

Rocks and Landscapes of Marsden







The rocks which form the landscape around Marsden, West Yorkshire, were formed during the late **Carboniferous** period, about 315 million years ago. Rocks of this age are often called **Millstone Grit**, because the sandstone grains are gritty and rough and were therefore suitable for making millstones. There are three main rock types found in Millstone Grit rocks; **sandstones, siltstones** and **mudstones**.

Sandstones are made of sand grains. If you look at a fresh piece of sandstone with a hand lens you will see grey **quartz** grains, while occasional **feldspar** grains are pink, white or cream. **Minerals** have a particular chemical composition and crystal structure. All rocks are composed of minerals such as quartz and feldspar. **Siltstones** are like sandstones, but made of the very finest quartz particles.

Mudstones (often called **shales**) are made from mud composed of clay particles. **Clay particles** are complex minerals, with a variety of chemical compositions. Mudstones often produce good soils which hold water and provide nutrients for plants, but are rarely visible at the surface, as they weather rapidly to form a soil layer which is then colonised by vegetation. However, mudstones are sometimes seen in moorland gullies on steep slopes, where rain washes off surface layers to expose the solid rock.

There is an accessible mudstone gully at Goniatite Gully, off Mount Road (SE 032 102). However, this is a Site of Special Scientific Interest, so permission should be obtained from the National Trust office at the Old Goods Yard, Marsden, before taking a group there.



-  The Watershed Landscape Project Area
-  Railways and stations
-  Pennine Way
-  Pennine Bridleway

Sandstones at Pule Edge Quarry.



Sandstones can be seen on the natural crags at Buckstones (SE 012 137) and on Pule Hill (SE 032 105).



Dark grey mudstones lying below a bed of sandstone at Butterley Reservoir.



Mudstones in Goniatite Gully, Mount Road.

How rocks are made from sediments

The Carboniferous sands, silts and muds in this area were deposited in shallow water by rivers. Afterwards, they were buried by many metres of sediment and **compressed** so that the water was squeezed out.

Water moving through the sediments carried minerals which **cemented** the sand and mud grains together to make sandstones and mudstones. Small amounts of iron were washed through the sediments and have been sufficient to colour the sandstones the typical yellow or brown colour that we associate with Millstone Grit sandstones.

Sandstones in the Huddersfield area are usually cemented by quartz cement, which makes them sufficiently tough to be used as building stone. However, some sections of sandstones are cemented largely by iron, though there is never enough iron for the rock to have any economic value. Iron-rich rocks have an orange or dark brown colour and can be seen in Pule Edge Quarry.

Carboniferous times

During Carboniferous times, the area that is now Britain was part of a large continent which lay across the equator. The Carboniferous rocks found in West Yorkshire are all of **late Carboniferous age**. At this time, the area 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 or north-west 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.

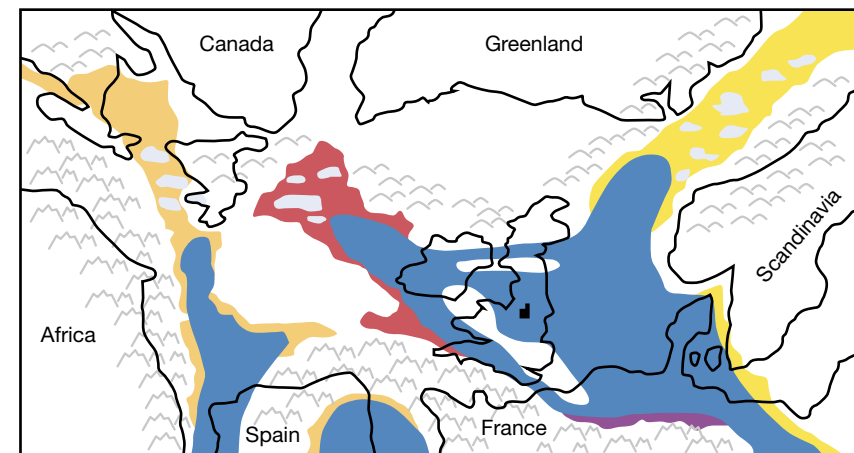
The diagram on the right shows how the area which is now the UK lies between a northern continent (now Greenland and Canada) and a southern continent (now Scandinavia, western Europe and northern Africa). The Atlantic Ocean did not start to open until about 60 million years ago, so is not shown on the map below.











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,



Patches of weak sandstone in Pule Edge Quarry, cemented by iron instead of quartz.



- | | | | |
|---|---------------------|---|-------------------------|
|  | Lake |  | Sediment from the north |
|  | Sea |  | Sediment from the west |
|  | New mountain chains |  | Sediment from the south |
|  | Old mountain chains |  | Other sediments |
|  | Land being eroded |  | Huddersfield |

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 wet, forests grew on the surrounding lowlands, so sometimes tree branches drifted onto sandbanks, carried by rivers in flood. 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. You can see these sandstones in Pule Edge Quarry.

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

Fossils

Mudstone beds occasionally include fossils of marine creatures, such as **brachiopods**, **bivalves** and **goniatites**. This shows that sea-level must have risen from time to time to flood low-lying land, bringing sea creatures with it. When they died, their shells were embedded in mud layers and fossilised. The gully near Mount Road is eroded into mudstones which have many goniatites, which is why this locality is a Site of Special Scientific Interest.

Plant fossils are common in the sandstones, as branches and tree trunks were carried by flood waters and left stranded on river sandbanks as the flood waters



Plant fossils in Pule Edge Quarry.

receded. 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.

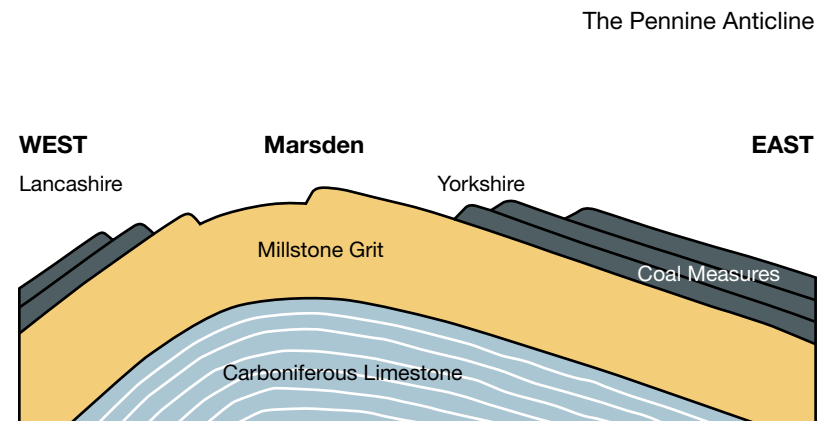
Coal Measures rocks

Later in the Carboniferous period, the continent was above sea-level for longer periods of time because rivers built out deltas into the shallow seas, in the same way that the Mississippi river deposits sand in the Gulf of Mexico nowadays. Equatorial forests thrived, so that rocks of this age contain thicker coal seams.

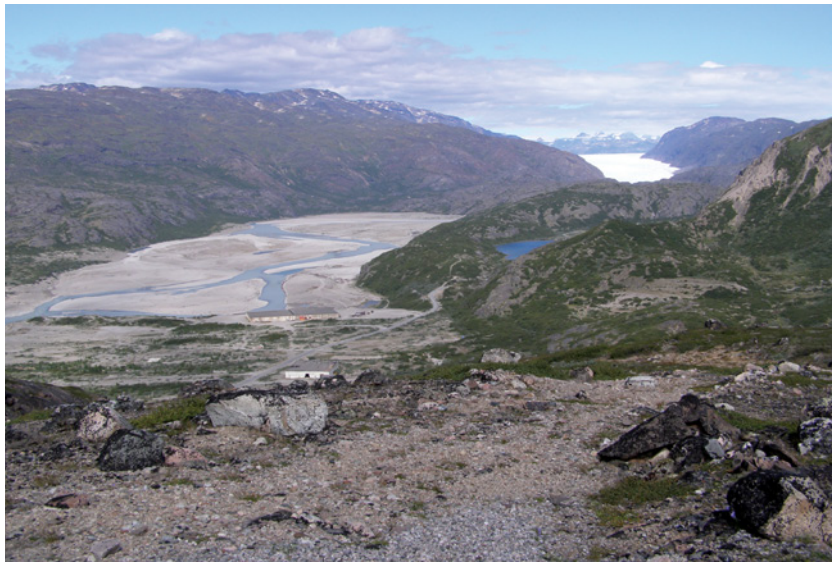
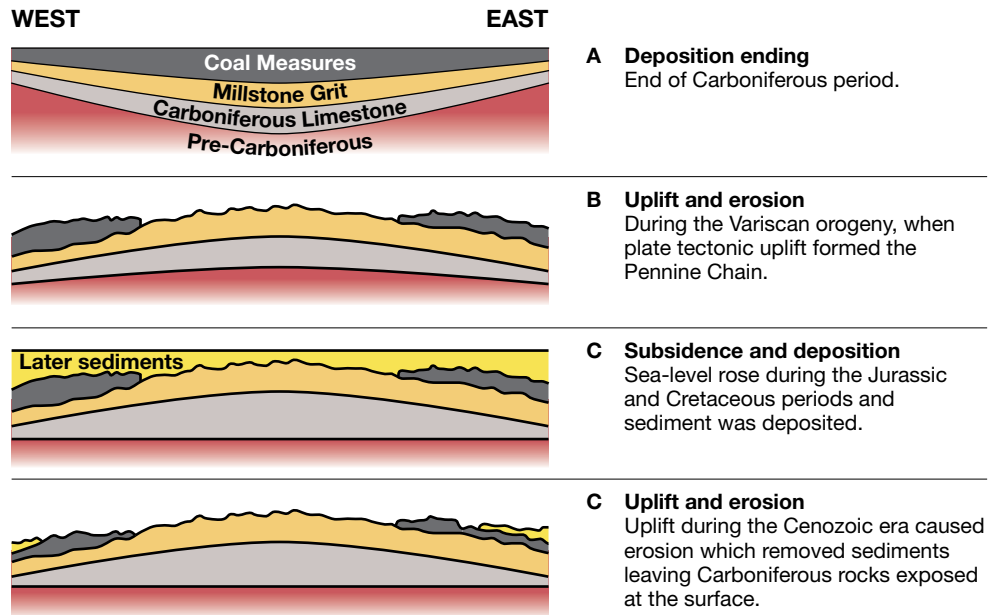
Rocks formed at this time, from 310-300 million years ago, are often called **Coal Measures**. Sandstones, siltstones and mudstones are still found, interbedded with thick coal seams which have been worth exploiting. The Coal Measures are found both east and west of Marsden, in the coalfields of Yorkshire and Lancashire, respectively. Huddersfield town centre stands on the edge of the Yorkshire coalfield and many coal seams were exploited in small scale mining operations throughout the last few centuries, with the last mines being closed in the early 1950s.

Variscan orogeny and the Pennine anticline

At the end of the Carboniferous period, this area was uplifted and tilted during a major collision between two tectonic plates. This mountain-building period is called the **Variscan orogeny** and culminated in the uplift of a high mountain range across Europe. The effects are seen in south-west England more than the



The Pennine Anticline



Glacial valley in Greenland filled with sediments brought by glacial melt water.

rest of Britain. However, northern England was uplifted into the Pennine **anticline**, which is an upfold.

For millions of years after the end of the Carboniferous period, the present Pennines were a range of hills trending north-south from the Midlands to southern Scotland. The continental plate on which Britain lies is very stable at present, so fault movements and their resulting earthquakes are rare.

The missing 280 million years

For the last 280 million years, northern England has been an upland area on a continent which has drifted very slowly northwards. Vegetation flourished in warm times and animal life developed, as reptiles, birds and mammals evolved. However, because any sediments and rocks have been eroded away, there is very little evidence in this area to show what happened since the late Carboniferous period until the onset of the ice ages 1.8 million years ago.

Glacial times

During the last 30 million years, global climate has been cooling down, culminating in the development of huge ice-sheets in the last 1.8 million years. Global temperature has fluctuated since then, resulting in many advances and retreats of ice sheets over Northern Europe. Ice sheets grew in cold times in high mountain areas and advanced into the lowlands. However, most of the evidence of early ice advances has been obliterated by later events.

The last glacial stage, called the **Devensian**, was at its maximum about 17,000 years ago, when ice covered the high ground in the Yorkshire Dales and the Lake District and flowed from the north down the Lancashire Plain and the Vale of York. **Glacial till**, also known as boulder clay, is the debris left behind when ice melts and is found to the west of Marsden in the Castleshaw area (SD 997 093) at a height of about 250m.

There is no evidence that ice flowed down the Colne valley in the Devensian glacial period. However, it would have been possible to stand on Standedge and look westwards into Lancashire to see valleys filled with ice. The high hills around the Colne Valley would have had snow cover during each winter. In spring the melt water flowed down the valley and deposited more sediments on the valley floor.



Landslip at March Hill Holes.

As temperatures rose at the end of the Devensian glacial about 14,000 to 12,000 years ago, ice melted and glaciers became thinner. In the final stages of the glacial period, the thickest ice was confined to the valleys. As the ice completely melted away it left behind extensive deposits of glacial till which now fill the Lancashire Plain and Vale of York.

Landslipping

The steep slopes around the Colne Valley were prone to **landslipping** at a time when the climate was still very cold after the ice sheet had melted about 12,000 years ago. To the north of March Hill is an area of land called March Hill Holes, which has hummocky, irregular slopes. This is one of the most extensive landslips in the Pennines.

Ice lay close by to the west, so cold temperatures meant that very little vegetation could grow. Lubrication by melting snow allowed sandstones at the top of slopes to slide down weaknesses in wet mudstones below, causing landslips on the sides of valleys. However, the slope movement would not have occurred suddenly, but would have been made up of small slides over many seasons. Because there would have been very little vegetation to stabilise the slopes, these processes were able to continue for some time after the ice finally melted until temperatures warmed up sufficiently for a tree cover to develop.

This type of landslide is called a **rotational landslide**, as the pressure from the saturated sandstone at the top of the slope cuts into the softer mudstone, in the way in which a rounded scoop cuts into ice-cream. The material which slides gradually down the hill tilts backwards so that ponds develop in the depressions, as shown in the photo on the left.

Considerable research has been done on a similar landslide near Castleton in the Derbyshire Peak District. It is suggested that the Mam Tor landslide is still slowly creeping downslope underneath the vegetation cover, particularly after wet winters. This is probably also true for the landslide on March Hill.

Trees growing on hill sides reduce the likelihood of further landslipping, because they take water from the ground so reducing the lubrication in the soil. Their roots stabilise the subsoil and find their way into joints in the solid rock. However, in this area, tree growth is prevented by sheep grazing, so it is likely that slow movement is still taking place here.

Sudden rock falls occur in sandstone quarries, particularly during the winter after water in joints in the rocks has frozen, thus expanding the cracks. A rock fall occurred in Worlow Quarry on Pule Hill in January 2006 as shown in the photo below. Great care should be taken at all times when visiting quarries.



Quarrying on Pule Hill

If you look at a map of Pule Hill, you can see that stone has been extracted in past times, though there are no active quarries at the moment.

The 6" Ordnance Survey map published in 1854 shows five quarries on Pule Hill. The largest at that time was Netherley Quarry (SE 038 107) above Old Mount Road, where there are extensive spoil tips. However, this was shown as 'Old Quarry' on a map from 1892 so may have been disused then.

Nab End Quarries (SE 031 118) were also sizeable in 1854 and were still working in 1933. They are recorded in trade directories as being owned by James Wood of Owlery from 1917 until the 1930s.

Pinglet Head Quarry (SE 035 118) on the north side of Pule Hill, just above the A62, was in operation at this time but was shown in 1892 as being disused. The cottages on the A62 nearby are called Millstone Cottages, which gives a clue as to what was produced in the quarries.

Worlow Quarry (usually known as Askham's Quarry, after a previous owner) on the south side of the hill (SE 033 103) was active in 1854 and still working in 1933.

Pule Edge Quarry (SE 032 108) on the west side of the hill was small in 1852. By 1892, however, it was much more extensive. However, the 1892 map does not show the inclined plane which now leads down to the A62, so therefore it must have been built later to take stone down to the road.

Trade directories from 1860 to 1881 record Thomas Haigh and Samuel Whitehead as quarry owner/managers, but do not record which quarries they were associated with. Samuel Whitehead lived at Forest on Mount Road, so perhaps had connections with Netherley Quarries.

Throughout that period the directories mention other stone masons, particularly William Dyson, Edmund Carter, James Holroyd and John Whitehead. The Wood family was working stone from the 1890s until the 1930s, with various members of the family mentioned in trade directories. As John Wood is recorded as living at Owlery in the 1920s, the Woods may have owned the Nab End Quarries, which are nearby.

The Whitehead family was recorded as stone-masons until 1912 at least continuing the line that Samuel Whitehead began in the 1860s. Whiteley is a new name in the 1920s and 1930s, but it is not recorded which quarry the family was associated with.

The Geological Memoir published in 1933 recorded that there were four working quarries on Pule Hill; Nab End Quarries, Pule Edge Quarry, Worlow Quarry and Netherley Quarry. All extracted sandstones and gritstones, but Pule Edge Quarry produced paving setts.

Other quarries in Marsden

The quarries on the south side of the Meltham Road extracted **ganister**, which is a particularly pure form of sandstone. It is made of quartz grains and also cemented by quartz. This makes it a very hard rock, unlike other sandstones in that the sand grains are fused together to make a crystalline texture. As there is a low percentage of impurities the rock is white, though it often contains plant rootlets which look like black strings running through the rock.

Ganister was used to make firebricks and was therefore particularly valuable. It is not common, so where it is found, it was often considered to be worth quarrying. Gate Head Quarries (probably at SE 059 119), close to Marsden, were still working in 1933. The ganister from the Meltham Road quarries may have been used locally in firebricks as there was a foundry in Marsden for many years.

However, the Meltham Fireclay Company, which started in the 1900s, was a large operation, employing 200/300 people at its height. It used ganister from quarries at Wessenden Head in Meltham and closed in 1985. Ganister from Marsden may have been transported to Meltham for processing, thus keeping the Meltham Road quarries open until well into the 20th century.

It would be interesting to know when the Marsden quarries closed. However, it has not been possible to find that information for each quarry, so it is surmised that the closures started to take place during the 1930s and 1940s, which would be similar to the pattern in other areas of Huddersfield. In 1933, the sandstone quarries at Shooter's Nab and Deer Hill, as well as Netherley Quarry on Pule Hill, are recorded in the Geological Memoir as 'standing'. This means that they were not being worked at the time, but were still available for use if there was a demand.

Uses of sandstone

Sandstone has been used for building for centuries. For strength for use in building, the sand grains need to be very well-cemented together so that the individual sand grains are not forced apart by frost. If bedding planes are far apart then the stone can be worked in any direction without it breaking along weaknesses, so it is called **freestone**. However, sandstones with closely-spaced bedding planes can be split into **flags** or **roofing slates** and they are also very valuable. Stone which breaks irregularly can be used for field or garden walls and

Stone for wall building and for setts (for footpaths and roads) was squared off neatly.

Large blocks of high quality stone were used for steps and gateposts.

The gatepost in the photo is given some decoration, using the mason's hammer and chisels.

Thin flags were used for roofing slates.

Larger stones were squared off for use on corners and kneelers at the top of walls.

Roughly shaped stones were used for wall building.

any waste stone can be crushed into gravel as aggregate and was often used for tracks.

Freestones were worked by stone-masons into smooth blocks and used to face the front walls of more important buildings. This finish is called **ashlar**. An ashlar finish was used for the Marsden Mechanics building and the lower floors of some of the shops, as shown in the photo. Rougher stone, without a smoothed finish, was used for upper floors of buildings in Marsden and for cottages and farm buildings.



Marsden Mechanics building



Drystone wall in Marsden



Slaithwaite Hall



Setts, walls and gateposts in Marsden

Water supply

Sandstones are **porous**, which means that the pore spaces between the sand grains can hold water, even though some of them are filled with quartz cement which holds the grains together. Some sandstones have up to 30% pore space. The pores are often connected to each other, so that water can flow through the rock. Sandstone then is a **permeable** rock, so is useful as an **aquifer**, which means that it stores water which can also be pumped out as a water supply. Footpaths across sandstones are usually sandy and relatively dry.

Mudstones are **impermeable**, which means that water does not flow freely between the clay particles. The microscopic pore spaces in a mudstone are not interconnected and thus do not allow water movement. Footpaths across mudstones are usually muddy as water does not have the opportunity to drain away, even in dry weather.

The layering of sandstones and mudstones in West Yorkshire gives this area a plentiful water supply. Rain falls onto the ground surface and soaks into the soil and then into the rock below, if it is not intercepted by buildings or vegetation. The ground water saturates the sandstones providing an excellent source of clean water which can be pumped out for human use. Because sandstone layers are sandwiched between mudstones, the water in the sandstones can't soak deeper into the ground, so is held relatively close to the surface which makes it easily available as a water supply. The **water table** is the top surface of the groundwater within the saturated sandstone.

Where sandstones overlie mudstones, **springs** are found on the surface. As this geological situation occurs commonly in the Colne valley, settlement on hillsides high above streams has been possible. Water was piped or channelled into troughs along roads or in hamlets.

Wells were also dug down through mudstone or sandstone to intersect the water table so that the whole area had an accessible supply of water, allowing farms and hamlets to be built anywhere.

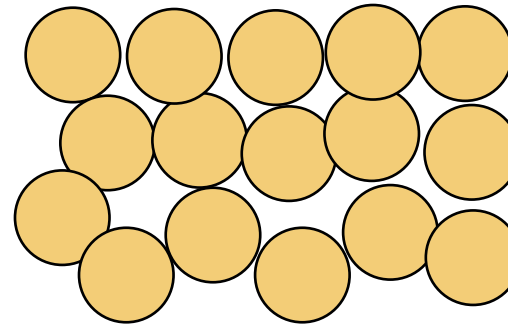


Diagram to show sandstone permeability

The pore spaces between the sand grains are filled with water.

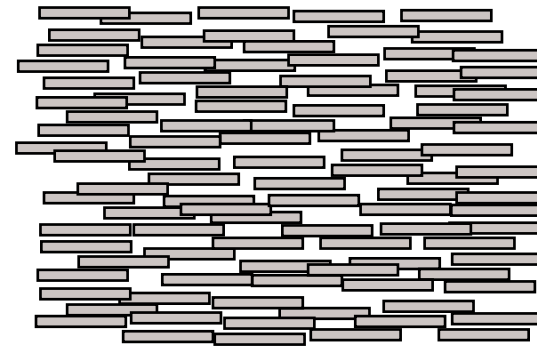
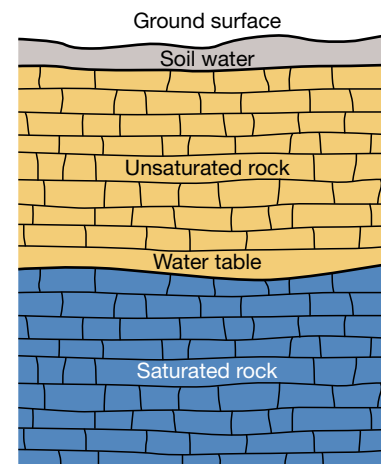


Diagram to show mudstone permeability

The spaces between the mud particles are not connected so water cannot flow through the rock.



Rocks, weathering and soils

There are many places in the Marsden area where soils can be seen lying above the rocks from which they are derived. Soils are made of about 25% each of four materials – air, water, mineral content and organic content.

Above the solid rock lies the subsoil of broken, weathered rock fragments. The rock provides the **mineral content** (sand and clay particles) in a soil. To this is added the **organic content** from the vegetation growing on the surface.

Soils in the Marsden area which have developed on sandstone will tend to be well-drained, as the weathered sand grains allow water to pass through easily. However, this is not the case at the base of hill slopes, which are muddy whatever the rock type! Sandy soils are usually infertile as the sand grains are quartz, which is made of silica and does not hold useful minerals such as calcium and magnesium, amongst others.

Soils which have developed from mudstones (shales) will be darker in colour and will hold water more easily as the clay particles are very tiny and do not let water drain through. So footpaths on mudstones will often be muddy, whatever the weather. Soils on mudstones are fertile as clay particles have a varied chemistry.

In the valley bottoms, the soils are derived from **alluvium**, which is the material left by river floods and often consist in this area of both sand and clay particles. The clay content means that the soils are relatively fertile, but they may also be reasonably well-drained if there is a high enough sand content.

Porosity and permeability experiments

Teachers and pupils can collect samples of rocks, sub-soils and soils as well as organic material like leaf mould.

Rocks are **porous** if they allow water to soak in. Rocks are **permeable** if they allow water to flow through, because there are interconnected spaces. Sandstones are nearly always permeable because the sand grains are not packed together closely, leaving pore spaces between the sand grains. In sandstones, sand grains are cemented together, but the Pennine sandstones are not cemented very well and still contain plenty of interconnected pore spaces so that water can soak through.

Visit one of the local quarries and collect fresh samples of sandstone. Fresh sandstone will be pale in colour, instead of the dark weathering layer. If you can find some mudstone in local gullies (a locality is given in the teacher's notes), bring a sample back so that you can compare sandstone with mudstone.

Add drops of water to the fresh surface of a sandstone sample and see if the water soaks in. If you add more water, see if it flows through the rock and drips out at the base of the sample. Pupils should be able to notice that water soaks easily into sandstone and also will soak the whole rock, as it is porous and permeable. Mudstone, on the other hand, may allow a small amount of water to soak in, but as it is impermeable, water will not pass through and is more likely to run off the surface.

Connect this exercise with the idea of aquifers, which provide much of Huddersfield's water. Springs occur where water emerges from the ground at a boundary between sandstone and mudstone where the water is forced to the surface as it cannot move easily through impermeable mudstone. Maps show springs and pupils may know of springs in their local area. Some road-side troughs are fed by springs, though some take water from field drains, rather than springs.



A spring near Butterley Reservoir, where water seeps out onto mudstone, turning it dark in colour and allowing vegetation to flourish.

Places to visit

To see the geological and geographic features in the Marsden area, a good view point is the car park at Buckstones on the A640 at SE 017 136.

Worlow (Askham's) Quarry (SE 037103) Because of the potential for rock falls it would not be appropriate to take young children to this quarry. Older groups would need to stay away from the faces and look at the quarry from a safe distance.

Pule Edge Quarry (SE 032 108) The quarry faces seem to be stable, though there are many boulders and steep faces. Leaders would need to exercise their own judgement about whether this site is suitable for a visit by a group. It is accessible using the footpath up the inclined plane from the lay-by on the A62.

Nab End Quarries (SE 031 118) are very accessible as they are close to footpaths a short distance from the A62 at Owlars. The same precautions apply about stability of the rock faces. These quarries have excellent examples of iron concretions, called 'mare's balls' by local people.

Walk arrangements

If you want to enjoy a brisk walk from Marsden to Pule Hill to take in the fossil site at Goniatite Gully as well as Pule Edge Quarry, then there are footpaths and tracks which lead from the centre of Marsden and would give a circular walk of 4-5 km. Parking in the large car park next to Marsden Station is advisable, as you would also be able to look at the National Trust exhibition area which is open between 9.00am and 5.00pm daily.

There is a climb of at least 200m from Marsden up to Pule Hill. The triangulation point at the summit of Pule Hill is 437m, but gradients on footpaths on the hill are fairly gentle, although some the old quarry and spoil tip slopes lie at a steep angle.

Because Pule Hill is largely above 400m it is wise to carry waterproof clothing and wear good boots or shoes. It is also useful to carry drinks and a snack. If there is cloud on the hill, carry a compass for navigation. However, you will get the most out of the walk if you chose a day when you can see the views.

Public toilets are available in the centre of Marsden next to the Marsden Mechanics.

Acknowledgements

Colin Waters of the British Geological Survey

Judi Thorpe of Marsden History Society

Photos © Alison Tymon

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Addison, R, Waters, C N, and Chisholm, J I, 2005, *Geology of the Huddersfield District*, Sheet description of the British Geological Survey, 1:50,000 Series Sheet 77 Huddersfield p10

Rocks and Landscapes of Huddersfield, 1998, Huddersfield Geology Group, available from the Tolson Museum, Huddersfield

Guided walks around the Rocks and Landscapes of Castle Hill, 2006, West Yorkshire Geology Trust, available from the Tolson Museum, Huddersfield

Useful maps

OS SHEET 1:50,000 Landranger 110 Sheffield and Huddersfield

OS SHEET: 1:25,000 OL 21 South Pennines

British Geological Survey map 1:50,000 Sheet 86 Glossop 2012

Written by Alison Tymon © West Yorkshire Geology Trust 2013

www.wyorksgologytrust.org

West Yorkshire Geology Trust (WYGT) is part of a national network of voluntary 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 Marsden area has three LGS sites, at Butterley Cutting, Pule Edge Quarry and March Haigh and Buckstones. 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