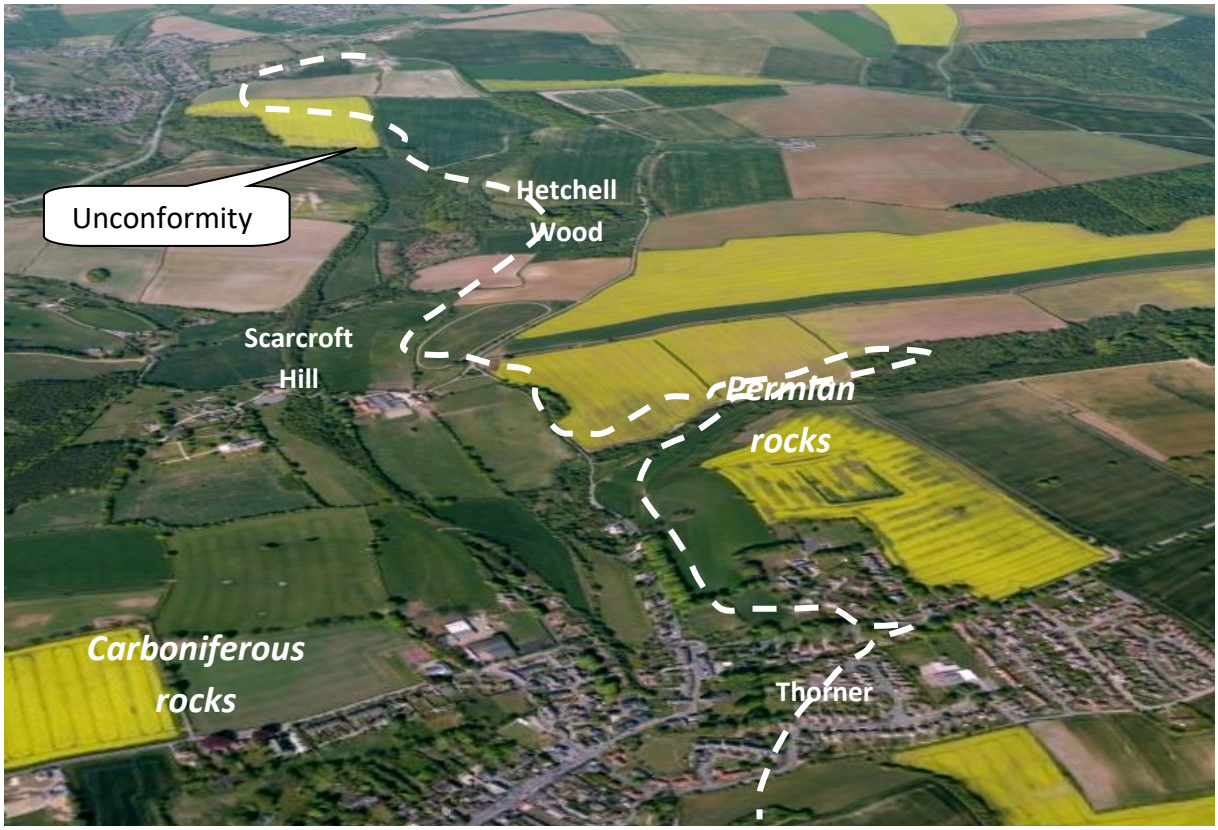
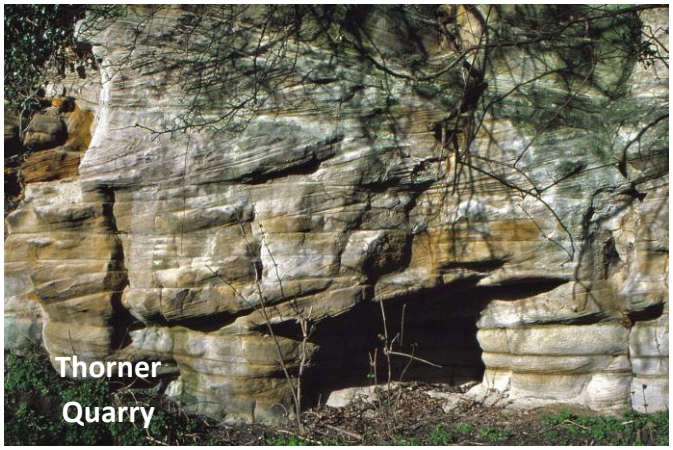
Permo-Carboniferous Rocks and Unconformity in NE Leeds



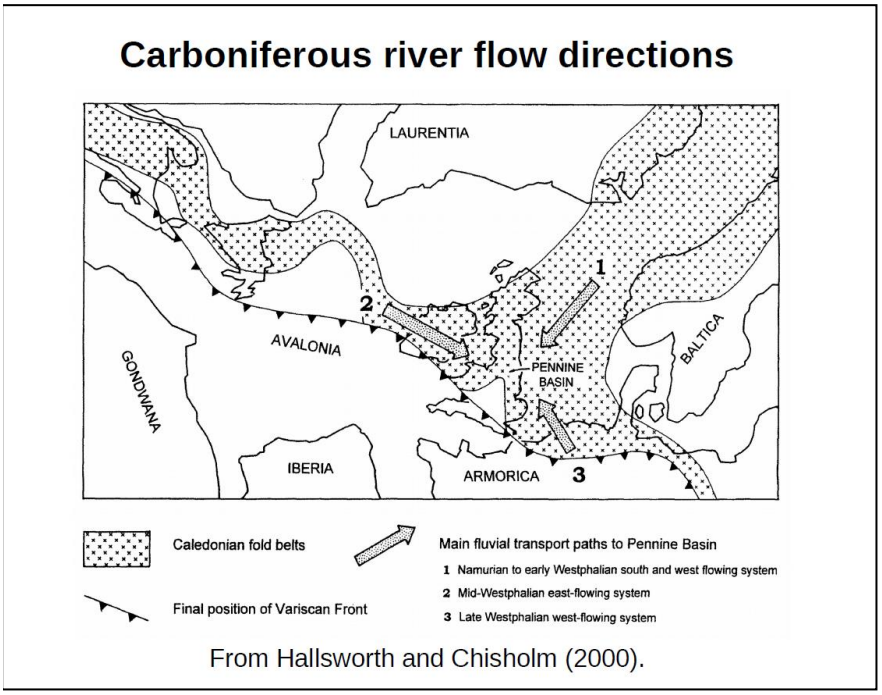


The Geology of the area around Thorner

Thorner lies on the Permo - Carboniferous Unconformity with **Carboniferous** rocks making up the land to the west and **Permian** rocks that to the east. There is a thick covering of glacial deposits and soil, so outcrops are largely restricted to manmade ones in a number of abandoned quarries and road and railway cuttings.

The **Carboniferous** rocks of the area are of Namurian age **Millstone Grit Group** and consist of various grades of massive sandstones separated by shales. The general dip is to the south and this produces a series of ridges with steep, north facing scarp slopes and gentle dip slopes facing south.

At the time of the deposition of the Millstone Grit group rocks (approx 320 Ma) the area was part of the large, actively subsiding **Pennine Basin**. Most of the sediments were eroded from the surrounding land surfaces lying to the north and transported into the basin by rivers where they were deposited as fluvial and deltaic sediments. The deltas prograded in a southerly direction with their surfaces periodically being flooded by rises in sea level. The sandstones were formed mainly in fluvial environments under high energy levels whereas the fine-grained deposits, mainly mudstones and silts, were deposited in low energy lakes or lagoons. The thickness of Millstone Grit Group in this area is approx 800 - 1200 m.



From Hallsworth and Chisholm (2000).

Westphalian age, Pennine Coal Measure rocks, representing a change from deltaic sediments of the Millstone Grit Group to prolonged periods of emergence as coastal and delta plains where land flora flourished, were almost certainly deposited on top of the Millstone Grit Group but have been eroded by late /post-Carboniferous uplift. The earth movements that caused this were part of the Variscan Orogeny and resulted in the folding, faulting and uplift of the thick Carboniferous sediments. These were compressive forces caused by the closure of the Rheic Ocean and associated continental collision. The principal faults in the area around Thorner are normal and run in two directions, NE - SW and NW -SE.

Through late Carboniferous to **mid**-**Permian** times the area underwent severe erosion under a hot, arid climate and a great thickness of Carboniferous strata was removed, including all of the Westphalian Pennine Coal Measures. The land was worn down to one of subdued hills formed by the more resistant sandstones and rocky plains where the soft shales were more readily removed. The plains were covered by wind-blown and water lain muds, sands and breccias. Deposition occurred in hollows, resulting today in patchy outcrops of varying thickness and nature. They make up the **Rotliegend Group** but are poorly represented here. By mid-Permian times extensional tectonics had created a vast land locked basin that stretched from eastern England to Poland. The Thorner area lay at the western margin of this basin which, in late Permian times was the invaded, from the north, by the **Zechstein Sea**. This covered the area in a shallow sea in which carbonate mud was deposited which, on lithification, became the dolomitic limestones of the Zechstein Group, **Cadeby Formation** (**Wetherby Member**). Fossils are scarce in these rocks and restricted in type which suggests the existence of a hostile environment in which only specialists could survive.

Quaternary.

Glacial deposits are tills of Anglian age as, during Devensian, the area lay between the ice lobe in the Vale of York and the ice sheet that covered the Pennines.

Economic.

Sandstones (flagstones and gritstone) have been quarried for local building. The site known as Pompocali is in fact made of quarry waste, but its age is uncertain. Roman foundations in York are made of gritstone and as this is the closest outcrop there are suggestions that this is their source. Limestone has been quarried for building and lime

Divisions of Carboniferous time in Yorkshire

<table>
<tr><th rowspan="2">System</th><th colspan="3">Standard Divisions</th><th colspan="3">Regional Divisions
Western Europe</th><th rowspan="2">Obsolete terms</th><th colspan="2" rowspan="2">Lithostratigraphy</th></tr>
<tr><th>Sub-system</th><th>Global Series</th><th>Global Stage</th><th>Stage</th><th colspan="2">Sub-stage</th></tr>
<tr><td rowspan="7">Carboniferous</td><td rowspan="5">Pennsylvanian</td><td rowspan="2">Upper</td><td>Gzhelian</td><td rowspan="2">Autunian
Stephanian</td><td colspan="2" rowspan="2">Kuzel
Stephanian C
Stephanian B
Stephanian A</td><td rowspan="5">Silesian
Upper Carboniferous</td><td colspan="2">Warwickshire Group</td></tr>
<tr><td>Kasimovian</td><td colspan="2" rowspan="2">Upper Pennine Coal Measures</td></tr>
<tr><td rowspan="2">Middle</td><td rowspan="2">Moscovian</td><td rowspan="3">Westphalian</td><td colspan="2" rowspan="3">Asturian
Bolsovian
Duckmantian
Langsettian</td></tr>
<tr><td colspan="2">Middle Pennine Coal Measures</td></tr>
<tr><td rowspan="2">Lower</td><td rowspan="3">Bashkirian</td><td colspan="2">Lower Pennine Coal Measures</td></tr>
<tr><td rowspan="2">Namurian</td><td colspan="2" rowspan="2">Yeadonian
Marsdenian
Kinderscoutian
Alportian
Chokierian
Arnsbergian
Pendleian</td><td colspan="2" rowspan="2">Millstone Grit Group</td></tr>
<tr><td rowspan="4">Mississippian</td><td>Upper</td><td>Serpukhovian</td></tr>
<tr><td rowspan="2">Middle</td><td rowspan="2">Visean</td><td rowspan="2">Visean</td><td colspan="2">Brigantian
Asbian
Holkerian
Arundian</td><td rowspan="4">Dinantian
Lower Carboniferous</td><td>Yoredale Group</td><td>Bowland Shale Group</td></tr>
<tr><td>Great Scar Limestone Group</td><td rowspan="2">Worston Shale Group</td></tr>
<tr><td rowspan="2">Lower</td><td rowspan="2">Tournasian</td><td rowspan="2">Tournasian</td><td rowspan="2">Chadian
Ivorian
Hastarian</td><td></td><td rowspan="2">Chatburn Limestone Group</td></tr>
<tr><td>Courceyan</td><td>Block</td><td>Basin</td></tr>
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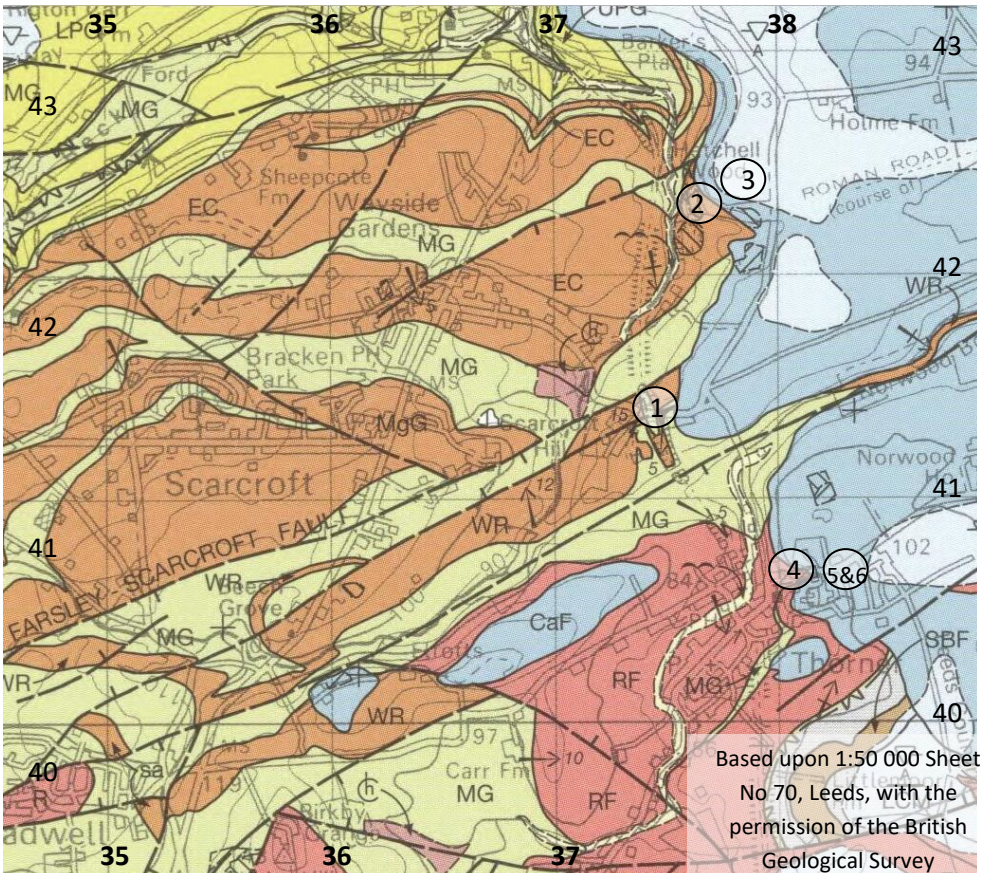
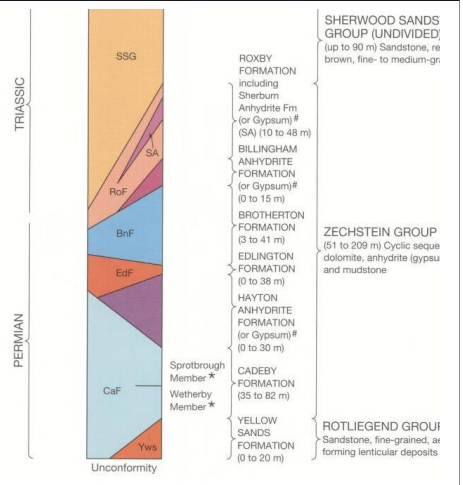
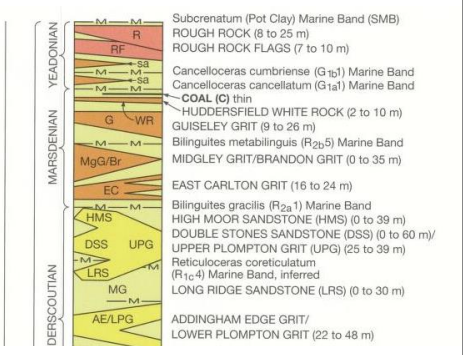
Based on DW Holliday & SG Molyneux (PYGS Vo 56 P1 pp 57-8. 2006)

Geological map of study area showing locations to be visited







Please note that site 1 is on private land and that access to it is only by permission of the owners

1. Scarcroft Railway Cutting. (GR 3742 4145)

The deep cutting exposes a section app 15 m thick through the **Huddersfield White Rock (**Marsdenian)**.** It is a coarsening upward sequence and dips northwards at around 15^0 - 20^0.

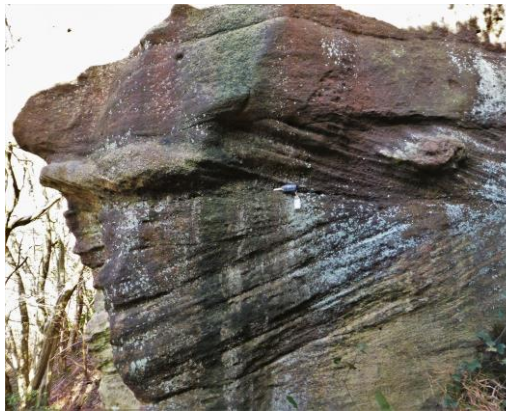
The sequence begins with dark grey mudstones which grade upwards into dark siltstones (stained red by iron oxidation), buff coloured, fine to medium grained flaggy sandstones then finally more massive, coarse sandstone. Plant and fish debris can be found in the mudstone with trace fossils (worm burrows) and plant impressions (bark) in the sandstones as well as ripple marks. This is a good example of a Namurian cyclothem showing the full sequence from marine to fluvial channel environment, formed as a delta advanced into a shallow lagoon/sea.

The north end of the cutting marks the position of the NE-SW trending **Farsley - Scarcroft Fault** which has downthrown the Huddersfield White rock to the south.

Coarsening upward sequence below **Huddersfield White Rock**. Scarcroft

2. Hetchell Crags (GR 3756 4245)

These form a line of west facing cliffs up to 10m high overlooking Bardsey Beck and extending for over 100m. Smaller outcrops occur along the southern edge of the wood and where there are also the remains of a large quarry, now totally overgrown. The rocks are massively bedded, coarse sandstones with large scale, trough cross-bedding. This is the **East Carlton Grit** (Marsdenian) which lies *below* the Huddersfield White Rock but is exposed here as it lies on the *upthrow* side of the **Farsley - Scarcroft Fault**. The sandstones are coarse grained, poorly sorted and contain several pebble beds which are lag deposits. Graded bedding is a common feature. Grains are angular and consist of quartz and feldspar as well as rock fragments. Current-bedding is generally from a northward direction but there are deviations from this as they represent sediments deposited within the main fluvial channels of the Namurian delta.



Cross-bedded **East Carlton Grit**. Hetchell Crag

3 Hetchell Wood Quarries (GR 3778 4242)

The outcrops here are all in long abandoned quarries and reveal up to 7 m of well bedded, cream coloured, fine grained dolomitic limestone. These are the **Late Permian** (Zechstein Group) **Cadeby Formation, Wetherby Member** which show that the **Permo-Carboniferous Unconformity** has been crossed. While this isn't exposed its position can be seen by a pronounced break in slope and a change in vegetation to one of calcareous grassland and beech woodland. The limestone was deposited as carbonate mud in shallow seas under an arid climate which is probably why, apart from what looks like broken shell material in some beds, there are few signs of any fossils: it was a hostile environment. The fine grain size and laminated nature of some beds point to a low energy environment of deposition. The actual process of dolomitisation is not fully understood but was diagenetic. Some horizons contain calcite lined vugs which are probably later features caused by dissolution and re-deposition.

Well bedded dolomitic limestone of **Cadeby Formation**. Hetchell Quarry

4. Thorner Quarry (GR 3806 4067) **and roadside exposures**

(The quarry is private land - do not enter)

From at least 1852 until the 1940's the quarry, now in private hands, contained houses; some built into the rock faces. 4-5 m of **Rough Rock Flags** (Yeadonian) are exposed in the quarry face. The outcrops visible over the wall from Church Hill are very yellow and show strong, quite large scale, cross-bedding. Further up the hill beyond the wall smaller roadside exposures are accessible in which the rock can be seen to be a fine - medium grained, micaceous sandstone that shows strong cross-bedding. These are interpreted as having been deposited at the end of distributary channels of the Namurian delta as bars. Some exposures are cut by white mineral veins containing barytes.

Cross-bedded, **Rough Rock Flags**. Thorner Quarry

5. Church Hill (GR 3813 4067)

Small exposures at pavement level of a fairly soft, fine grained, yellow sandstone. No mica is visible in these and they are believed to be the Permian **Yellow Sands** (Rotliegend Group) and indicate that the **Permo-Carboniferous Unconformity** has been crossed. Here, this represents a time gap of approximately 60 Ma. The sand is detritus deposited on an eroded surface of Carboniferous rocks in a tropical desert. Above this is a band of hard, limey mud possibly representing a marine transgression at the start of the Zechstein Group.

Yellow sandstone overlain by hard limey mud

6. Retaining Wall (GR 3815 4066)

The retaining wall on the north side of Church Hill has clearly been built in stages over a period of time as it is patchwork of different stones and styles. The stone is mixture of Carboniferous sandstones and Permian limestone; more than likely all local. Of particular interest are some of the limestone blocks as they contain fossils. These include **bivalves, gastropods** and also some small **stromatolites**. The source of these blocks is currently unknown.

Fossiliferous dolomitic limestone (Cadeby Formation?) in wall on Church Hill