SISTEMA GLACIAL

1. GENERALIDADES

- **Glaciações:**
  - **no tempo geológico;** (T)
  - **Modificações:**
    - ambientais
    - superfície do planeta
      - erosão
      - depósitos
    - ajustamentos isostáticos
    - variações eustáticas ←
    - seres vivos
      - migração
      - extinção

- **Linha de neve** 3.3

- **Geleira - Definição**

2. GEOMORFOLOGIA DAS GELEIRAS

- **processos atuantes**
- **regiões**

3.13 - 21.9 - .....

3. CLASSIFICAÇÃO DAS GELEIRAS

- **Morfologia:** vale, piemonte, calota 267
- **Genética:** 13.2
  - Terrestre
    - Glacial
    - Fluvio-glacial
    - Glacio-lacustre
  - Marinha
    - Proximal
    - Distal
- **Térmica:** 6
  - Base seca (polar)
  - Base úmida (temperada)

4. FLUXO GLACIAL

- **Deformação plástica** 6
- **Deslizamento**
- **Movimento**
- **Crevasses** A - B

5. EROSÃO GLACIAL

- **Abrasão:**
  - polimento
  - estriação
  - moagem
  - → farinha glacial 4.1
  - → substrato polido/estriado 4.5
- **Fraturamento:** congelamento/degelo 9

6. TRANSPORTE GLACIAL

- **Geleira alpina:** Morainas 21.18
- **Geleira continental:** C

7. DEPÓSITOS

- **Não estratificados:** Tills 13.3 - 3.22 - 6.10
- **Estratificados:**
  - pró-glaciais
    - Marinhos 3.1 - 31
    - Terrestres
  - contato glacial
    - esker 8.14 / 21.19
    - kame 8.10 - 8.11
    - kattle 8.12 - 8.8
    - drumlim

8. EVIDÊNCIAS DE ATIVIDADE GLACIAL

21.16
21.17

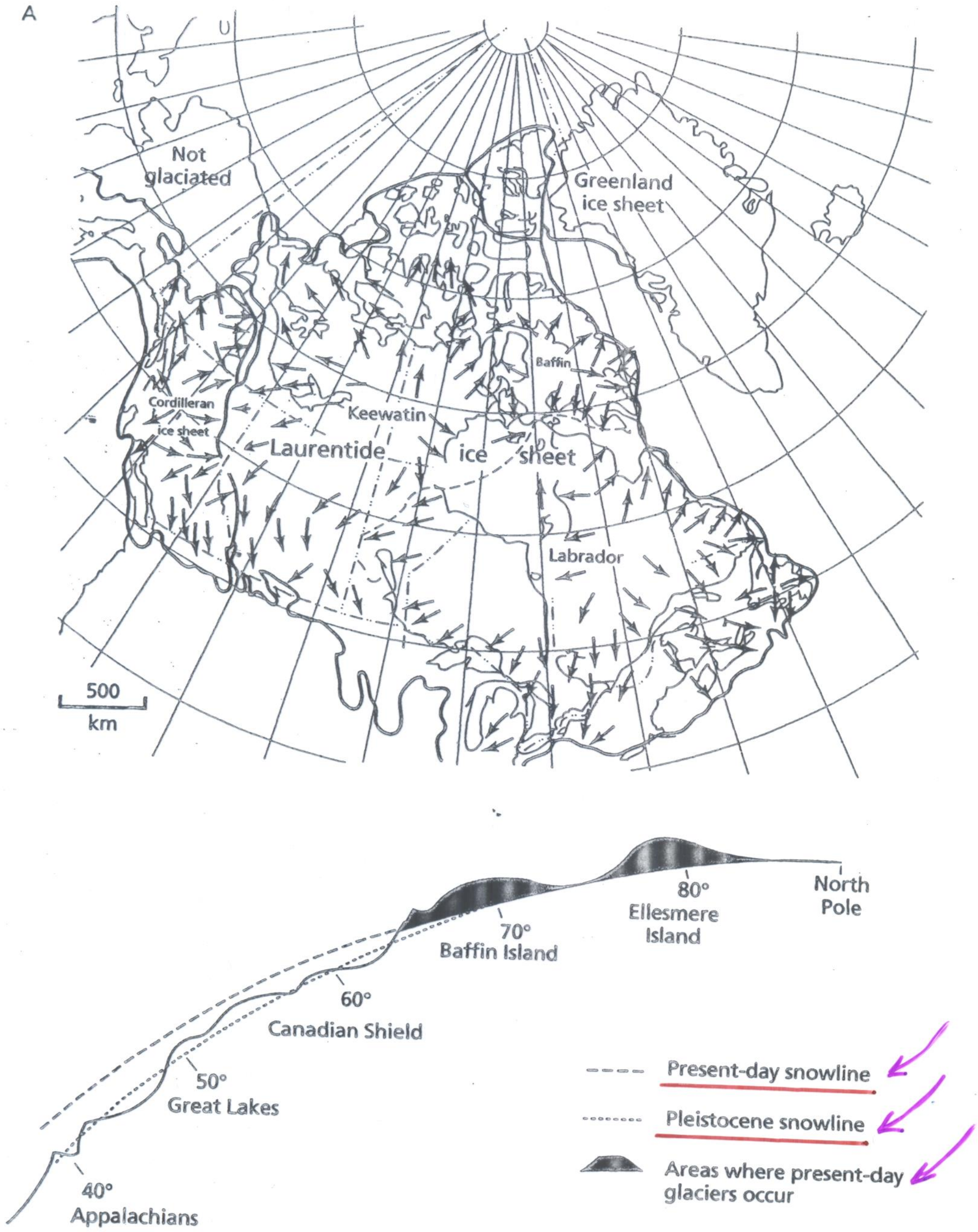


FIGURE 3.3 Localization of centers (Labrador, Keewatin) of North American ice sheets at midlatitudes, where the Pleistocene snowline intersected Earth's surface. *(A)* Map showing Keewatin and Labrador centers of Pleistocene glaciation and direction of ice movement (arrows). *(B)* Schematic profile along a north-south line from the North Pole to latitude 40° N, showing altitudes of present and Pleistocene snowlines in North America. (After Stearn, Caroll, and Clark 1979.)

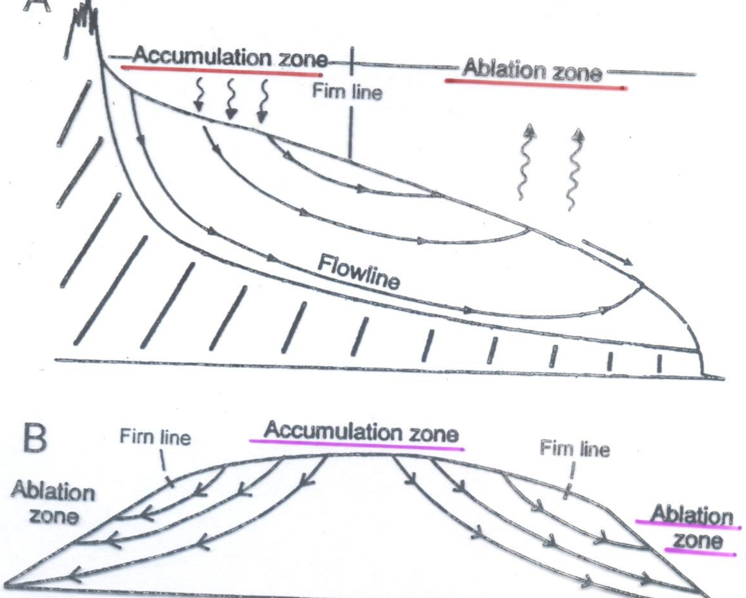


FIGURE 3.13 Diagrams of idealized glaciers showing zones of accumulation, ablation, and the firn line. *(A)* Valley glacier; *(B)* ice sheet. (After Sudgen and John 1976.)

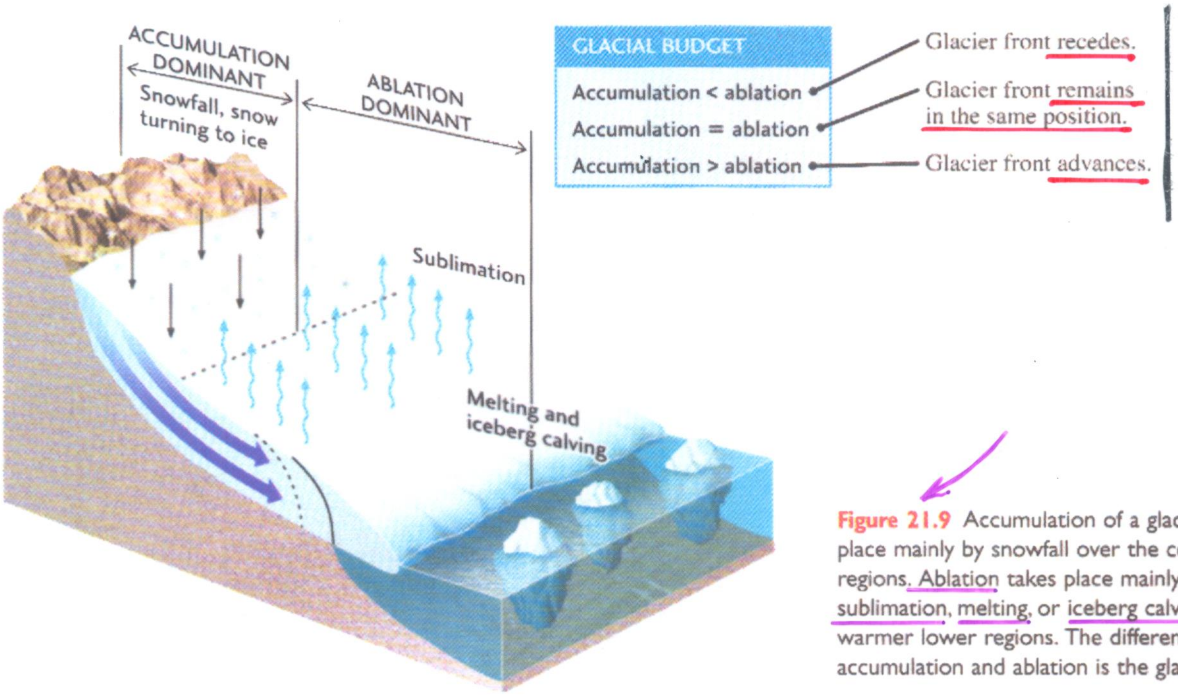


Figure 21.9 Accumulation of a glacier takes place mainly by snowfall over the colder upper regions. Ablation takes place mainly by sublimation, melting, or iceberg calving in the warmer lower regions. The difference between accumulation and ablation is the glacial budget.

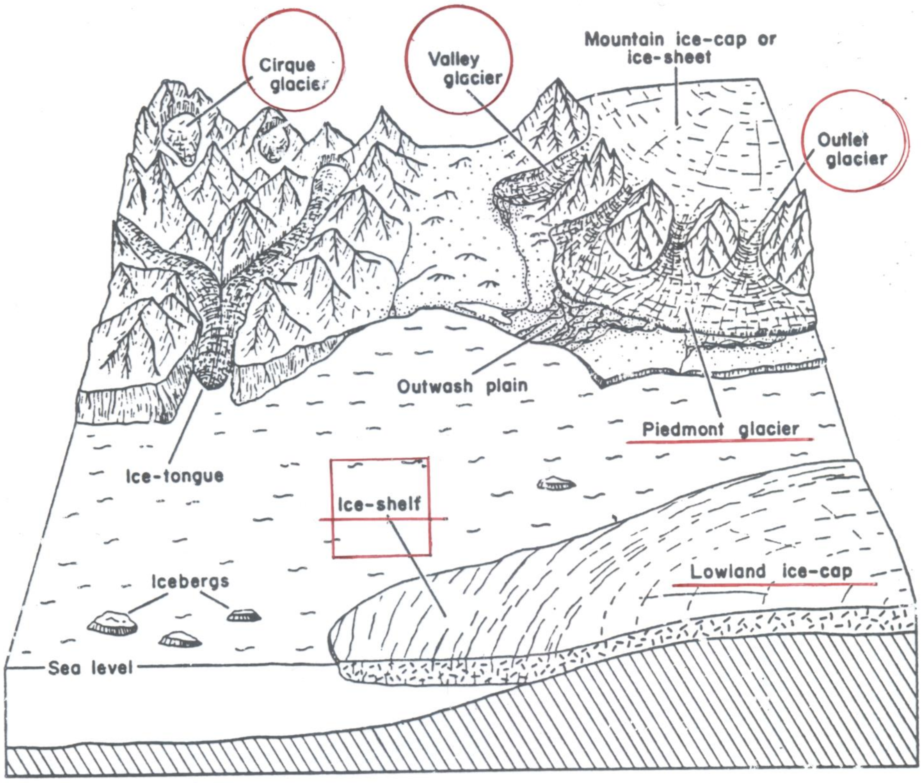


Fig. 267. Scheme showing various forms of occurrence of glacial ice. (After Allen, 1970).

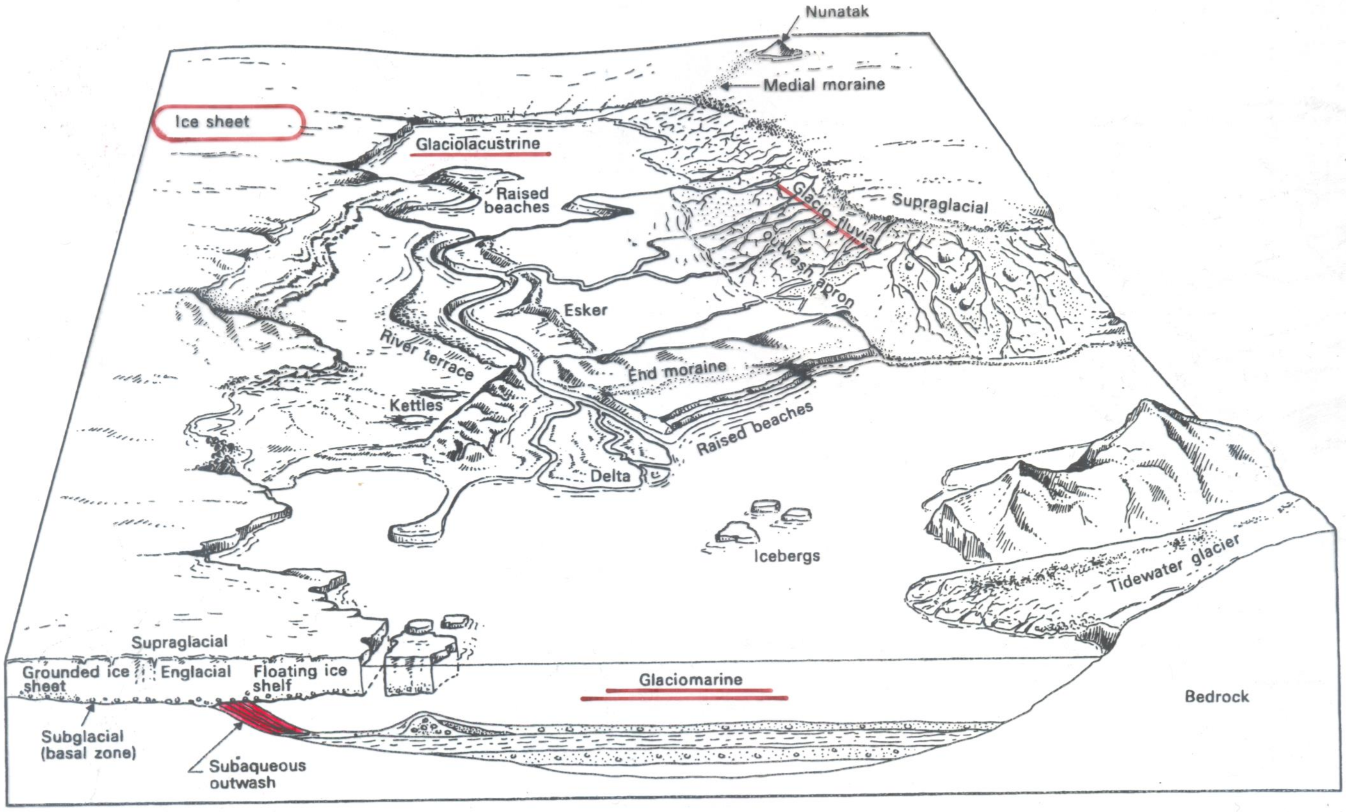


Fig. 13.2. Glacial environments and associated landforms typical of glaciated areas, including glaciofluvial outwash fan, ice-contact end moraine, glacial lake- and sea-bottom deposits, raised beaches and marine delta.

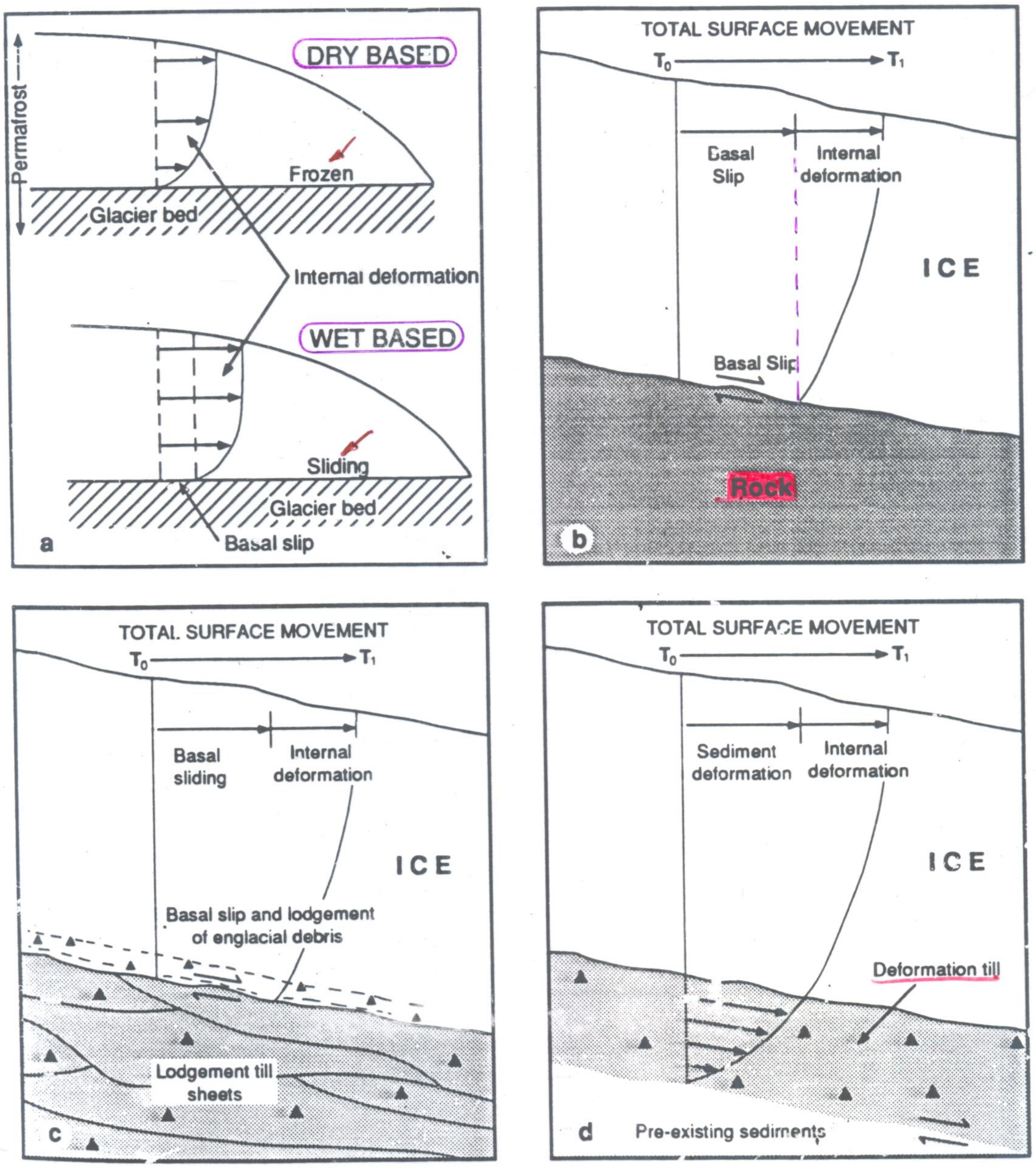
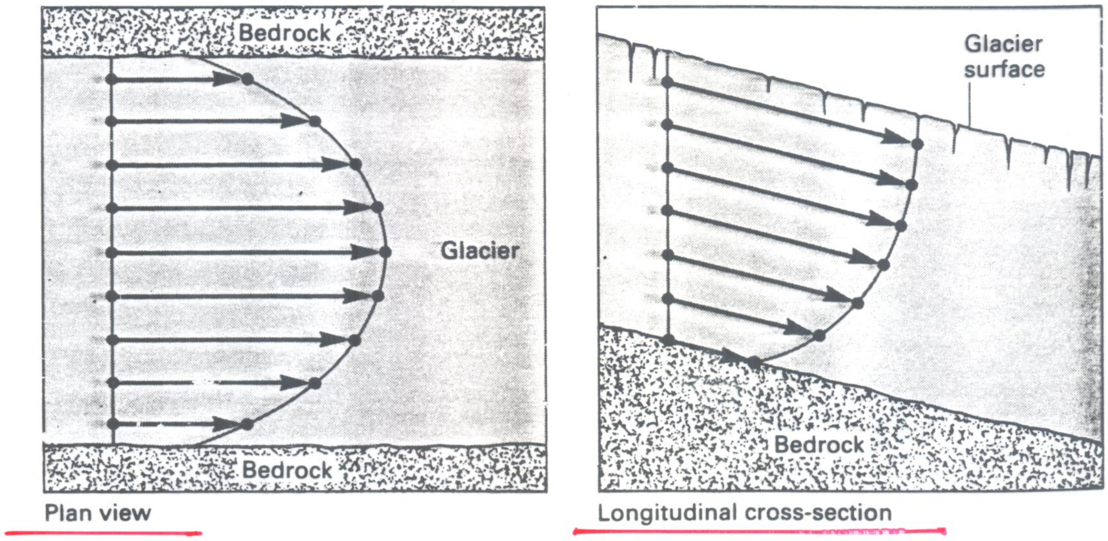


Figure 6 A) Top, movement of dry-based (polar) glacier by internal deformation. Glacier is frozen to the bed; bottom, in contrast wet-based glaciers move by internal deformation and basal sliding. Horizontal arrows indicate relative amounts of ice movement. B) Movement of wet-based glacier on bedrock substrate. C) "Stiff-bed" mode. for accretion of till sheets below wet-based ice (see Fig. 8). Accretion occurs by incremental smearing of englacial debris against substrate (lodgement till). D) "Soft-bed" model where till is produced below wet-based ice by subglacial shearing of overridden sediments (deformation till; see Fig. 14).

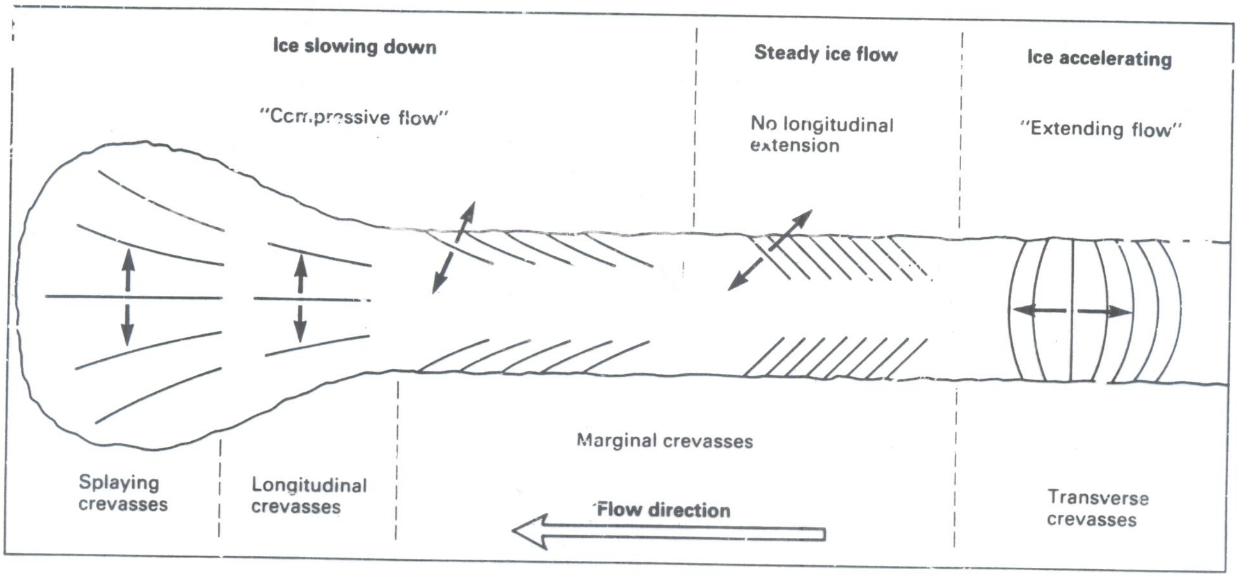
Fig. A

Ice flows by internal deformation. The arrows depict the distance particles will travel over a period of several years. Those in the centre and in the upper part of the glacier travel the furthest.



B

Plan view of the principal types of crevasse in the tongue of a valley glacier, together with the types of flow involved. The arrows, which are at right angles to the crevasses, indicate the directions in which the ice is pulled apart.



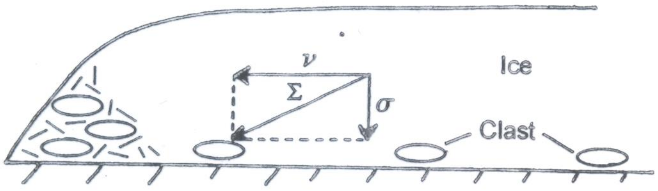


FIGURE 4.1 Schematic cross section of a glacier showing conditions necessary for abrasion. Abrasion occurs when the combined forces of weight (σ) and movement (ν) of a glacier push a clast against the bedrock or against another clast, as indicated by the vector sum $\Sigma = \nu + \sigma$.

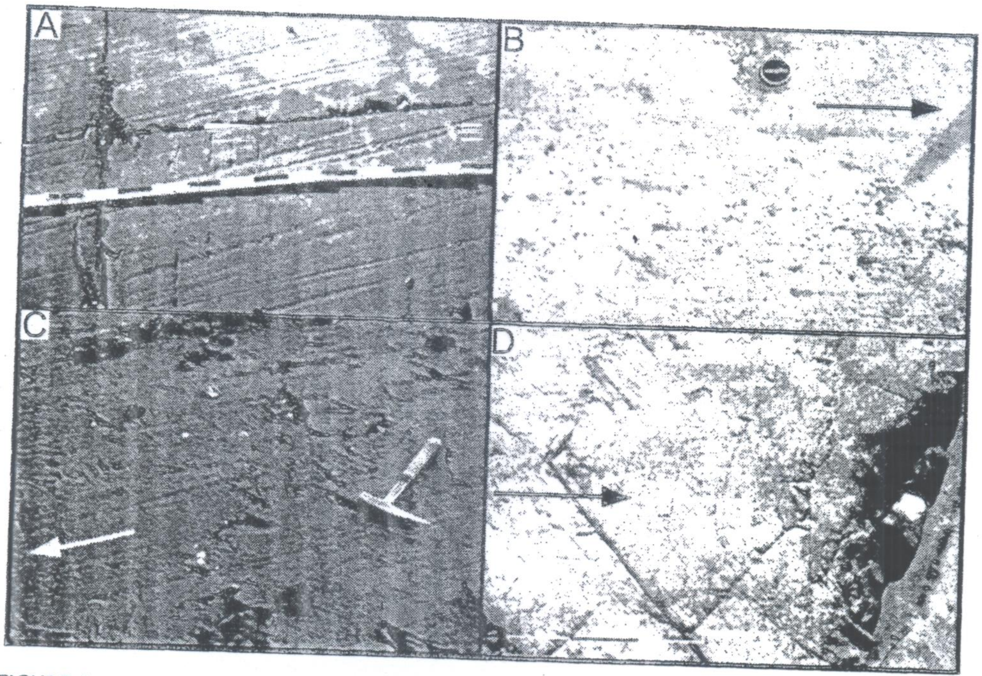


FIGURE 4.4 Photographs of selected small-scale glacial erosional features. *(A)* Simple striae; *(B)* wedge-shaped striae; *(C)* crescentic gouges; *(D)* crescentic fractures. (Arrows show direction of glacier flow.)

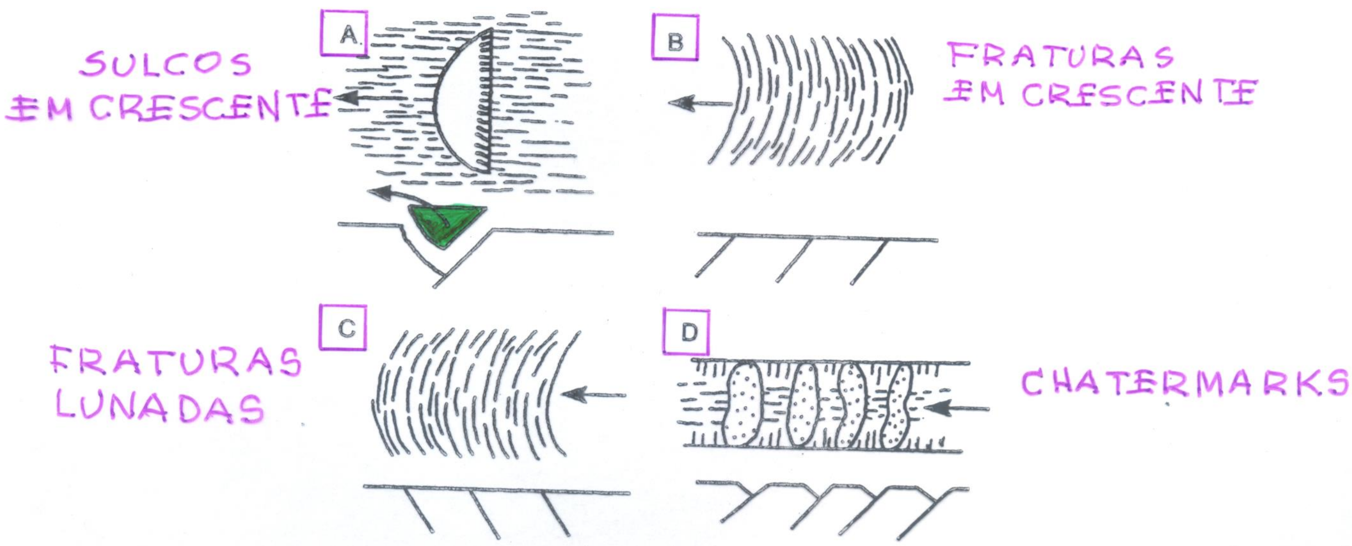


FIGURE 4.5 Diagrams of selected small-scale glacial erosional features in plan and section. *(A)* Crescentic gouges; *(B)* crescentic fractures; *(C)* lunate fractures; *(D)* chattermarks. (After West 1968.)

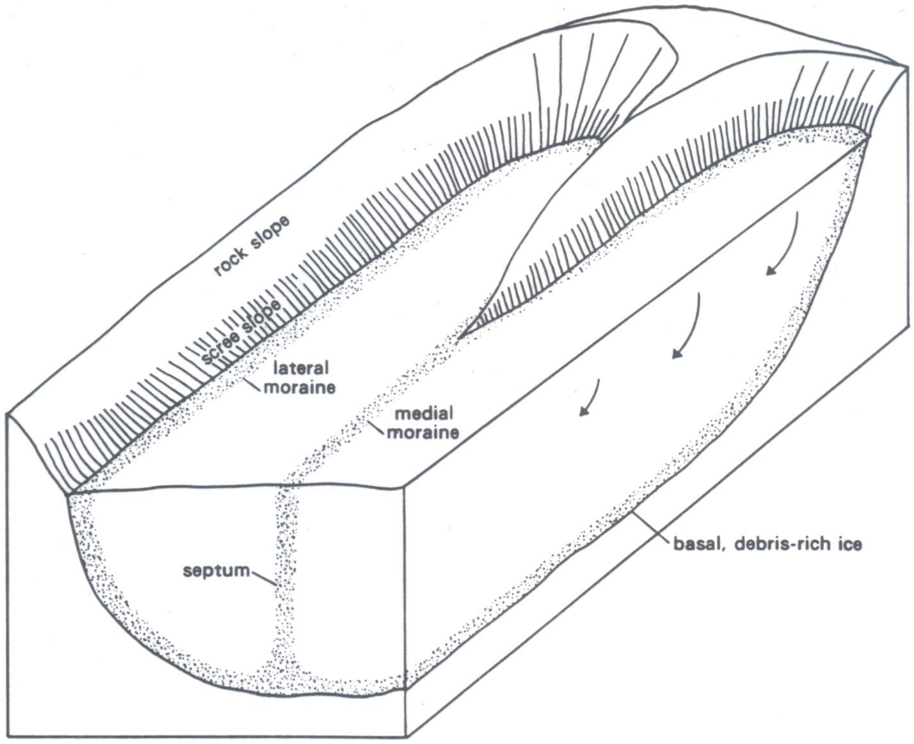


Fig. 2-13. Paths followed by supraglacially derived debris.

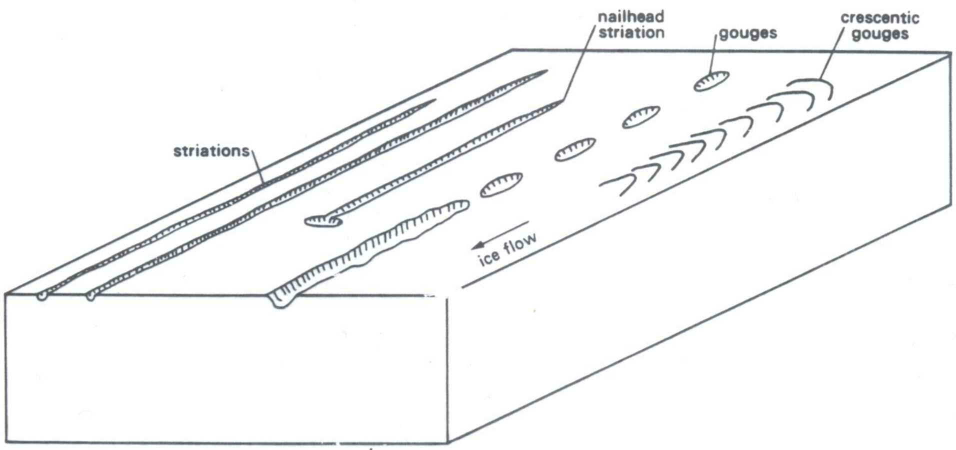
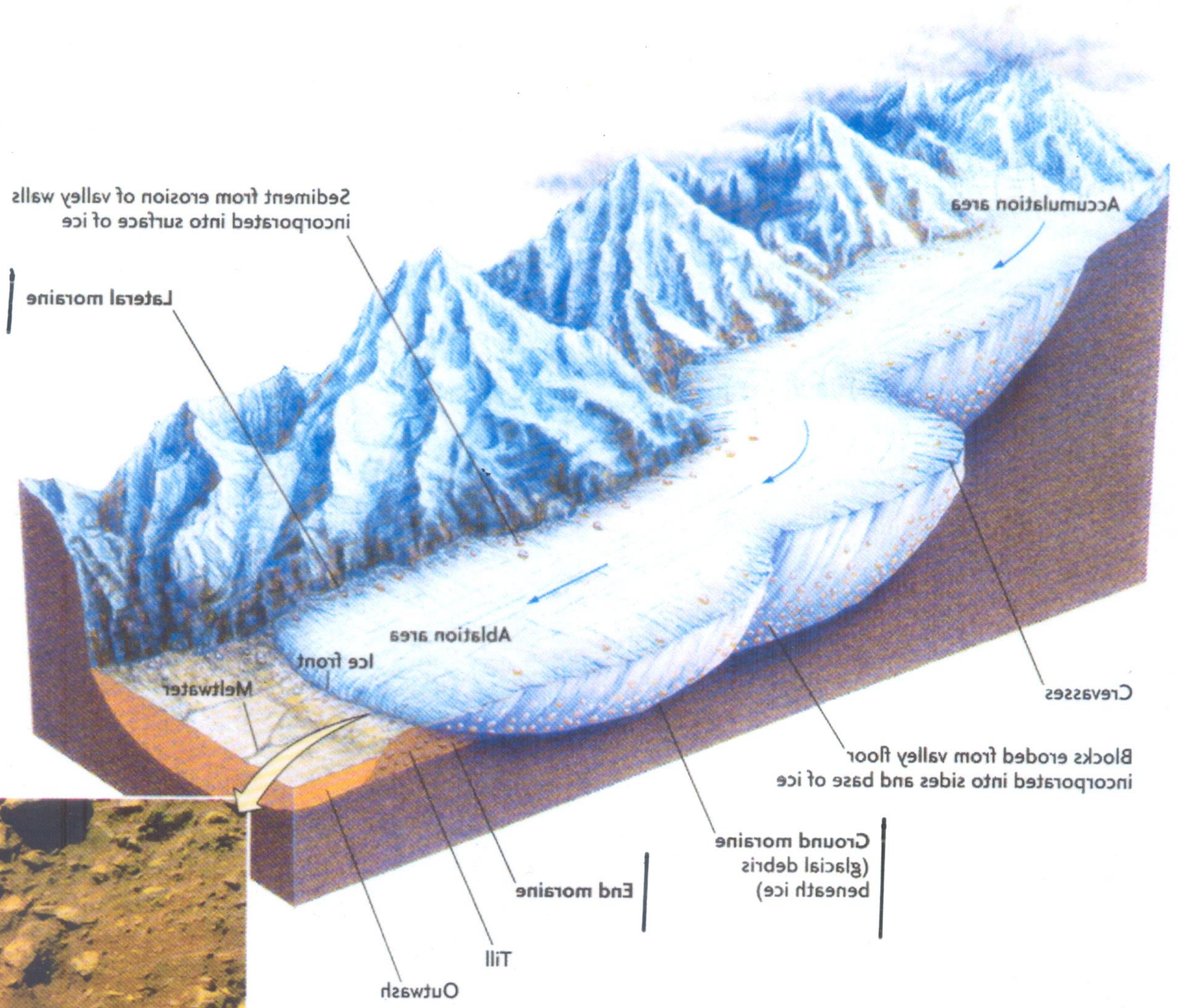
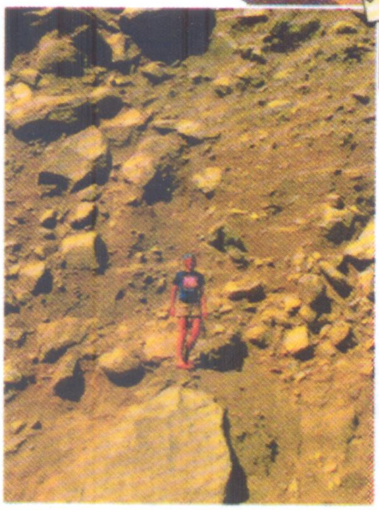


Fig. 2-9. Glacial abrasion forms.

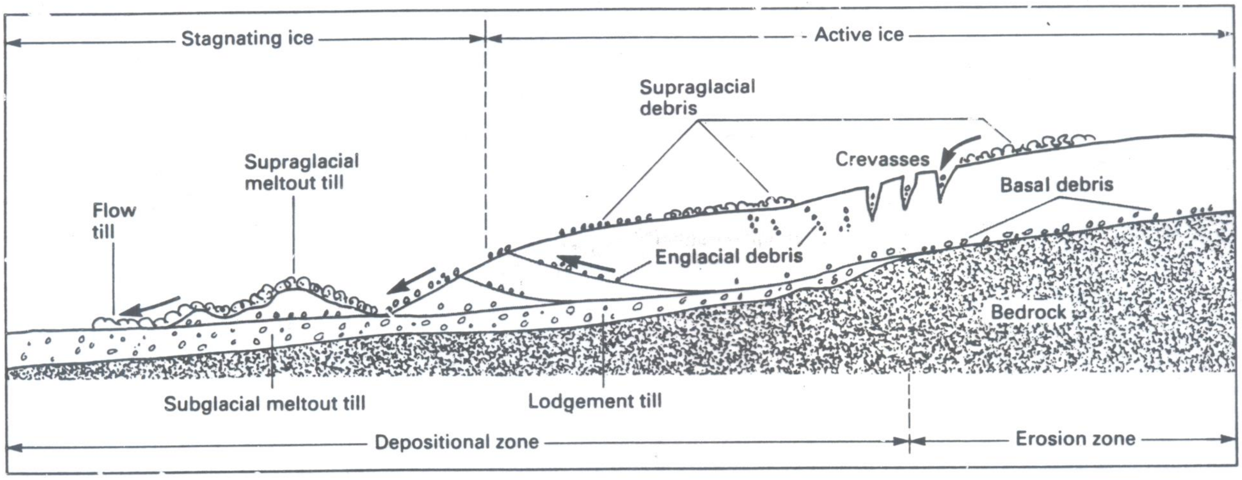




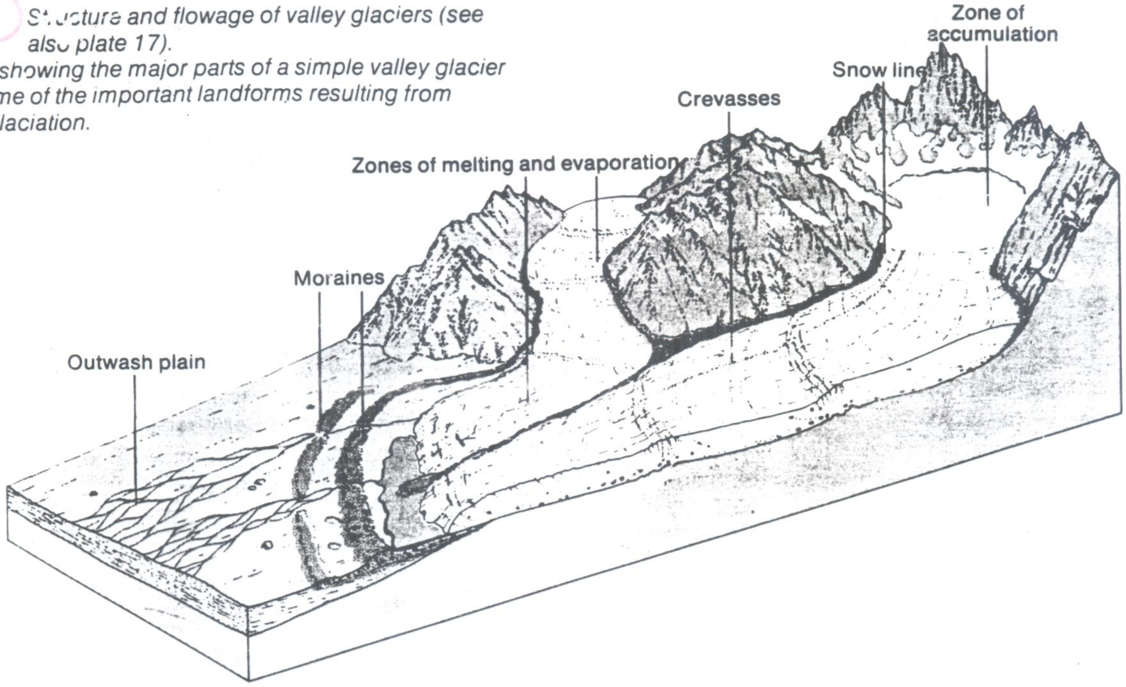
Moraine deposits

Figure 21.18 Glacial till is deposited as an end moraine at the ice front, as lateral moraines at the rocky valley walls, and as a ground moraine beneath the ice. Meltwater streams deposit glacial outwash downstream of the ice front. Till deposited during the Pleistocene epoch on the eastern side of the Sierra Nevada in California. Note the differences in particle sizes and the lack of stratification. [Martin Miller.]

(c) Longitudinal profile through a retreating valley glacier, illustrating debris in transport and some of the varieties of glacial sediment that result from deposition.



14.3 Structure and flowage of valley glaciers (see also plate 17).
Sketch showing the major parts of a simple valley glacier and some of the important landforms resulting from valley glaciation.



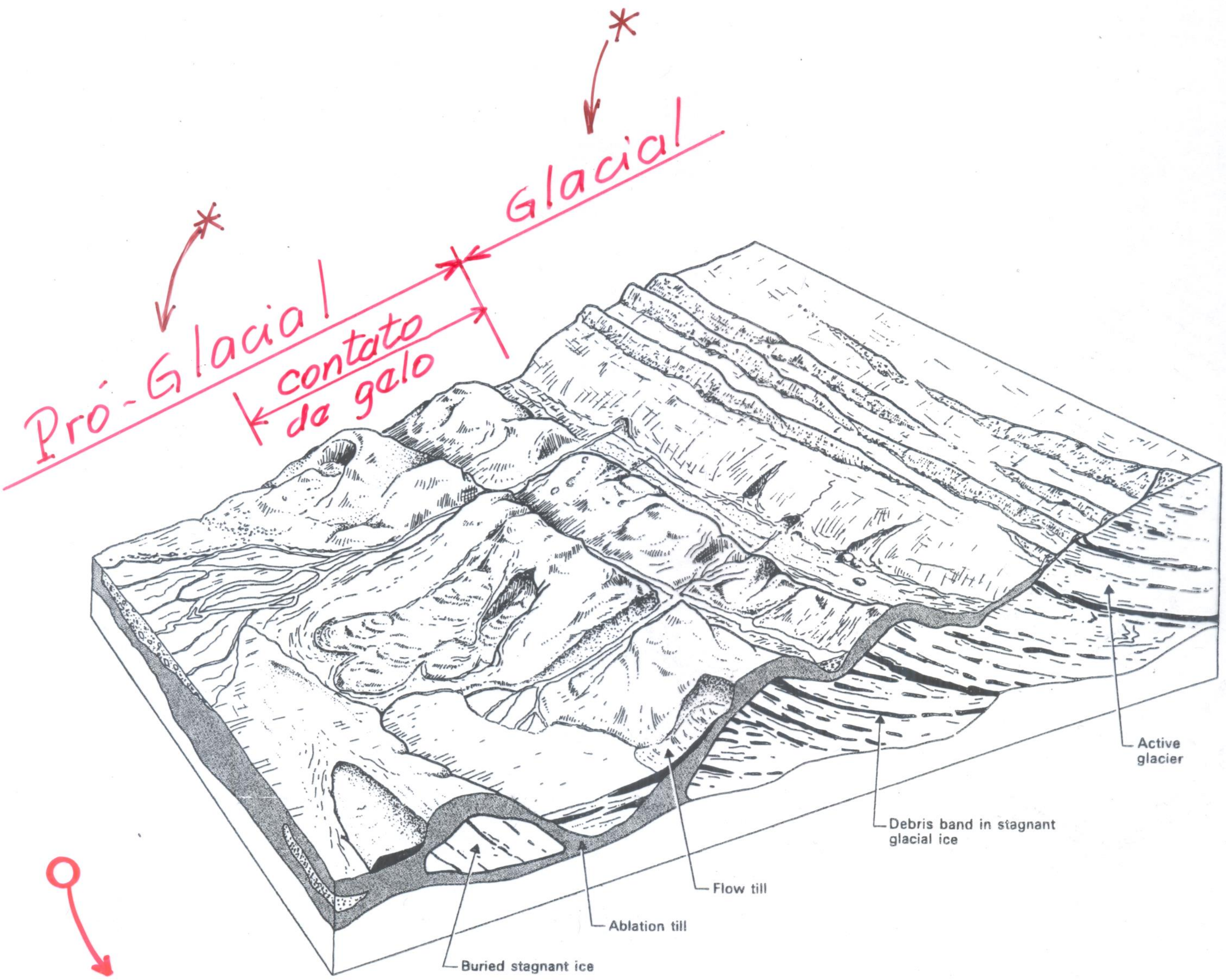


Fig. 13.3. Supraglacial to ice-contact proglacial zones of a glacier whose margin is gradually retreating, and which is thermally cold at the margin. Subglacial material is brought into the glacier by basal freezing and thrusting. This material is released at the surface as ablation till, as the enclosing glacial ice gradually melts. Ablation till is reworked by flowing meltwater, and may slump downslope to form flow tills. Beds of flow till can be intercalated with proglacial stream or lake deposits, and may be extensively reworked (modified from Boulton, 1972).

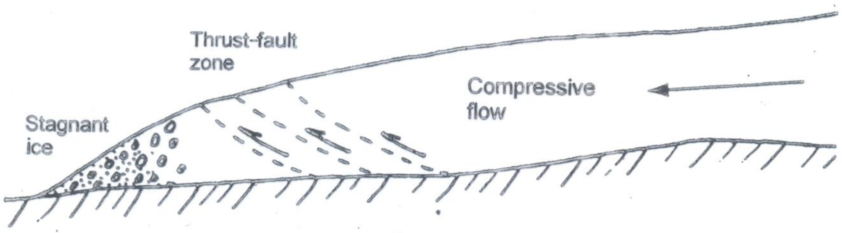


FIGURE 3.22 Schematic longitudinal cross section showing thrust-fault (shear) zone at a glacier terminus.

Glacial Landforms Formed by Glacial Sediments

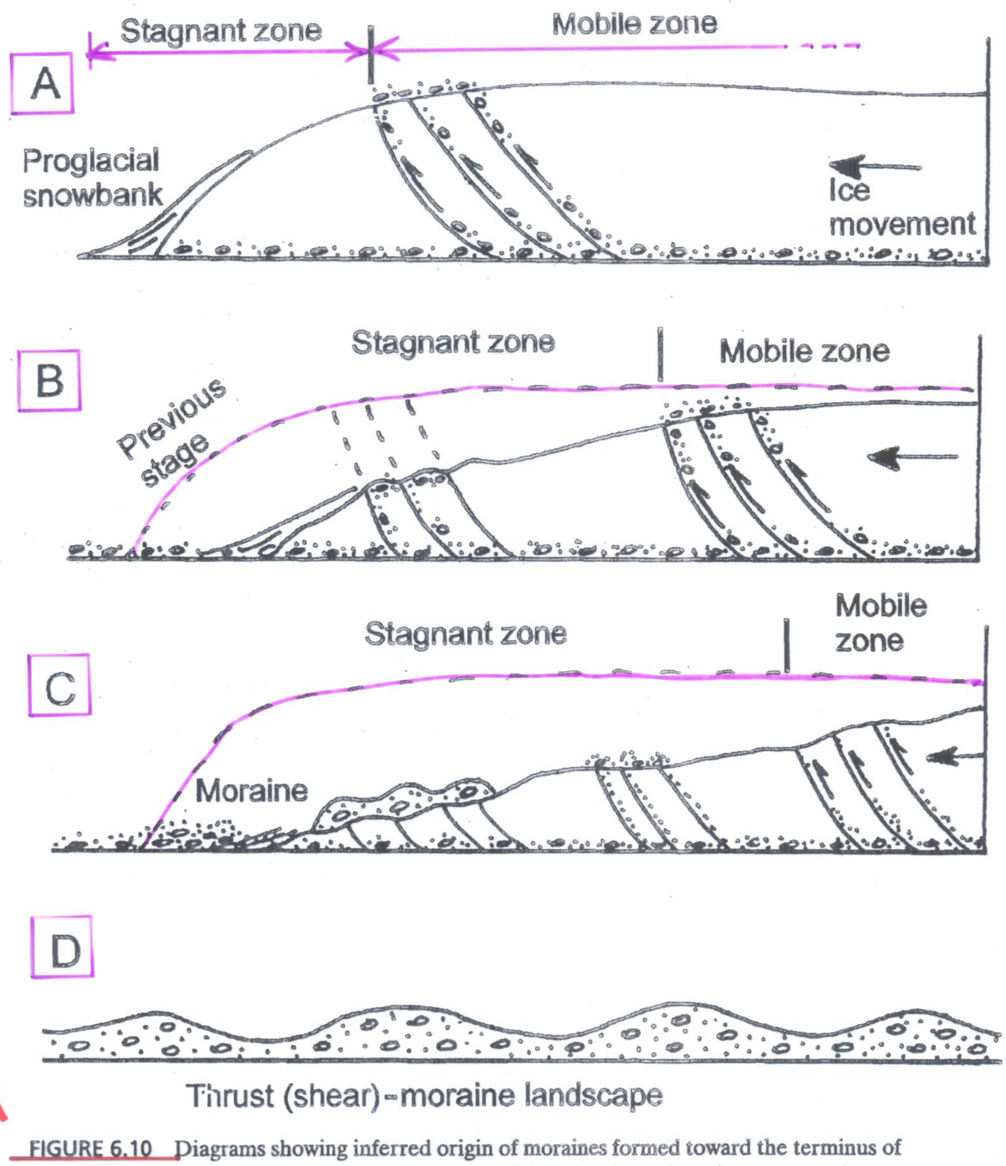


FIGURE 6.10 Diagrams showing inferred origin of moraines formed toward the terminus of part of the Greenland Ice Sheet near Thule, Greenland. The ridges form in correspondence to active thrust (shear) zones where much debris has been carried to the terminus. Periods of active thrusting alternate with periods of melting and thinning of the glacier; and once released, the debris forms separated subparallel ridges. *(A–D):* progressive melting of terminal ice and shift of active (mobile) shear zone (thick arrows indicate ice flow direction; half arrows indicate relative movements along active thrusts). (After unknown; see website for update.)

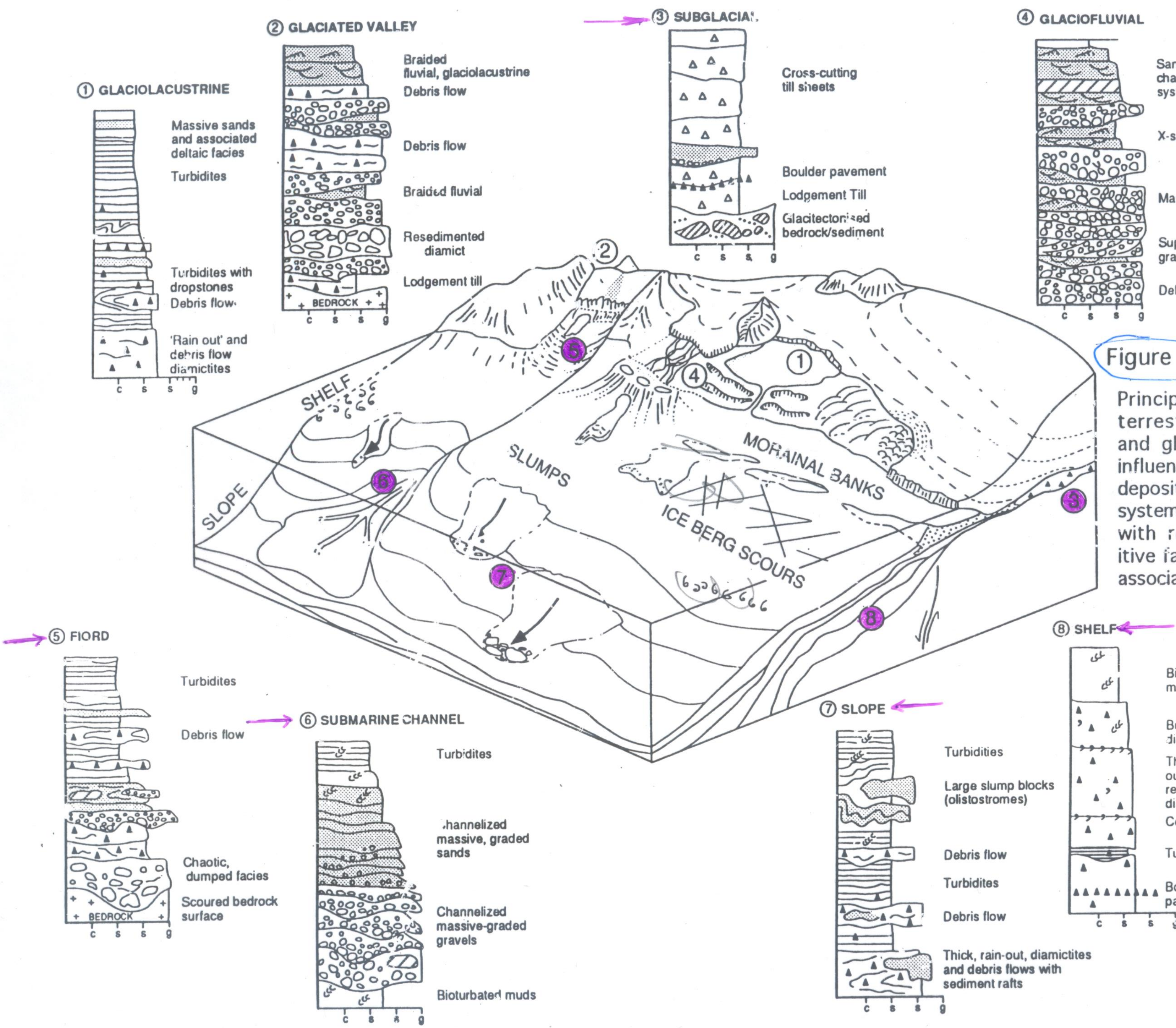


Figure 3.1

Principal glacio-terrestrial(top) and glacially-influenced marine depositional systems(bottom) with representitive facies associations.

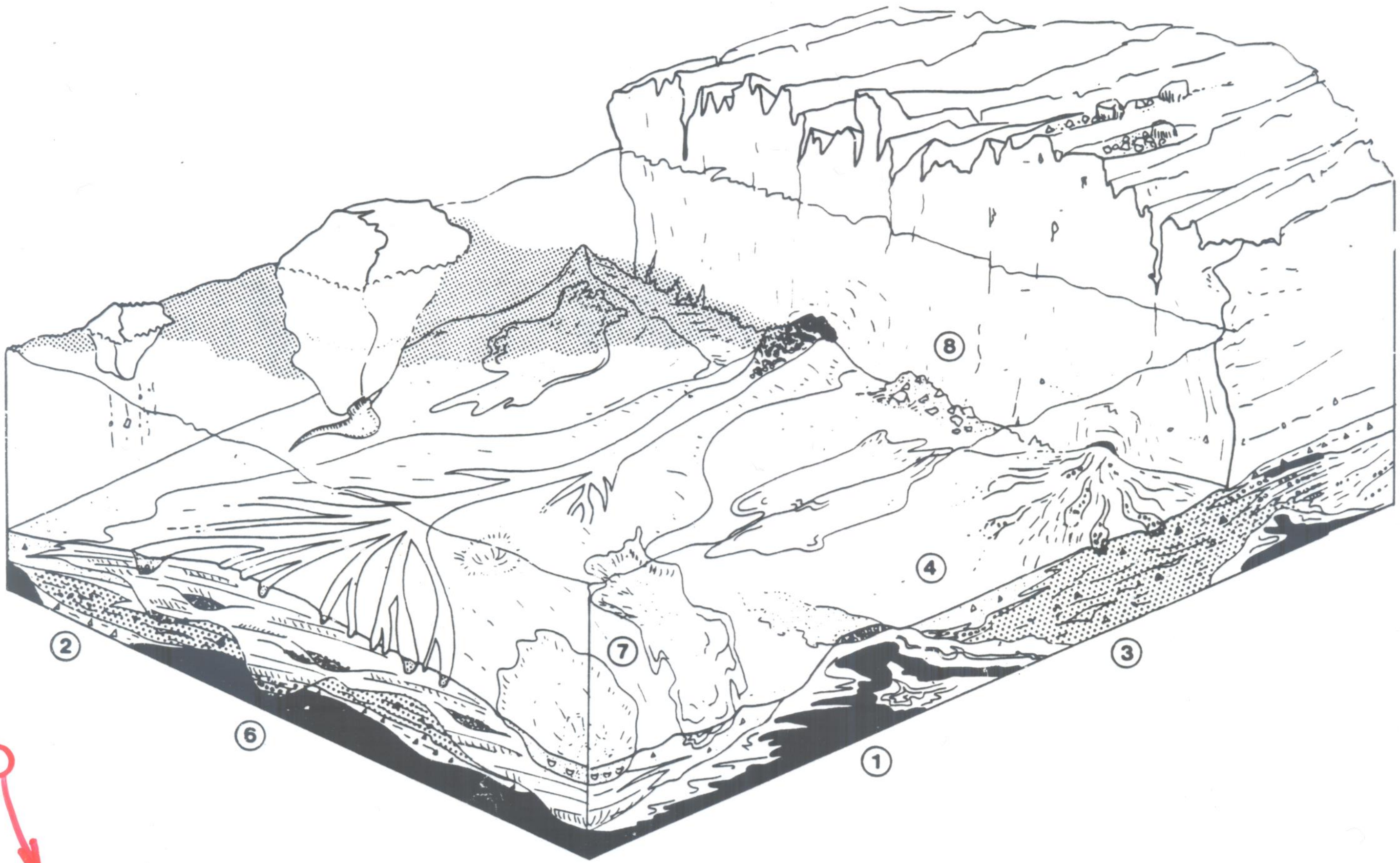
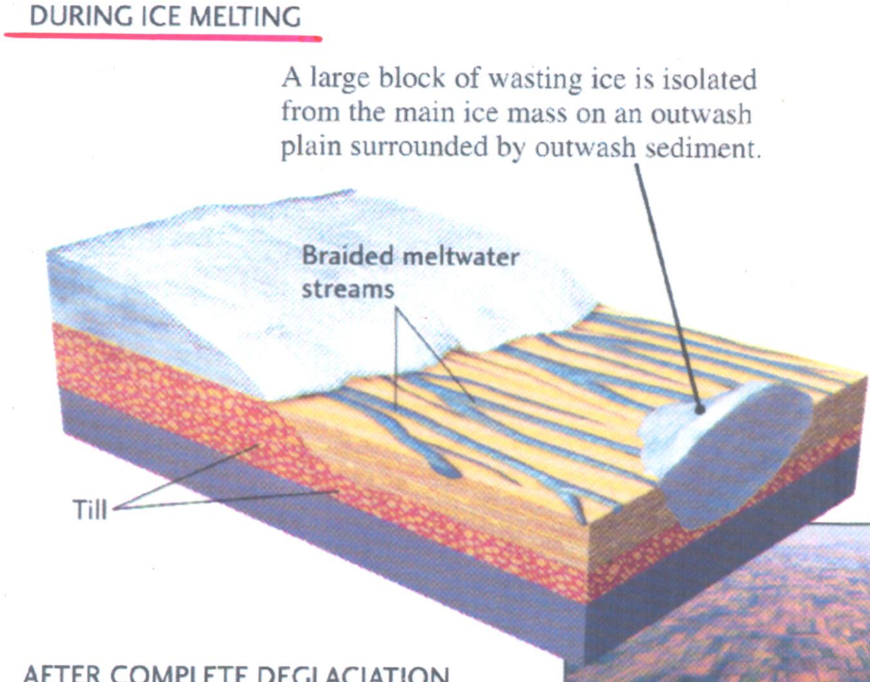


Figure 31 Proximal subaqueous sedimentation. 1) glaciotectonized marine sediments; 2) lenticular lodgment or deformation till units (see Figs. 10 and 14); 3) coarse-grained stratified diamictc (Fig. 32 B); 4) pelagic muds, sandy diamicts, 5) coarse-grained proximal outwash; 6) interchannel cross stratified sands with channel gravels; 7) resedimented facies (debris flow, slides and turbidites); and 8) supraglacial debris. Deformation results from ice advances, melt of buried ice and iceberg turbation. Suspended sediment plumes shown by shading. Same model may apply, with modifications, to sedimentation adjacent to grounding lines below large ice shelves.

Figure 8.14. In this side-looking aerial photo the rounded smooth slope in the upper right (I) is the snout of Woodworth Glacier, Alaska. The narrow, irregular ridge (E) extending outward to a glaciofluvial fan (F) is an esker of recent origin. Its outer part at least was formed at a time when the edge of the ice was up against the glaciofluvial fan, for the sharp, steep slope at the fan's inner edge is an ice-contact face (IC). The esker becomes braided (B) about one-third of the way toward the ice, suggesting that there it was formed near the receding edge of the ice by streams flowing in interconnected ice-walled channels and not in a single ice tunnel. About halfway to the current ice front, the stream was in an erosional mode, and from there back it cut channels (C) into the subglacial floor. The ground-moraine sheet (GM) to the right of the esker is nicely ridged, and at least two of the ridges can be seen to start just to the lee of large boulders (B) near the ice front, just left of the rightmost proglacial lake (L). This splendid picture is a veritable textbook of glacial features. (Photo by Bradford Washburn.)



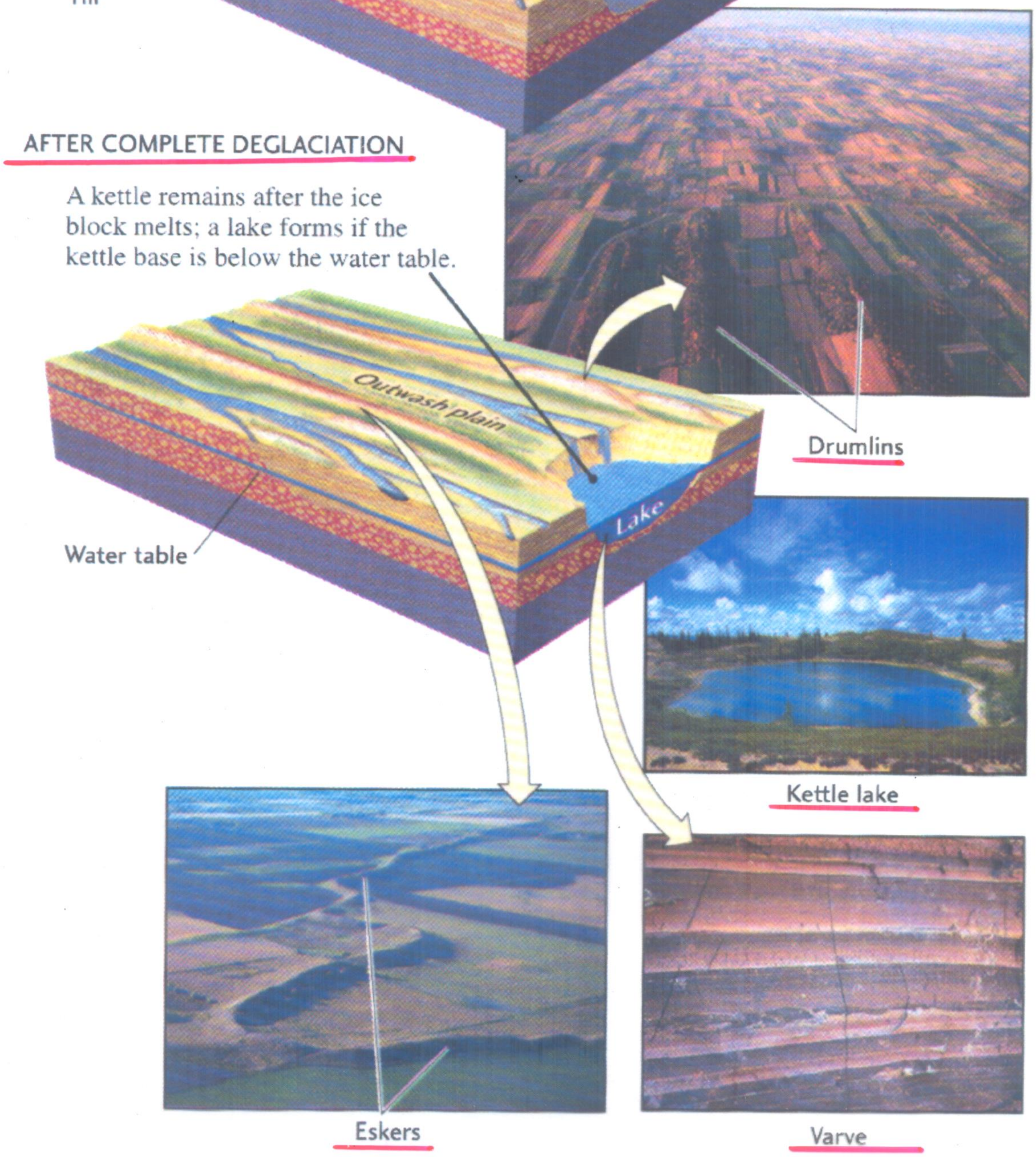


Figure 21.19 Glacial deposits. As a glacier retreats, it may leave behind large blocks of wasting ice that are gradually buried by outwash from the receding ice front, forming a kettle. *Drumlins*, from Rochester, New York. The steep side usually faces the direction from which the ice came, but the reverse is also found. [John Shelton.] *Kettle lake*, near headwaters of the Thelon River, Canada. [Galen Rowell/Corbis.] Pleistocene *varved clay*, from an excavation in Stockholm, Sweden. The light layers are the coarse sediments deposited in a lake during warm seasons. The dark layers are the fine clays deposited when the lake was frozen in winter. [John Shelton.] *Esker:* This sinuous ridge was formed by an ice age glacial stream near Dahlen, North Dakota. [Tom Bean.]

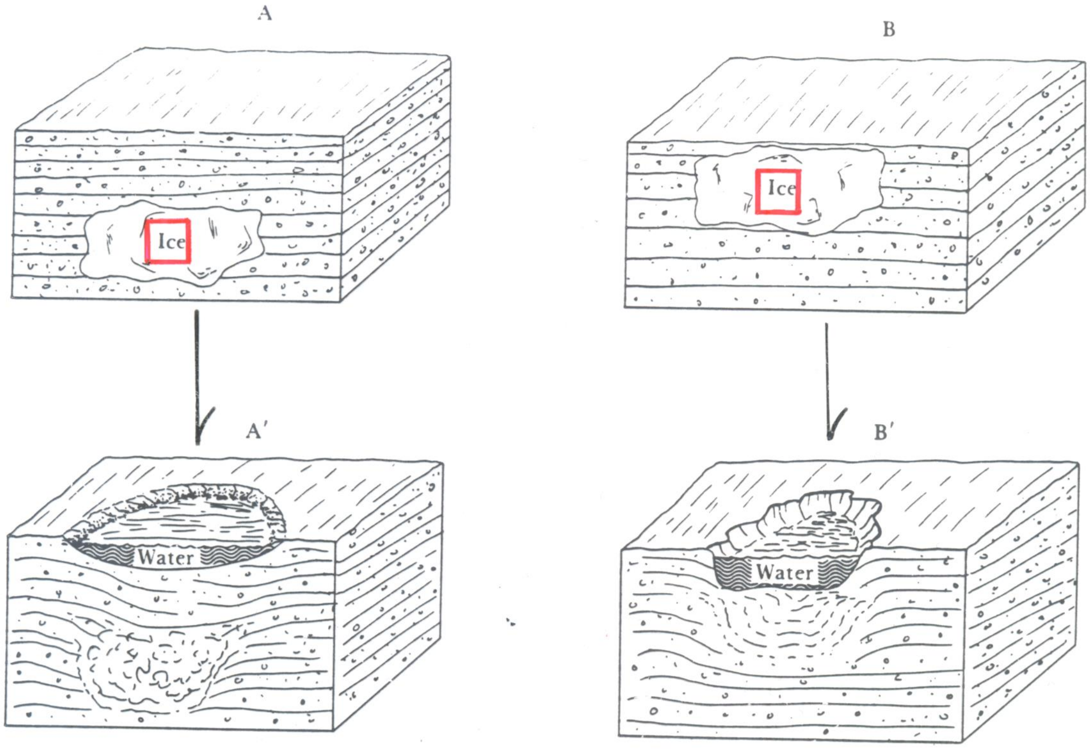


Figure 8.10. These interpretive sketches illustrate differences in the configuration of kettle holes formed by deeply (A, A′) and shallowly (B, B′) buried ice masses. Kettle holes with steeper banks and more irregular outline generally indicate shallow or incomplete burial of the ice.

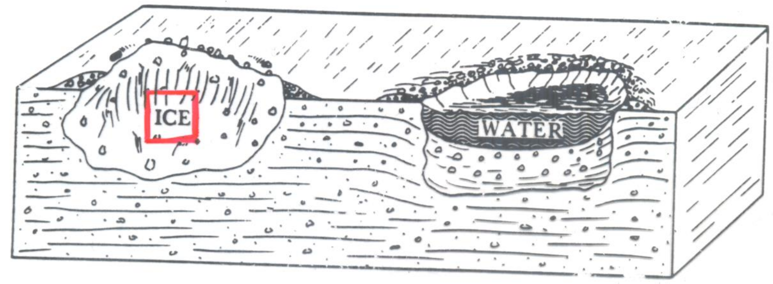


Figure 8.11. The bouldery rampart (right) around the edge of some kettle holes is formed by the shedding of debris from a partly buried block of dirty ice (left).

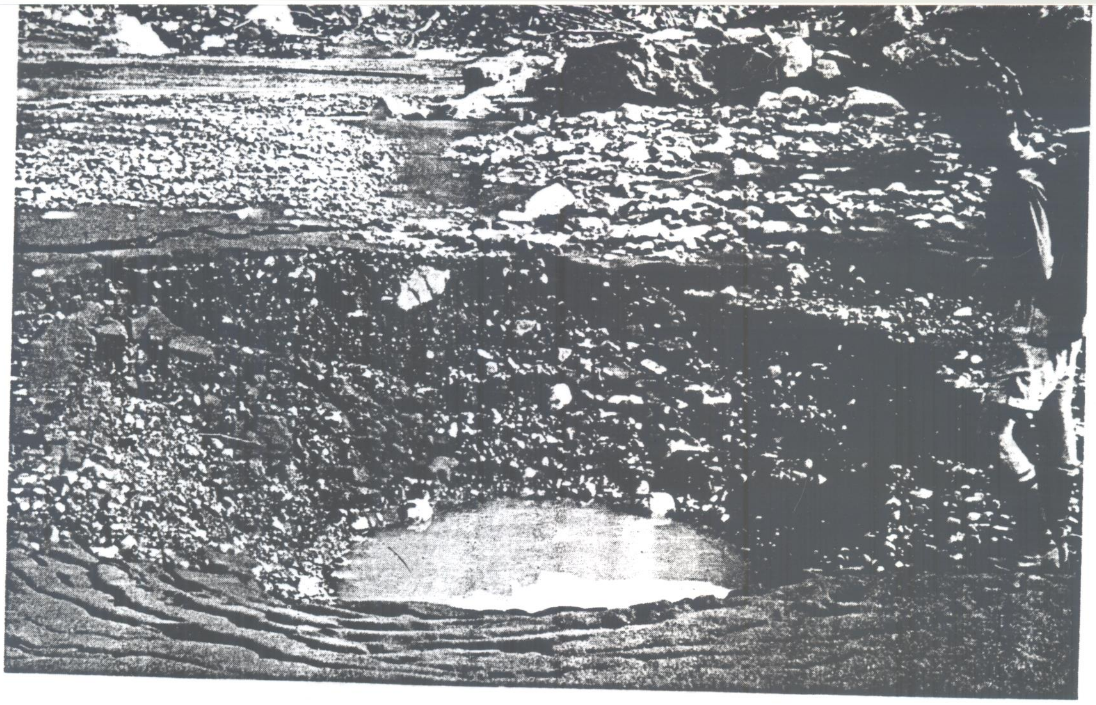


Figure 8.12. A small kettle hole in outwash debris near the edge of Malaspina Glacier, Alaska, formed the day before yesterday, geologically speaking, by melting of a small completely buried block of glacier ice.

ICE FLOW

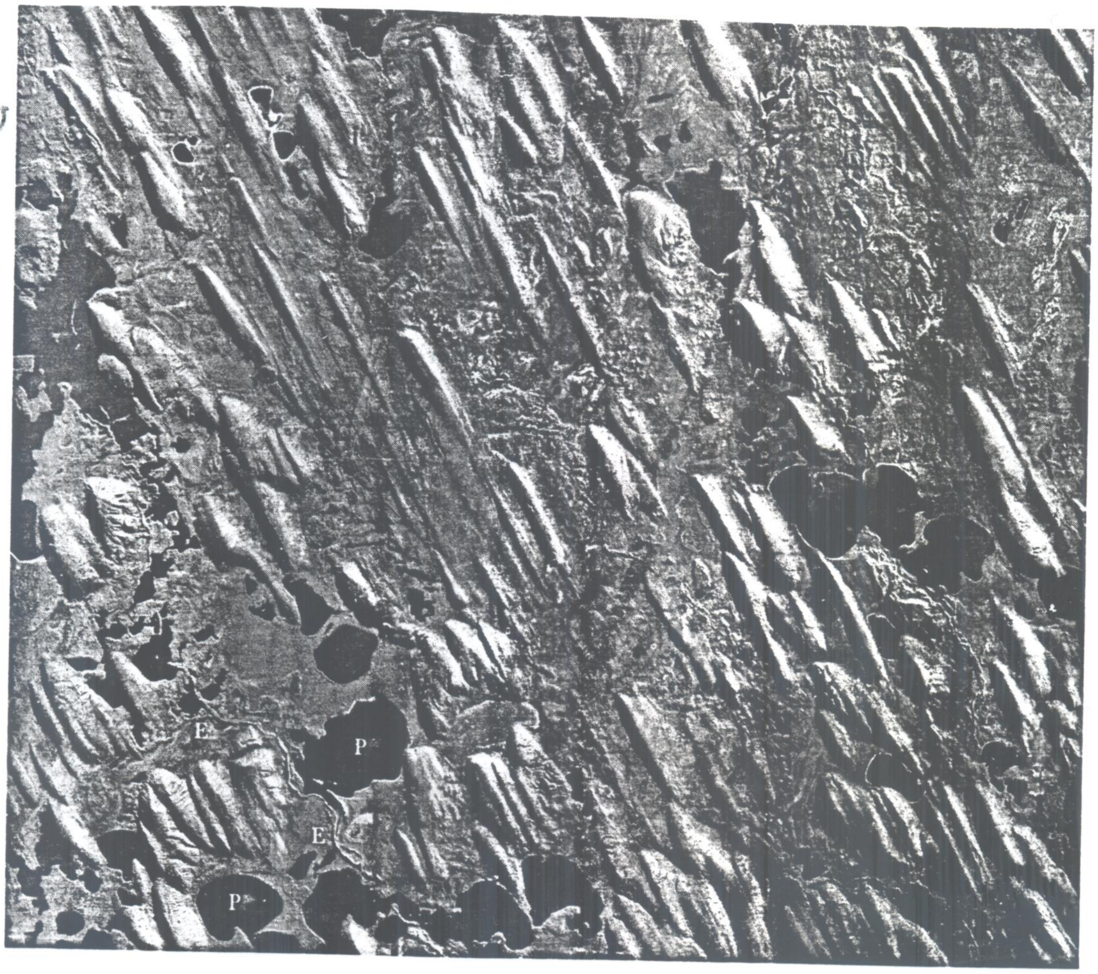


Figure 8.8. A swarm of drumlins in Ontario, Canada, formed by ice moving from upper left to lower right. As drumlins go, many of these are unusually long and narrow, but the classical blunt upstream nose and tapering narrow tail are apparent on most. There can be little doubt that ice moving toward the lower right shaped these hillocks. Several eskers are also shown, the longest and best in the lower left (E). Dark spots are ponds (P). (Photo [A14509 5] reproduced from the collection of the National Air Photo Library by permission of Energy, Mines and Resources, Canada, Her Majesty the Queen in Right of Canada.)

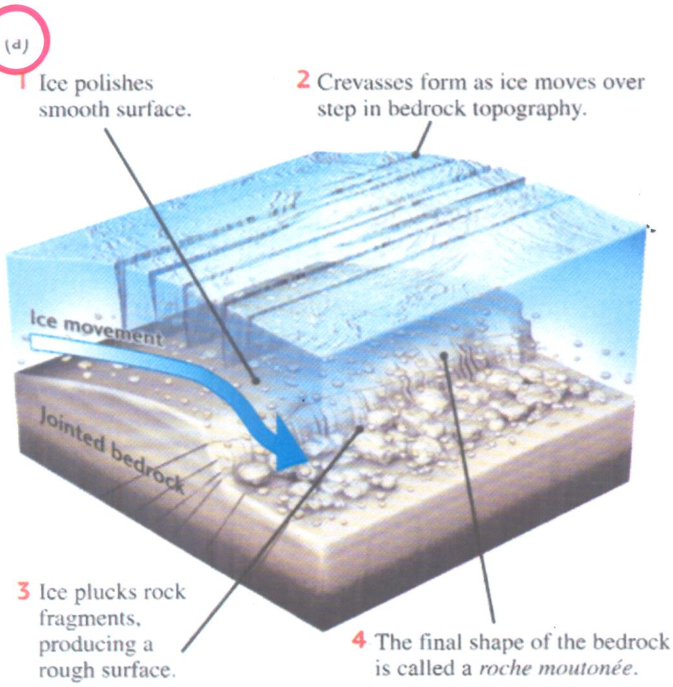
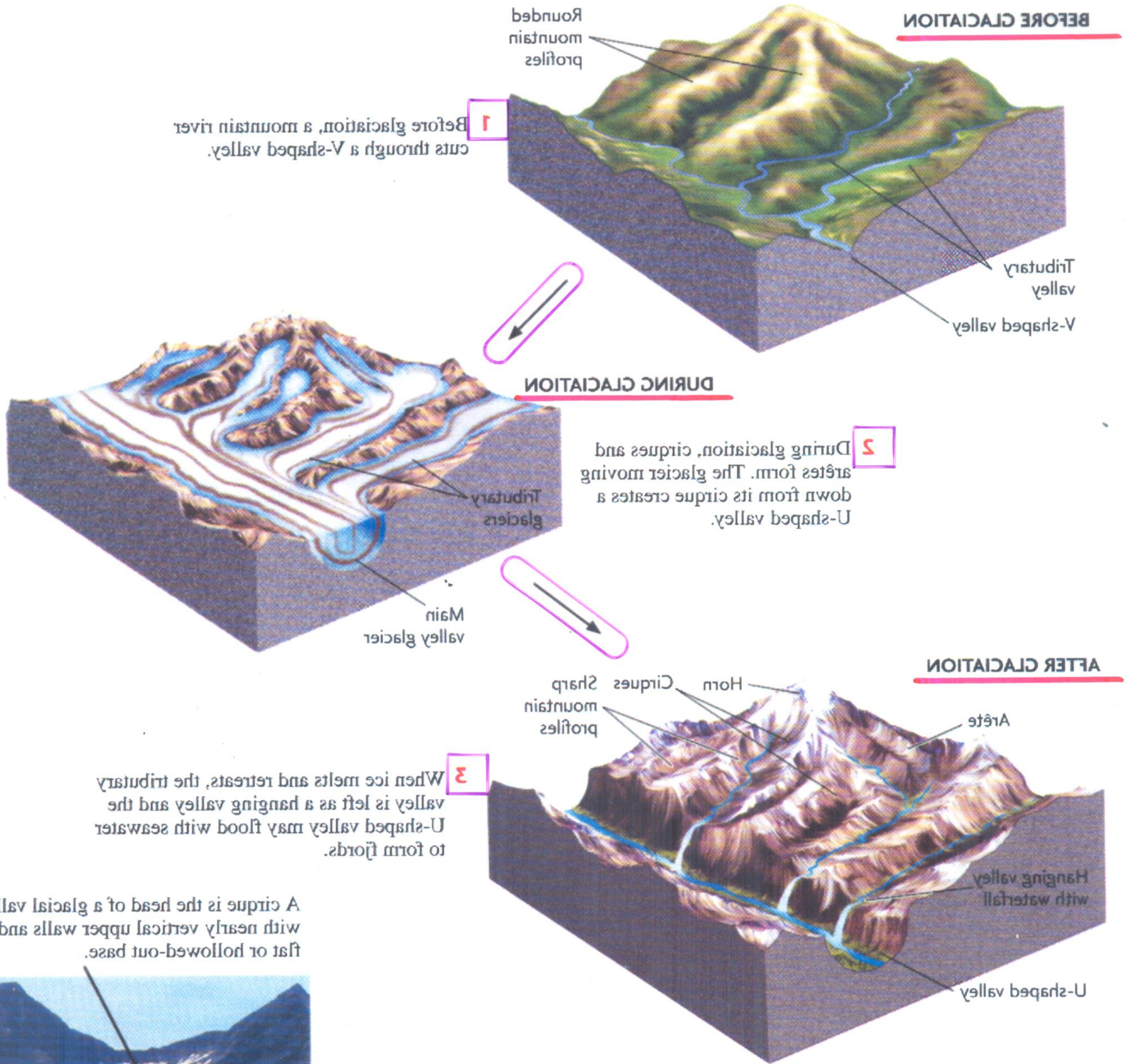
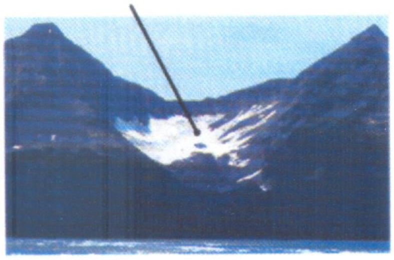


Figure 21.16 (a) A *roche moutonée* is a small bedrock hill, smoothed by the ice on the upstream side and plucked to a rough face on the downstream side as the moving ice pulls fragments from joints and cracks. (b) A *roche moutonée* known as The Beehive rises above Sand Beach at Acadia National Park in Maine. [Robert E. Nelson, Colby College.]



A cirque is the head of a glacial valley, with nearly vertical upper walls and a flat or hollowed-out base.



Arêtes are sharp, jagged crests along an eroded divide.

A glacial valley is U-shaped, with steep sides, hanging valleys, and waterfalls.

A fjord is a U-shaped valley occupied by an arm of the sea.