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.

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.

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.
**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)

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

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

e) A crescent-shaped mound of rock debris lying across a steep-sided valley (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)

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)

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