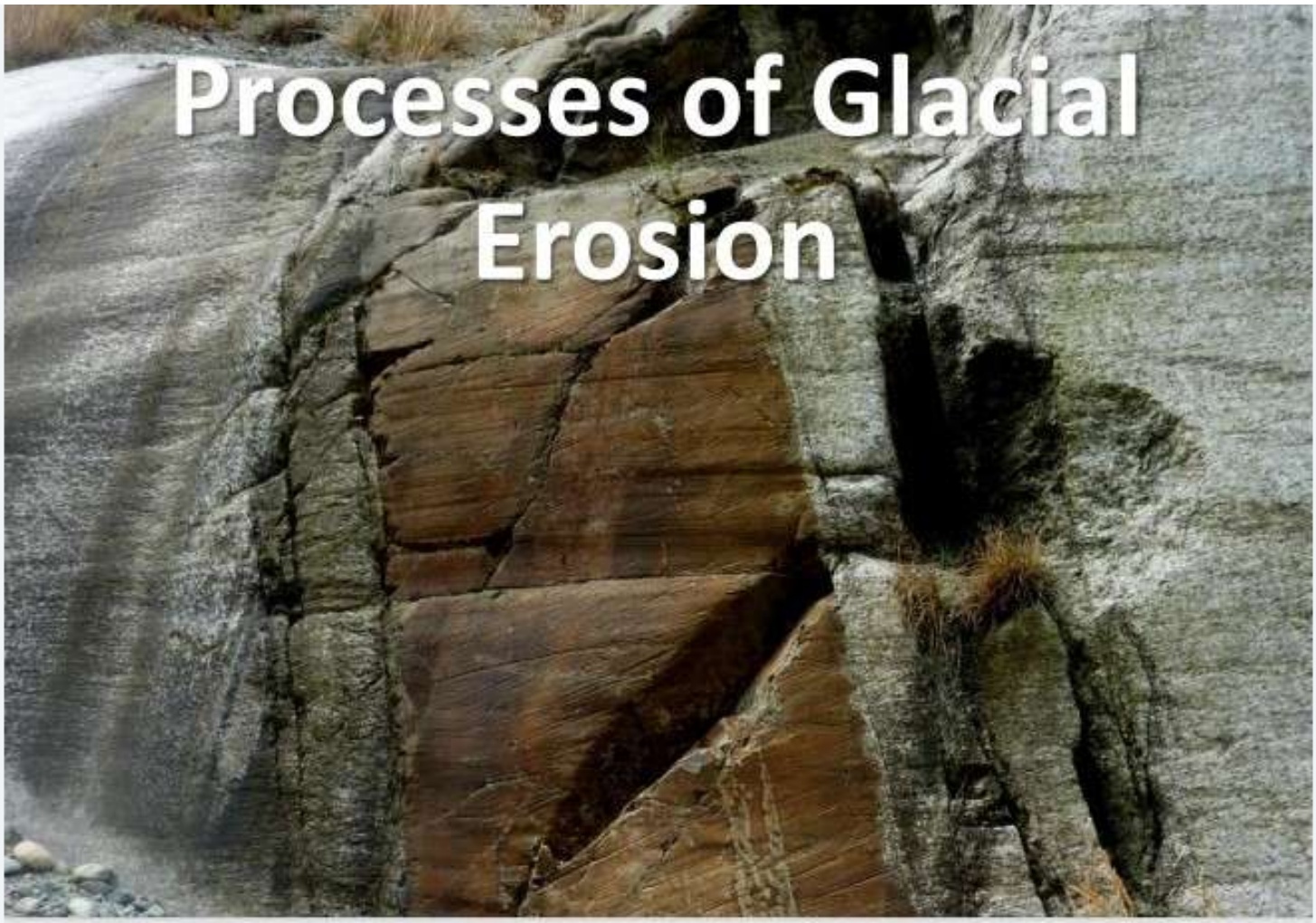


Processes of Glacial Erosion

Topics

Erosional processes

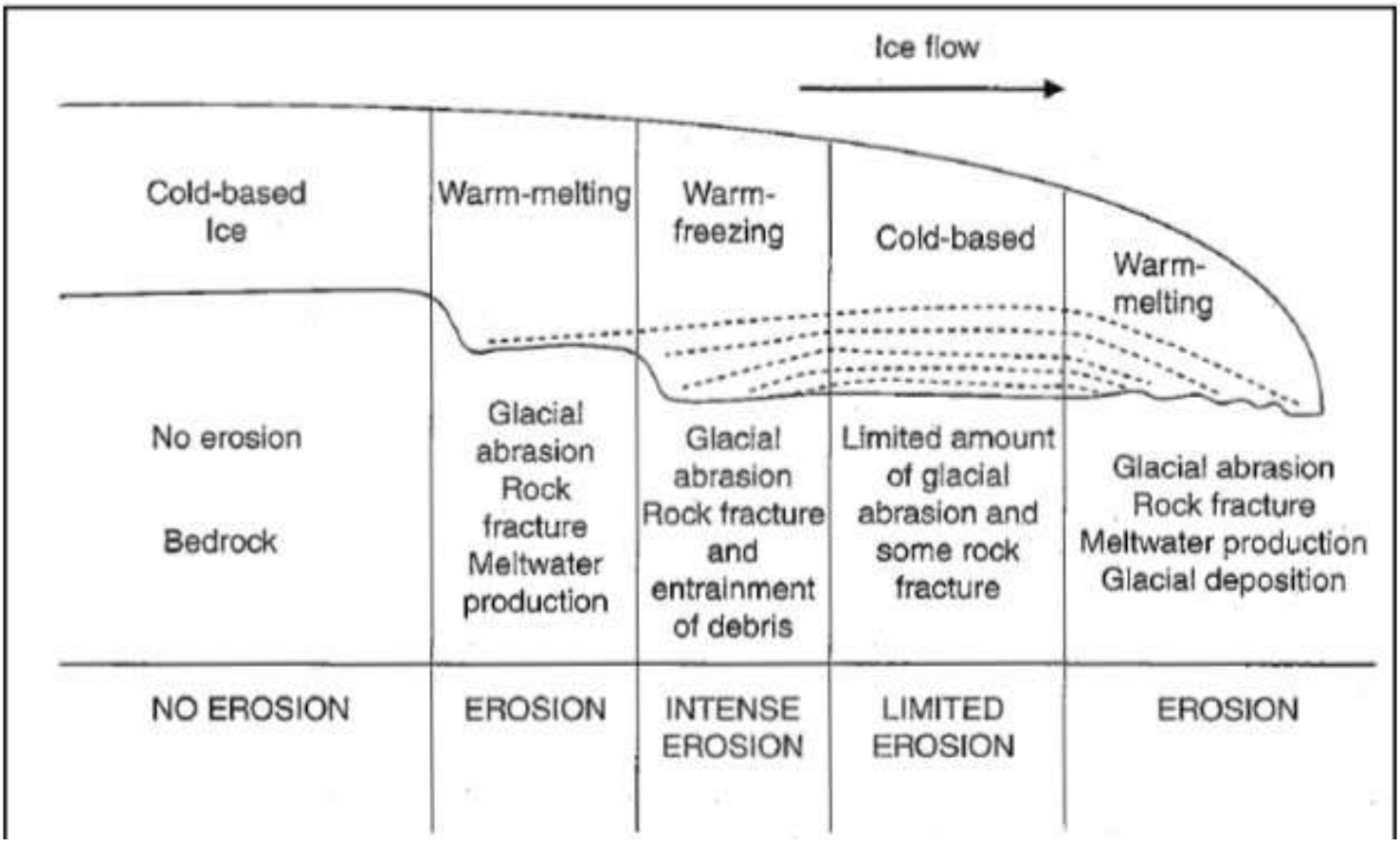
- conditions under which glaciers erode their bases
- models and mechanisms of erosion
- glacial quarrying
- particle entrainment

Erosional features

- micro-scale erosional features (striae etc.)
- meso-scale (e.g., roches moutonée, whalebacks)
- macro-scale (rock drumlins, cirques, U-valleys, arêtes etc.)
- rates of erosion (glaciers vs rivers)

Conditions under which glaciers erode their bases effectively

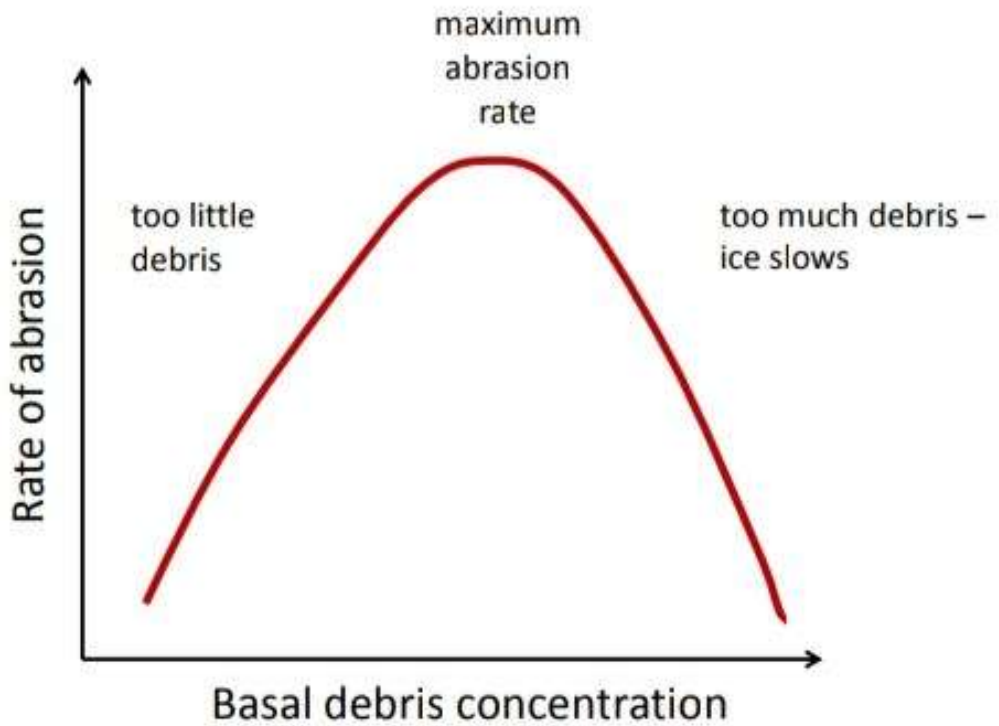
- Glaciers with frozen bases do not generally slide along the ice-bed interface, and therefore do not erode their bases.
- In general greatest erosion is associated with warm-based glaciers that have basal melting.
- Transition from warm to cold (or water to ice) will contribute to quarrying.
- Fast-flowing glaciers are likely to erode more effectively than slow glaciers.
- Fluctuations in water pressure will promote quarrying
- In areas glaciated several times most of the glacial erosion may be completed during the first phase of glaciation.



Mechanisms and models of sub-ice erosion

Erosion of rock beneath a glacier is primarily achieved by rock and mineral fragments embedded in the ice

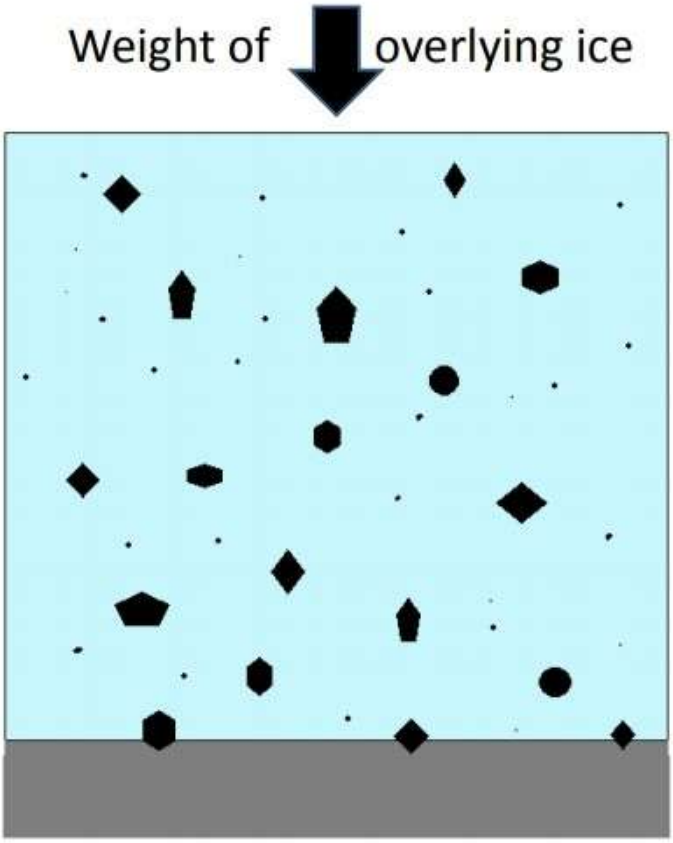
Abrasion rate vs ice-debris concentration

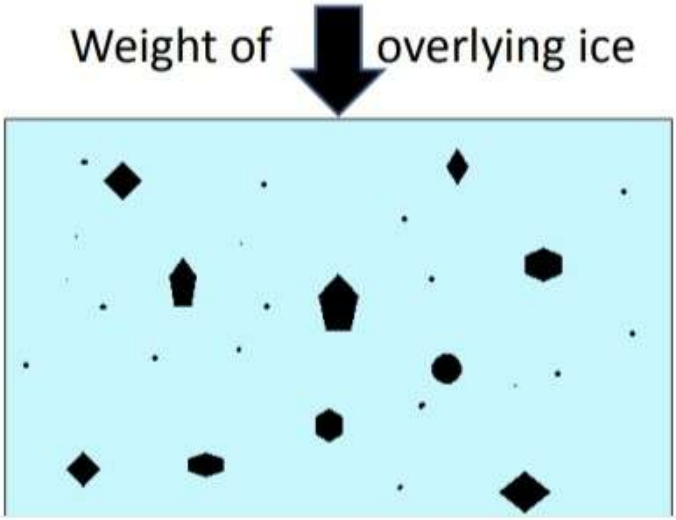


Boulton model

- "effective normal pressure" (weight of overlying ice minus basal water pressure) will affect the rate of abrasion
- increasing basal water pressure increases the rate of basal sliding but decreases the effective normal pressure
- ice with more rock fragments is more effective at abrading rock, but tends to move slower than "clean" ice
- abrasion and lodgement (deposition of till) are part of a continuum

After Bennett and Glasser, 2009



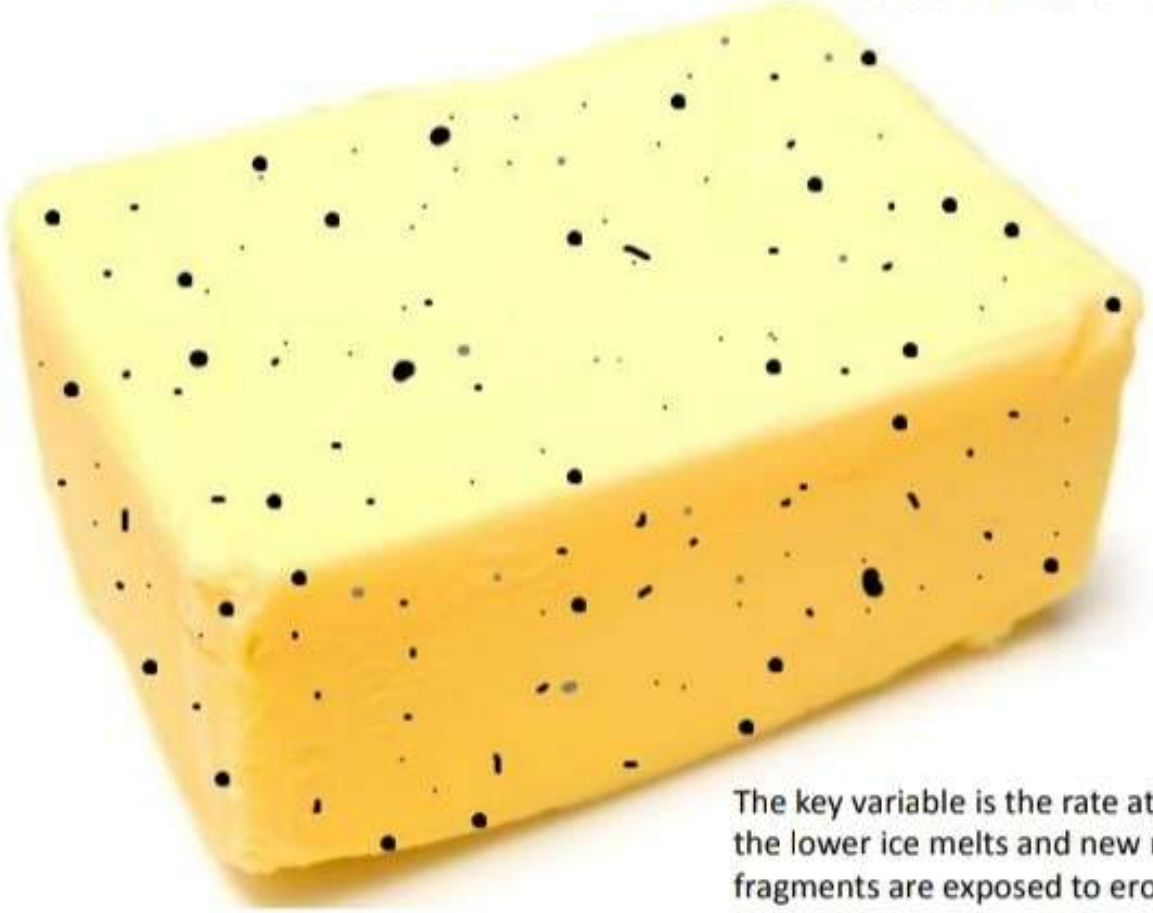


Hallet model

- "effective normal pressure" is not important because the rock clasts are "floating" in the ice and are not necessarily pushed down by the ice because of the ice is so much weaker than the rock fragments
- pressure of fragments against the bed is determined by the rate of flow towards the bed
- that rate is controlled by the rate of melting at the ice-bed interface
- basal melting is favoured by (i) rapid flow, (ii) thick ice and (iii) high surface T

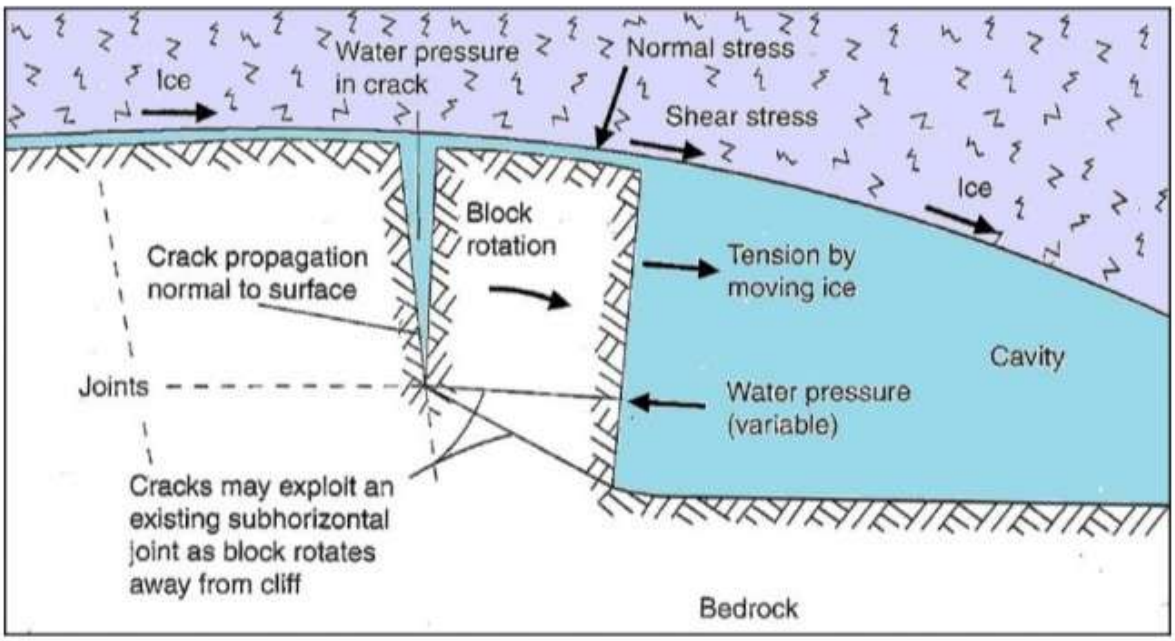
After Bennett and Glasser, 2009

Hallett model



The key variable is the rate at which the lower ice melts and new rock fragments are exposed to erode the rock below.

- Removal of large pieces from bedrock
- Starts with fracturing (may or may not be initiated by glacial processes)
- Water pressure changes may be important
- Freeze-thaw cycles are probably not important but freezing of water due to P changes are
- The presence of basal cavities is important



After Bennett and Glasser, 2009