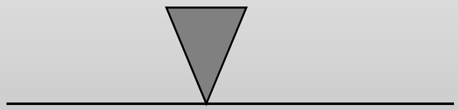
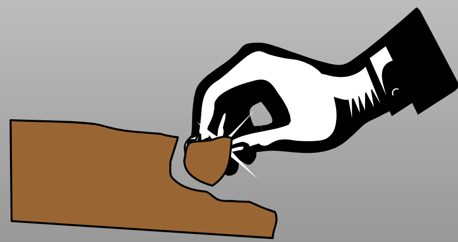
Subglacial Erosion

1. Abrasion



2. Plucking



ABRASION

Basal velocity

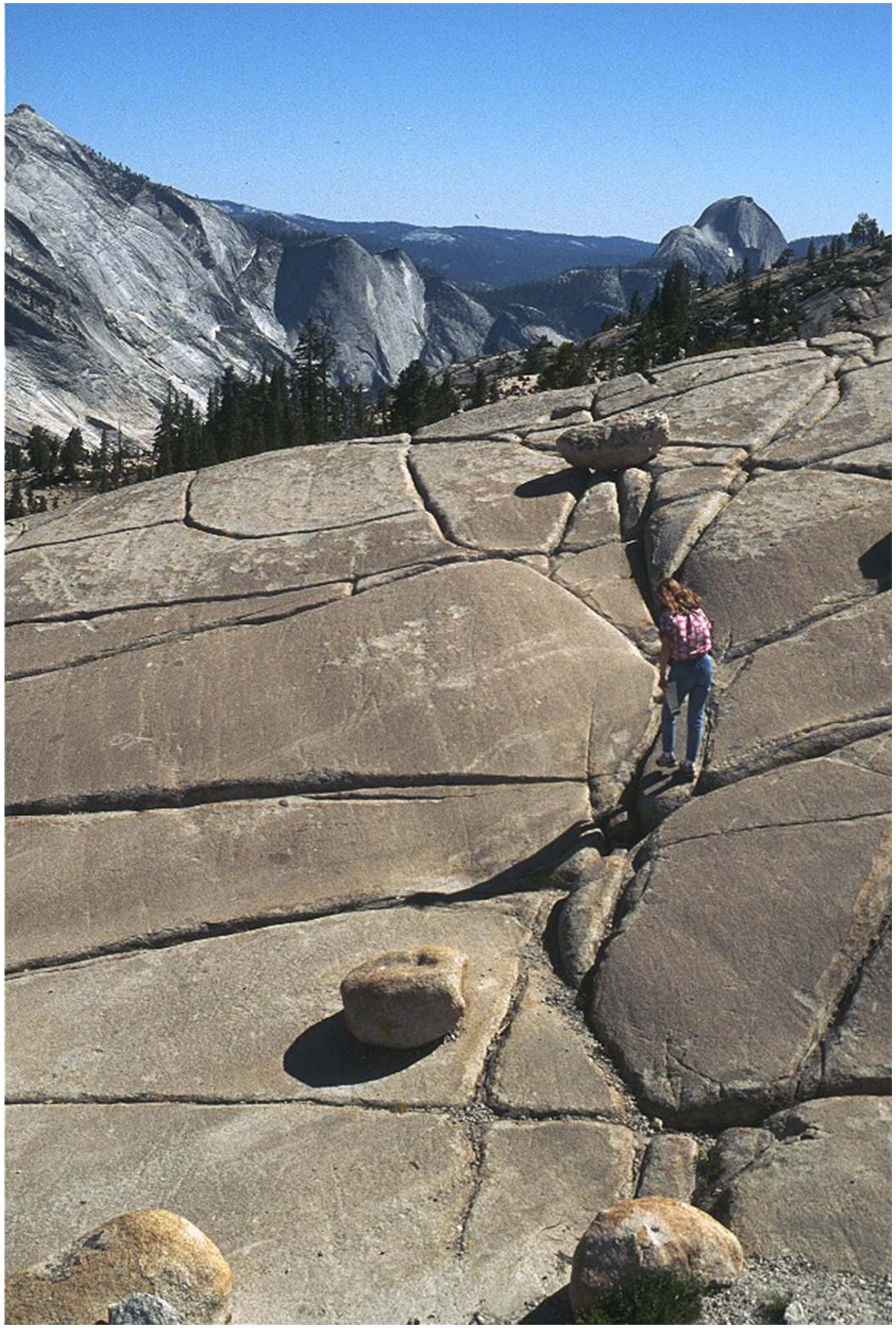
Oneonta, NY

Cornell Geology

South Cascade Glacier

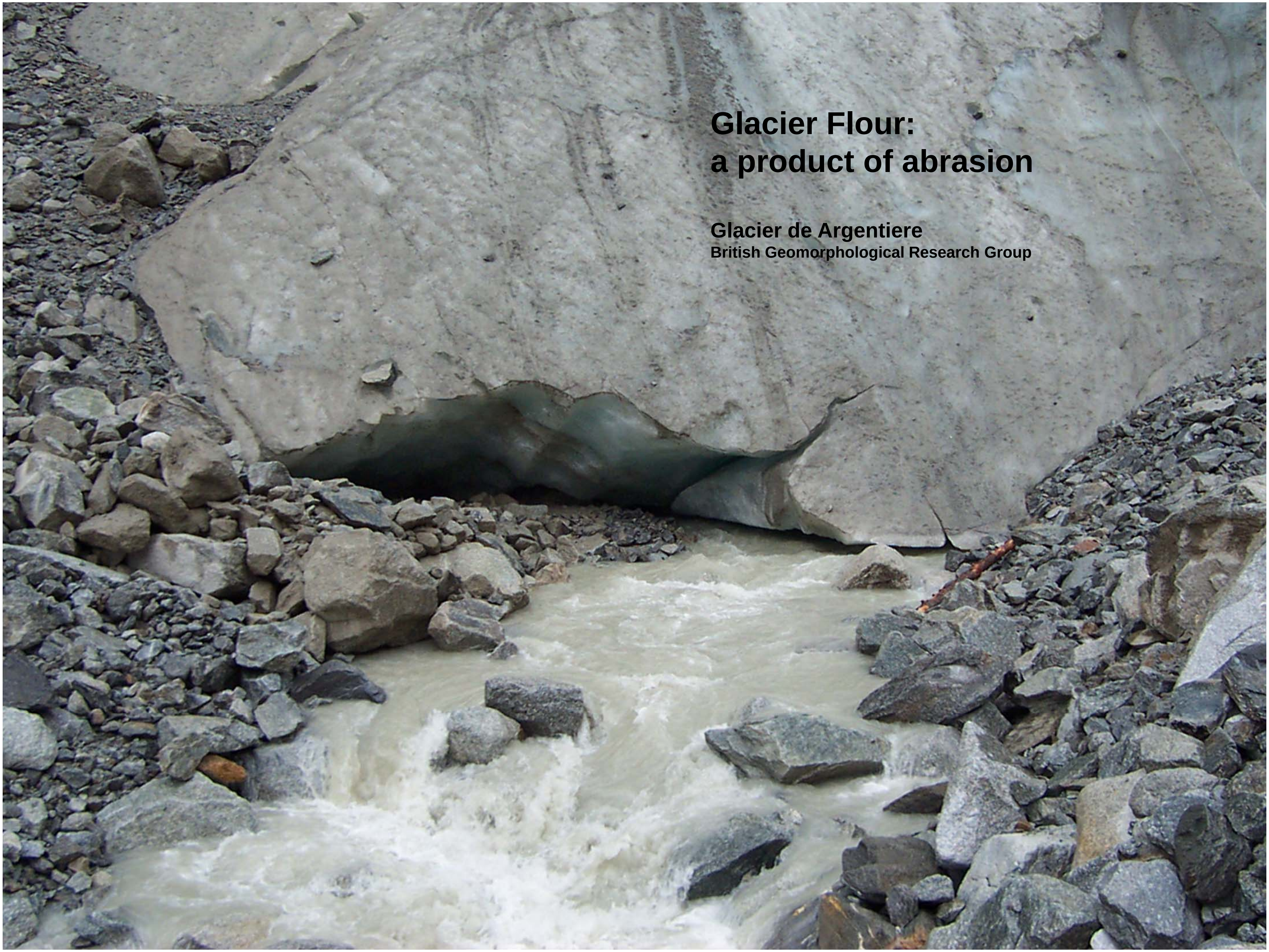
K. Cruikshank

K. Cruikshank

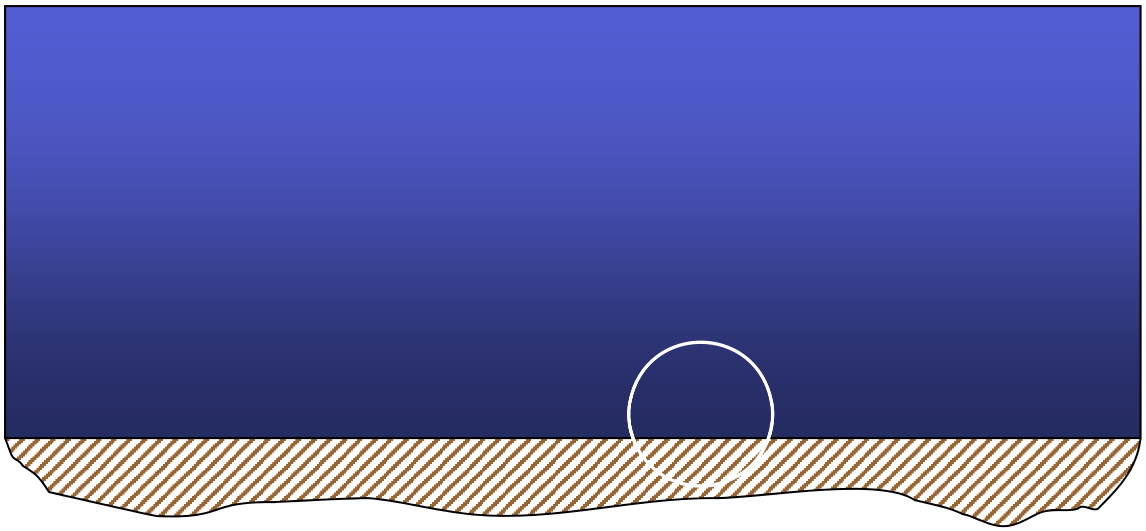


http://www.youtube.com/watch?v=njTjfJcAsBg

Rieperbreen Glacier on Svalbard J. Gulley

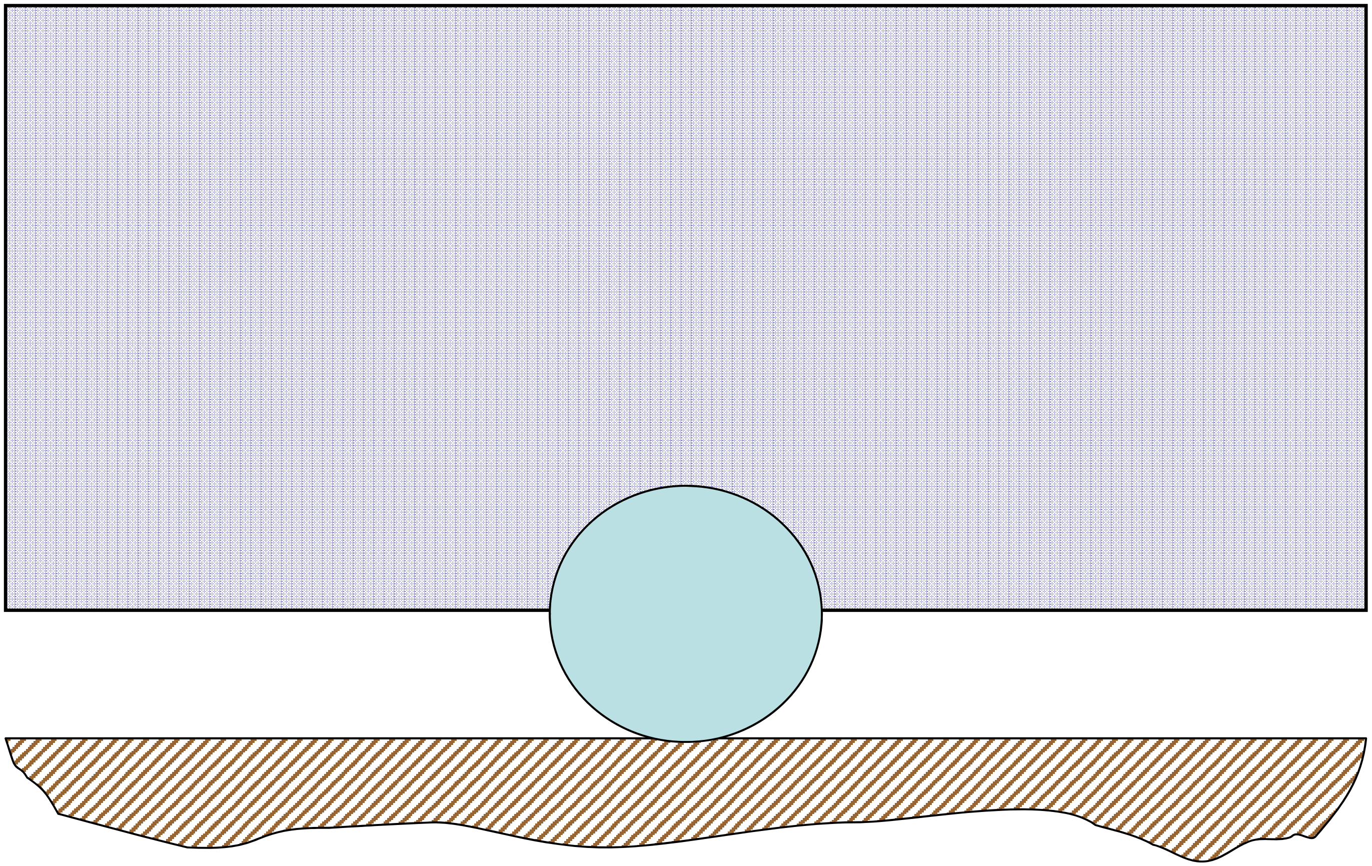

Glacier Flour:
a product of abrasion
Glacier de Argentiere
British Geomorphological Research Group

Abrasion

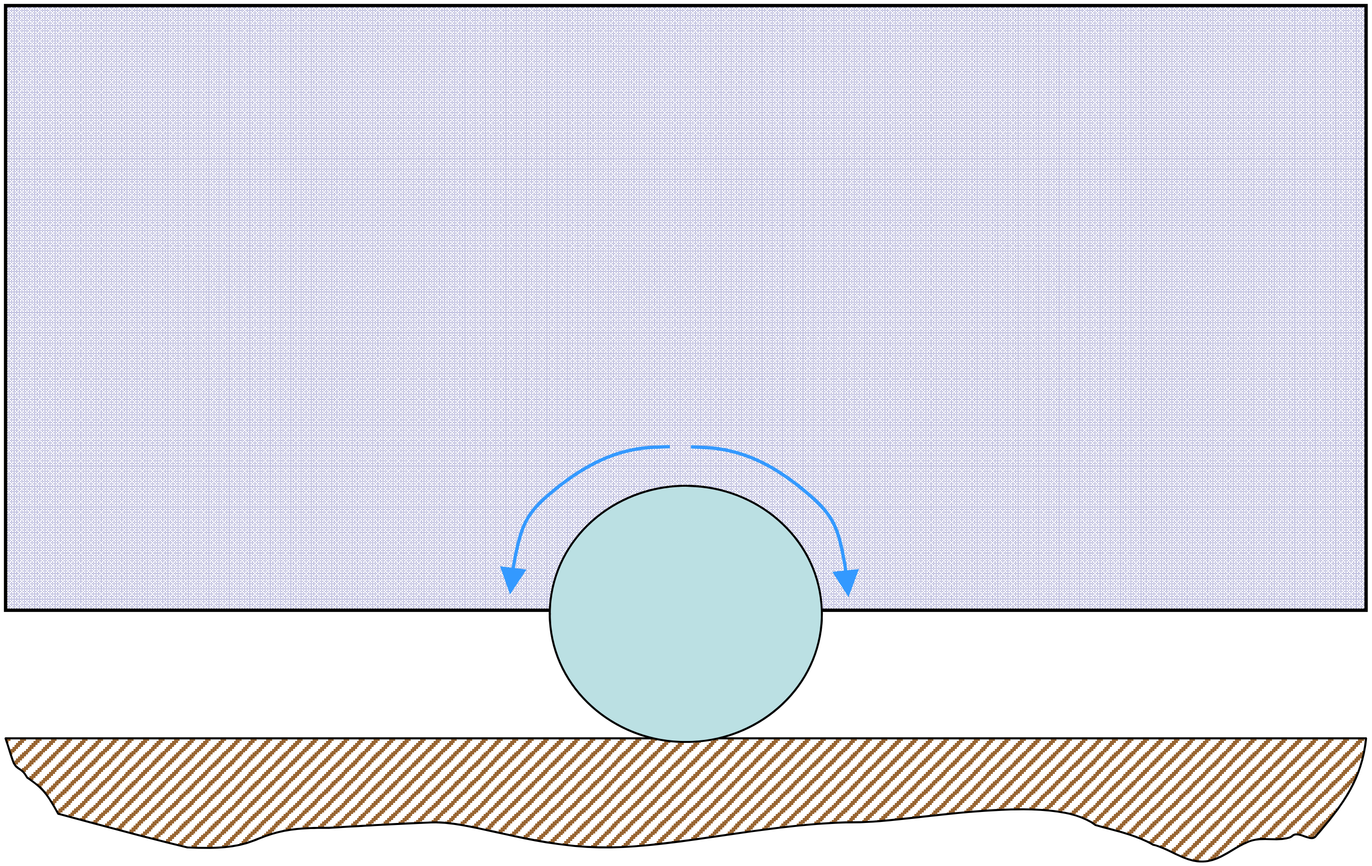


What is doing the abrading?

Temperature °C	Equivalent Mineral Hardness
0	Talc/Gypsum

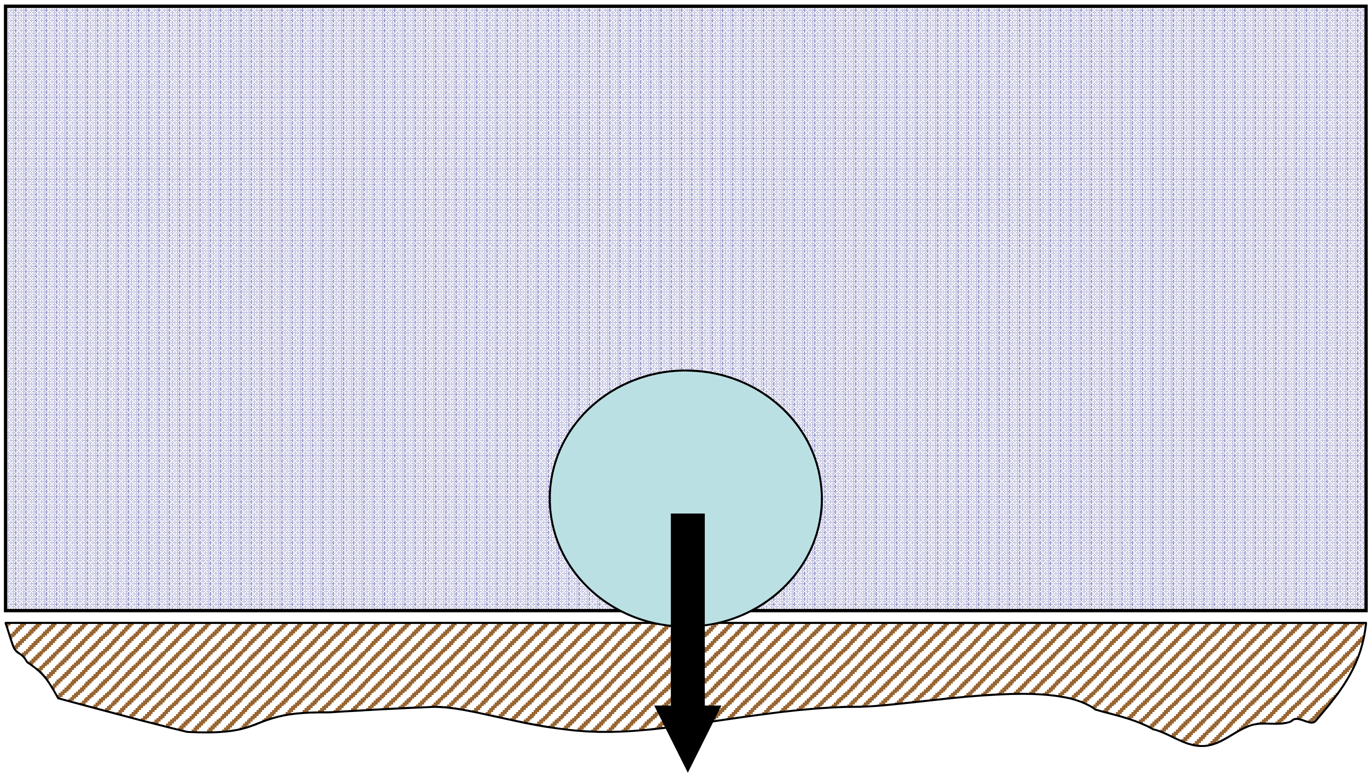


Is the ice riding on the particles?



NO! The shear stress of the ice is one bar.

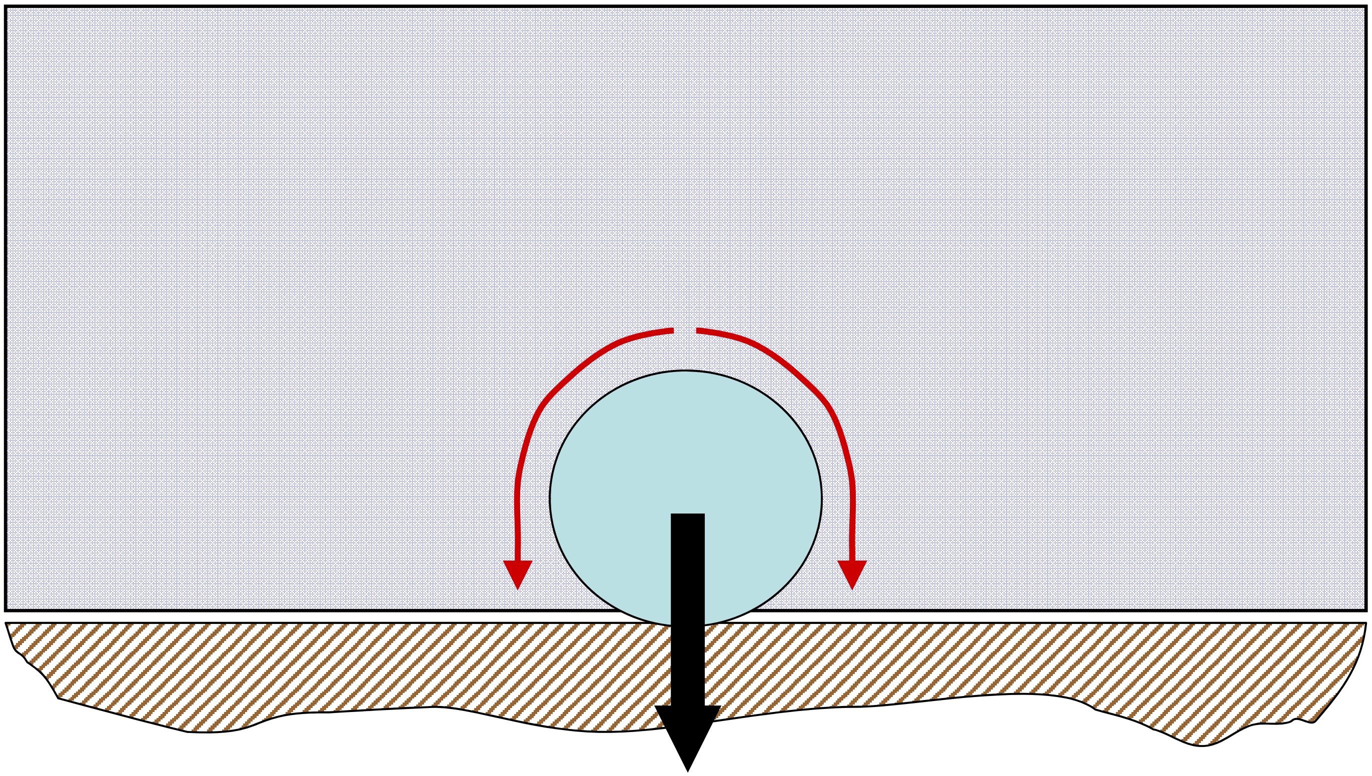
The ice flows around such particles



Force on the bedrock, F = ma

$$F = \frac{4}{3}\pi r^3 \rho_r g$$

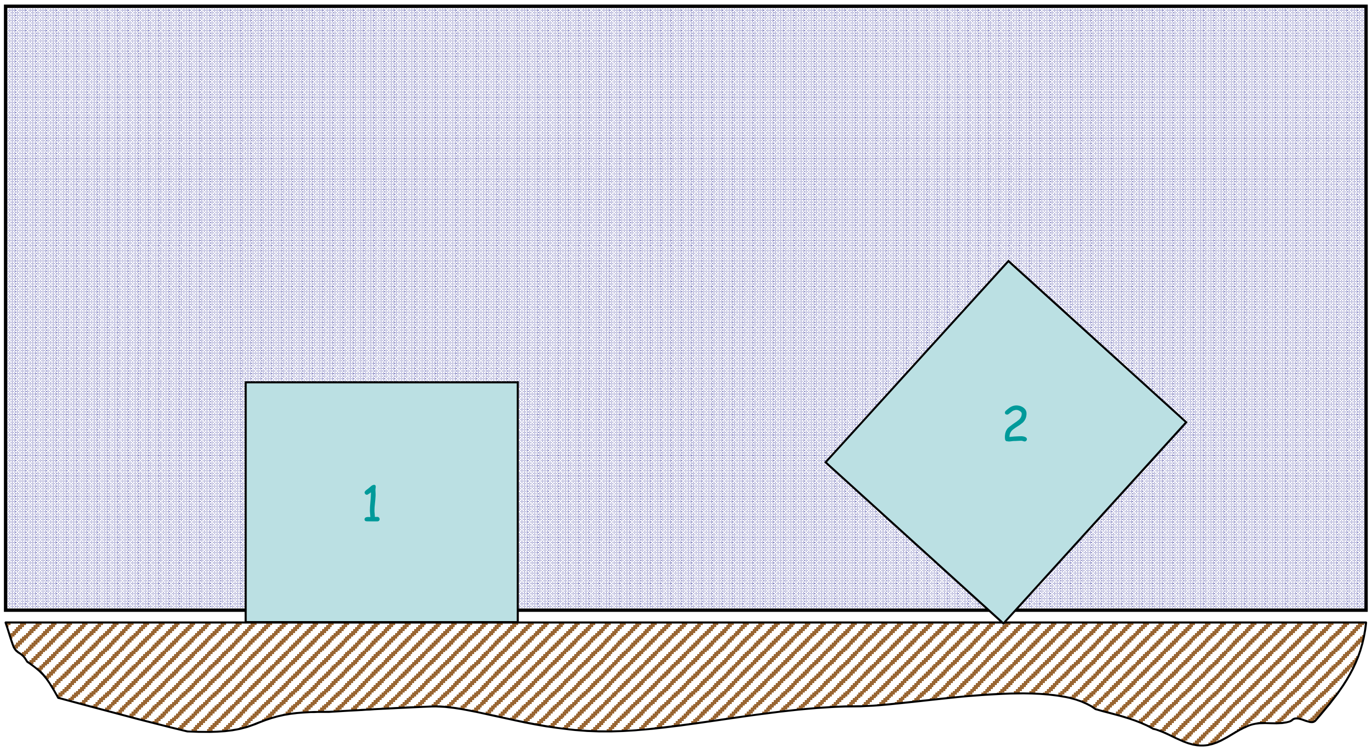
Actually, $F = \frac{4}{3}\pi r^3 (\rho_r - \rho_i) g$



A second force: drag!

F_d = C Area (melt rate)

$$F = \frac{4}{3}\pi r^3 (\rho_r - \rho_i) g$$



Pressure **on the bedrock, Force/unit area**

Same force, different normal stress (pressure)

If F = 1N (same in both cases) but contact area

$A_1 = 0.01m^2$ THEN τ_{n1} is 100 Pa

$A_2 = 0.00001m^2$ τ_{n2} is 10^5 Pa

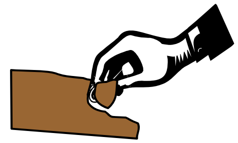
Factors affecting abrasion

- Concentration of debris
- hardness of the rock
- evacuation of fines
- glacier velocity

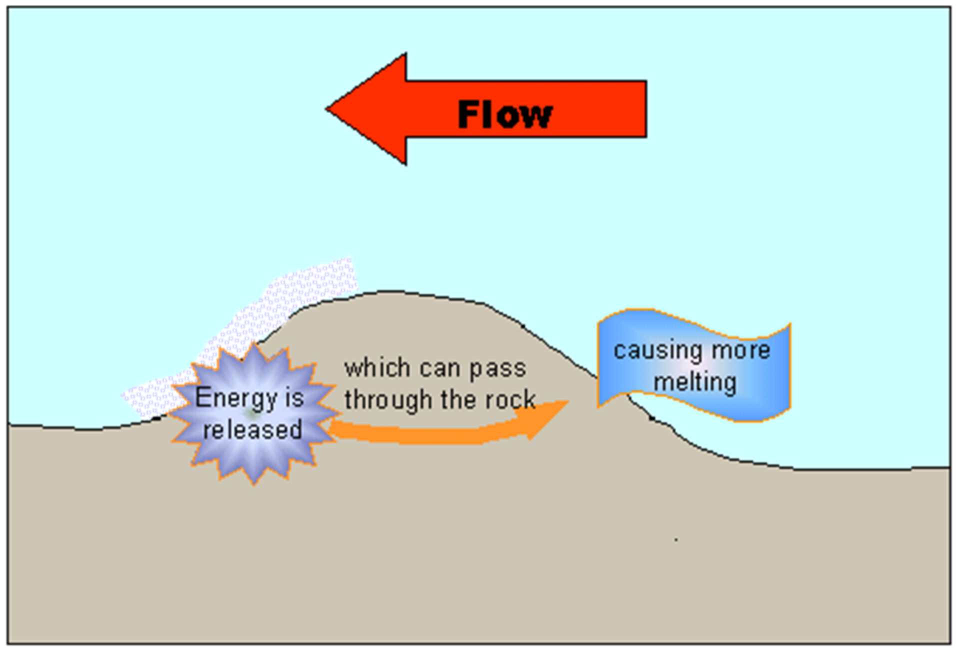
$$\dot{A} = k \, F_n \, C \, U$$

k - constant
F - contact force
C - concentration
U_b - basal ice velocity (sliding)

PLUCKING



New Zealand, University of Cincinatti


Flow
Energy is released
which can pass through the rock
causing more melting

Univer Aber.

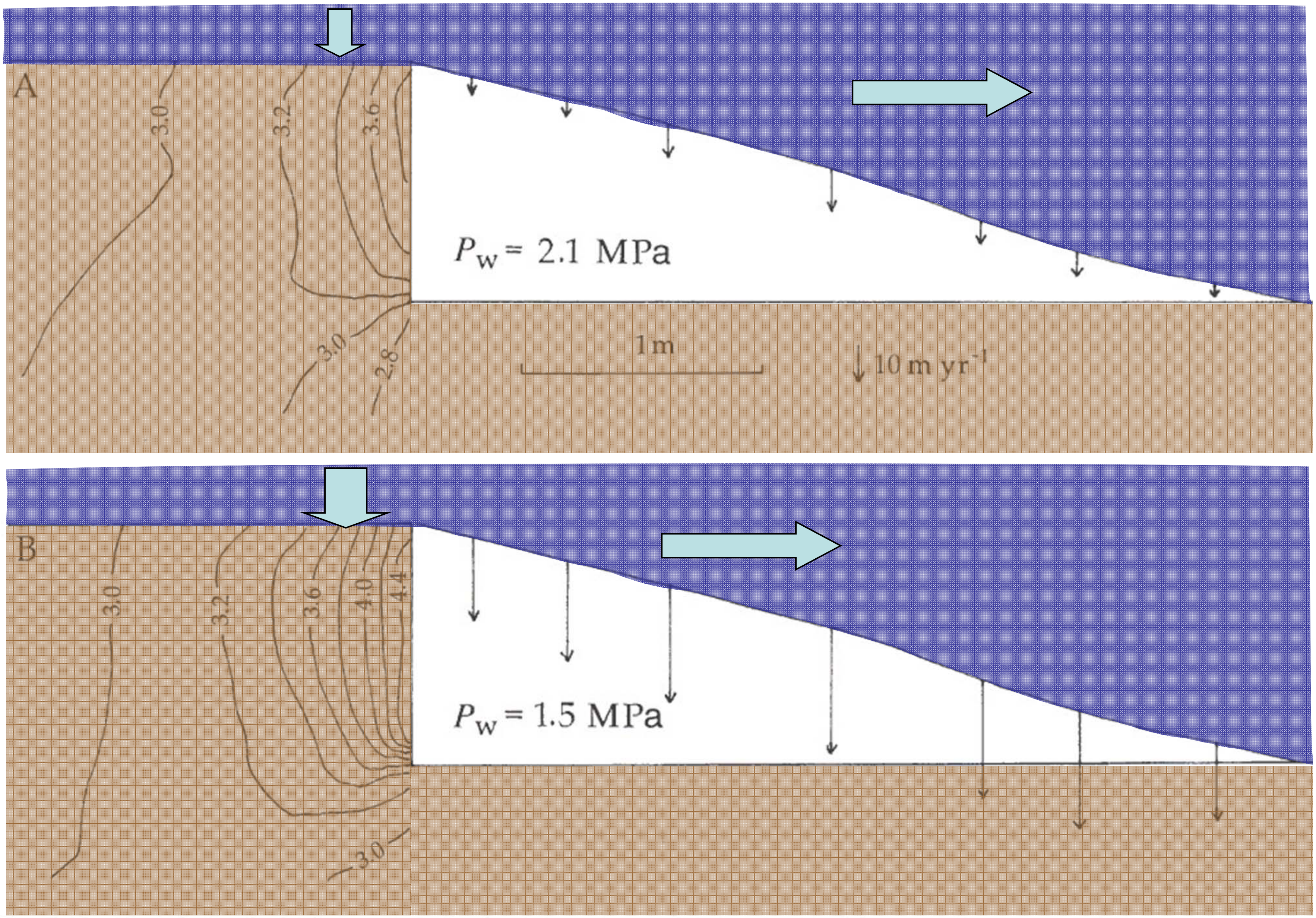
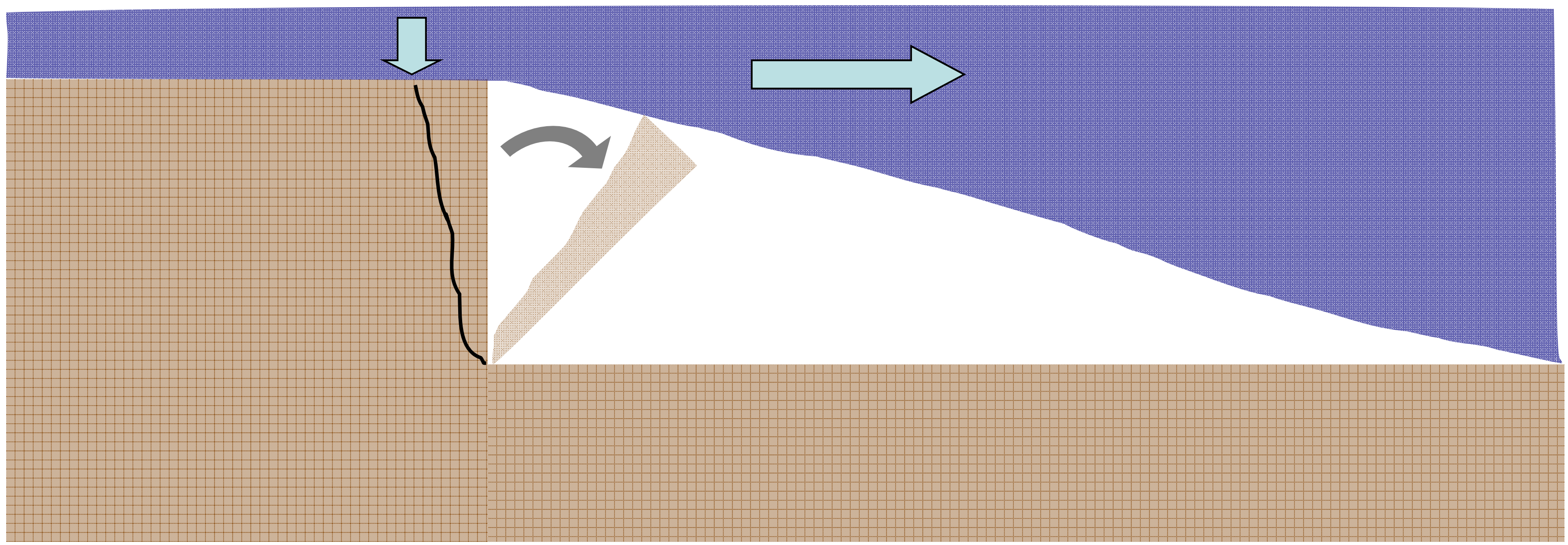
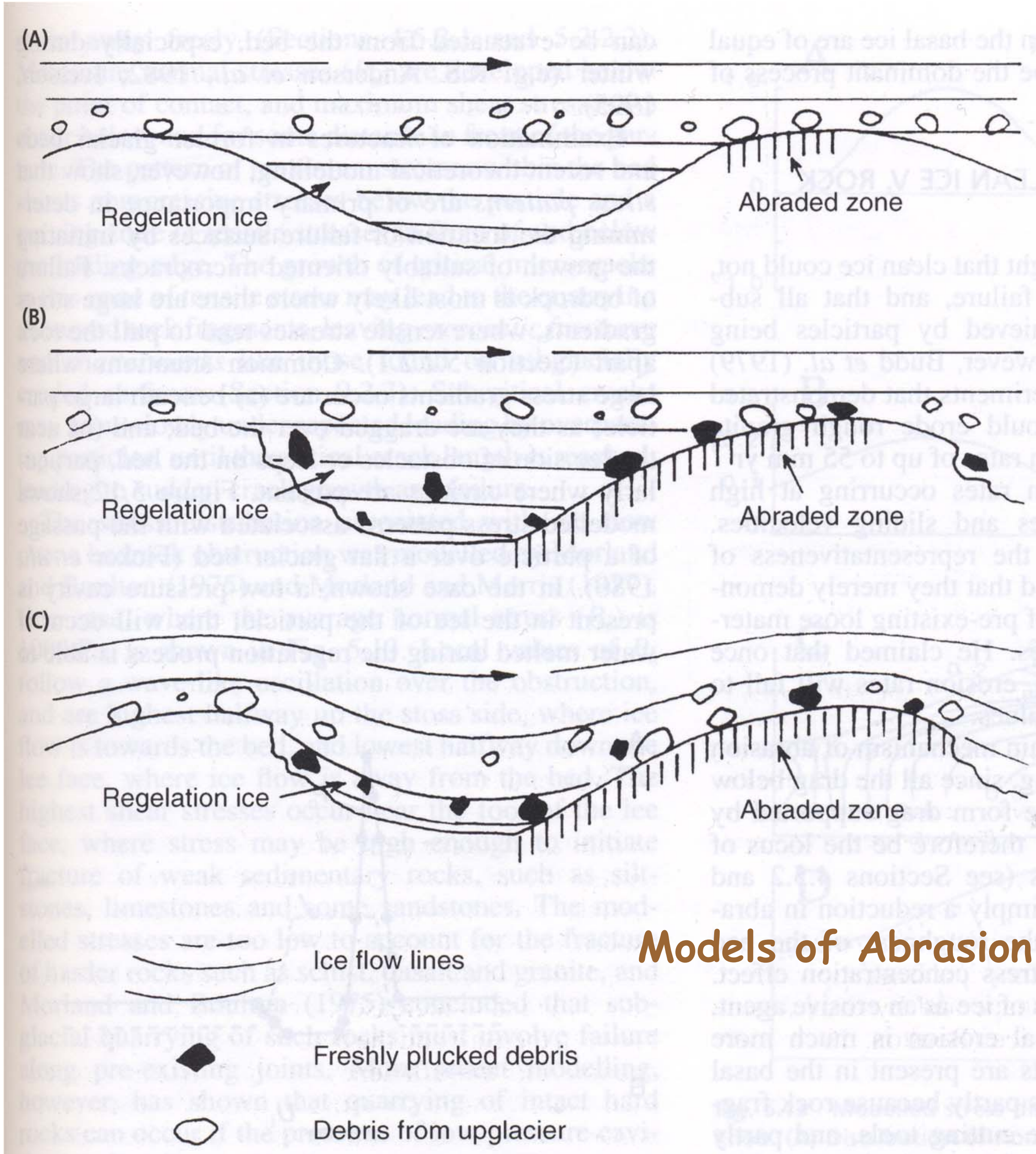


Fig. 5.14 Modelled principal stresses in bedrock upstream of a step cavity. (A) Steady-state case, where water pressure in the cavity (P_w) = 2.1 MPa. Principal stresses are at a maximum adjacent to the step. Downward-pointing arrows show the vertical component of ice flow in the cavity roof. (B) Stress pattern associated with a sudden drop of water pressure to P_w = 1.5 MPa. Note the dramatic increase in principal stresses and vertical ice velocities. (Modified from Iverson, 1991)



Models of Abrasion

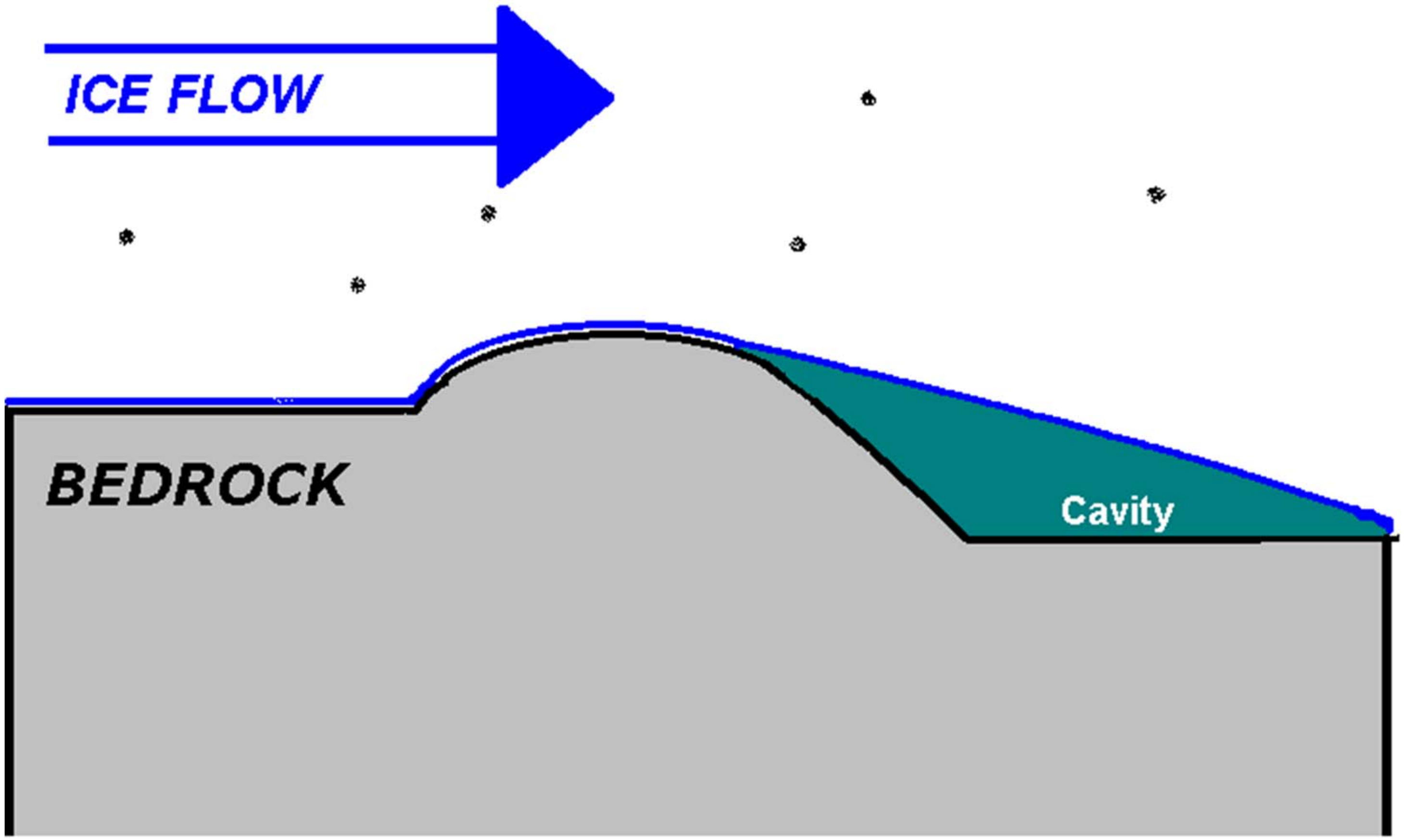


Sliding Alone

Sliding & Regelation

Enhanced Sliding & Regelation

From Benn & Evans, 1998



Montana State University/earthscape.org

Macroscopic Erosion

Erosion

$$\dot{A} = k\, F_n\, C\, U_b$$

k - constant
F - contact force
C - concentration
U_b – basal ice velocity (sliding)

Sliding

$$u_b = \frac{j\tau_b}{(\rho g h - P_w)^q}$$

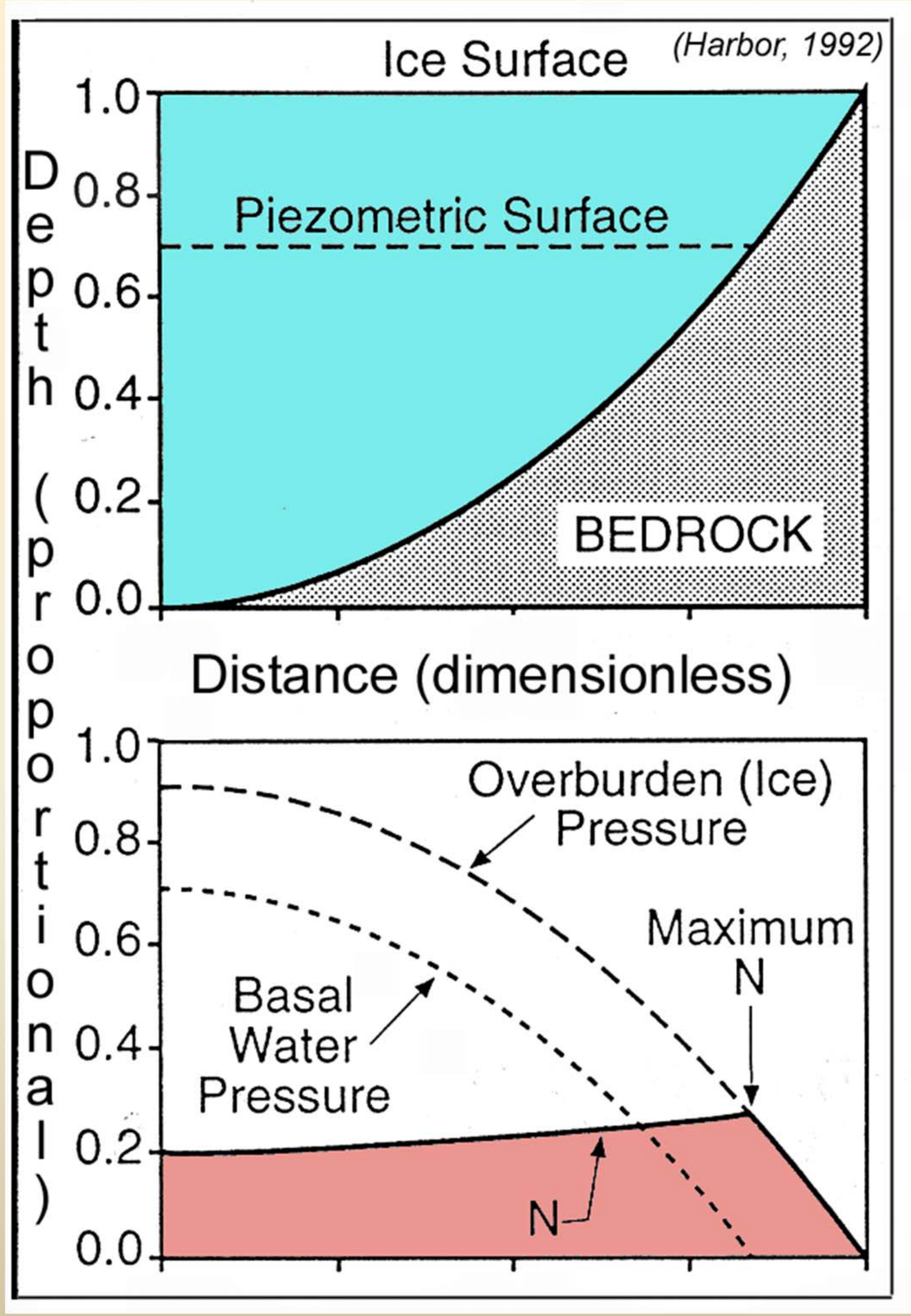
P_w is the subglacial water pressure
where j and q are empically
determined constants

Trough Erosion

- Erosion
  ~ f (effective pressure)

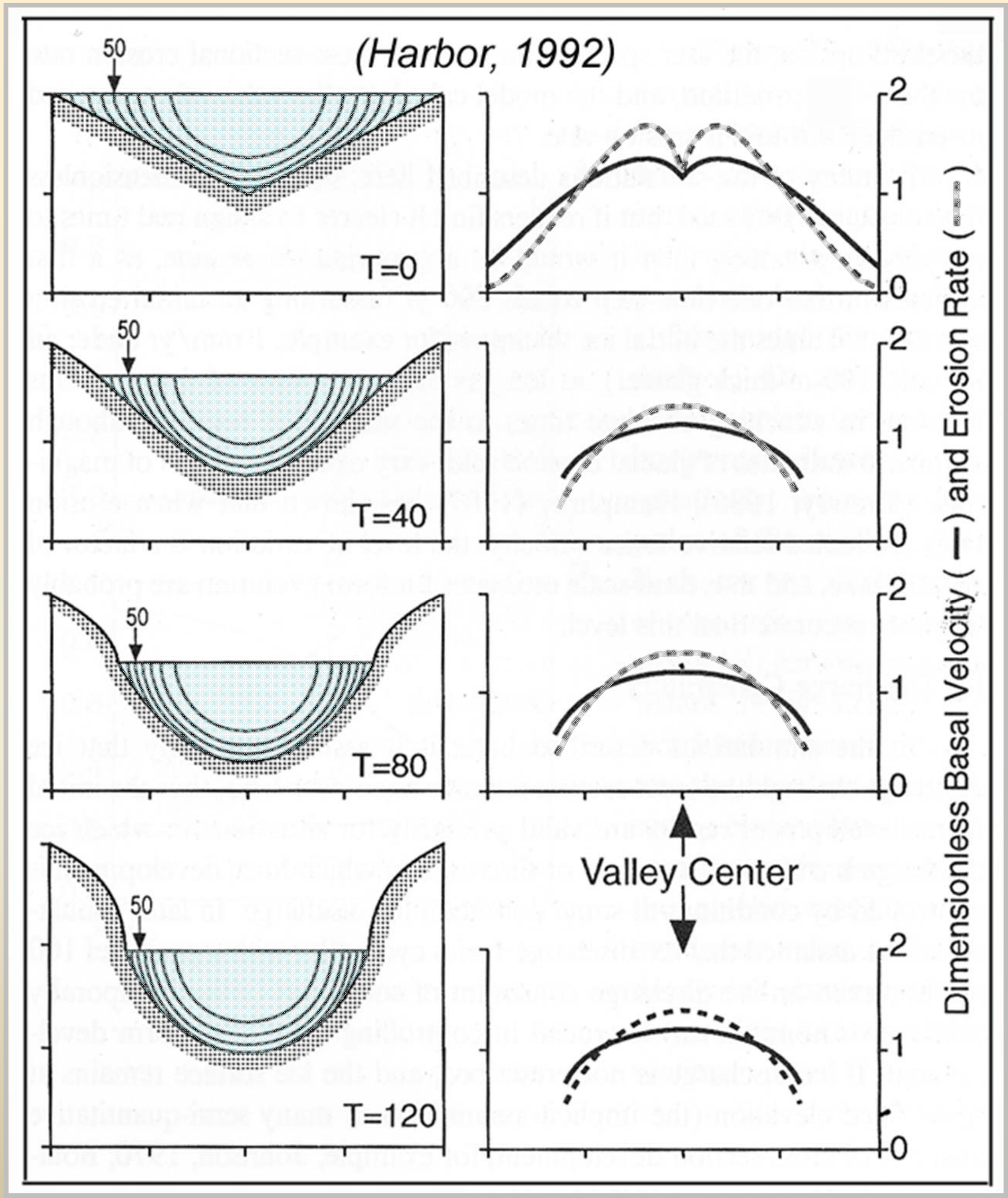
effective pressure

= ice pressure – water pressure



Trough Evolution

- Modeled by Harbor (1992)
- Results in “realistic” erosion
- Sequence is less realistic




END
http://en.wikipedia.org/wiki/File:1_yosemite_valley_tunnel_view_2010.JPG/