Rocks and Landscapes of Todmorden Moor

W YORKSHIRE GEOLOGY TRUST

Todmorden Moor is an upland plateau moor with an altitude of about 350 to 400m, reaching a high point of 441m at Carr and Craggs Moor. It lies between Cliviger Gorge to the north and Dulesgate to the south, with steep slopes down towards north and east into the Calder valley.

The Moor is cut by five different sandstone beds which run roughly north-south. These are of Upper Carboniferous (Yeadonian and Langsettian) age. The sandstones are exposed in Flower Scar Road and on small exposures on the moorland. There are good exposures in two disused quarries close to the Bacup road (A681).

Between each sandstone bed lie mudstones which contain a total of seven coal seams, which have been extensively worked on the Moor. Mudstones are exposed in some of the small gullies in the moorland, as well as in the spoil tips and along the line of the old tramway. Many of the spoil tips on the mine yield fossils within carbonate nodules. The coal seams and associated mudstones are an important source of **coal balls** (nodules containing beautifully preserved plant fossils) which are of great importance in the study of palaeobotany.

The Moor is covered with peat deposits which started to form during the Atlantic climatic period about 7000 to 5000 years ago, when the climate was particularly cold and wet.

Geological sequence

The oldest rocks on Todmorden Moor are the beds of the Holcombe Brook Grit (Marsdenian), going up through the Yeadonian Rough Rock to the Coal Measures Woodhead Hill Rock (Langsettian), which outcrops around Flower Scar Hill, followed by the Milnrow Sandstone, with the younger Dyneley Knoll Flags seen in the west of the area. There is a general dip of about 10º-12º to the west or west-south-west. A simplified version of the sequence is shown below.

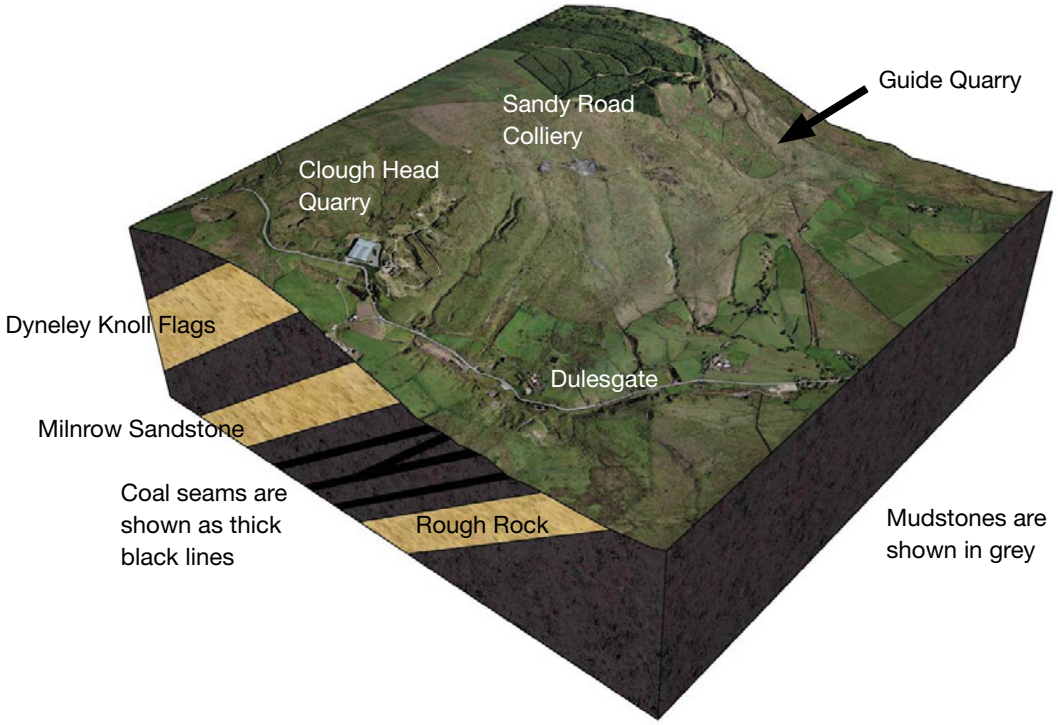
Sandstone is a sedimentary rock which is made up of sand grains. The sand grains are formed by the breakdown of pre-existing rocks by weathering. The composition of sandstone can vary, as a large number of different minerals may occur within the sediment which makes up the rock. The most common mineral

The Watershed Landscape Project Area

Railways and stations

Pennine Way

Pennine Bridleway



The track leading onto the moor from Clough Head Quarry exposes trough bedding in the Milnrow Sandstone, showing that the sandy sediments were deposited in river channels.

is grey **quartz** which is very resistant to weathering. **Feldspar** is a cream or white mineral and **muscovite mica** is white and reflects light like a mirror. Both minerals are hard to see in sandstone without using a hand lens or a magnifying glass.

For the sediment to develop into sandstone, it must be **compacted** to drive out water and the sand grains must be **cemented** together by other minerals. Quartz, calcite and iron oxides are the most common cementing minerals for sandstone. They are deposited in the spaces between the sand grains by water, and over time these minerals fill up the spaces by crystal growth. Iron is usually present in the cement, so that sandstones take on a reddish, yellow or brown colour.

There are several beds of sandstones of different ages on Todmorden Moor. The Holcombe Brook Grit is seen in a small exposure at Guide Quarry (SD 912 251). The Rough Rock is exposed in Flower Scar Road at SD 905 247 where it is seen as a very coarse grit and there are also low exposures of Rough Rock on the ridge to the south. The Woodhead Hill Rock is seen in Flower Scar Road at SD 903 248 and is a medium grained sandstone with flaggy bedding.

The Milnrow Sandstone is best seen in the eastern walls of the large quarry at Clough Head, to the east of the TEG composting plant. The lowest exposure is of an extensive bedding plane of yellow sandstones dipping at 10° towards the south-west, containing cross bedding with some scoured bedding planes. In the quarry face above, which is about 8m high and 100m wide, there are trough channels seen, the plan views of which are beautifully exposed in the quarry tracks.

The top quarry has siltstones interbedded with sandstone in its eastern face. The Milnrow Sandstone is capped with fireclay in this area, so probably the western sections of these quarries were exploited for this resource, though there is no exposure at present. The Dyneley Knoll Flags were exploited in a quarry at the west end of Flower Scar Road.

Mudstone (often called **shale**) is a sedimentary rock which is made of clay particles. **Clay** is defined as the finest grade of sedimentary particles and can only be observed through a high powered microscope. Clay particles commonly form as breakdown products of feldspars and other silicate minerals. The small size and plate-like shape of clay particles means they remain in suspension in water currents in lakes, rivers or seas and are only deposited when water flow is extremely slow-moving or stationary. Over time, clay builds up and is compressed into beds less than 1cm thick, called **laminations**, and forms a solid rock which can be grey or black (if the rock has a high carbon content).

Mudstone in a gully on the west slope of Todmorden Moor.

Calcareous concretions found on a spoil heap at SD 901 244.

The mudstones on Todmorden Moor often contain **calcareous nodules**. These are made of calcite which has soaked through the mudstone. The nodules often contain fossils of shells of sea-creatures, in particular goniatites. **Goniatites** are coiled sea-shells and are the ancestors of ammonites found in the Jurassic and Cretaceous periods.

A calcareous concretion found on Todmorden Moor, with a small goniatite next to it.

The fossils found in calcareous nodules are beautifully preserved because they are not crushed, as fossils usually are when they are found in rocks which have been compressed. These concretions should not be confused with coal balls, which have plant fossils in them, rather than marine fossils.

Carboniferous times

In late Carboniferous times about 315 million years ago, the area which is now Britain was a lowland plain which enjoyed a hot, wet tropical climate, with mountains lying to north and south. Large rivers flowed from the north-east into the lowlands, which were periodically flooded by shallow seas. Sea level altered frequently because of glacial fluctuations in the ice-sheet which lay over the South Pole.

Channel sandstones

Sediment brought down from the mountains by rivers was deposited in estuaries or on the tops of deltas, in an environment similar to the present-day Mississippi or Ganges deltas.

Wide, shallow river channels flowed between sandbanks, surrounded by flat plains which were occasionally flooded when rainfall was very high or snow melted in the mountains to the north. Because the climate was warm and rainy, forests grew on the surrounding lowlands, so sometimes tree branches drifted onto sandbanks, carried by rivers in flood.

This photo shows a river in the Amazon Basin showing the sands and muds being deposited on the channel banks, surrounded by forest. The sands that form the Upper Carboniferous Millstone Grit sandstones were typically deposited in these large channels, which is why they often contain plant fossils. However, most of the forest plant species were unrelated to plants today, so the forests would have looked very different.

Surrounding the river channels were low lying areas with lakes, marshes and lagoons. The mudstones (shales) were deposited in the still waters of marshes and mires and were covered up from time to time by sand brought into the lake by floodwaters, which now form the sandstone beds.

Coal and fireclay

The mudstones on Todmorden Moor include many **coal seams**. When the tropical forest branches and leaves died, they fell into stagnant water where they decayed slowly, forming a black organic mud. After time, other sediments were laid down on top of the carbon-rich mud, as river channels brought down more sand. Water, oxygen and hydrogen were driven out of the plant remains by the weight of water and sand. Carbon from the plants remained to form coal seams.

Layers of yellow/grey clay are often found above and below coal seams. These deposits are called **fireclay** and they formed from the soil layers in which grew the trees and ground vegetation that formed the coal. The rocks on Todmorden Moor have thick layers of fireclay below coal seams and these have been exploited to make refractory bricks for furnaces.

Coal balls

Coal balls are limestone concretions, which are not made of coal, but are found in coal seams. They are made of peat found in Carboniferous forests which was covered in calcium and magnesium carbonates in sea water before appreciable compaction or alteration took place. The plant remains in the peat were turned into hard calcite (**permineralised**) and each separate cell was preserved, giving an exceptionally preserved fossil plant assemblage. Coal balls therefore preserve plant structures in superb detail, including spores and cells.

Since their discovery in 1855 in the coal seams of Yorkshire and Lancashire, they have been described in up to 200 localities world wide. Palaeobotanical research using coal balls continues at present. It has been commented by present researchers that ‘coal balls provide a unique opportunity to study the biology and ecology of those plants which inhabited the coal swamp environment.’ (Scott and Rex p124).

Coal balls in Lancashire and Yorkshire are only found associated with two coal seams. The Upper Foot Coal (called the Bullion Mine after the rounded

A thin layer of pale fireclay can be seen under the 8cm scale card in this photo taken at Dimples Quarry, Haworth.

Coal ball from Sandy Lane Colliery, Todmorden Moor.

Coal balls can be found on the spoil tips at the Sandy Road Colliery site on Flower Scar Road and on the tramway line nearby. If you find any coal balls, they should be passed on to a museum or to researchers, as research on these fossils is continuing.

concretions or bullions found in it) is a persistent seam in the Lancashire coalfield and is the equivalent to the Halifax Hard Bed coal of the Yorkshire coalfield. The Upper Foot Coal combines with the Lower Mountain Coal to form the Union Coal, in the Dulesgate area of Todmorden Moor. In parts of these two seams, there are abundant coal balls and concretions but elsewhere they are completely absent. In West Yorkshire they have only been found commonly in the Dulesgate area, which includes the Todmorden Moor colliery at Clough Foot and the Saunder Clough and Clough Head collieries, all now disused.

James Lomax, the son of a colliery manager from Bury, Lancashire, worked for 20 years in local mines during which time he developed an interest in using microscopes to study thin sections of coal balls and became an expert in fossil plants. He provided many thousands of thin sections of coal balls to university researchers, particularly W C Williamson at Owens College, Manchester and many other academic researchers in later years. Thin sections from coal balls made by James Lomax can be found in several museum collections.

Marie Stopes (later famous for her work on birth control) and D M S Watson wrote a scientific paper in 1908 in which they analysed the distribution of coal balls within and around the coal seams. They found that coal balls within the coal seams represented the swamp vegetation itself, whereas calcareous concretions, which were often found in the marine mudstones above a coal seam, represented plant material which had drifted from nearby areas and been fossilised in non-swamp areas and often include animal fossils.

Scott and Rex (see reference below) studied coal balls from sites in Lancashire and Yorkshire, as well as from Belgium, the Netherlands and the USA. The British coal balls were mostly obtained from spoil tips in the Burnley area in Lancashire, but coal balls from Clough Foot Colliery on the edge of Todmorden Moor were also used. Coal balls appear to be abundant in coal seams in the USA and the former states of the USSR, but rare elsewhere. This enables researchers to try to establish the conditions in which they formed, which remain obscure (Scott and Rex p134). Research into coal balls is continuing in many parts of the world.

History of mining and quarrying on Todmorden Moor

There has been very extensive coal mining on the Moor. The sites of at least four mines probably drift and shaft mines, with associated spoil tips, are still visible. Clough Head Colliery, on the site of the present quarry in Dulesgate, mined the Upper Foot Coal and the Lower Mountain Coal seams (called the Half Yard Coal in 1896) as did the nearby Todmorden Moor Colliery at Clough Foot and the colliery at Saunder Clough. An old tramway from Sandy Road Colliery to an unnamed mine to the north has yielded many fossils in nodules from the waste material. At Saunder Clough in Dulesgate there was a fireclay works which produced bricks.

Quarrying of sandstone has also taken place and there is a very large disused quarry at Clough Head on the south side of the Moor in the Milnrow Sandstone. The place name Slate Pit Hill in the west of the area shows that the Dyneley Knoll Flags were extensively worked, including in a large quarry at the western end of Todmorden Moor. A stone crusher was located at Guide Quarry at the east, which worked the Holcombe Brook Grit. Bacup Natural History Society removed the grinding-stone and floor for safe-keeping but the depression in the ground is still visible.

Acknowledgements

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http://www.todmordenmoor.org.uk/geology.html

www.wyorksgeologytrust.org

Useful maps

OS SHEET 1:50,000 Landranger 103 Blackburn and Burnley

OS SHEET: 1:25,000 Explorer OL21 South Pennines

British Geological Survey 1:50,000 Geological Sheet 76 Rochdale

Further reading

Minerva Heritage Ltd, 2013, *Riches of the Earth: Over and Under the South Pennine Moors*, Pennine Prospects

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www.wyorksgeologytrust.org

West Yorkshire Geology Trust (WYGT) is part of a national network of groups which are actively conserving important geological features. These sites include rocky crags, active or disused quarries, railway cuttings and stream beds. Important sites are called Local Geological Sites (LGS) and there are about 80 in the county. The Todmorden area has five LGS sites, at Gorpley Clough, Great Bride Stones, Green's Clough, Paul and Pudsey Cloughs and Todmorden Moor itself. For further information on each site, look at the West Yorkshire Geology Trust website at http://www.wyorksgeologytrust.org/sitescalderdale.html. West Yorkshire Geology Trust aims to encourage public enjoyment of rocks, fossils and landscapes and link geological features with the local industrial heritage. WYGT also maintains a database of Local Geological Sites and encourages landowners and managers to participate in good site practice and management

This leaflet has been produced with support from the Watershed Landscape Project, a three year Heritage Lottery Funded project managed by Pennine Prospects to enhance and conserve the South Pennine upland landscape and its heritage, whilst improving access for all.

The aims of the project are to protect the internationally important natural and historic features of this special landscape and to encourage greater understanding and enjoyment of the area so that it is further valued and protected. The project has been telling the fascinating stories of the moors by offering opportunities to get involved in local heritage projects, delivering moorland conservation initiatives, developing resources to help people explore the landscape, hosting exciting events and activities, and working with artists and writers on an original creative arts programme.

For more information about the Watershed Landscape Project please visit **www.watershedlandscape.co.uk**