Rocks and Landscapes of Gorpley Clough, Todmorden

W YORKSHIRE GEOLOGY TRUST

Gorpley Clough, near Todmorden, West Yorkshire (SD 914 233) is a very attractive, steep-sided valley, into which the river has incised a gorge with many small waterfalls. There is a footpath which runs up the clough as far as Gorpley Reservoir and returns on the north side of the valley.

Gorpley Clough is a Local Geological Site (LGS) and also a Local Nature Reserve. The site is a fine example of a Pennine clough containing deciduous woodland with many species of flowers, mosses and ferns. The views from the top of the valley towards the moors are spectacular.

There is a small car park at SD 918 237 adjacent to the track leading up to the clough. A geological interpretation board has been installed at the car park. The footpath up the clough is a right of way and footpath improvements by Calderdale Council have improved access and safety.

Hazards in the clough include uneven paths, slippery bridges, steep slopes, falling trees, rock faces and landslips. It is dangerous to enter the mine adits (tunnels) as they are liable to collapse.

The clough acts as an overflow for Gorpley Reservoir whenever the water rises above a certain level. The water flows through pipes rather than the overflow from the dam, so it is not possible to tell when this will happen. The water flow in the stream can increase twentyfold without warning and unpredictably, which may be a hazard to anyone standing in the stream. The discharge can occur even when the weather has been dry. Yorkshire Water can be contacted by phone for information before visiting the site.

Rocks in Gorpley Clough

The rocks in the clough are the Millstone Grit Group of Upper Carboniferous (Marsdenian) age, approximately 315 million years old. The **sandstones** and **mudstones** form a series of cascades and waterfalls in the clough below Gorpley Reservoir.

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

A fresh piece of sandstone with orange bands of iron oxides.

Mudstone with laminations exposed by a tree fall in the upper part of Gorpley Clough.

Regular bedding in the Fletcher Bank Grit at the lowest waterfall.

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.

Some sandstones are called **grits** or **gritstones** because their sand grains are large and angular, which gives the rock a gritty and rough texture.

For the sediment to develop into sandstone, it must be **compacted** to squash water out and the sand grains must be **cemented** together by minerals. Quartz, calcite and iron oxides are the most common cementing minerals. They are deposited in the spaces between the sand grains by water moving through the sediments 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, when the rock is freshly broken.

The sandstones in Gorpley Clough are, from oldest to youngest, the Fletcher Bank Grit, the Guiseley Grit and the Huddersfield White Rock, shown on the cross-section on page 4.

Mudstone (often called **shale**) is a sedimentary rock made of clay particles. **Clay particles** are the finest of sediments and can only be observed through a high powered microscope. 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.

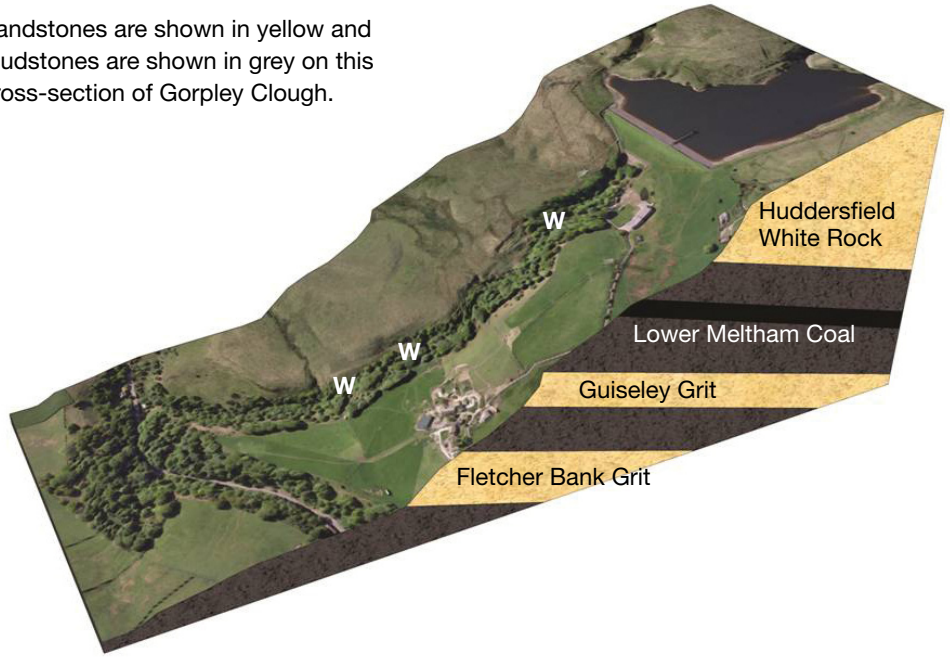
Once clay particles come into contact with each other, they tend to stick together because they are cohesive. Over time, the clay particles build up and are compressed into thin beds called **laminations**, which form a solid **mudstone**, which can be grey or black (if the rock has a high carbon content).

Regular bedding and Cross bedding

Sedimentary rocks are made up of layers or beds. If the upper and lower surfaces of the bed are parallel, the bedding is said to be regular. **Regular bedding** forms when sediment settles out of a slow, steady water current.

Geologists usually name each different bed of sandstone after the place where it was first identified. Sometimes, however, better examples are found elsewhere

Sandstones are shown in yellow and mudstones are shown in grey on this cross-section of Gorpley Clough.



during later surveying, so the names are changed. This has happened in this area of the Pennines recently.

The sandstones are more resistant to erosion than the mudstones so they form waterfalls in the river bed. If you walk up the footpath, you will meet each waterfall in turn and be able to identify the sandstone which has formed it. The waterfalls are shown by the letter W.

The **Fletcher Bank Grit** (formerly called the Gorpley Grit) is about 25m thick in Gorpley Clough. It is a massive thickly bedded grit with large sand grains and is overlain by a thin coal seam which is not visible under the vegetation on the valley slopes.

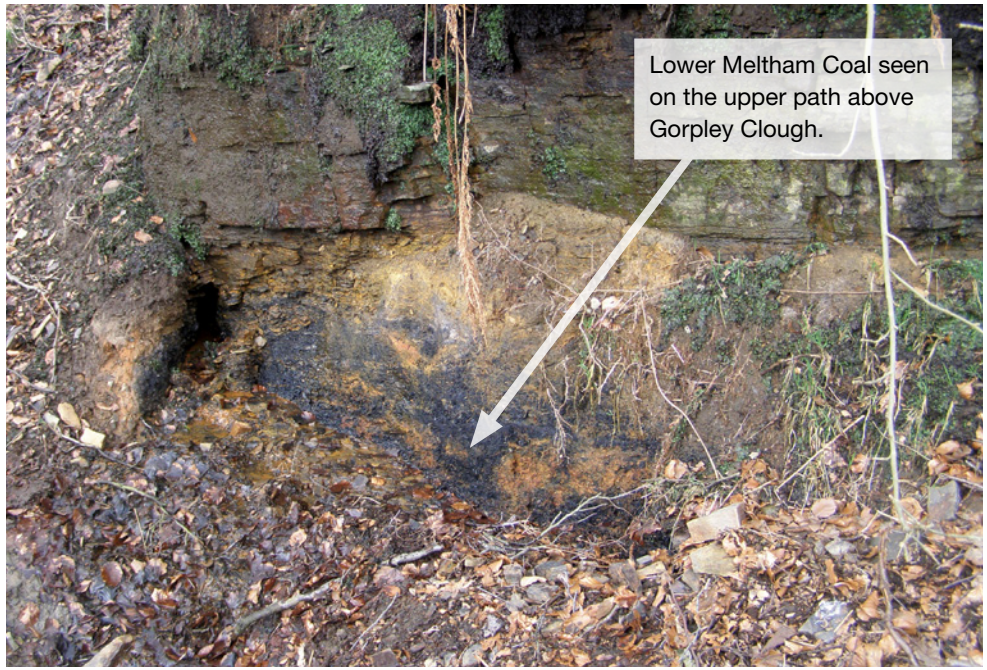
Guiseley Grit (formerly called the Hazel Greave Grit) is a fine-grained sandstone. At Gorpley it is about 6m thick and has thin beds separated by thin sandy mudstones.

The **Huddersfield White Rock** (formerly called the Holcombe Brook Grit) is usually a pale colour (though not white) and has small sand grains. The rock is variable in thickness but some thin beds can be seen in the upper sections of the valley above the top footpath.

The Lower Meltham Coal seam in Gorpley Clough

Large forests grew on low-lying deltas during Upper Carboniferous times and it is this vegetation which became buried and over time formed coal seams which can be found in the Todmorden area. However, the species of plants found in the Carboniferous forests are very different from the trees and shrubs of today's vegetation.

Mine abandonment plans from the Coal Authority show that the mines in Clough Foot, Dulesgate, do not extend as far as Gorpley Clough, so the adits (tunnels) in Gorpley Clough may have been exploratory. Recently the bank near to the adits has been cleared and a small seam of coal, in black mudstone, has been exposed. It appears to be about 20cm thick and is thought to be the Lower Meltham Coal, which is rarely thick enough to be worked profitably.



A mine adit seen from the upper path above Gorpley Clough. The laminated mudstones which can be seen lying above the mine entrance are very weak and do not support the mine adits, which are very likely to collapse.

Waterfall over the Guiseley Grit. The tufa deposit is to the north side of the plunge pool where the moss is growing.

The mine adits should not be entered as they are likely to collapse. They may provide roosting places for bats, so should not be disturbed.

Waterfalls in Gorpley Clough

Three resistant beds of sandstone, divided by beds of mudstone, cut across the clough and form the waterfalls as shown on the diagram on page 4.

The middle waterfall falling over the Guiseley Grit at SD 915 235 has an extensive formation of **tufa** along the north side of the plunge pool. Tufa is a calcium carbonate mineral formed from ground water which has moved through the rocks picking up calcium carbonate which probably originates from fossil shells. When the ground water mixes with air at a waterfall, the calcium carbonate mineral is precipitated and covers moss and rock faces.

The tufa is forming on the mosses at the side of the waterfall, rather than on the rock faces. Much of the deposit consists of petrified moss and appears still to be forming. It is dangerous to wade across the plunge pool in case there is a sudden rise in water level in the stream because of a release of water from Gorpley Reservoir upstream.

The Todmorden area during the Carboniferous period

During the Carboniferous period, the continent on which the present UK is situated had an equatorial location and therefore experienced a hot and rainy climate. The area was a lowland plain with mountains lying to north and south. Large rivers flowed from the northeast into the lowlands, which were periodically flooded by shallow seas. Marine mudstones were deposited at times of high sea level, followed by sandstones as the deltas built out into the sea. Sea level altered frequently because of glacial fluctuations in the ice-sheet which lay over the South Pole.

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. The sands that form the Upper Carboniferous sandstones were typically deposited in these large channels.

Because the climate was warm and wet, forests grew on the surrounding lowlands, so sometimes tree branches, carried by rivers in flood, drifted onto

The photo shows a river channel in the present Amazon basin with sand and mud sediment being carried by the water and deposited on the river banks. Northern England would have looked like this during Upper Carboniferous times, 315 million years ago.

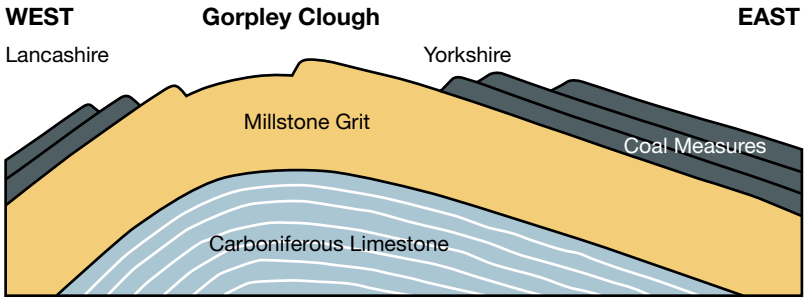
Photo © Hugh Quarterman

sandbanks. You can often see **plant fossils** in field wall stones, as quarrymen regarded them as waste rock which reduced the strength of the stone for building. It is not easy to find tree branch fossils in Gorpley Clough, but you might see them in other areas.

Vegetation which decomposed in swamps and mires was sometimes buried by other sediments and over time formed **coal seams**, some of which can be found in the Todmorden area. However, the species of plants found in the Carboniferous forests were very different from the trees and shrubs of today's vegetation.

The sediments of the Pennines were folded by continental plate collisions called the **Variscan Orogeny**, at the end of the Carboniferous period. The rocks were squeezed together to form the **Pennine Anticline** (an **upfold**). The rocks in Gorpley Clough dip at a gentle angle to the south-west, as they lie on the western limb of the anticline.

The Pennine Anticline



Landslipping in Gorpley Clough

Steep-sided cloughs are liable to landslip because massive beds of sandstones lie above weaker mudstones. In the heavy rainfall in the Todmorden area, sandstones become saturated with water and the mudstone laminations are lubricated to make the rock face unstable. The sandstones are undermined if the mudstones start to slip and a whole section of rock can collapse down the steep valley slopes.

In this photo, taken after heavy rainfall during the winter of March 2011, the sandstones which form the top of the slope under the trees have slipped down over the black mudstones below them. The large blocks of bedded sandstone have fallen to the base of the landslip into the stream. The mudstone fragments break up easily and are washed away by the river water. In March 2011, some sections of the stream were blocked and had to be dug out by volunteers.

Acknowledgements

Lucy Muir, who surveyed Gorpley Clough and wrote a report in 2011 from which some of this material is taken.

Photos by Alison Tymon amd Hugh Quarterman

References

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Wright, W B, Sherlock, R L, Wray, D A and Tonks, L H, 1927, *The Geology of the Rossendale Anticline*, Memoirs of the Geological Survey Sheet 76 Rochdale

Aitkenhead, N, Barclay, W J, Brandon, A, Chadwick, R A, Chisholm, J I, Cooper, A H, and Johnson, E W, 2002, *British Regional Geology: the Pennines and adjacent areas*, British Geological Survey

Useful maps

OS 1:25,000 Explorer OL 21 South Pennines

OS 1:50,000 Landranger 103 Blackburn and Burnley

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

Further reading

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

www.wyorksgeologytrust.org

West Yorkshire Geology Trust (WYGT) is an active group of volunteers, whose aim is to promote geodiversity in the five districts of Bradford, Calderdale, Kirklees, Leeds and Wakefield. Our objectives are to maintain a database of Local Geological Sites in the five districts to provide information for local authorities and other statutory bodies. We also promote geology for the general public, using guided walks, activities and events for children. We write and produce interpretation boards and leaflets for some of the important Local Geological Sites, as well as maintaining an informative website.

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**

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