PERIGLACIAL PROCESSES & LANDFORMS

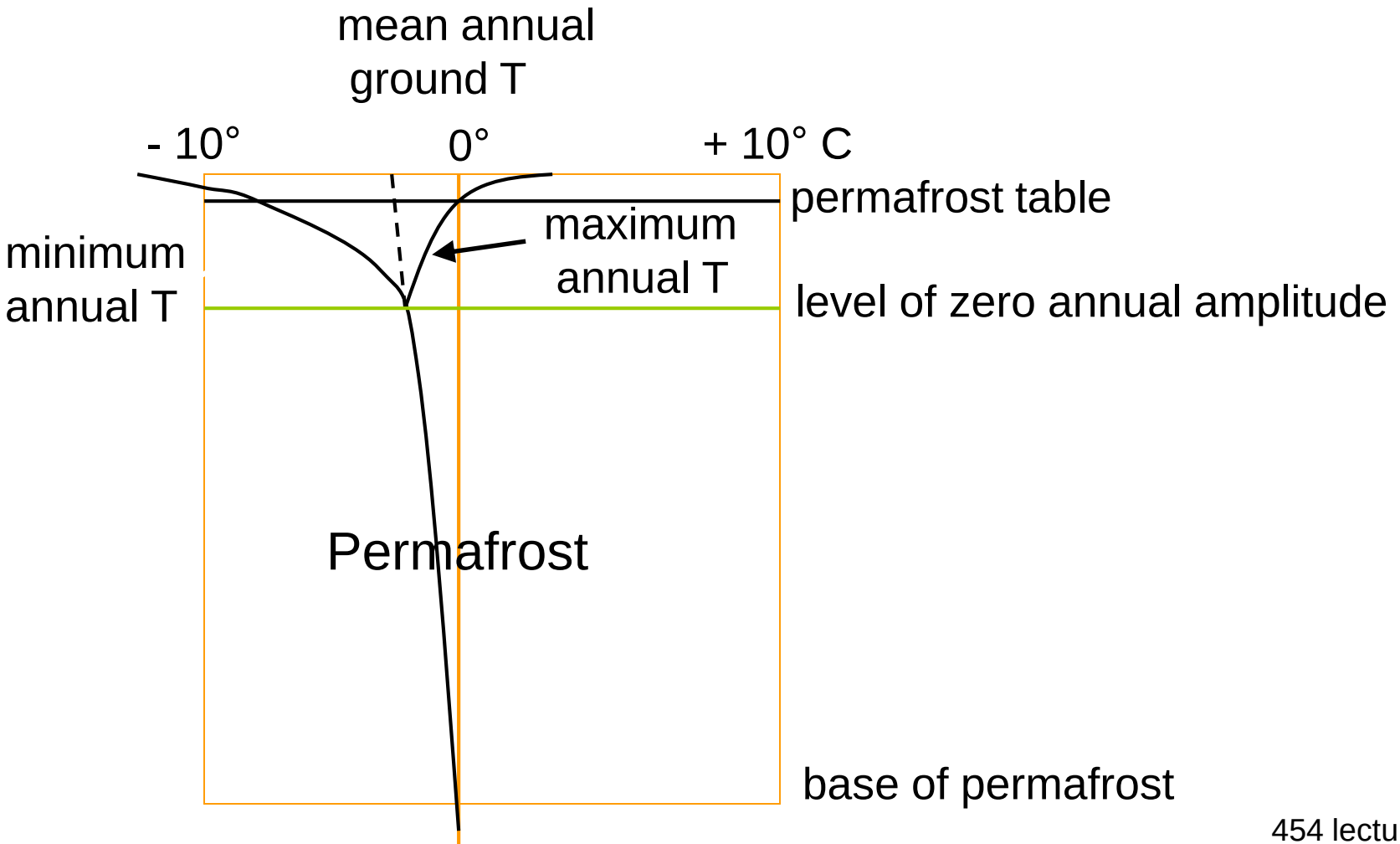
Periglacial processes
- all non-glacial processes in cold climates
- average annual temperature between -15°C and 2°C
- fundamental controlling factors are intense frost action & ground surface free of snow cover for part of year

Many periglacial features are related to permafrost – permanently frozen ground

Permafrost table: upper surface of permafrost, overlain by 0-3 m thick active layer that freezes & thaws on seasonal basis

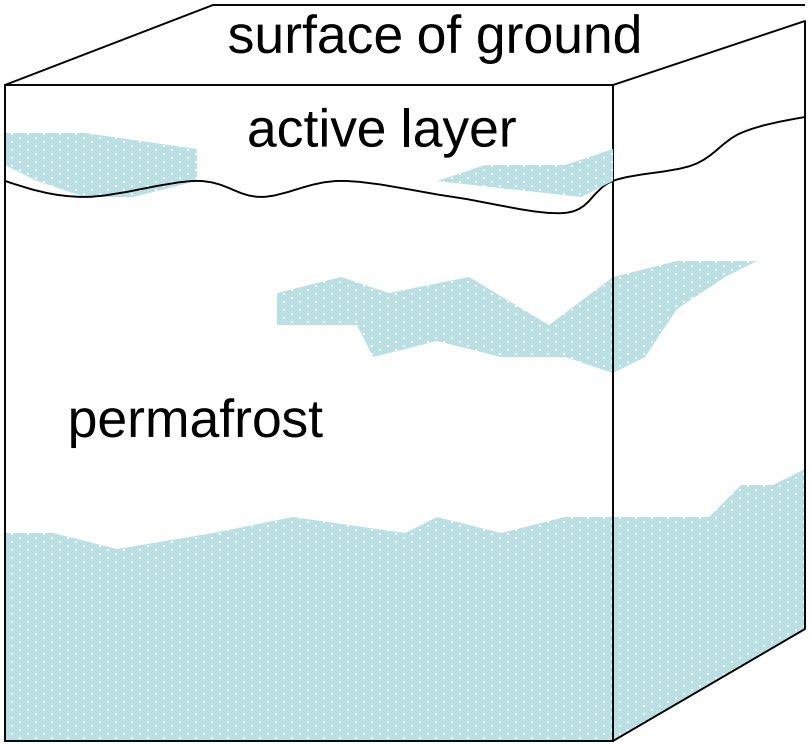
Effects of frost action & mass movements enhanced by inability of water released by thawing active layer to infiltrate permafrost

Temperature fluctuations in permafrost to about 20-30 m depth; zero annual amplitude refers to level at which temperature is constant



Slumping streambank underlain by permafrost, northern Brooks Range, Alaska

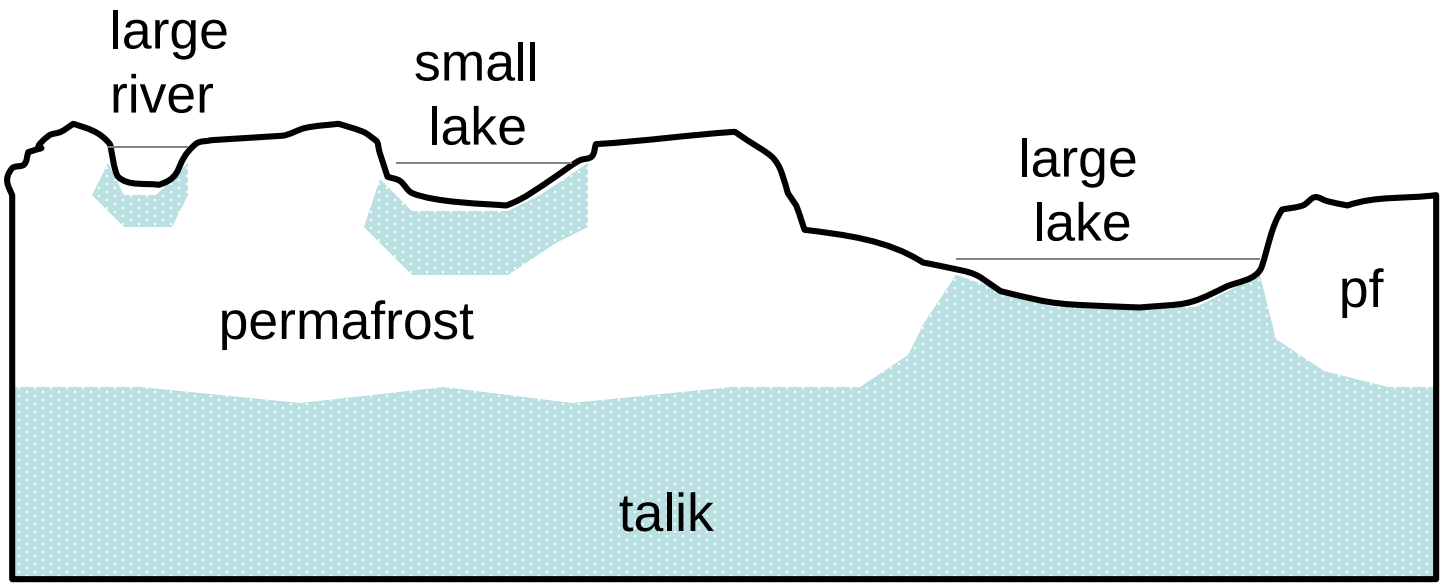
Taliks: unfrozen ground around permafrost



permafrost table (upper surface of permafrost)

talik

Permafrost tends to mimic surface topography



Effect of surface water on the distribution of permafrost – taliks underlie water bodies

Stream cutbank underlain by permafrost

Where annual temperature averages ≤ 0°C, ground freezing during the winter goes deeper than summer thawing – each year adds an increment & the permafrost grows until it is stopped by geothermal heat (~ 1°C/30 m decrease)

Because permafrost accumulation rates are in cm/yr, thick permafrost can be tens of thousands of years old

Permafrost underlies 26% of the Earth's surface, in both continuous and discontinuous (talik) types

The southern limit of continuous permafrost is at the -6°C annual isotherm, & discontinuous permafrost ends at -1°C

Sporadic permafrost: isolated zones of frozen ground that are probably relicts of former climate

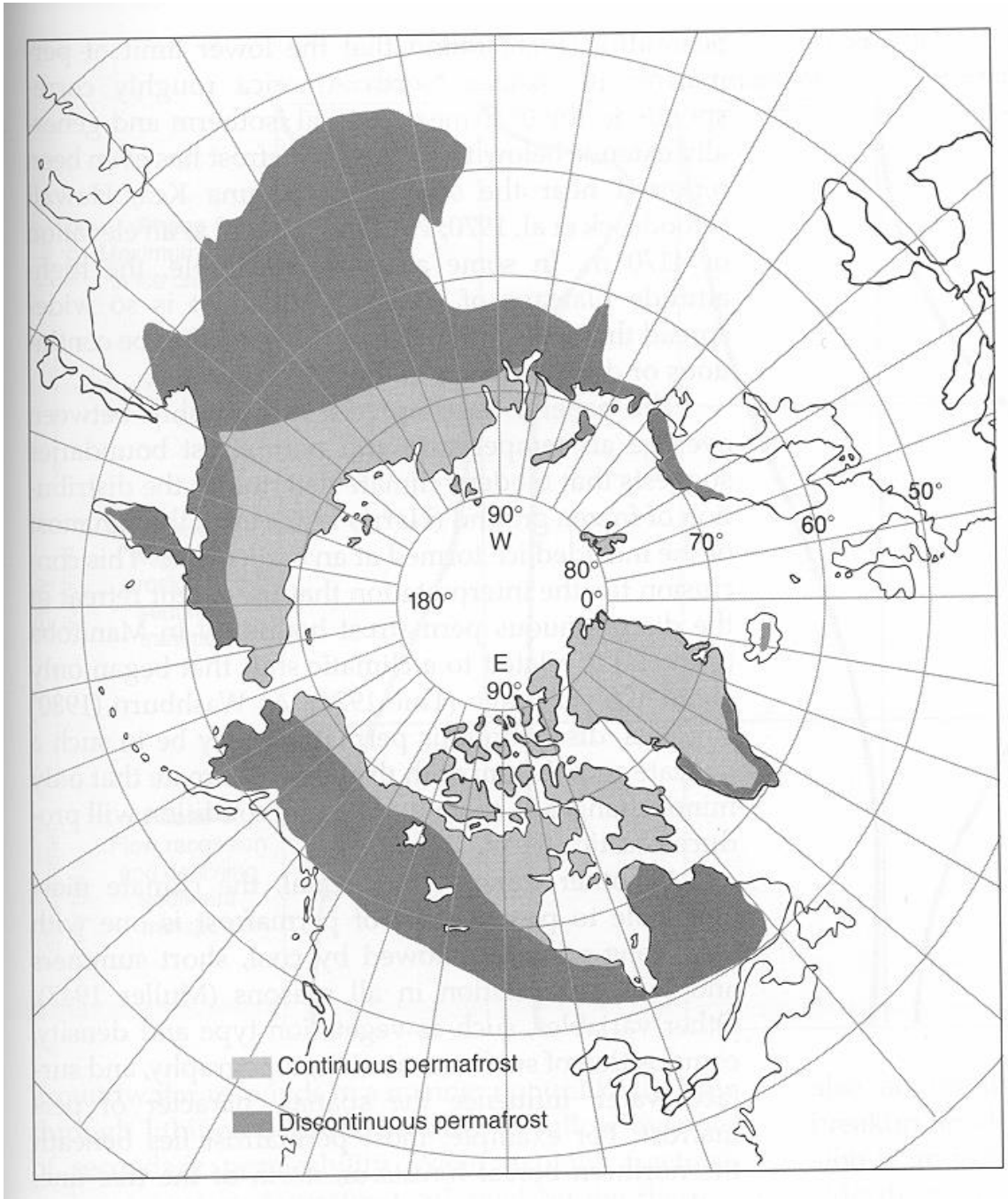


FIGURE 11.6

Extent of continuous and discontinuous permafrost in the Northern Hemisphere.

(After Ferrians et al. 1969)

Periglacial zones are dominated by frost action & mass movement

Frost action:

driving force is growth of ice within a soil or rock

ice in soil can be interstitial or pore ice (in coarse sediments), or segregated ice – lenses or wedges in fines such as uncemented silt (but not impermeable fines such as clay)

formation of segregated ice depends on rate of freezing, size of pore spaces, & ability of water to be drawn to central freezing plane or point

talus slope, Rocky Mountain N.P., CO

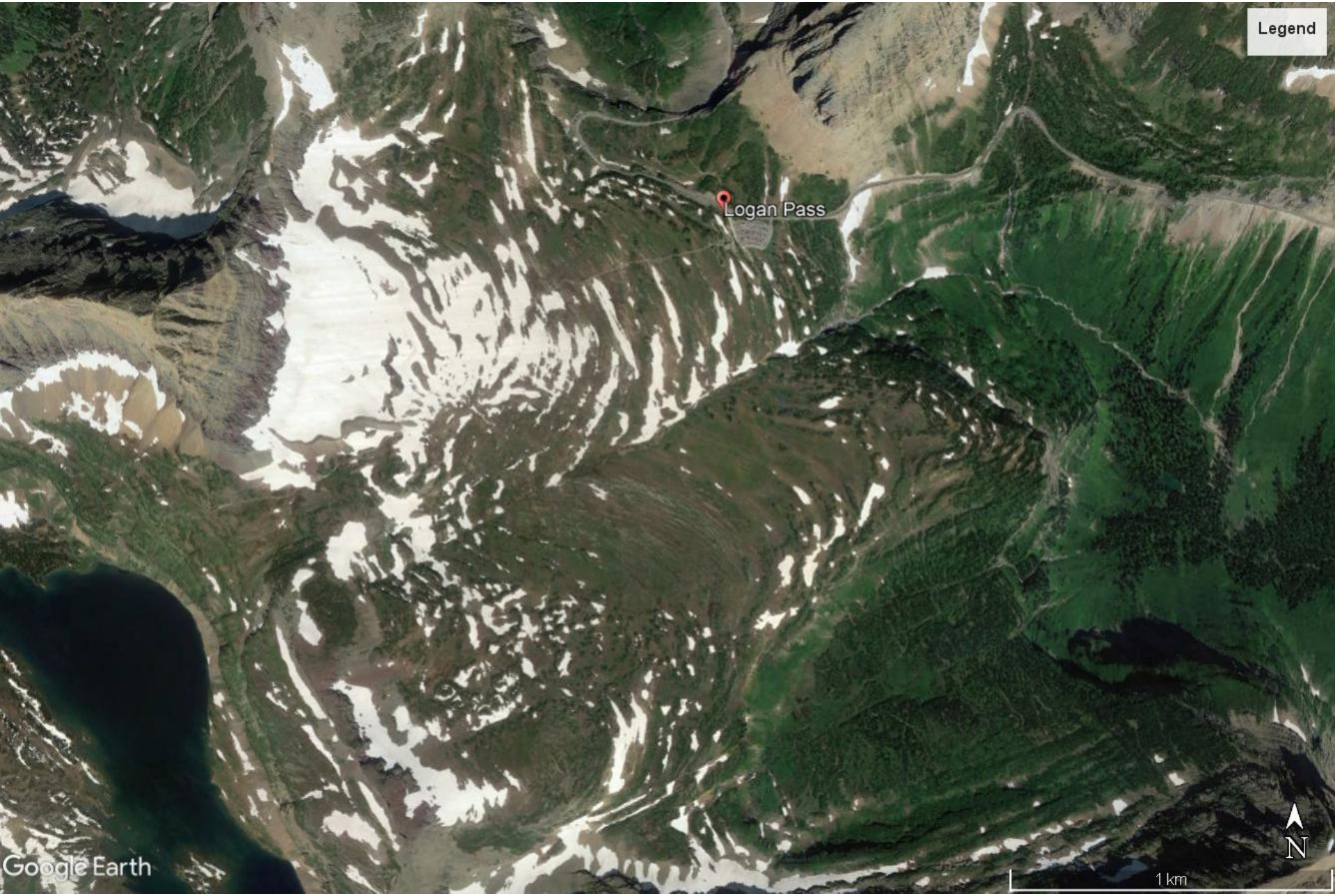
talus slope, San Francisco Peaks, AZ

alpine zone, Bighorn Mts., WY

nivation hollows, Logan Pass
Glacier National Park, MT

avalanche scars,
Cabinet Mts., MT

Logan Pass, Glacier National Park, MT



Processes of Frost Action

Frost wedging
- prying apart of solid material by ice
- effectiveness depends on number of freeze-thaw cycles; rapid freezing; high water content
- produces angular debris

Frost heaving
- vertical displacement of matter in response to freezing; forces large particles surface-ward relative to fines
- thrusting – horizontal movement

Two hypotheses of explanation are

i) frost-pull: stones & fines are lifted together; fines, being cohesive, collapse on thawing into cavities below the coarse particles

ii) frost-push: stones conduct heat better than soil, so stones cool quickly, & the first ice forms beneath them & pushes them upward

Probably, both processes act together

Surface form occurs as needle ice (piprake) – ice crystals 1-3 cm long in unvegetated, loamy soils

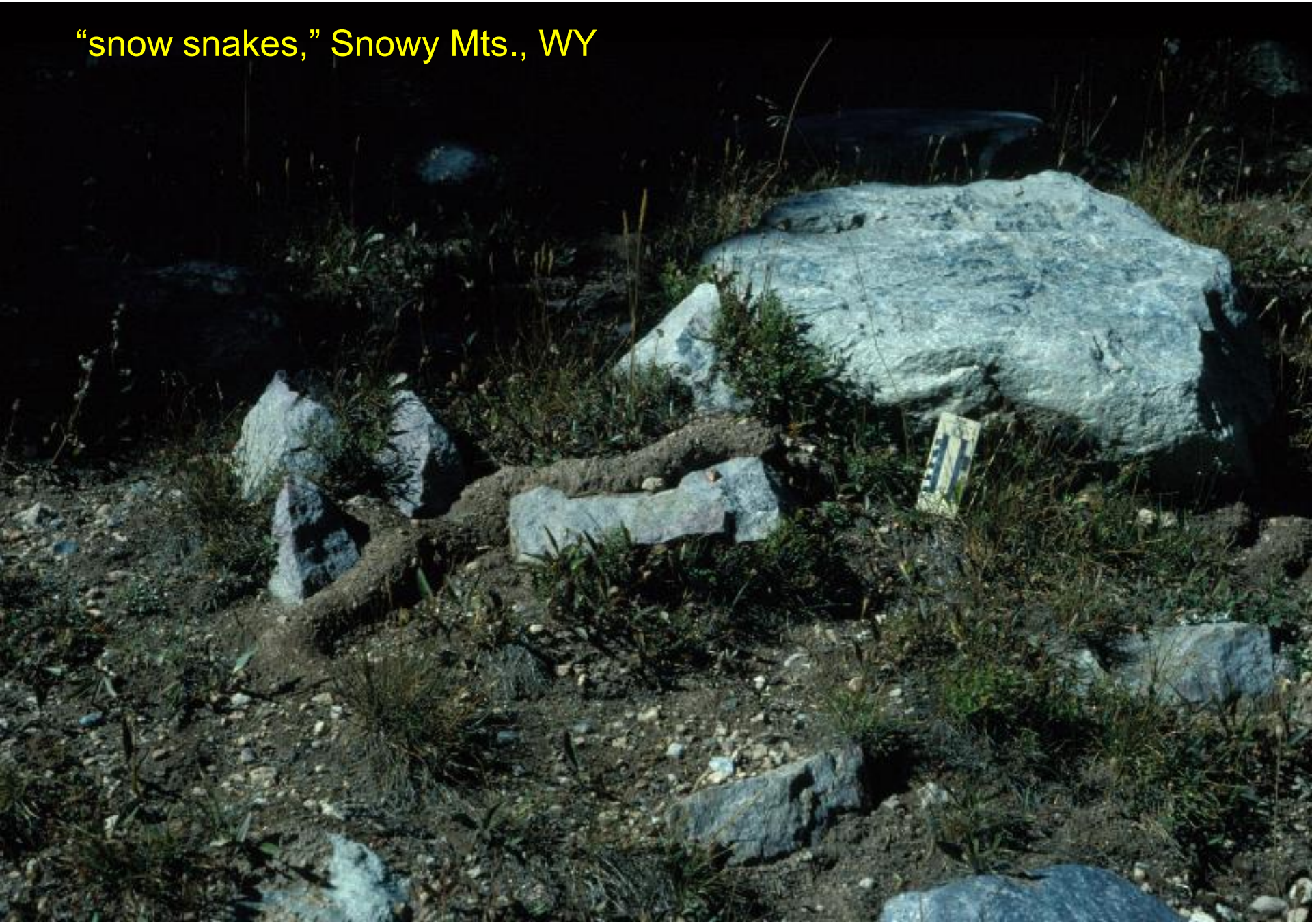
iii) frost cracking: development of fractures at low temperature due to thermal contraction, rather than associated ice expansion on freezing; can produce polygonal network of fractures


needle ice, Nepal


needle ice, n Sweden


needle ice, n Sweden


soil disturbed by needle ice, AZ
PENTAX


“snow snakes,” Snowy Mts., WY

White River National Forest,
Colorado

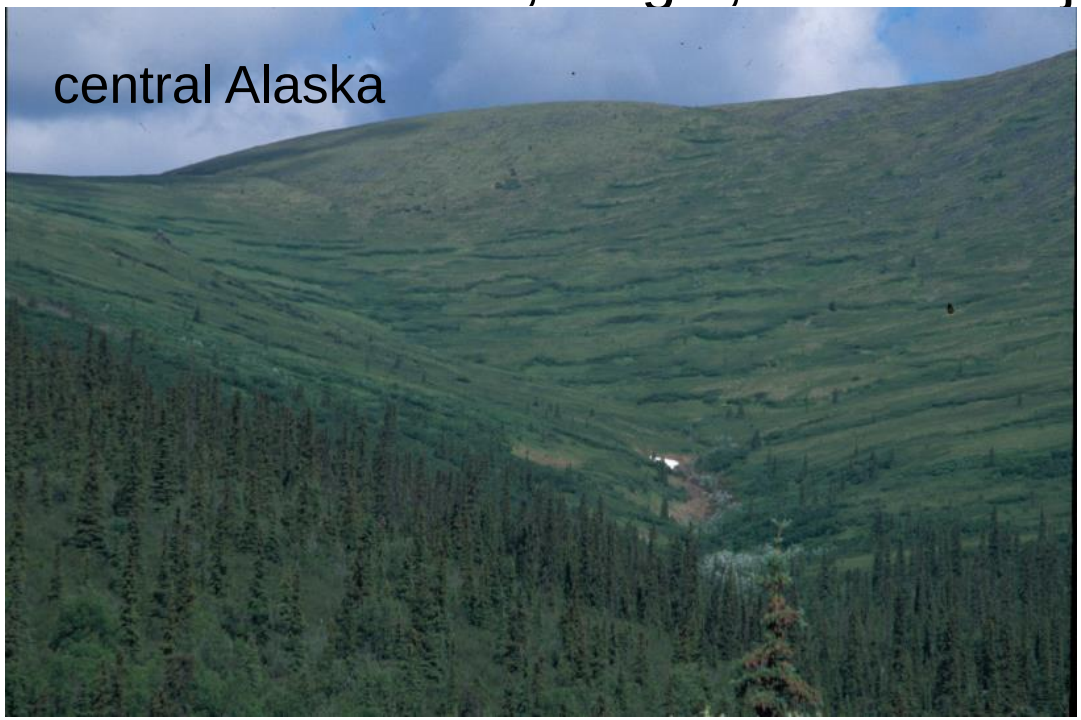
Two types of mass movements – frost creep & solifluction – dominate in cold regions

Frost creep: downslope movement of particles in response to expansion & contraction, and under the influence of gravity
freezing & thawing generate cycle of expansion/contraction with downslope component

Solifluction: slow flowage in saturated soils in periglacial regions
gelifluction is a type – soil flowage associated with frozen ground
when water is released from the active layer in summer, the permafrost prevents infiltration, & the saturated soils behave like viscous fluids, flowing on 1° slopes
most effective in silty soils

Landforms associated with mass movements

Solifluction lobes: large, tongue-like masses of surface debris, 30-50 m wide; single, or several joined laterally



Blockfields: broad, level areas covered by moderate to large angular blocks of rock
on slopes these are called block slopes, block streams, etc
display internal fabric indicative of movement
may originate through solifluction & other processes

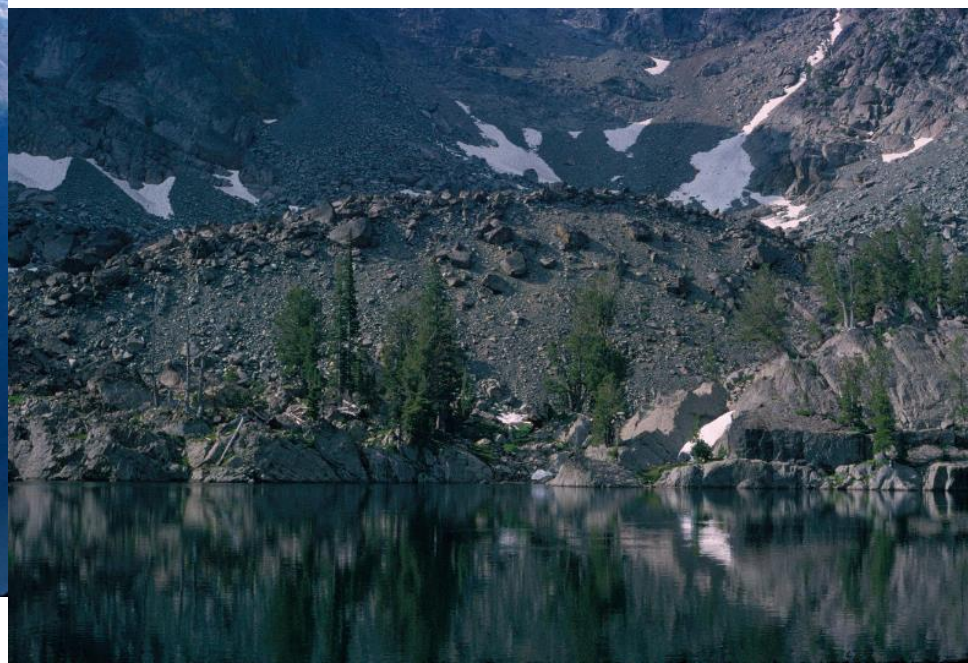
solifluction terraces, Glacier National Park, MT

Solifluction lobes on hillslopes in north-central Alaska

Rock glaciers: composed of angular rock particles

- head in cirques, plan-view similar to ice glaciers
- spread in lobate or tongue-like forms
- ice below surface may be interstitial cement (ice-cemented type) or a mass (ice-cored)
- may be transitional between nonglacial process & glacier with thick mantle of surface debris
- steep front
- active in polar, subpolar & mid-latitude high mountains

Idaho




Legend
Google Earth
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N
400 m

inactive rock glacier,
Rawah Wilderness, CO

mass movement/rock glacier,
Indian Peaks, CO