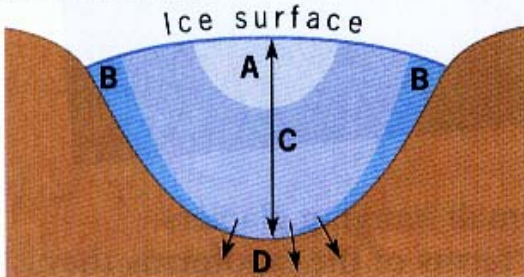


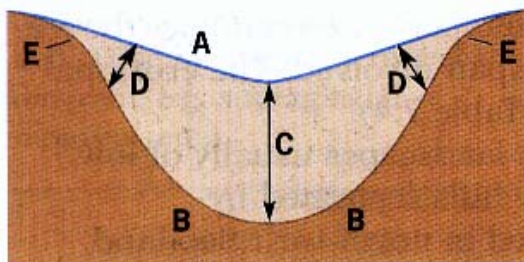
The Formation of a Glacial Trough (U-shaped valley)

a Ice at work



- A Zone of maximum ice velocity
- B Zone of minimum velocity and maximum drag
- C Maximum ice thickness
- D Maximum forces applied

b Impact of valley glacier erosion



- A Pre-glacial fluvial valley cross-section profile
- B Post-glacial valley cross-section profile
- C Greatest overdeepening
- D Minimal deepening and slope retreat
- E Shoulder of overdeepening (break of slope)

most of their lengths, but a shallow threshold or sill at the sea end.

**Friction cracks:** a term used to describe a variety of rock fractures induced by the passage of a glacier over bedrock.

- A) Snow accumulates and the glacier expands down the shallow valley.
- B) Size and weight of the glacier increases, carving out the valley.
- C) As the climate warms, the glacier retreats, leaving a deeper valley.

**Valley Glacier:** a glacier that occupies a pre-glacial valley, either resulting from the coalescence of several cirque glaciers (**Alpine type**) or flowing from the edge of an ice cap or ice-sheet (**outlet glacier**).

**Friction cracks:** a term used to describe a variety of rock fractures induced by the passage of a glacier over bedrock

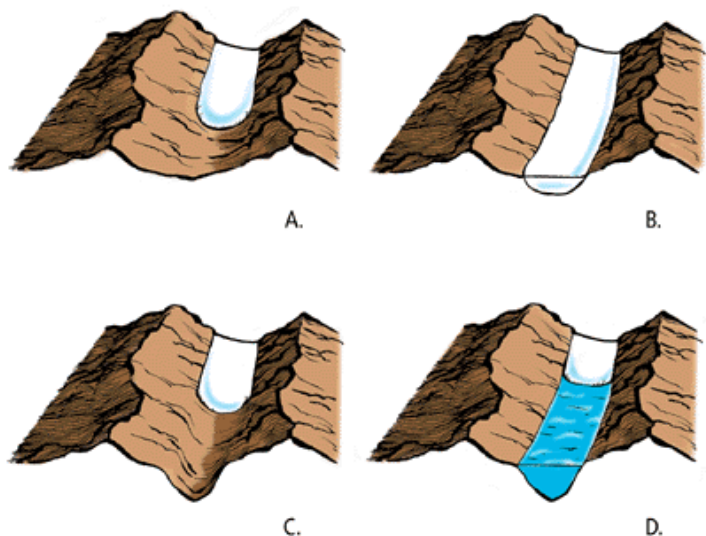
**Glacial trough. U-shaped valley:** a valley that has been over-deepened, widened and straightened by glacial erosion. The valley sides will be considerably steeper than the pre-glacial V-shaped valley. The glacier occupies the entire valley, rather than merely a channel in a river valley. Interlocking spurs are planed off to form truncated spurs and minor irregularities in the valley floor are smoothed out, although reigel bars may form and *paternoster lakes* (finger lakes) may be created. The U-shaped valley may terminate headwards in a trough end or it may form part of a breached divide (*glacial diffluence* or *glacial transfluence*). The valleys sides may be marked with debris fans where tributary streams descend steeply from neighbouring *cirques* or *hanging valleys*.

**Hanging valley:** a tributary valley with a floor that is substantially higher than the floor of a neighbouring glacial trough that has been over-deepened by a greater body of ice. Any river flowing along the base of the hanging valley may fall as a waterfall into the main glacial trough.

**Truncated spur:** a valley side spur that has been abruptly cut off at its lower end by the erosive action of a valley glacier creating a sudden change in slope.

**Finger Lake:** a narrow, linear body of water occupying a glacially over-deepened valley and sometimes pounded by a morainic dam. Many of the Lake District's Lakes exhibit such characteristics.

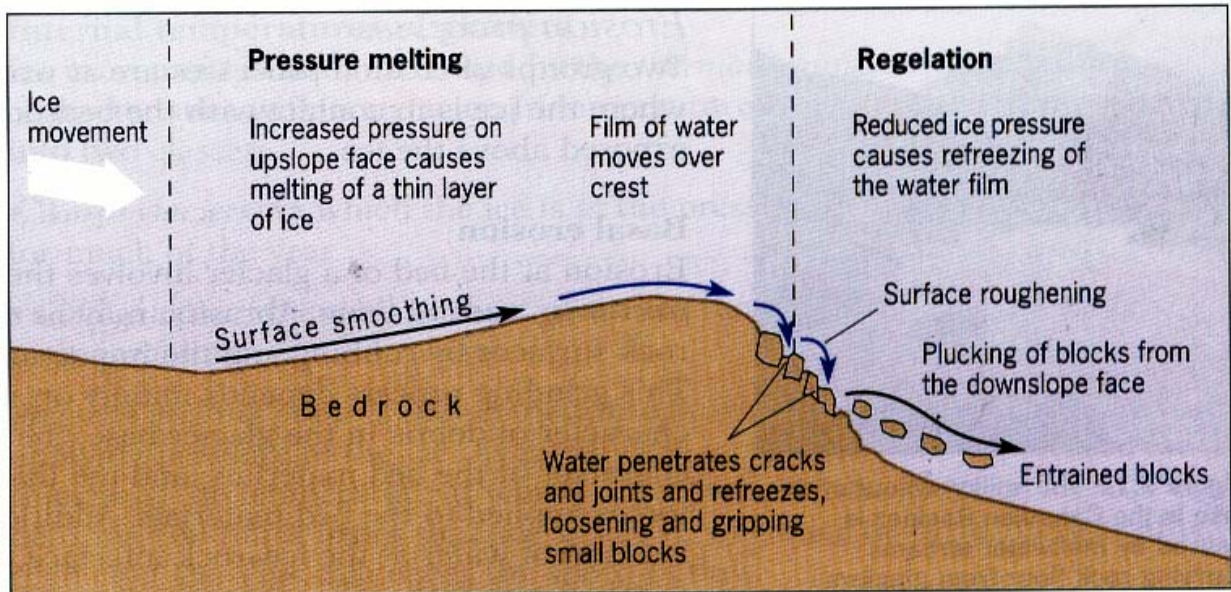
**Fjord:** a long narrow inlet of the sea bounded by steep mountain slopes, which are of great height and extend to considerable depth below sea level. A Fjord is formed by the submergence of a glacially over deepened valley due to post-glacial sea level rise. Fjords have deep water for



**D) As sea level rises, water floods the valley, stopping at the terminus of the glacier**

**Glacial stairway:** a glaciated valley, the floor of which rises upstream in a series of rock steps and alternating, glacially excavated rock basins often filled with lakes. The stairway may be determined by geological structure, with the steps formed in very hard rock such as granite. Modern views regard stairways as being partly formed by glacier wave functions, rather than merely by rock structure.

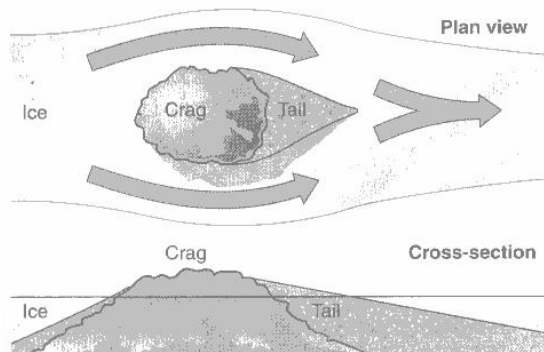
**Roche moutonnée:** a glacially moulded rock with an asymmetrical form. One slope (**stoss** - facing upstream) is gentle and has been smoothly abraded. The other slope (**lee** – facing downstream) has been plucked and is irregular and broken.



**Crag-and-tail:** a topographical feature in which a resistant mass of rock (crag) has withstood the passage of an ice sheet, thereby protecting an elongated ridge (the tail) of more easily eroded rock. In some cases the tail is composed of till which has survived the eroding power of the ice sheet.

**CRAG AND TAIL**

A **crag and tail** is formed when a very large resistant object obstructs ice flow. The ice is forced around the obstruction, eroding weaker rock. Material immediately in the lee of the obstruction is protected by the crag and forms a tail. Edinburgh Castle rock is an ancient volcanic plug whereas its tail is formed of limestone.



**Paternoster lakes:** a series of lakes in glaciated valleys, impounded behind moraines or in rock basins closed at their lower end by rock bars (see *glacial stairway*)

**Ribbon Lake:** a temporary narrow body of water impounded between the front of an ice sheet at its recessional moraines.

**Small Scale Erosional Features:**

**Chatter marks:** Tiny crescent scars on a glacially smoothed bedrock floor. They may be formed by pounding and “kneading” by boulders loosely imbedded in the *basal till*. They should not be confused with *striations*.

**Straitions, glacial straiæ:** tiny grooves or scratches on the surface of an ice-abraded rock, produced by the scouring action of rocks frozen into the base of a glacier.

**Fluting:** a type of corrugation (grooves run parallel to each other) worn on the surface of a rock due to glacial abrasion.

## The Impact of Erosional Landforms on Human Activity

*You must understand both the positive and negative impacts of the landforms on human activity.*

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### Agriculture

#### Advantages

- ❑ Alluvial soils that accumulate in glacial troughs can be flat and fertile. Mechanical cultivation of arable crop such as cereals may be possible, providing the climate is suitable, such as in the Swiss Alps.
- ❑ Some south facing Alpine slopes may be suitable for viticulture.
- ❑ In Nepal, sides of glaciated valleys are terraced and may support arable and pastoral farming.
- ❑ The sheltered, clean water of Scottish sea lochs and Norwegian fjords are suitable locations for commercial fish farming for species such as salmon.

#### Disadvantages

- ❑ Steep slopes, irregular surface and thin, often acidic soils restrict most areas subject to glacial erosion, such as the Lake District, to marginal pastoral farming such as sheep and beef cattle.
- ❑ Access to high areas is usually poor and unsuitable for modern machinery. High areas often attract cool temperatures and high rainfall prohibiting most arable crops and restricting pastoral farming to hardy livestock such as sheep, goats, alpaca (Peru).
- ❑ Livestock in high Alpine pastures have to be moved to more sheltered lowland areas in winter.

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### Settlement and Communication

#### Advantages

- ❑ Glacial troughs may provide sheltered locations for settlements such as Keswick (Lake District).
- ❑ Features such as crag-and-tails have provided good defensible sites for settlements, such as the site for Edinburgh Castle.
- ❑ The heads of sea lochs and fjords provide sheltered locations for small ports and fishing villages such as Trondheim (Norway) and Gairloch (Scotland).
- ❑ Glacial troughs provide route ways through upland areas, such as Glen More in Scotland and the Brenner Pass in Austria, for road, rail or even canal links.

#### Disadvantages

- ❑ Settlement sites and subsequent growth are often restricted by lack of flat land.
- ❑ Extensive agriculture, such as sheep wool farming, can lead to highly dispersed settlements.
- ❑ Steep terrain restricts road, rail and air transport. The construction and maintenance of roads and railways is increased in areas with high relief.
- ❑ Rockfalls and avalanches require specific and costly engineering and management.
- ❑ High snowfalls can leave mountain routes impassable.

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### Mineral Extraction and Energy Production

#### Advantages

- ❑ Glacial erosion can expose, or make accessible, valuable minerals or rocks such as South Wales coal, North Wales slate (in glacial troughs) or Yukon gold (in outwash deposits).
- ❑ Steep sided glacial troughs, sparse population density and high rainfall provide good locations for hydro-electric or pumped-storage power stations (e.g. Fasnakyle (HEP) in Scotland and Dinorwig (PSP) in N Wales.)

- ❑ Glacial uplands in Wales are sites of upland wind-turbine power stations.

### Disadvantages

- ❑ Access is often poor in glaciated uplands.
- ❑ Glaciated uplands are often distant from areas consuming electrical power increasing the cost of transmission.

### **Leisure and Tourism**

#### Advantages

- ❑ Glaciated uplands, such as the Lake District, provide attractive, mountain and lake scenery, which attracts walkers and other tourists.
- ❑ Areas such as the Alps attract people interested in activities such as skiing, snow boarding, rock climbing, and extreme sports.
- ❑ Finger lakes such as Windermere attract visitors interested in water-based activities such as powerboats, sailing, wind surfing and fishing.
- ❑ Some glaciers, such as the Athabasca Glacier in Canada are tourist attractions in their own right.

#### Disadvantages

- ❑ Mineral extraction and energy production may conflict with other uses such as tourism.
- ❑ In environmentally protected glaciated areas such as Snowdonia, the construction of power stations, quarries and electricity transmission lines may be subject to strict planning regulations and restrictions
- ❑ Tourism in glacial areas may be seasonal (summer in the Lake District), winter in ski resorts.
- ❑ Access to glaciated uplands may be poor, particularly for air transport.
- ❑ Winter sports carry risks of avalanche. Evidence suggests that some "off-piste" skiing can help to induce avalanches.
- ❑ Most upland areas have poorer weather than equivalent lowland areas with cooler temperatures and higher rainfall. Seathwaite in the Lake District is the wettest place in England.

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## **THE SYNOPTIC LINK**

For the Synoptic Link, you need to be familiar with the opportunities and challenges that exist in UPLAND AREAS (either glaciated in the past and/or currently active) for:

- ❑ **Tourism**
- ❑ **Energy Production**
- ❑ **Quarrying**
- ❑ **Transport**
- ❑ **Agriculture**
- ❑ **Settlement.**

The emphasis in the synoptic link is on the human activity, not the physical processes. You need to be familiar with a range of activities, linked to the areas you have studied (e.g. Snowdonia, Lake District, Canadian Rockies, etc). You should appreciate the variables influencing the ability of people to overcome the challenges of glaciated uplands, in order to exploit the opportunities. These will include capital, technology and knowledge.

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