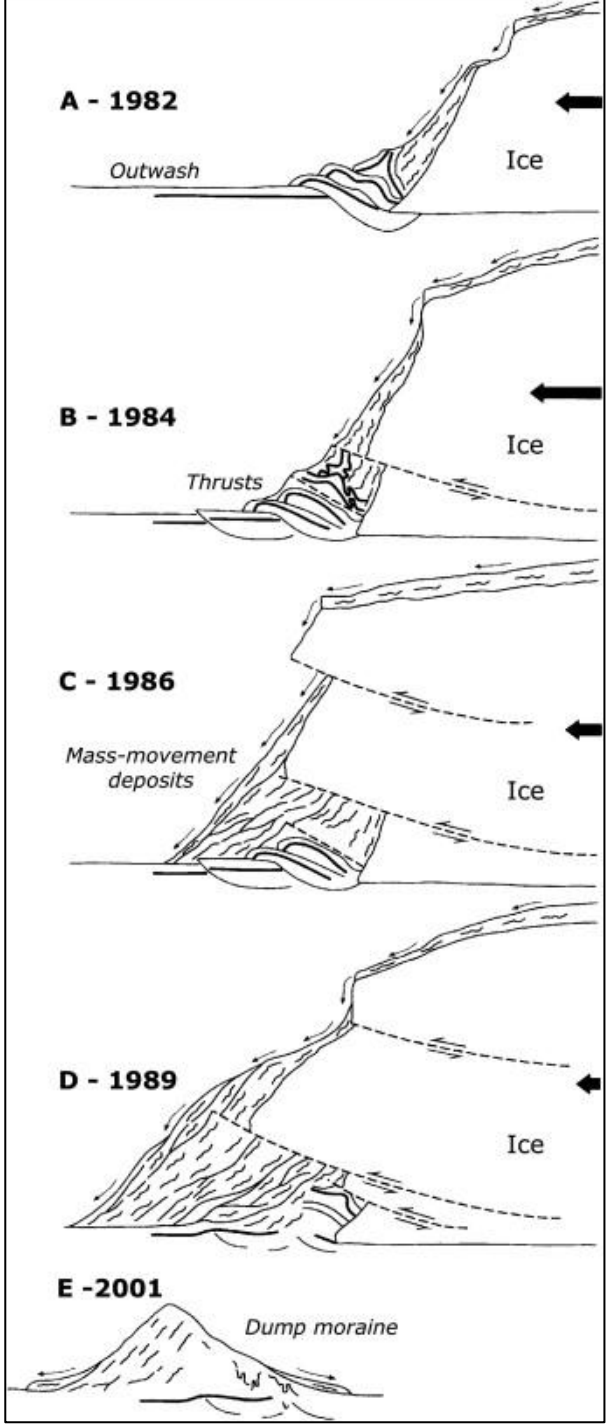
Sediments and tectonic structures in section 1. Tectonic stress from right to left. (A) Minor folds in laminated LPT* in the upper centre. (B) Series of thrusts in LPT at the base. The lowermost thrust occurs at the gravel/LPT interface. (C) Close-up of a high strain shear zone at the base of the section. Note the sigmoidal foliation between the thrusts determining the relative sense of movement.

*LPT = loess, peat and tephra deposits that formed a blanket in the pro-glacial area

Benediktsson, et al., 2009

Dump moraines

- Supraglacial (and subglacial) material that accumulates at a stationary margin and is then deposited by slump and flow processes at the ice edge
- Dump moraines can form in both frontal and lateral positions
- Material is not deformed as in glaciotectonic moraines and is not bedded as in kames

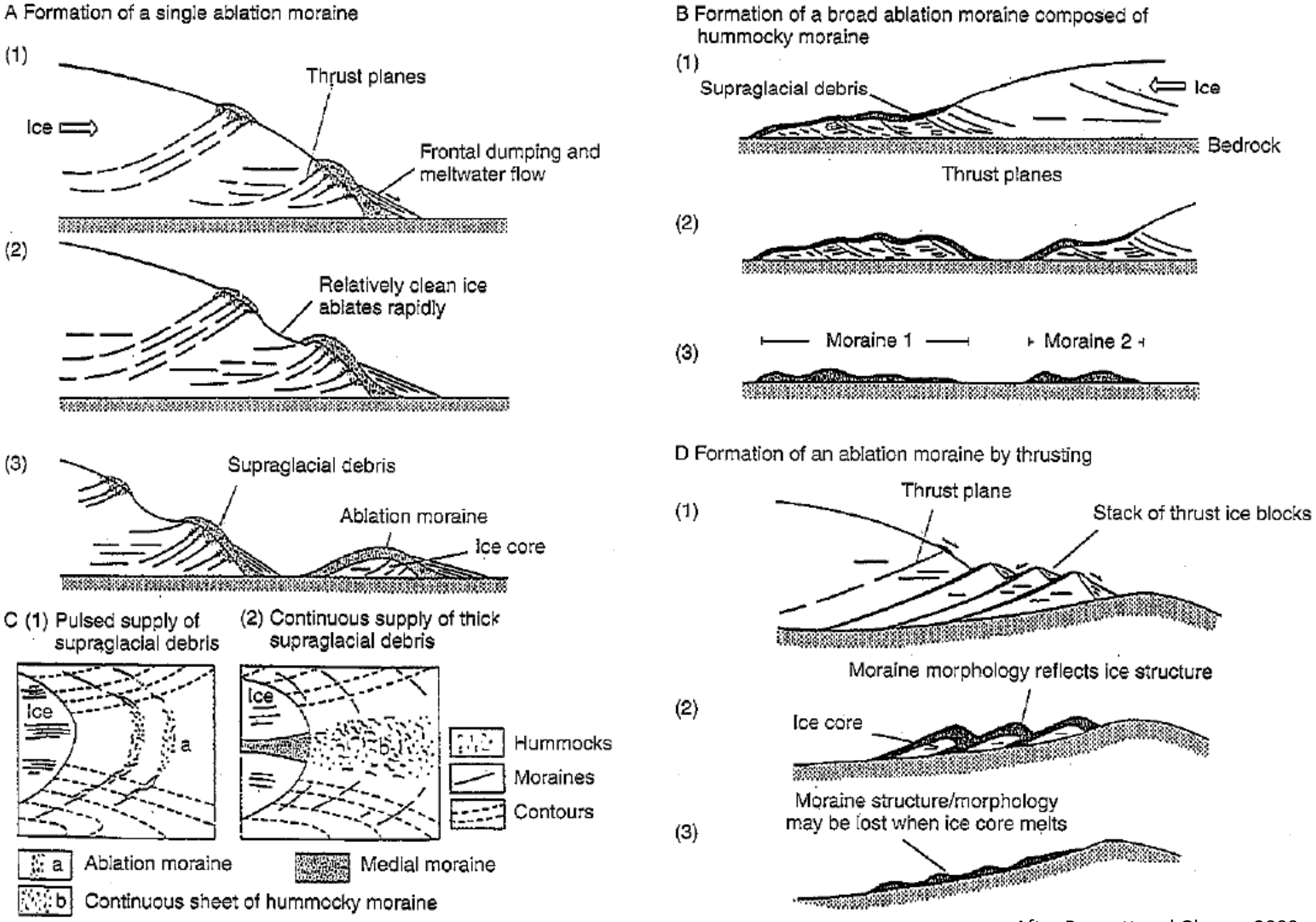


Kruger et al., 2002

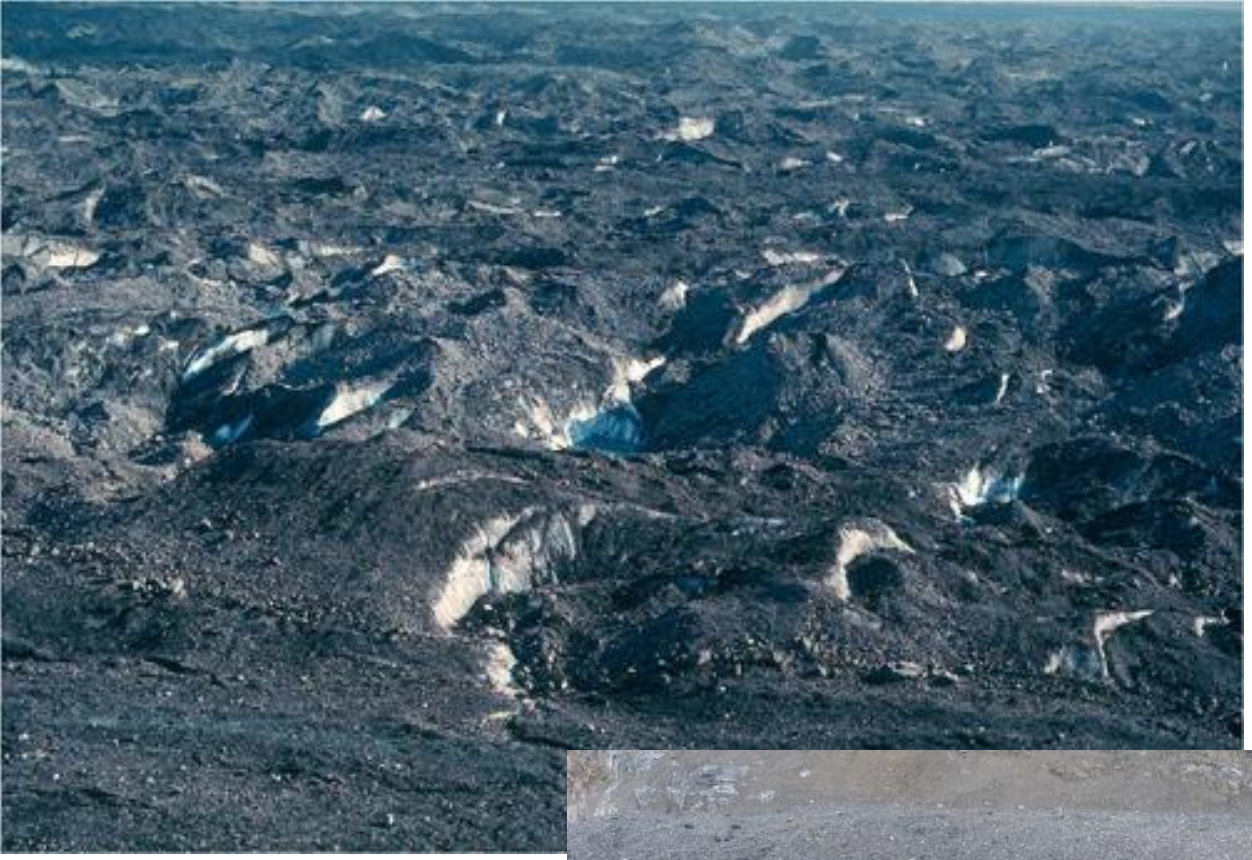
http://people.su.se/~iborg/bildarkivet/bildsidor/glac/moran/ib256.htm

Ablation moraines

- Supraglacial material that is present on the surface of a pro-glacial stranded ice block that subsequently melts
- Hummocky terrain is a common product
- Composition will be reflective of supraglacial material (angular, coarse)

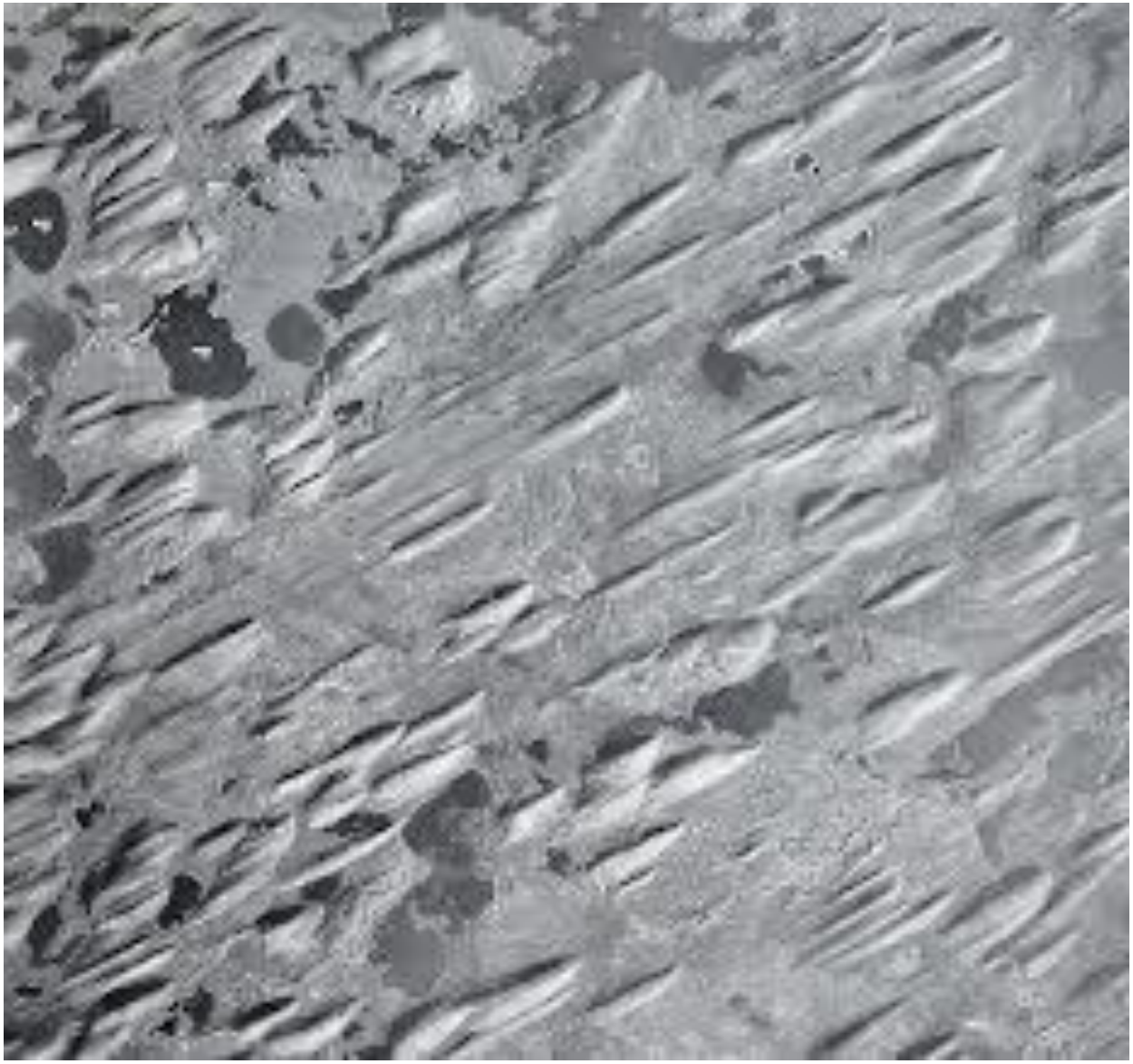


After Bennett and Glasser, 2009



USGS

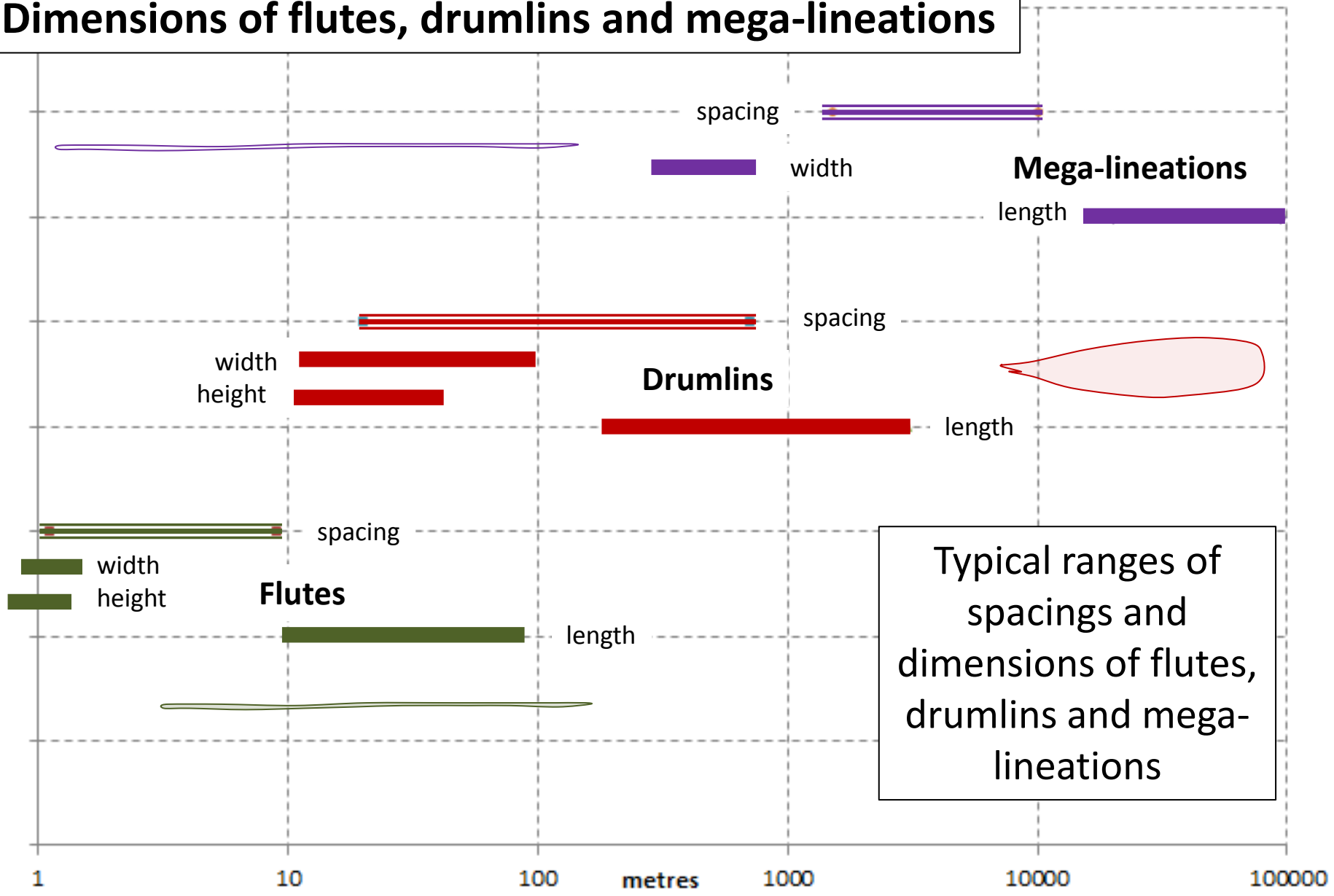
Debris-covered stranded ice - Athabasca glacier



Flutes, drumlins and mega-lineations

Streamlined • positive • subglacial • depositional

Dimensions of flutes, drumlins and mega-lineations



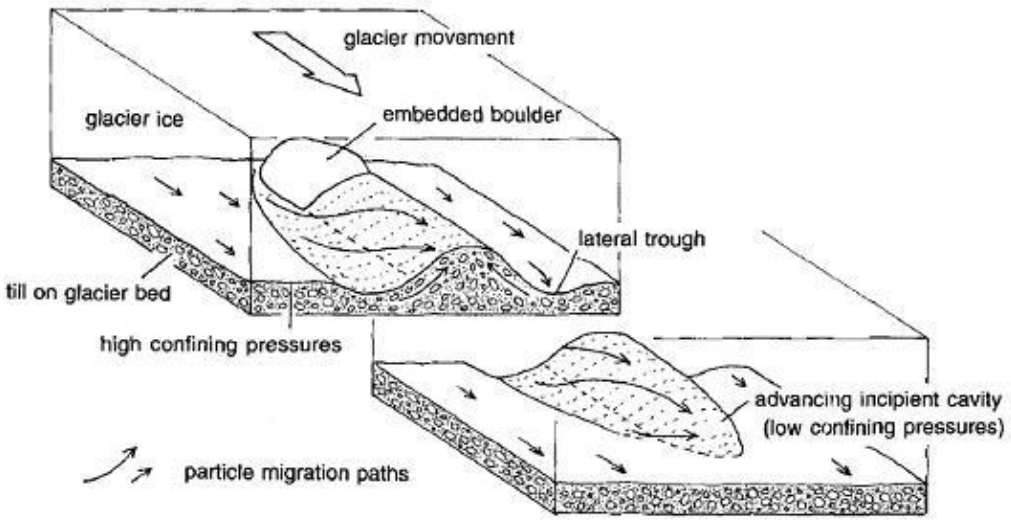
from data in Bennett and Glasser, 2009

Flutes (Brúarjökull, Iceland)

https://notendur.hi.is/oi/bruarjokull_photos.htm

Sólheimajökull

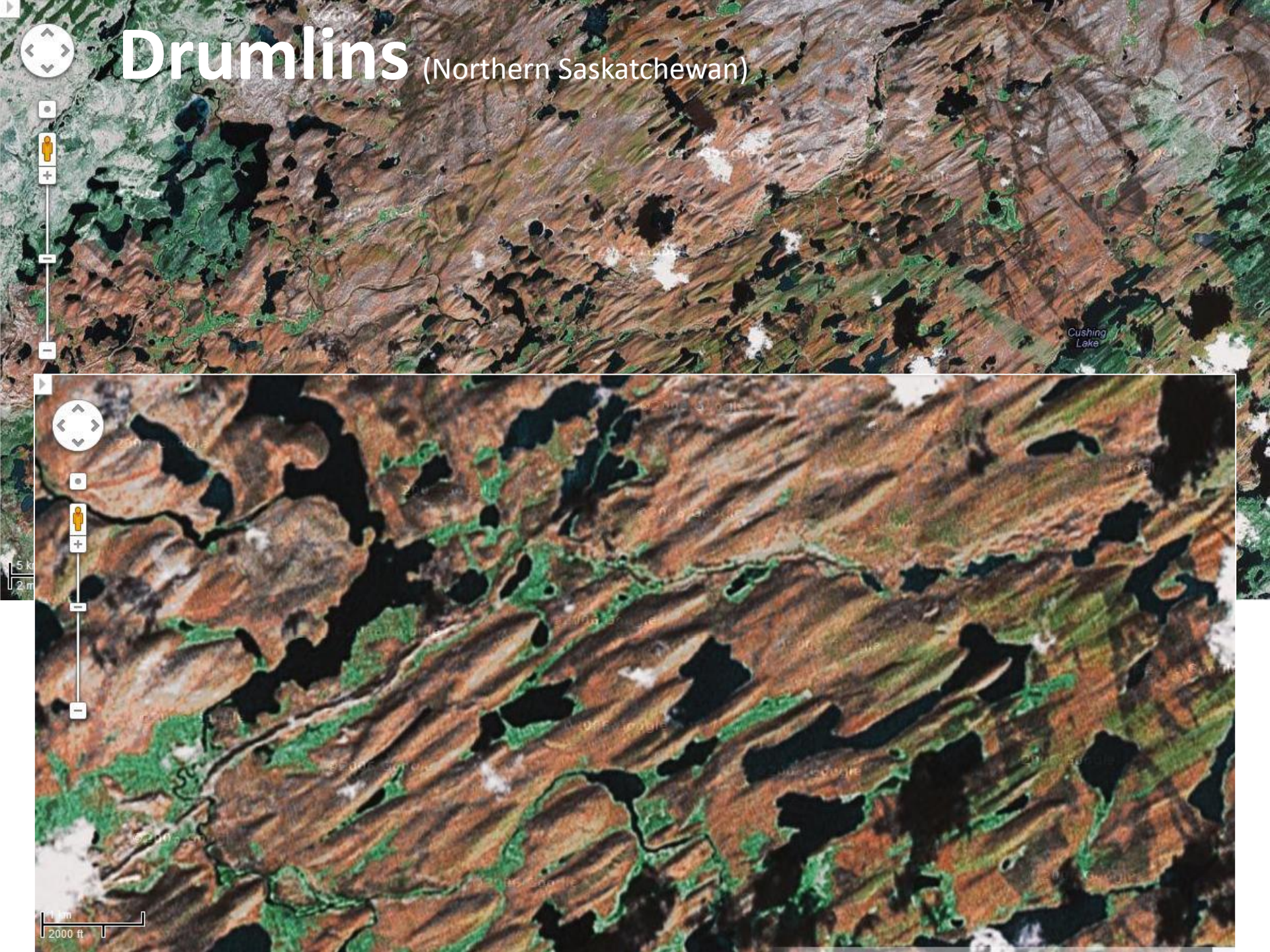
http://www.sheffield.ac.uk/drumlins/flutes



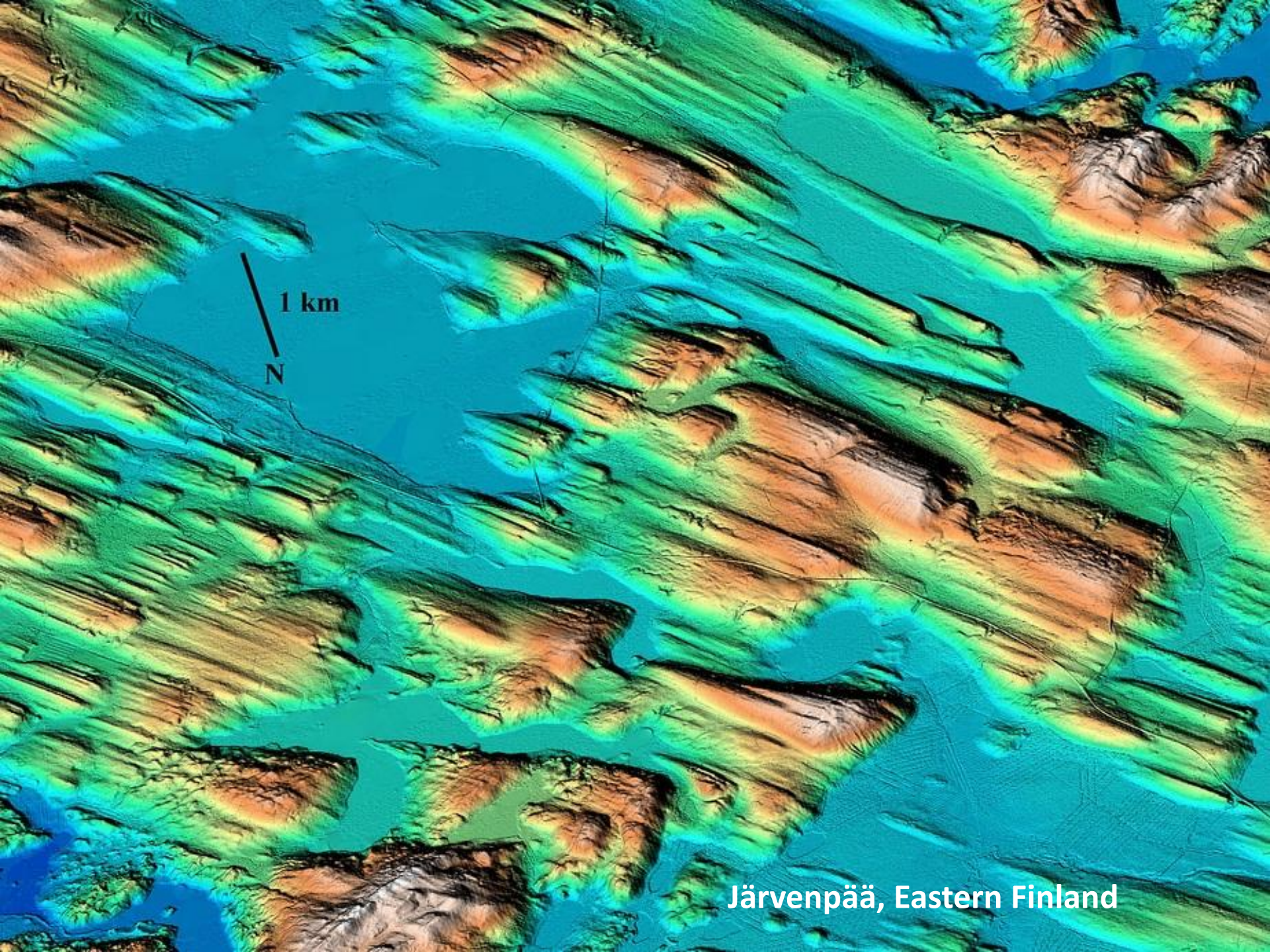
http://libwiki.mcmaster.ca/clip/index.php/Main/FORMATION

https://notendur.hi.is/oi/glacial_geology_photos.htm

Drumlins (Northern Saskatchewan)



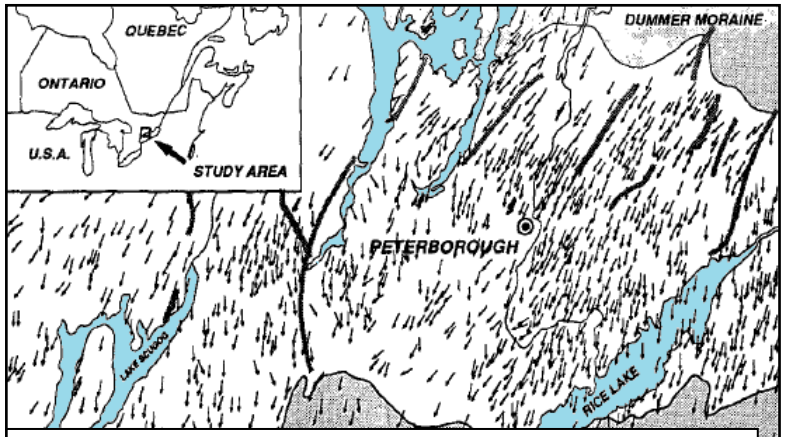
Morley, Alberta

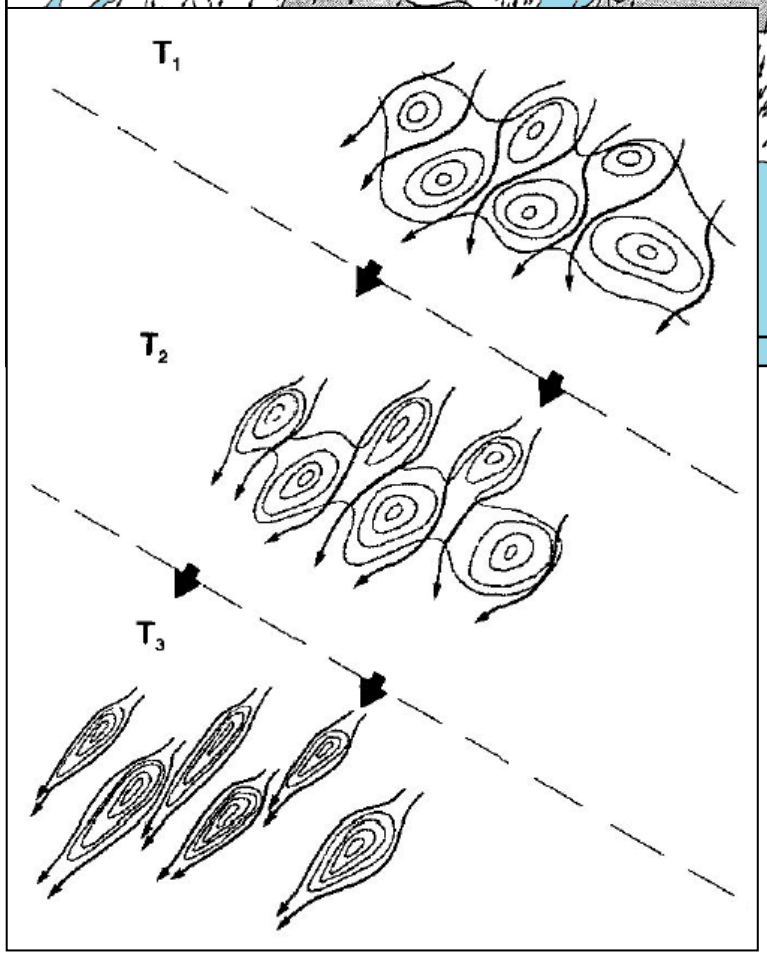


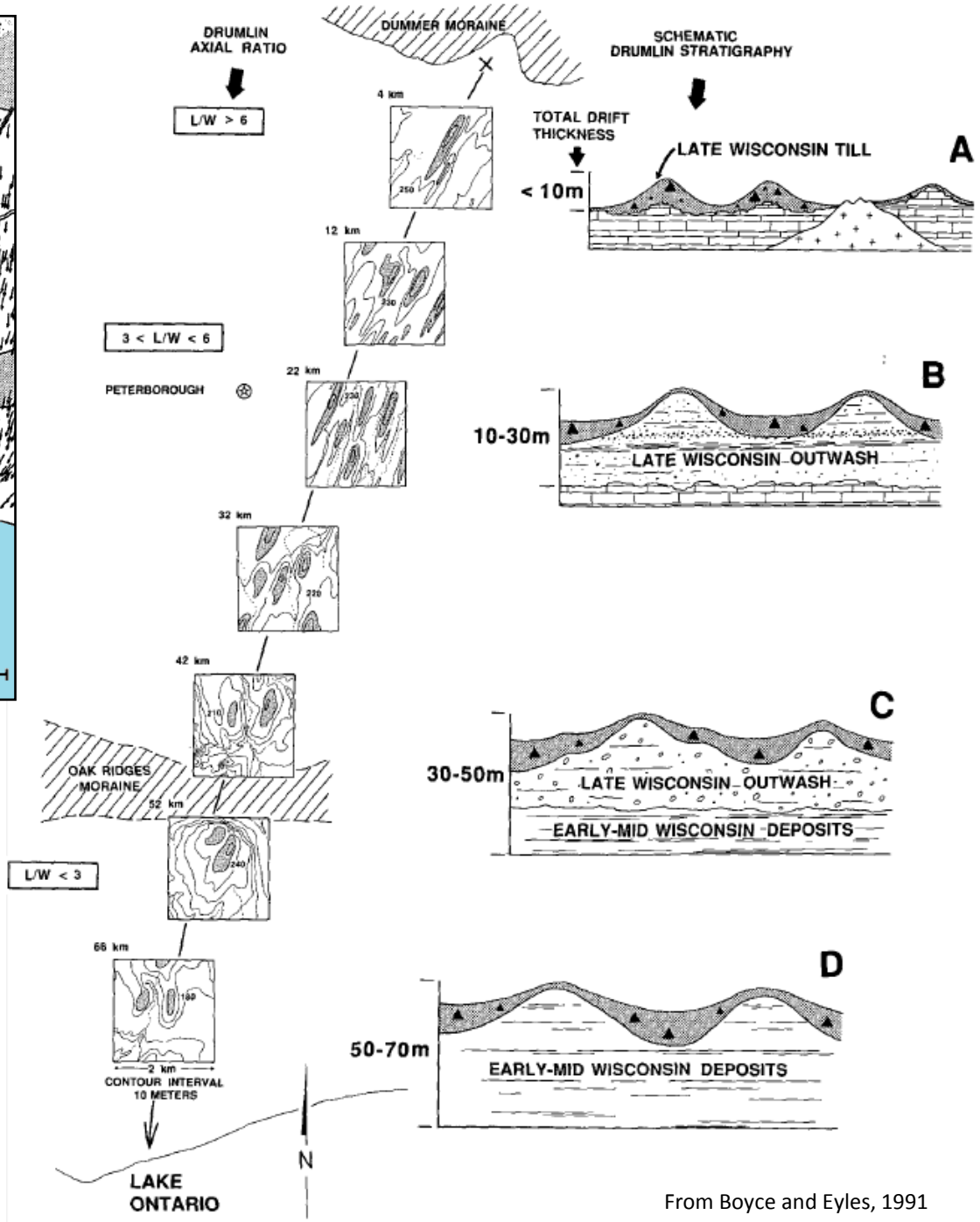
Järvenpää, Eastern Finland

There is wide diversity in the morphology and sedimentary composition of drumlins, and there are several theories (and significant controversy) on their formation. Some of the consistent features of most of the theories are:

1. A bedrock or other obstacle may be important in initiating the formation of a drumlin,
2. Deformation of existing till (and/or fluvial sediments) likely takes place,
3. Elevated water pressures may enhance this process by reducing the strength of the sediment, and
4. Drumlinoid features may become increasingly streamlined over the duration of their formation.

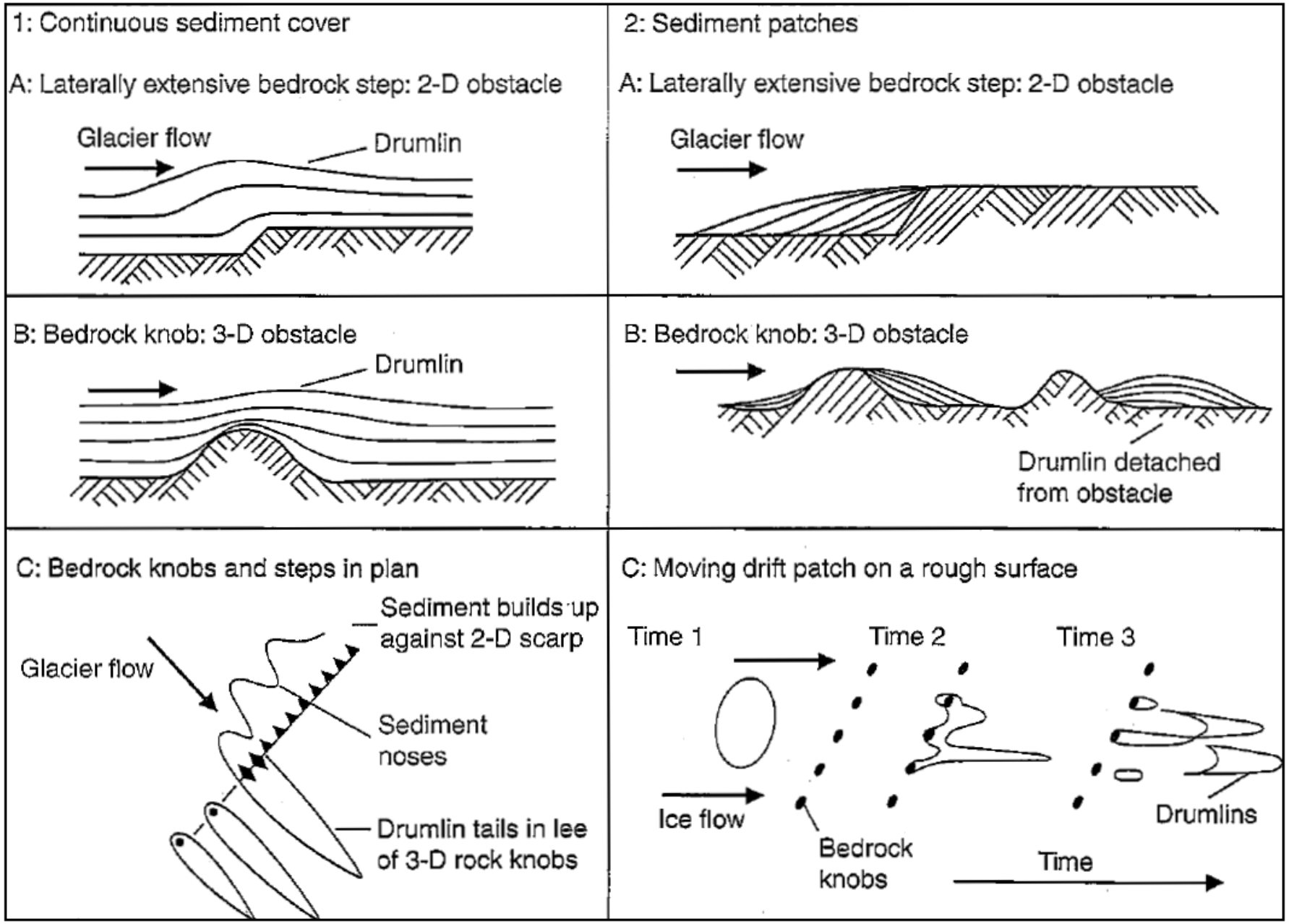






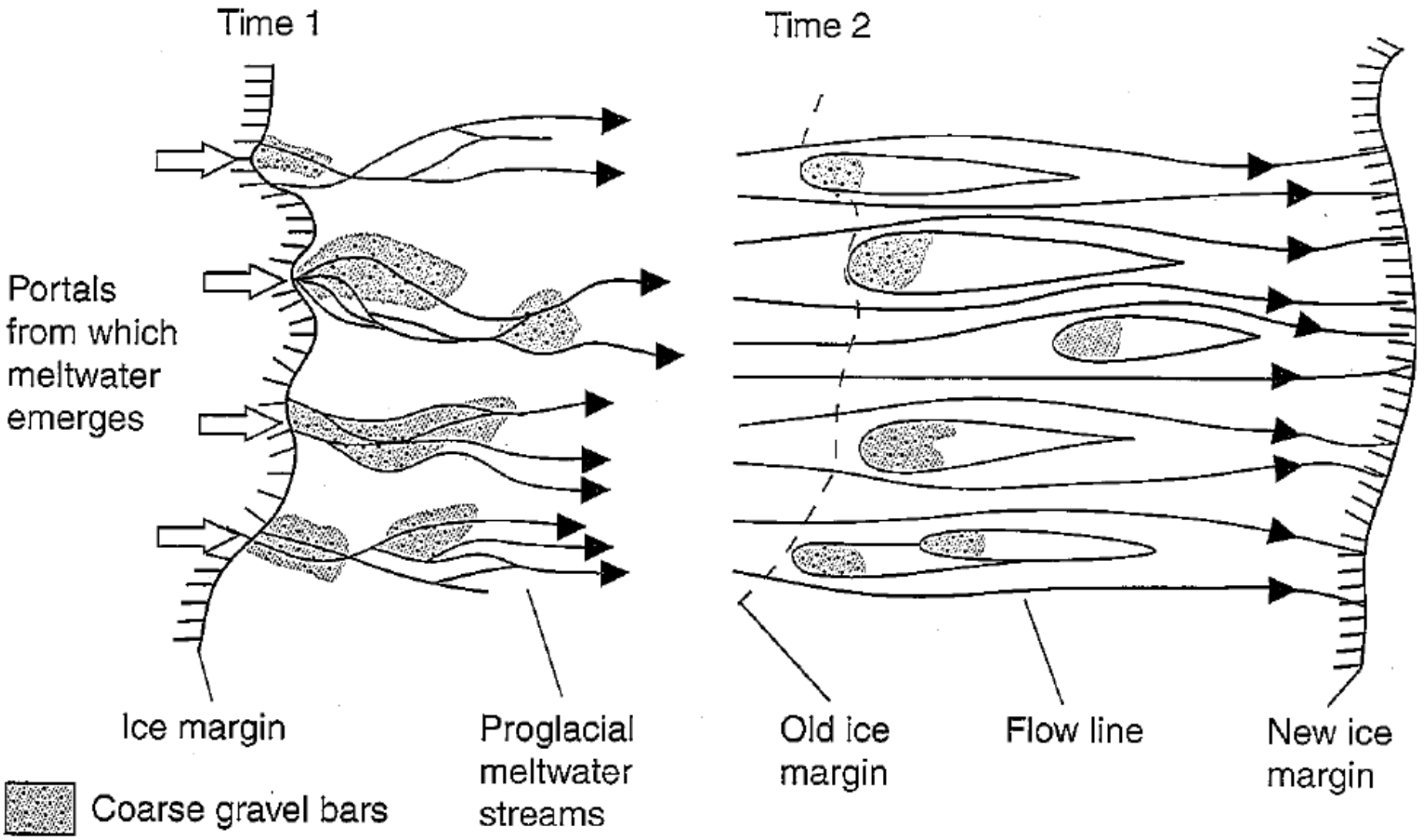
From Boyce and Eyles, 1991

Models for drumlin formation



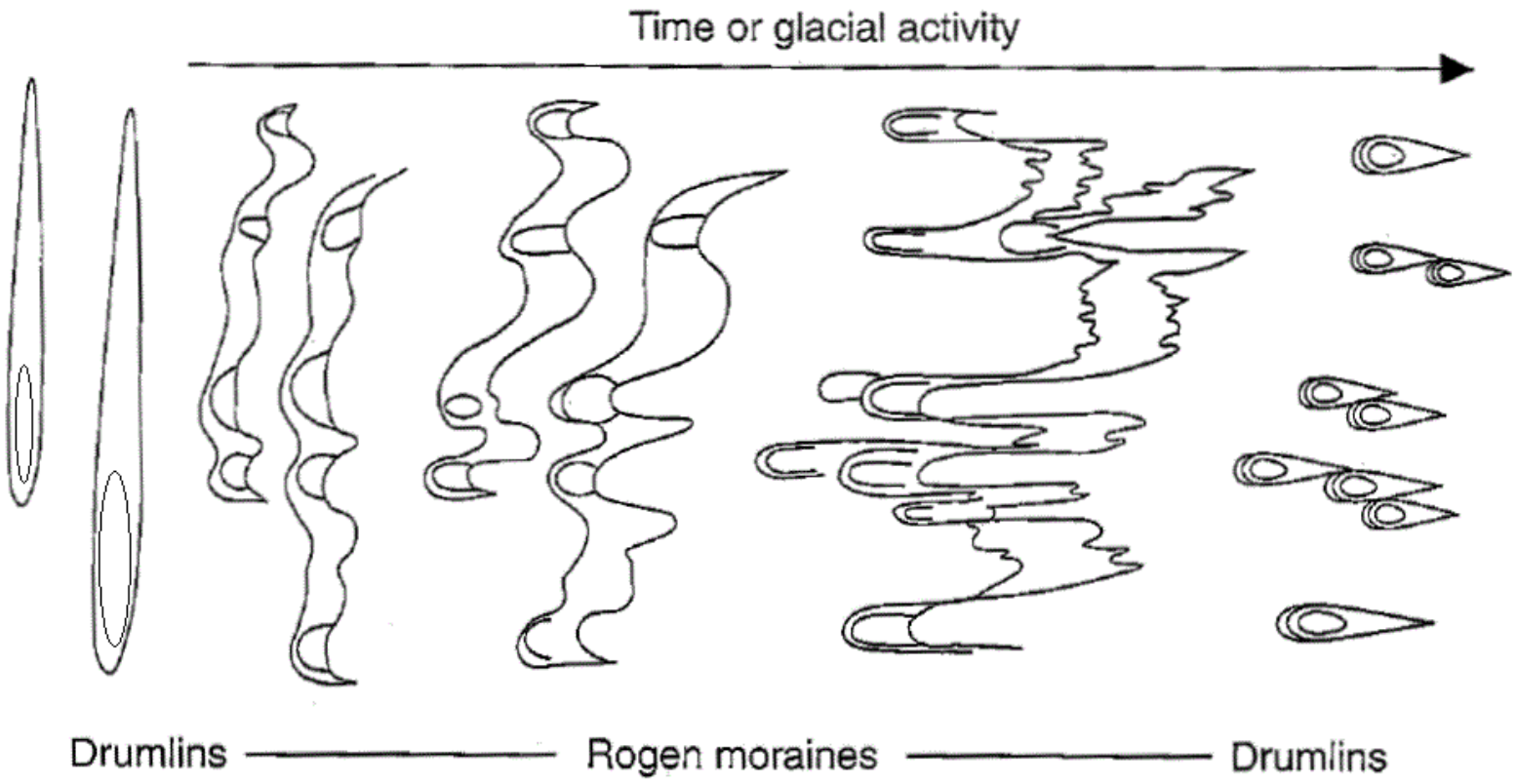
After Bennett and Glasser, 2009

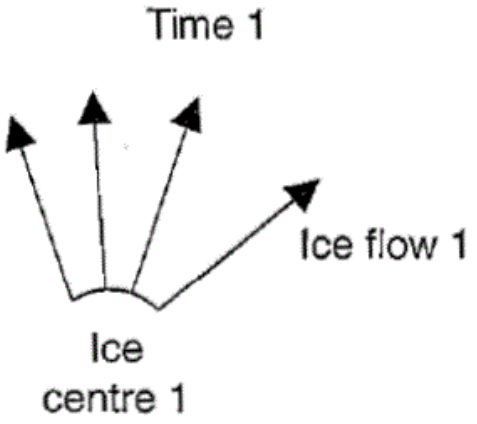
Drumlins overprinted on outwash deposits

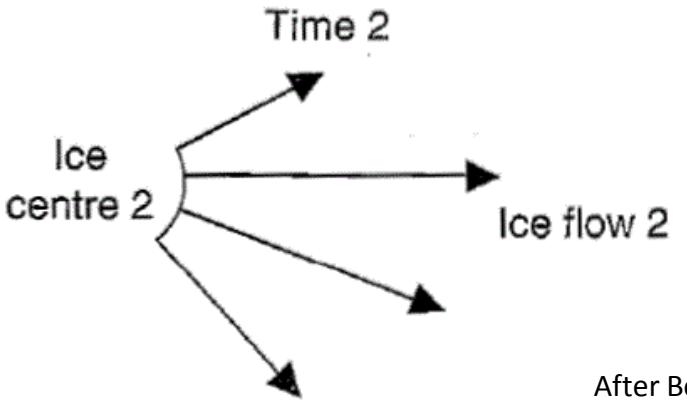


After Bennett and Glasser, 2009

Modification of drumlins following a change in ice direction

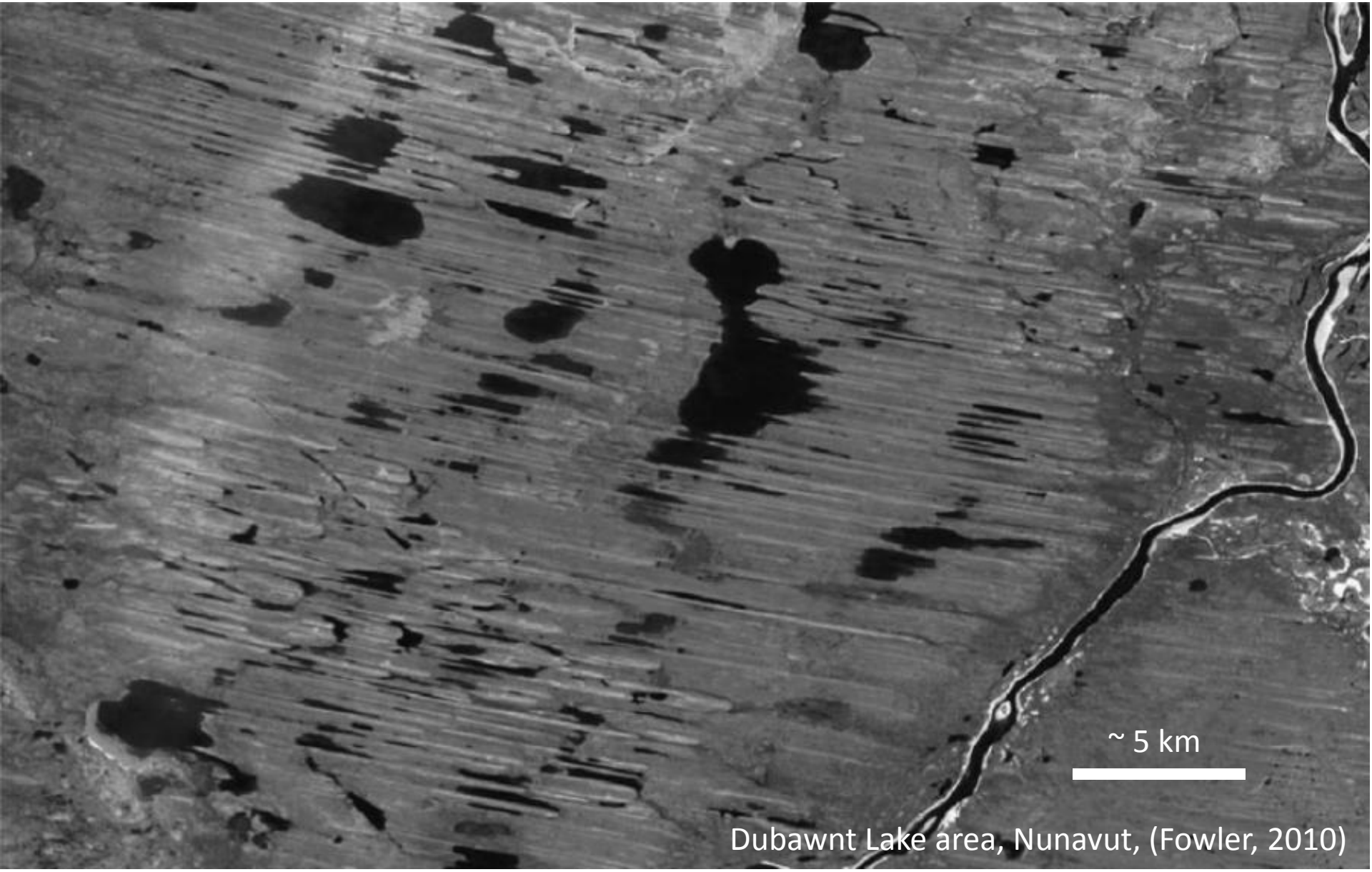






After Bennett and Glasser, 2009

Mega-scale glacial lineaments

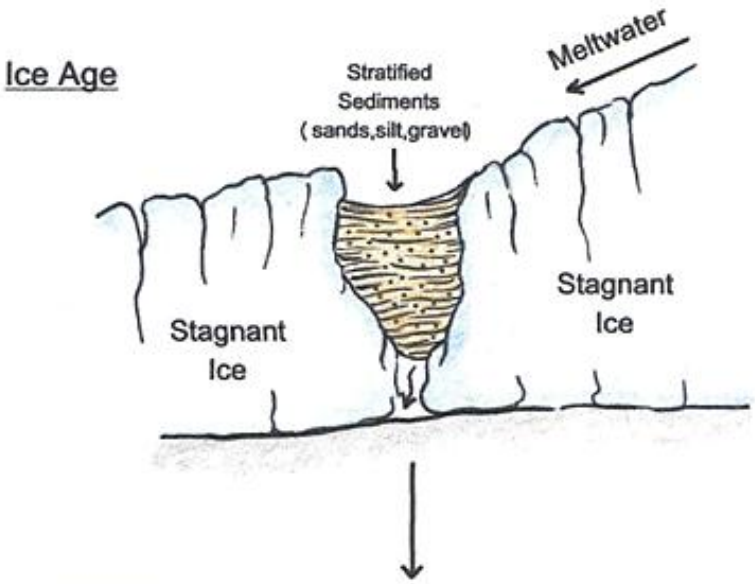


Linear features in this area range from ~6 to ~40 km long

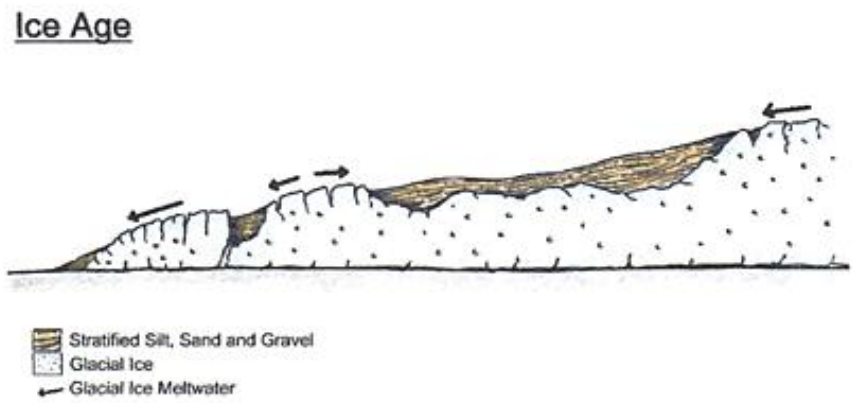
It is generally (though not universally) assumed that mega-scale glacial lineaments are formed by processes similar to drumlins.

Stokes and Clark (2002) suggest that very long lineaments (up to 13 km) with L:W ratios as high as 40 are formed underneath ice that is moving particularly fast.

Glaciofluvial depositional features: Kames and Kame terraces

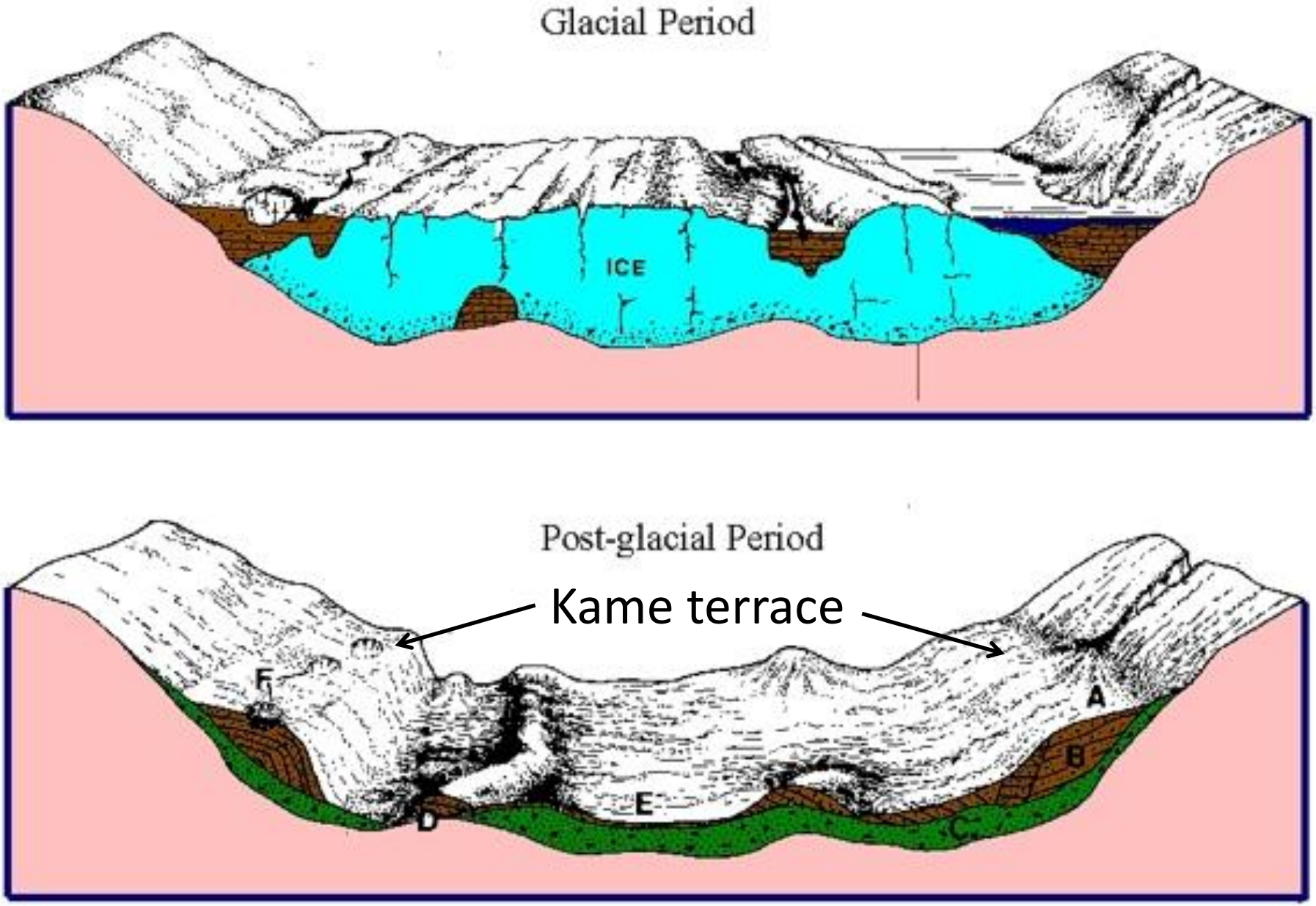


Formation of A Kame

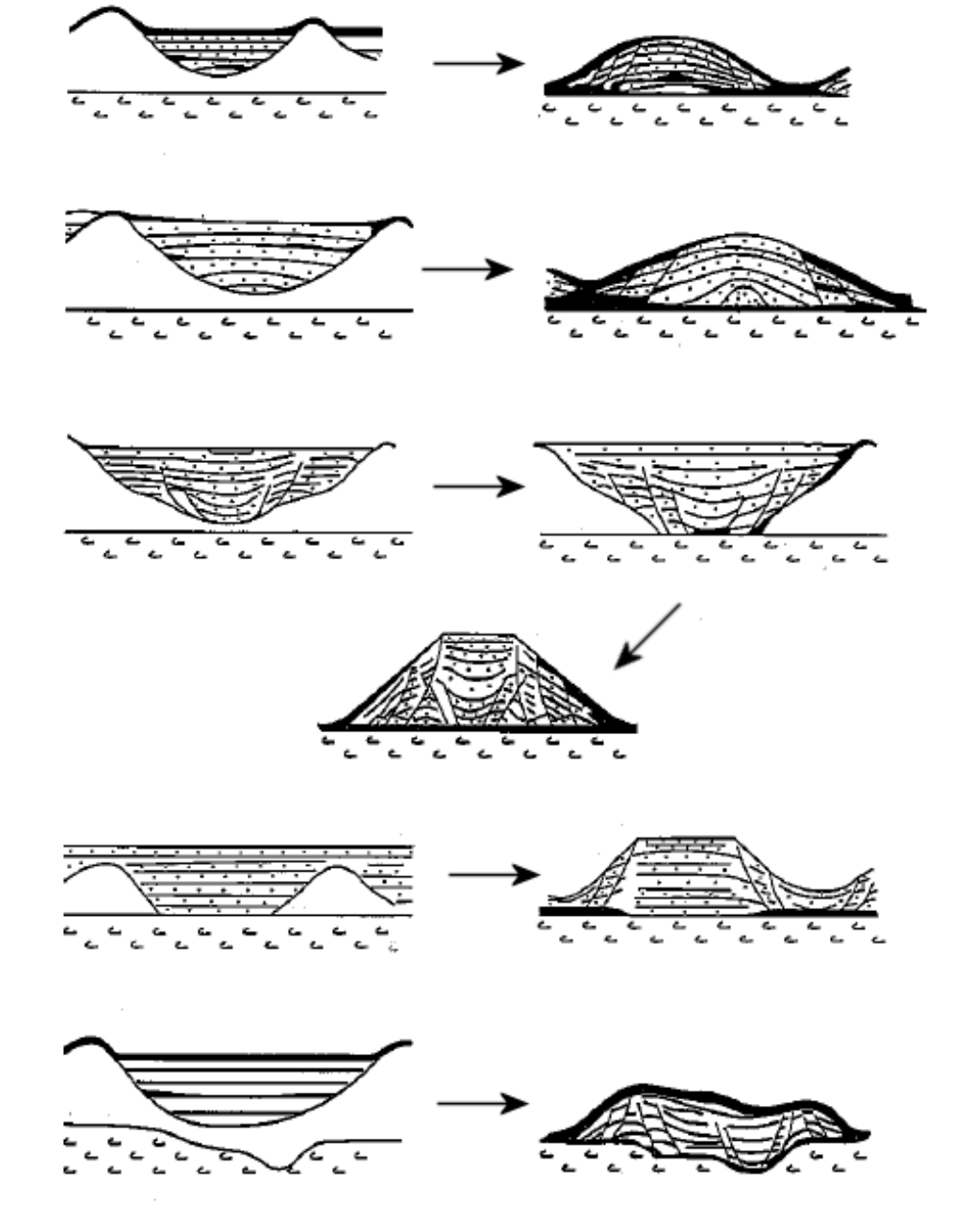


Formation of Kame Deposits

http://www.york.ca



http://www.gov.ns.ca/natr/meb/field/vista2.asp



Kames and kame terraces are characterized by bedding and post-depositional faulting.

After Bennett and Glasser, 2009

Glacier d'Arolla,
http://www.swisseduc.ch/glaciers/glossary/kame-terrace-en.html

Characteristics of material in depositional landforms

Feature	Stratification	Deformation	Rounding	Sorting
Seasonal push moraines				
Glaciotectonic moraines				
Dump moraines				
Flutes				
Drumlins				
Mega-scale lineaments				
Kames				
Kame-terraces				