Evidence from the deep freeze – under or near the ice sheets
Photographs of glacial and periglacial landscapes

Many parts of the world were once covered by ice sheets or glaciers which have now melted; these are glaciated regions. Nearby areas were not actually covered by ice, but the ground was frozen for much of the year. Such areas are called periglacial areas.
Although the ice melted 10,000 years or so ago and the frozen ground thawed out, there is often evidence preserved in the landscape of what the conditions **were** like at the time.
Imagine that you have been given eight photographs from an old uncle (shown on the final sheet). You know he had travelled widely, but that he never got round to labelling the photographs! Read the information below, and then work out which photographs show a landscape which was formed by an ice sheet or a glacier, and which show landscapes formed in periglacial conditions (near an ice sheet, but not actually covered by it).

Ice sheets and glaciers:
- can carry rock debris uphill as well as downhill;
- pile up curved mounds of rock debris in front of them, which remain behind when they melt;
- dump rock debris beneath them and then can shape it into a series of oval mounds;
- leave rock debris which is a jumble of partly rounded blocks, or ice-scratched blocks, embedded in clay.

Deposition from a modern melting glacier, Athabasca Glacier, Jasper National Park, Alberta, Canada.

In periglacial conditions:
- repeated freezing and thawing can move the particles of the ground, so that it forms polygonal patterns;
- blister-shaped mounds over 40m high may form when water from below freezes and forces up the ground;
- when the upper part of the ground thaws out in the summer, large blocks may slide downhill, over the frozen ground beneath;
- rock debris slides down slopes and leaves a jumble of angular rock fragments embedded in clay.

Modern periglacial patterned ground to the west of Mugi hill on Mount Kenya in Kenya, West Africa.

Two photographs that Uncle did label.

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The back up

Title: Evidence from the deep freeze – under or near the ice sheets

Subtitle: Photographs of glacial and periglacial landscapes

Topic: Using photographs to distinguish between landscapes formed by ice sheets or glaciers and those formed by periglacial processes.

Age range of pupils: 14 – 18 years

Time needed to complete activity: 10 minutes

Pupil learning outcomes: Pupils can:
- examine photographs selectively in order to extract evidence for former environments;
- describe some landscape features formed as a direct result of the action of moving ice;
- describe some landscape features formed as a result of periglacial processes;
- distinguish between the two environments listed above.

Context: This activity can be used to bridge the divide between science and geography in schools. It can be used to enhance lessons on the landscape features associated with an 'Ice Age'.

The characteristics of the deposits formed under or near an ice sheet or glacier may also be studied.

Note that, although the Earth has been subject to a number of 'Ice Ages' in the past, the evidence here relates to the last Ice Age, which began about 2.5 million years ago, with the last ice sheets in Europe and North America melting about 10,000 years ago.

The locations of the photographs are:
GLACIAL FEATURES:-

- e) A terminal moraine of till or 'boulder clay' at the snout of a retreating valley glacier, Jotunheim Mountains, Norway;
- a) An erratic of Silurian age sandstone resting as a perched block on top of younger Carboniferous Limestone, near Austwick, North Yorkshire, U.K.;
- c) A set of drumlins or rounded mounds (sometimes called 'basket of eggs' topography), seen from the Settle to Carlisle Railway, North Yorkshire, U.K.;
- f) Till ('boulder clay') exposed in a river cliff, Borrowdale, Cumbria, U.K.;

PERIGLACIAL FEATURES:-

- d) A pingo in the Mackenzie Delta, Canada, at 69° 24' N, 133° 05'W.;
- h) Polygons in permafrost in Siberia, Russia, at 68° 20' N, 51° 08' W.;
- b) A slipped block in the Rivelin Grit (Carboniferous), Burbage Valley, near Sheffield, U.K.;
- g) 'Head', a mobilised periglacial deposit, exposed in a river cliff, Porter Valley, Sheffield, U.K.

Following up the activity:
Ensure that pupils are aware of the factors which influence the landscapes, as described in 'Underlying Principles'.
In regions which have undergone glacial activity during the 'Ice Age', the landscape of the area around the school may bear evidence of these former conditions. If there is a 'drift edition' of the local geological map it may be possible to spot deposits of glacial or periglacial origin. Pupils could be taken on a local field excursion to examine landscapes and geology at first hand. Pupils could be encouraged to 'fly' with Google Earth and search for other similar features in Arctic or high mountain regions.

Underlying principles:

- Moving ice can carry rock fragments of widely varying sizes, from boulders to fine 'rock flour'.
- When the ice melts, its load is dropped without any sorting of the fragments, resulting in a deposit known as 'till' (or 'boulder clay' in older texts). Boulders are typically embedded in a matrix of clay.
- The snout is the end of a glacier where the rate of melting is equal to the rate of accumulation of ice. It may stay in the same place for a considerable time, when till is deposited as an arc-shaped mound known as a terminal moraine.
- Till that is deposited beneath the ice sheet or glacier is often moulded by the movement of ice above it, to form whale-like shapes, known as drumlins. One end of these is usually blunter than the other. The blunt end points in the direction from which the ice was flowing.
- The exposed ground around major ice sheets may be permanently frozen, termed permafrost.
- Water from below ground can sometimes penetrate the permafrost. It then freezes and pushes up the ground above it. In extreme cases, this produces a circular mound up to 40m or so high, known in the Inuit language as a pingo.
- Repeated freezing and thawing of the ground sometimes leads to the movement and sorting of larger particles, resulting in polygonal shapes of 'patterned ground'.
- In regions where the surface layers of permafrost thaw out in the summer, rock masses may be moved considerable distances down slopes, over the still frozen ground below. This process is known as solifluction.
- Material which has been moved by solifluction is poorly sorted and the rock fragments in it are angular. It is known as 'head'.

Thinking skill development:
Pupils study the photographs to build up a cognitive pattern. Cognitive conflict may occur in matching the properties of the rocks to the postcards. If pupils follow up the activity by relating rock types to other landscapes, bridging skills are involved.

Resource list:

- class sets of photographs of glacial features and periglacial features printed from these sheets.

Useful links: The website of the British Geological Survey contains an extensive library of excellent photographs of landscapes and geological features, and geological map extracts, which may be freely used in the classroom situation. See http://www.bgs.ac.uk/opengeoscience/home.html
Teachers in countries other than the U.K. may prefer to use a search engine to find photographs of rocks and landscapes in their own country and under their own climatic conditions.

Source: Devised by Peter Kennett of the Earthlearningidea team.

Uncle's collection of photographs

a) A huge block of sandstone lying on top of limestone. The limestone underneath is geologically younger than the sandstone. The sandstone block has been moved from an outcrop about 5 km away. (*Photo: Peter Kennett*)

b) A huge block made of the same coarse sandstone as the rocks of the cliff edge in the background. (*Photo: Peter Kennett)*

c) Smooth topped mounds of clay and boulders. The mounds lie roughly parallel to each other. One end of each mound is 'blunter' than the other. (*Photo: Peter Kennett*)

d) A mound about 40m high, rising from a barren river flood plain. (*Photo: © Google Earth*)

e) A crescent-shaped mound of rock debris lying across a steep-sided valley (*Photo: Peter Kennett*)

f) A jumble of partly smoothed boulders and clay, exposed in a cliff. The boulders rest on the clay and mostly do not touch each other (hammer is 25cm long). (*Photo: Peter Kennett*)

g) A jumble of sharp, angular fragments of sandstone mixed up with clay. The scale is 50cm long (*Photo: Peter Kennett*)

h) Patterned ground on a gentle slope, near the coast. (*Photo:© Google Earth*)