

## Unit 4 Exemplar Report Cold Environments

**Note:** These exemplar reports are based on the work of candidates under examination conditions, during the January 2010 examination series. The reports were originally hand written but have been typed up, with diagrams redrawn. Errors, including QWC errors, have in most cases been kept. The aim of these exemplar reports is to highlight good practice and areas of potential improvement. The marking levels and examiners comments given are indicative and should be used as a basis for discussion in the classroom, rather than indicating a specific grade.

### Pre-release research focus:

**Explore** the variety of geomorphological processes and landforms associated with different glacial environments.

**Research** a range of locations including both current and relict glacial environments

**Report title: The variety of glacial landscapes results from distinctive processes.**

### Discuss

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#### Plan

- Processes=Glacial- alpine-polar- fluvioglacial -periglacial ?
- Argument for: Produce landscapes thru process making landforms? Argument against: Equifinality---not distinctive processes?
- Processes=?
- Whats a landscape? Current ?relict—Britain map
- Conclude

#### Section 1 Introduction and focus

The world consists of a variety of glacial landscapes which consist of different landforms created by different processes. The landscape can be in areas which are currently occupied by cold environments (glaciers, ice sheets and fluvioglacial) such as around the Arctic circle above latitude 60 degrees, or the Antarctic, and also the Alps extending through continental Europe. Landscapes can also be seen through relict landforms in areas once covered by ice such as the British Isles. This region had several ice advances during the early Quaternary period (stretching over 2.5m years) with the maximum being the Devensian in the Pleistocene epoch 18,000 years ago. Fig 1 shows how the ice reached as far as London.

Repeated advances and retreats, with periglacial and fluvioglacial processes acting in between glacial ones produced many distinctive but also difficult to identify in terms of processes, features at different scales. This is the concept of equifinality.

This report will assess these features in the British Isles as well as current processes at work in Canada, the Alps and Antarctica today



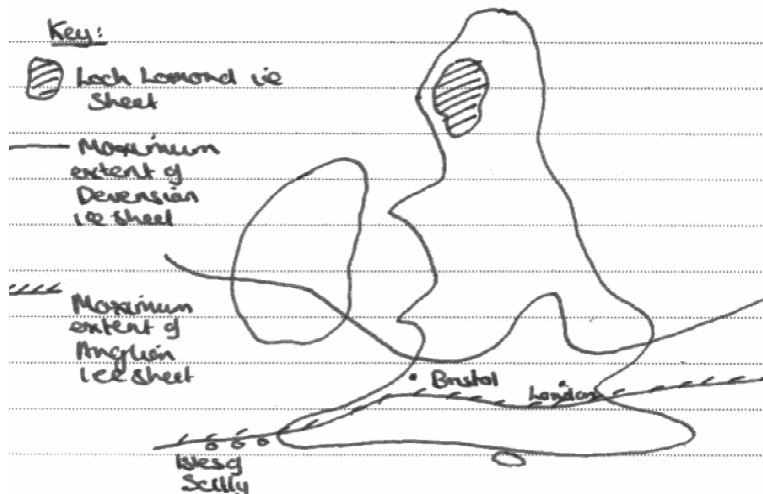


Fig 1 the British Isles showing location of relict landforms(to North of max ice advance line)

## Section 2 Analysis

### 2.1 The processes?

Processes are actions which shape the surface of the earth and many processes occur in glacial landscapes and can be classified into erosional and depositional. The former involves taking material away from an environment, wearing it away and reshaping the landscape whereas the latter, depositional involves the removal of and transport of a material to be placed elsewhere. The different processes can hence be listed as

- Nivation
- Abrasion
- Plucking
- Freeze thaw
- Frost heave
- Dilatation
- Ground contraction
- River processes in/under/at edge of ice

### 2.2 Resulting landforms/landscapes?

The processes occur in different environments, glacial and periglacial. Glacial environments can be subdivided into polar and alpine, and glaciers are masses of ice moving downhill under the influence of gravity. Landforms created in these areas include corries, aretes, pyramidal peaks and drumlins. Fluvio-glacial processes operate under and at edge of ice and produce large features like outwash plains and smaller ones like kettle holes. Periglacial refers to at or near the fringe of an ice sheet and here ground polygons, ice wedges and solifluction lobes are created.

### 3. Glacial processes

#### 3.1 ice sheets or valley glaciers?

Glacial environments result from a mixture of plucking, abrasion and freeze thaw. The landscape depends on whether the ice completely covers it or allows only high ground to be exposed and causes Nunataks. These are currently been formed in Antarctica, and in Britain the Stiperstones are thought to be mountains projecting above an ice sheet in a past glaciation. Plucking occurs when the glacier moves over rock and friction allows meltwater to occur at the base of the glacier. This water then freezes over the rock and pulls it out if jointed or weak and it gets imbedded in the moving ice.

#### 3.2 depositional landforms?

This englacial and subglacial material may eventually be deposited as moraines. A terminal moraine can be seen in Norfolk, where the ice reached its maximum extent before ablation took over. Lowland areas see more depositional forms for obvious reasons. Rocks plucked by a glacier can travel huge distances, and are called erratics because their geology is different to the ground below. The huge metres high Boulder Stone in Borrowdale, in the Lake District, is an example.

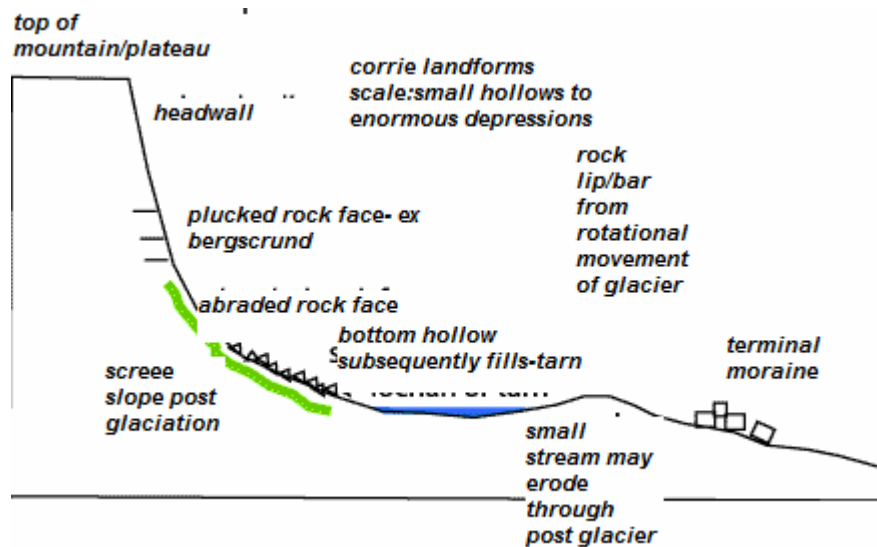
#### 3.3 erosional landforms?

Small scale: Abrasion is a process commonly described as sandpapering and exists at the base of a glacier widening and deepening previous V shaped valleys made by rivers. Striations may be seen on rock faces and help tell us in relict areas the direction of ice flow. Seen in New York state Park USA

Large scale: Freeze thaw is another process. It is a form of weathering which causes fragments of rock to break off. During warmer periods, eg daytime, ice melts and so water can enter fractures in rocks and during a colder time (night time) this water freezes and because ice is 9-10% more of the volume of water, it expands and causes the rock fractures to expand, eventually over time rock fragments will fall.

Freeze thaw is used, along with abrasion and plucking to form distinctive features. Snowdonia was once covered by an ice sheet 20,000km<sup>2</sup>. It made a distinctive landscape such as the North Glydeau region with 15 consecutive corries along the Nant Ffrancon U shaped valley, eg Cwm Idwal. A corrie is an armchair shaped hollow found at the top of a glacier where it forms. Nivation, a process involving the accumulation of snow occurs and glacier ice is eventually formed through diagenesis ( the compaction of snow to form glacial ice which has a density of 0.91) The snow accumulates more until pressure increases and rotational slip occurs forming a glacier to move downhill. The corrie is formed and is deepened by abrasion and plucking, as shown in Fig 2



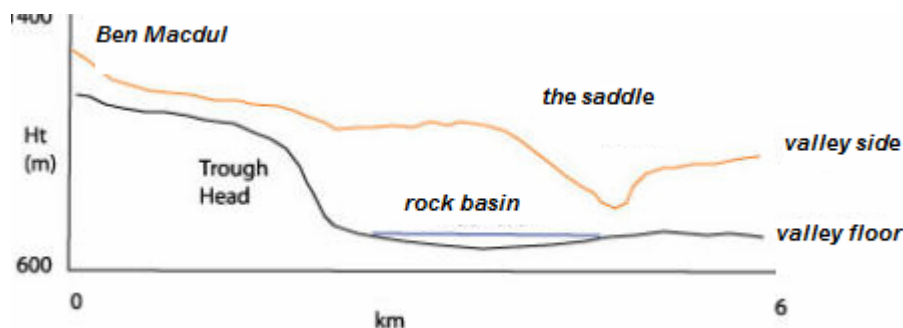


The Mer de Glace glacier in the French Alps has several corries and there are several in the Lake district too, filled in by water to create tarns eg red Tarn. Often they are North facing, about 315degrees because this is where minimum insolation occurs

When two corries erode backwards towards each other by further plucking, freeze thaw and abrasion, a sharp peak is formed called an arête for example striding Edge, in the Helvellyn range in the Lake District. When three or more corries meet a pyramidal peak is created like Snowdonia itself or on a bigger scale the Matterhorn at 4478m

Linton (1963) introduced a useful classification scheme for glacial valleys: Alpine valleys were cut by valley glaciers that were overlooked by high ground. In the Cairngorms, despite valley glaciers operating in the Quaternary, the phases of ice sheet cover mean that no true alpine valleys can be seen. Icelandic valleys form beneath ice sheets from existing valleys, and the preglacial valley is deepened and straightened, often to leave a well-developed *trough head* at the point of accelerating erosion such as Glens Avon and Einich.

Fig 3 shows the scale of the landscape features produced: source: [www.fettes.com](http://www.fettes.com)

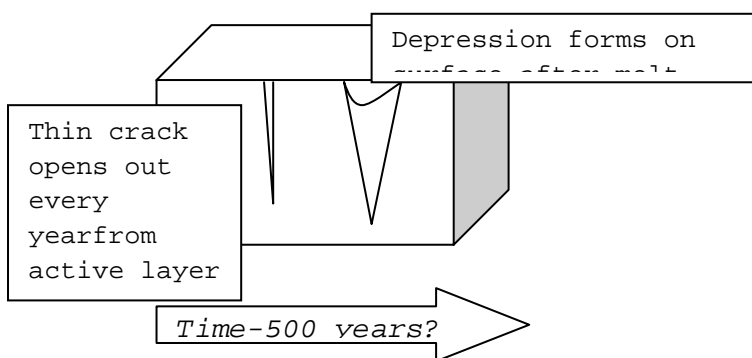


Through valleys like the Lairig Ghru are open at both ends, often caused by glaciers breaching the preglacial watershed.

#### 4. The role of Fluvio and periglacial processes?

The process of freeze thaw also occurs in current periglacial areas such as Alaska and the NW Territories of N Canada. Ice wedges, stone polygons and kettle holes are features. The latter are really part of fluvio-glacial processes since they are formed by stagnant ice breaking off a receding glacier and becoming partially or wholly buried by glacial outwash material. Many are found in the Cairngorms such as Lochan Deo, Glenmore in a complex of eskers, kames and meltwater channels. The size of the present hollow suggests a small original ice block: 100 x 50 x 5 m.

Freeze thaw cycles causes the formation of wedges, eg Oxford. These may be tiny to human size.



Ice wedge polygons are depressions where ice wedges face the land surface upwards. They are very distinctive in Greenland, and the Arctic, as are stone polygons and solifluction lobes.

#### Conclusion

The Lake District, the Scottish Cairngorms and Snowdonia all show evidence of glacial landscapes through a variety of landforms. East Anglia and Southern England also relate to glacial landscapes with outwash plains, dry valleys and erratics. This is due to glacial activity during the Quaternary where processes including freeze thaw, nivation, abrasion and plucking occurred, and so indicates they are distinctive processes for glacial landscapes.

The scale of these processes is staggering: in 2005 Science Daily reported the work of Professor Todd Ehlers in British Columbia, where over 2kms of rock was stripped by glaciers, probably 6 times faster than rivers and landslides did before glaciation

However there is a question over how distinctive these processes are: similar landforms can be created by different processes, called equifinality. There is a debate amongst researchers about the role of glacial, periglacial and paraglacial processes in especially the formation of screes, outwash features and even glacial troughs. The many ice advances and retreats, interglacials and subsequent resumption of temperate river and slope processes means landform are often difficult to pin down to one process only. There is no doubting the scale of glacial processes on the landscapes involved however!

## Bibliography

National Geographic

[www.lake](http://www.lake.district.gov.uk) district.gov.uk

[www.fettes](http://www.fettes)

Ray Mears Northern Wilderness

## **Examiner Comments**

<b><i>Overall summary</i></b>	<b><i>How this could be improved</i></b>
<b><i>Comments on the plan</i></b>  A useful aide memoire- does formulate an argument	Ref to case studies and list of processes to ensure focus on glacial only
<b><i>Comments on introduction, defining and focusing on the question</i></b>  Incomplete definitions (processes) although focused correctly on title of landscape rather than landforms, and introduces good concept of equifinality . Some idea on overlapping glacial/periglacial/fluvioglacial processes  Brief framework given on case studies to be used with some justification	What a distinctive glacial process actually is  This is left till the analysis section but should have been outlined at least in the introduction
<b><i>Comments on researching and methodology</i></b>  Wide range of relevant case studies, factual, accurate  Does refer to the scale of landforms and landscapes; there is a huge difference between a striation and a nunatak, or a U shaped valley and a corrie	Some overlap into periglaciation, not needed in a title which focuses on glacial , could have spent time on more details of glacial instead
<b><i>Comments on analysis, application and understanding</i></b>  High conceptual understanding and cogent argument.  Diagrams used to support answer, particularly good was the attempt at scale	
<b><i>Comments on conclusion and evaluation</i></b>  Strong ongoing evaluation and clearly stated end	Could have returned to some of case studies specifically



statement	
<p><b>Comments on quality of written communication and sourcing</b></p> <p>Coherent structure and sequencing with obvious report style sections. Some mini questions posed which helped to structure report without leading candidate away from main focus</p>	Occasional evidencing/sourcing within report. Vague bibliography at end, would be better to source in an ongoing way, which occurred a few times in the report.

Summary of marking levels awarded:

<b>D</b>	<b>R</b>	<b>A</b>	<b>C</b>	<b>Q</b>
Introducing defining and focusing on the question  (10)	Researching and methodology  (15)	Analysis, application and understanding  (20)	Conclusions and evaluation  (15)	Quality of written communication and sourcing  (10)
<b>L3</b>  6-8 marks	<b>L4</b>  12-15 marks	<b>L4</b>  17-20 marks	<b>L4</b>  12-15 marks	<b>L4</b>  8-10 marks

