Quaternary deposits

These varied deposits, and associated features, were formed during the Quaternary Period of Earth history between about 2.5 million years ago and the present day. The Quaternary Period is divided into two epochs: the Pleistocene which dates from 2.5 million years ago till 10,000 years ago and the Holocene which continues to the present day.

Currently protected sites of Quaternary deposits within the AONB SSSIs

SSSI Name/GCR Name/Grid Ref.

Moorhouse & Cross Fell/Valley bog [NY 763 331]

Upper Teesdale/Upper Teesdale [NY 819 290]

Red Sike Moss

Moorhouse & Cross Fell/Cross Fell [NY 687 344]

In addition, a number of SSSIs in Quaternary deposits are listed in the section on landforms (see Landforms, below).

RIGS

Bullman Hills — North Pennines giant erratics

Other representative sites in the area

River Tees, Cauldron Snout [NY 814 286] — till filling pre-glacial river channel

Haugh Hill, Harwood Beck, Teesdale [NY 859 297] — till exposure in side of drumlin

Knock Pike, Knock [NY 685 289] — cross-bedded glaciofluvial sand and gravel

Coalcleugh Moor, West Allendale [NY 796 446] — Peat

Quaternary deposits in Great Britain

At the start of the Quaternary, commonly called the 'Ice Age', an episode of global cooling resulted in the growth of ice sheets over much of Great Britain and Northern Europe. During the Quaternary, the climate oscillated between colder (glacial) and warmer (interglacial) stages. Approximately 14 stages of alternating glacial and interglacial conditions are believed to have occurred during the Quaternary in Great Britain. However, these are usually difficult to recognise in the sediments preserved today, owing to the destructive nature of the glaciers and ice sheets which removed the evidence of previous glacial episodes. The most recent (Devensian) glaciation terminated around 10,000 years ago. The extensive ice sheets, which in places were over 1km thick, resulted in erosion and modification of the existing landscape. The effects of persistent freeze-thaw action in ground which was often very deeply frozen, and the deposition of a variety of glacial sediments, further modified the pre-existing landscape.

Information derived from interpreting glacial landforms and the nature and morphology of glacial deposits, is essential to understanding the climatic conditions of the recent geological past. It may also provide valuable insights into likely future environmental changes related to possible global warming. Sediments deposited during interglacial periods, though preserved in comparatively few areas, record vital evidence about contemporary environments.

The deposits of the Holocene Period reflect erosion and deposition in a varied succession of environments during much milder climatic conditions. More recent, Holocene, fluvial deposits occur in almost all valleys or river courses. They are transitional, continuing to be affected by the river discharge controlling deposition or erosion of the sediment. These include a wide range of deposits including clays, silts, sands and gravels. Landslips occur in many areas and are not necessarily limited to steep slopes or hillsides. During the Holocene, peat deposits developed both in local topographic lows in the de-glaciated landscape and as extensive expanses of blanket bog over areas of high ground.

The study of Holocene fluvial sediments allows interpretation of the evolution of rivers or streams, including extreme events such as flooding. In places, such deposits may also record the influence of human activities.

Quaternary deposits in the AONB

Quaternary deposits are widespread. They conceal the bedrock in many of the valleys and over substantial areas of hill country. In the North Pennines, as in much of Great Britain, the surviving deposits date mainly from the Devensian glaciation, with only very limited and uncertain evidence of earlier glacial and interglacial stages.

Diagram showing the maximum extent of ice in the British Isles during the Devensian glaciation. Source: Everest (2003) after Boulton et al. (1985)

Detailed mapping of Quaternary deposits in the AONB is incomplete and it is not possible to depict adequately their distribution on a map at this scale. Except for geological mapping undertaken within the past three to four decades, the extent of superficial deposits is significantly under-represented on Geological Survey maps, as older surveys paid most attention to delineating bedrock, or 'solid', geology. The published geological mapping for the country extending northwards towards the Tyne Valley from Alston and Allenheads, including the valleys of the East and West Allen, lacks any depiction of Quaternary deposits, except for some Holocene fluvial deposits. Similarly, the absence of any adequate depiction of the extensive spreads of blanket peat over much of the Moorhouse-Upper Teesdale National Nature Reserve, reflects the late 19th Century vintage of much of the geological mapping here.

A number of topographical features, and the deposits of which they are composed, formed during Quaternary times, are considered below under the heading of Landforms. These include drumlins, moraine, kames and eskers.

Quaternary deposits wthin the AONB include:

Till (or boulder clay) usually consists of a heterogeneous mixture of grey silty clay, with rock fragments ranging in size from gravel and pebbles to boulders: lenses of silt sand and gravel may be present locally. Till cover is widespread, though discontinuous, up to 615m above sea level.

In places, notably parts of Teesdale, Weardale and the Vale of Eden, boulder clay occurs as elongate mounds known as drumlins (see Landforms, below). Till may fill pre-glacial, or buried, valleys (see Landforms, below). On the lower slopes in valleys, cover is generally asymmetrical with deep and extensive cover on valley sides facing away from the direction of ice flow (known as the lee side). This distribution pattern reflects the erosive activity of ice on slopes facing up- glacier. A feature of the till over substantial areas of the AONB is the local origin of many of the boulders within the till. This has been interpreted as evidence of the most recent ice sheets having their sources within the North Pennines, probably within the Cross Fell area.

Moraine is a term which was originally used to define the ridges of rock debris found adjacent to Alpine glaciers. This definition has since been expanded to include the rock debris deposit as well as the landform and is described as morainic drift. Several types of moraine, which reflect both the form and the process by which they formed, may be recognised. In the AONB, morainic landforms include lateral moraines and hummocky moraine (see Landforms, below). Striking examples of morainic drift occur at the foot of Cronkley Fell in Teesdale.

Erratics are boulders or larger blocks of rock, most commonly within till, that have been transported by glaciers and deposited far from their original source. They may therefore provide clear evidence of the direction of ice flow. Within the

AONB erratics of a variety of distinctive Lake District rock types are found, especially to the west of the North Pennine escarpment; erratics from southern Scotland are found in the north, adjoining the Tyne valley and its tributaries. In common with other parts of northern England, the North Pennines includes several striking examples of very large erratics, in some instances over several tens of metres across. These large erratics, or rafts, include the huge slices of Great Limestone which today form the Bulman Hills on Alston Moor and the masses of Dinantian limestones found on Herdship Fell to the west of Petergill Sike near Cow Green Reservoir.

Sand and gravel deposits are found mainly in limited areas on the North Pennine Escarpment. These are bodies of sand and gravel, deposited mainly by braided streams of water discharging from the Devensian ice sheets as they melted. These deposits may take the form of kames or eskers (see Landforms, below).

Peat deposits include both extensive blanket bogs, generally in the uplands, and basin peats. These latter deposits occupy hollows or depressions in glacial drift or ice-eroded bedrock. Generally blanket peat is around 2 metres thick, whereas basin peat may be much thicker. The extensive mantle of peat on Alston Moor, around the headwaters of the rivers Tees and Tyne, and extending up to Cross Fell, comprises one of Europe's largest and most important areas of blanket bog. Internationally important research into a wide range of environmental aspects of peat bogs of this sort, including their biodiversity, conservation and management, is currently being undertaken by the North Pennines 'Peatscapes Project'.

Head is the term used to describe spreads of poorly sorted angular rock debris mantling hillslopes and deposited by gelifluction. This process is the flow of bodies of water-saturated debris over frozen ground and usually only occurs in the uppermost approximately three metres of superficial deposits. Such material is almost certainly very widely present over many hillsides within the AONB, though it has not been separately identified on published geological maps.

Scree and blockfields form as a result of the accumulation of angular rock fragments created by alternate the 'freeze-thaw' process during periglacial conditions. Blockfields accumulate on approximately horizontal surfaces and gentle slopes. Movement of broken rock in soil during prolonged 'freeze-thaw' action may create areas of patterned ground, including stone polygons or, on more sloping ground, stone stripes. Where such broken blocks have been moved by gravity down steeper slopes, accumulations of scree are the result. Examples of these can be seen on parts of the highest North Pennine hills. Scree forming talus slopes and cones are well- developed on the North Pennine Escarpment, especially beneath the Whin Sill outcrop at High Cup Nick.

Holocene fluvial deposits include a variety of sediments, ranging from silts and clays to coarse sands and gravels, which form flat spreads adjoining streams and rivers. Such deposits may accumulate as flat sheets on river or stream flood plains. Fluvial deposits occur in close proximity to all current river channels and some abandoned channels. River terraces are accumulations of similar materials above the modern flood level. They represent accumulations of alluvial material deposited during earlier phases of river development. They record changes in the river conditions and may reflect climatic conditions during Holocene times.

Impact on the landscape

Processes which were active during the Quaternary period have exerted an important influence on the landscape. The most important of these processes undoubtedly date from the major glacial episodes, though it is important to appreciate that, in common with all landscapes, that of the North Pennines remains dynamic and is still evolving.

Over much of the area, extensive spreads of till give rise to rather smooth slopes. The prominent terrace features associated with the cyclical deposits of the Carboniferous limestones, sandstones and shales, locally contrast dramatically with much more subdued rounded till-mantled slopes. The deposition of till, notably in the central areas of the North Pennines, has caused an asymmetrical appearance to valleys such as the Nent and East Allen, with one smooth side and the other well-featured with solid bedrock benches. The 'half egg' shaped hills, known as drumlins, are characteristic of till in parts of Weardale, Teesdale and the Eden Valley at the foot of the North Pennine escarpment.

Complex patterns of glacial drainage channels, in places associated with deposits formed during ice-melting, are prominent on the steep slopes of the North Pennine escarpment.

Extensive areas of peat-covered blanket bog comprise one of the most distinctive, and internationally significant, landscape features within the AONB.

Holocene fluvial deposits form flat ground adjoining rivers and streams.

Impact on biodiversity

Where Quaternary deposits mantle the solid rock the soils reflect the composition of the 'drift' rather than the bedrock. These deposits also influence infiltration of water and the movement of groundwater. Sand and gravel deposits commonly support very well-drained soils in contrast to the poorly drained soils commonly found on spreads of till.

Extensive spreads of comparatively impervious till may have encouraged the development of blanket peat. The North Pennines hosts a major proportion of Europe's total area of blanket bog. Important research into the biodiversity and management of such upland peat bogs is currently being undertaken as part of the North Pennines 'Peatscapes Project'.

River terraces and alluvial deposits support a characteristic flora. Shingles are well - drained and adjoining rivers these areas may be subject to rapid erosion and flooding. Some plant species and communities are dependent on this erosion to suppress competition resulting from choking by faster growing species.

In addition, some fluvial deposits in the AONB support rare metallophyte plant communities including Thlaspi alpestre and Minuartia verna. These are found on gravel bars such as 'The Islands, Alston shingles' SSSI, where the fine sediment contains high concentrations of heavy metals derived both from natural concentrations of mineralisation and from mineral processing waste.

Economic use

Some of the small areas of glacial sand and gravel deposits have been worked as a local source of sand and gravel, particulary near the foot of the North Pennine escarpment. In addition, erratics boulders and clearance stones, derived from glacial deposits, have been employed in drystone walls and vernacular architecture (see Built Environment below). Peat deposits have been worked as a fuel both for domestic use andl for lead smelting.

Wider importance

The Quaternary deposits of the AONB provide important insights into the varied Earth processes that shaped the area during episodes of glacial, interglacial and post-glacial conditions. The importance of some of the area's Quaternary deposits in contributing to understanding of comparable deposits elsewhere in Great Britain and beyond is recognised in the designation of a number of GCR sites.

Conservation issues

Because most of the Quaternary deposits within the area comprise unconsolidated, or comparatively easily eroded, materials, permanent exposures are uncommon. Sections through these materials, in stream banks or in quarry faces typically degrade rapidly or soon become vegetated and obscured. Permanent exposures are few and generally difficult or impossible to maintain.

One of the most widespread, and internationally most significant, of the area's Quaternary deposits is the extensive covering of hill peat that mantles many of the interfluves. This very recent geological deposit has much to contribute to the understanding of past and present environments which may offer valuable insights into future environmental management. In addition, the blanket bogs of the North Pennines comprise a major proportion of the European resource

of this unusual habitat. Internationally important research into a wide range of aspects of peatland environments, biodiversity and management is currently being conducted through the North Pennines AONB 'Peatscapes Project'. An important facet of current peatland management is the programme of blocking of drainage ditches (grips) to assist in restoring conditions favourable for preservation and re-establishment of peat formation.

Selected references

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Figures

(Figure 46) Diagram showing the maximum extent of ice in the British Isles during the Devensian glaciation.

(Figure 47) Boulder clay in river bank, Haugh Hill, Harwood Beck,Teesdale © B.Young, BGS, NERC.

(Figure 48) Large limestone erratic, Herdship Fell, Teesdale © B. Young, BGS, NERC.

(Figure 49) Pre-glacial channel of the River Tees (in background) Cauldron Snout © B.Young, BGS, NERC.

(Figure 50) Peat overlying boulder clay, Plenmeller Opencast Coal Site © BGS, NERC.

Full references

Diagram showing the maximum extent of ice in the British Isles during the Devensian glaciation.

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