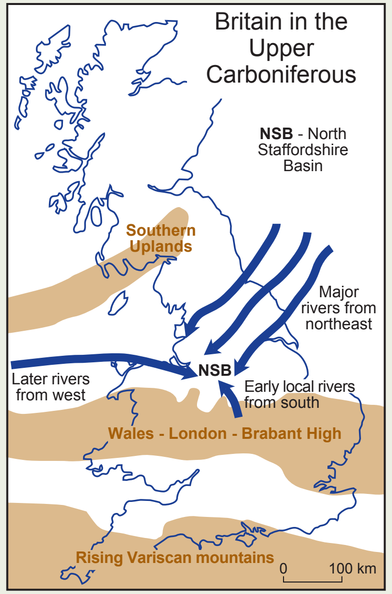
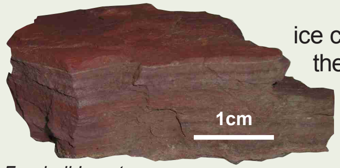
GEOLOGY

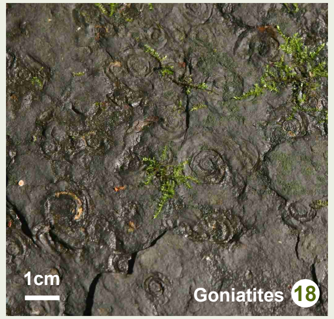


The rocks of the Churnet Valley belong to two geological time periods, the Upper Carboniferous (here about 318 - 313 million years old) and the Lower Triassic (250 - 245 million years old). See the column next to the map overleaf.

Carboniferous sediments were deposited near to the equator, close to sea-level, in a low-lying muddy delta on the southern margin of a continent called Laurussia. Muds, silts and sands were laid down in cycles due to global climate change. Global warming melted the southern polar ice cap. Sea-level then rose, flooding the delta depositing muds containing marine fossils such as goniatites. Global cooling then caused the ice caps to grow again, sea-level fell and rivers deposited muds and then sandier material in the delta. Eventually the delta surface emerged. Plants colonising this new land formed peat in swamps. Later this was buried and turned into coal. The lower part of the sequence contains thicker and coarser sand units forming part of the Namurian 'Millstone Grit' sequence; the upper muddier part containing more coal and ironstone belongs to the Westphalian 'Coal Measures'.



Froghall Ironstone



Goniatites 18

19 Goniatite concretion

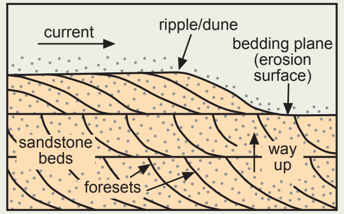
Late in the Carboniferous Laurussia collided with the continent of Gondwana to the south to form the super-continent Pangaea. The rocks were then uplifted and folded in a mountain building episode called the Variscan Orogeny.

GEOLOGY

Earl's Rock 34

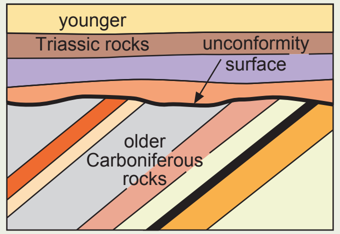
Rocks of Permian age are missing here due to that uplift. During the Triassic, the region was at northern hot desert latitudes. Large braided rivers deposited sands and pebbles unconformably over the eroded Carboniferous rocks (see unconformity diagram below). These rivers flowed from the fast-eroding Variscan mountains in south-west England and Brittany. As the highlands were gradually lowered, the rivers became more meandering and the sands finer grained. The rocks were later fractured and faulted by late Triassic earth movements associated with the opening of the Atlantic Ocean.

CROSS BEDDING



Cross-bedding is a feature found within layered (bedded) sediments and sedimentary rocks. It consists of a series of sloping layers between the main, normally flat, bedding plane surfaces. It is formed by the deposition of sediment on the downcurrent side of dunes and ripples in either air or water. Erosion of the tops of these sloping layers can be used to determine the 'way up' of sedimentary rocks, and the slope direction can be used to determine the direction of the flow of ancient rivers and winds.

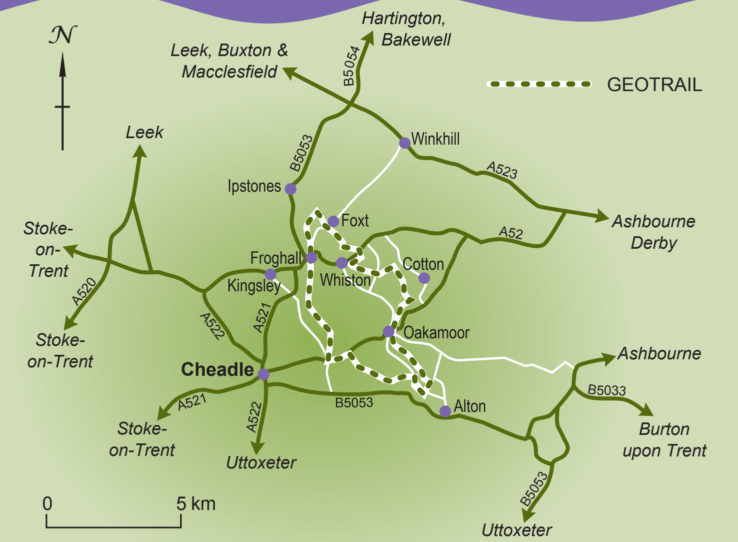
UNCONFORMITY



An unconformity is a geological surface which represents a time gap in the geological record. The surface separates a younger sequence above from an older one below. An angular unconformity is where the older rocks below the unconformity have been uplifted, tilted and/or folded and then exposed to erosion before the deposition of the younger ones.

In the Churnet Valley the Carboniferous rocks were uplifted and tilted gently westwards at the end of the Carboniferous Period during the Variscan Orogeny. The sequence was then eroded down to the Lower Westphalian / Upper Namurian level during the Permian and deposition resumed in the Lower Triassic above the unconformity. Thus, this unconformity represents about a 65 million year time gap.

LOCATION MAP



A project managed by **Richard Waller** and **Ian Stimpson** on behalf of the Staffordshire RIGS Group with financial support from the Staffordshire Aggregates Levy Grant Scheme 2007. Text and photos by **Patrick Cossey, Peter Floyd, John Reynolds, Ian Stimpson** and **Richard Waller** unless otherwise stated. Design by **Rosie Duncan.**

The Staffordshire RIGS Group gratefully acknowledge the support of:

- British Geological Survey
- Forestry Commission
- National Trust
- North Staffordshire Railway
- WBB Minerals Ltd
- Landmark Publications (LP)
- Staffordshire Moorlands Community & Volunteer Services
- Staffordshire Moorlands District Council

A member of UKRIGS, the Staffordshire RIGS Group is a voluntary organisation responsible for the conservation of regionally important geological and geomorphological sites in Staffordshire. For more information contact:
Staffordshire RIGS - **www.staffs-rigs.org.uk**
North Staffordshire Group Geologists' Association - **www.esci.keele.ac.uk/nsgga**
Staffordshire Wildlife Trust - **www.staffs-wildlife.org.uk**

This trail is dedicated to the memory of Ken Rout, founding member of SRIGS.

Remember to follow the country code and please do not hammer the rock surfaces. Be safe, plan ahead and follow any signs; leave gates and property as you find them; protect plants and animals and take your litter home. Keep dogs under close control and consider other people.

Printed by MC Print Services Tel: 01782 370080 *Cover photograph: Star Wood*

Staffordshire County Council
Staffordshire ALSF Aggregates Levy Grant Scheme
defra
KEELE UNIVERSITY
North Staffordshire Group Geologists' Association 1858 1948
STAFFORDSHIRE UNIVERSITY
The Wildlife Trusts Staffordshire

The Churnet Valley Geotrail

True Grits and Ghosts of a Great Industrial Past

Staffordshire RIGS Group

The Churnet Valley Geotrail

INTRODUCTION

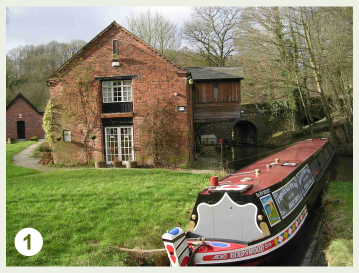
Welcome to the Churnet Valley Geotrail. This geotrail is designed to give the visitor a glimpse of the rocks, minerals, fossils and industrial heritage of the area which is intimately linked to the local geology. The whole trail is 25km long, which is probably too long to be tackled all in one go. We strongly recommend that it should be completed in sections from the access points at Froghall Wharf, Oakamoor, Rambler's Retreat, Hawksmoor Nature Reserve and Highshutt. Alternative routes to make shorter circular walks are indicated in this guide in *italics*.

The trail mainly follows public footpaths and other marked trails, including part of the Staffordshire Way, but **visitors should note that some of these have steep sections and muddy, uneven terrain** and the use of suitable footwear is advised. **There are also some sections along minor roads where particular care should be taken of the traffic.**

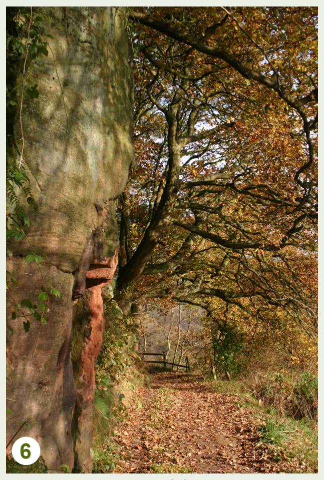
Visitors are encouraged to view all features of interest from the geotrail itself unless a permitted access route away from the trail is indicated. To fully appreciate the trail, visitors will find it useful to read the background information overleaf. The age of rock units can be found in the column at the top right of this page.

FROGHALL WHARF - WHISTON 1 - 12

From the historic Froghall Wharf **1** follow the Froghall 'Green Walk' towards Foxt. The path follows the outcrop of the Froghall Ironstone. Look out for several old mineshafts and a stream which dissects red mine spoil **2**. *If the bridge is closed, return down the trail to a path on the left across a stream. Take the left fork after 100m to stops* **3** *and* **4** *and then rejoin the trail.* In Whieldon's Wood **3** the Woodhead Hill Sandstone is exposed in the stream. Upstream, look out for an ochre layer from the processing of ironstone for coloured dye. The trail passes an outfall **4** draining a mine in the overlying Crabtree Coal and then climbs out of the valley past more coal workings.


1

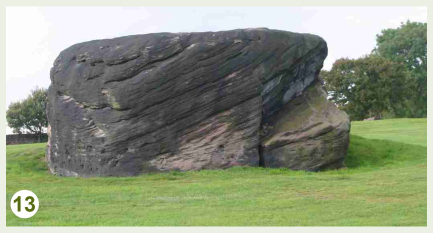
Continuing towards Foxt, a break in slope **5** marks the line of a fault, separating the Rough Rock sandstones of Namurian age from the younger Westphalian mudstones down in the valley. From this point onwards notice the use of different sandstones in buildings and walls. From Foxt, follow the road downhill and take a footpath on the left to an exposure **6** of red/orange Chatsworth Grit. Beyond the stile, head down to Shirley Brook. A short detour left leads to a tramway bridge and an exposure of the Roaches Grit **7**. In the next valley **8**, Namurian mudstones are exposed providing a rare glimpse of this dominant Carboniferous rock type.


6

The trail climbs back up to the tramway cutting **9** in Chatsworth Grit. Look out for the bleaching of the sandstone next to minor faults. *An alternative route back to Froghall Wharf follows this tramway downhill.* Return uphill and take the right fork **10**. Cross Whiston Common and turn right, over the A52 and take Black Lane into Whiston village **11**, **12**. Try to locate buildings made of blocks of copper slag, waste from the Whiston smelter, now demolished. *From Whiston, an alternative route back to Froghall Wharf continues along the lane to the A52, before following a footpath along a former tramway back to the start of the trail.*

WHISTON - RAMBLER'S RETREAT 13 - 27

Return to the footpath crossing the golf course eastwards to the prominent block of Rough Rock **13** showing large scale cross-bedding formed by a Namurian river. ***Which way do you think the river was flowing?*** Try to find contortions of the bedding due to water escape as the sediment compacted and solidified. The trail follows a wall of local rock to a view **14** over Moneystone Quarry (**do not enter**). Rock Cottage **15** is built into the Rough Rock at one end.


13

Follow the road to the right and then immediately take the first footpath on the left, next to a wall. After 300m turn right across a field. Continue down to a farm track and turn right along a terrace. In this area (Cotton Dell), steeper slopes relate to the outcrop of resistant sandstones and grits whilst gentler slopes occur on softer mudstones. The terrace here **16** is associated with a mudstone within the Chatsworth Grit. Lower down is another terrace in mudstone on top of the Roaches Grit. River erosion has cut down through more mudstone to the Ipstones Sandstone at the valley bottom. A fault along the valley then repeats the sequence with Roaches Grit forming the ridge at Cotton College. The Ipstones Sandstone forms the ridge on the horizon with the Carboniferous Limestone outcrops at Ribden and Caldon Low lying beyond.

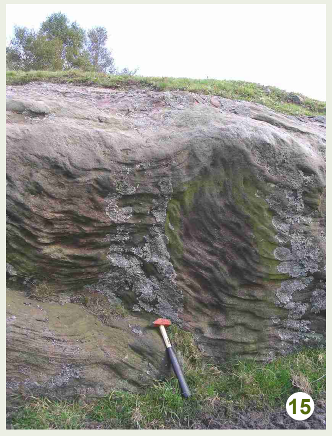

14

Continue south to a sharp left turn and follow the path to the bottom of Star Wood. Turn left up the valley to a point where it meets a path from the right **17**.

The fine grained, dark red/brown Ipstones Sandstone exposed here is the oldest rock on the trail. As the dip of the beds is steeper than the gradient of the valley, the rocks get progressively younger downstream towards Oakamoor. In the stream bed **18** is a red/buff iron-rich limestone. This unit, and the mudstones above, contain the marine goniatite *Reticuloceras gracile*; those below, have the land plant fossil *Calamites*. Here is fossil evidence of global sea-level change in Carboniferous times. Further south **19** mudstones contain more goniatites and a thin ironstone band. Return past the bridge **20**, through the poorly exposed Roaches Grit. Mudstone blocks containing fossils occur in the river **21**. Further downstream, the Chatsworth Grit forms a large cliff in the opposite side of the valley **22**.

This grit is accessible below the bridge **23** whilst down in the stream purple siltstones occur at the base of the unit. The trail now descends into historic Oakamoor **24**. Here, *an excellent industrial archaeological trail can be followed around the village*. Our trail continues along the Oakamoor-Denstone 'Greenway' following the track bed of the former Churnet Valley Railway and line of the Uttoxeter Canal. South of Oakamoor Station **25** the Chatsworth Grit outcrops again. Beyond is a fault where Carboniferous rocks are replaced by Triassic sandstones. Close by, the River Churnet **26** is a classic example of a misfit river meandering across its wide sediment-filled valley floor.

Just before Lord's Bridge **27** the Triassic Hawksmoor Sandstone is exposed. These include red cross-bedded sandstones and conglomerates deposited by rivers. From the cross-bedding it is possible to work out which way the Triassic rivers were flowing. ***How does this compare with the Carboniferous river deposits at* 13 *and the modern Churnet?*** Cross Lord's Bridge towards the Rambler's Retreat.

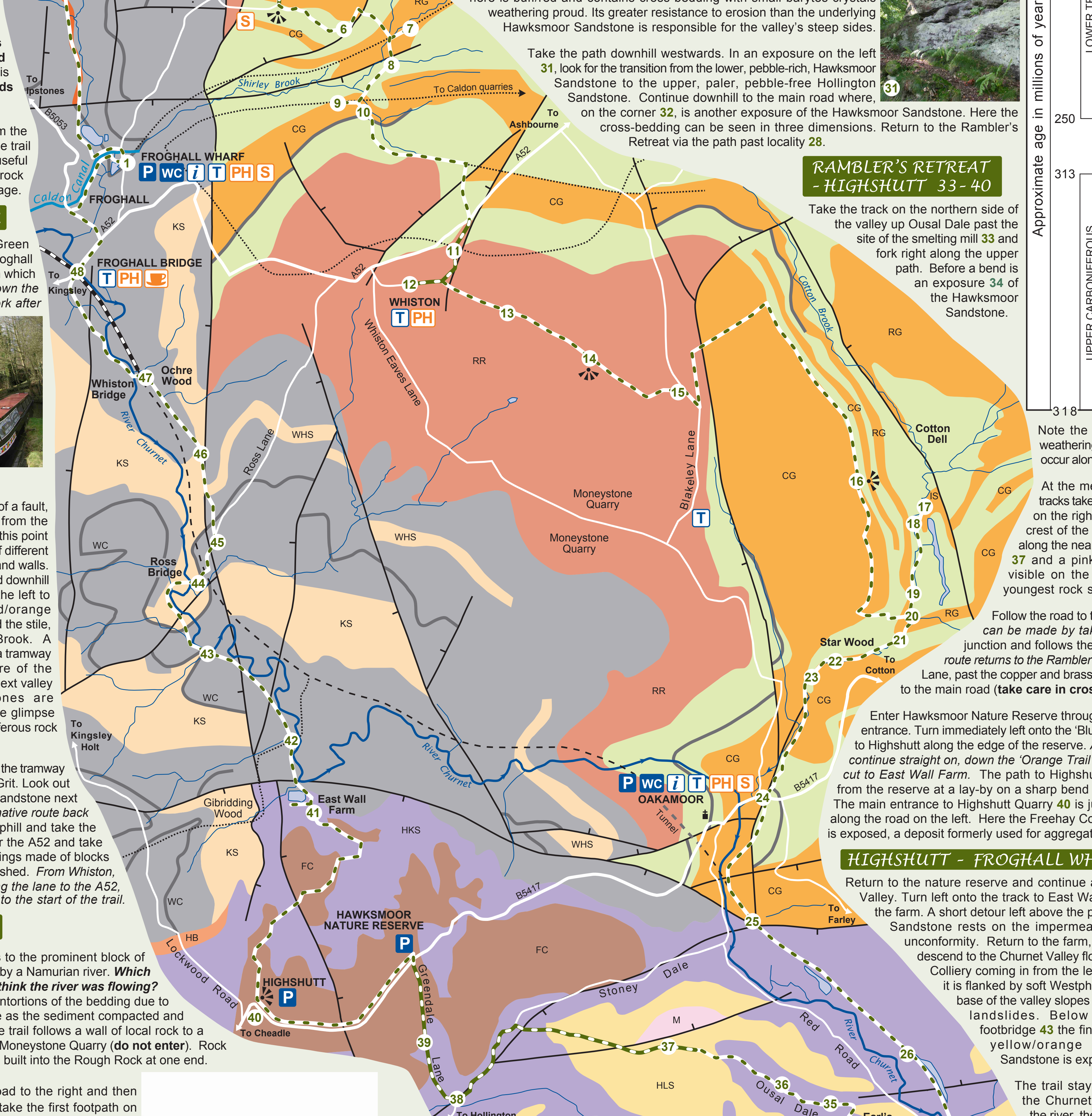

15


16

KEY

- GEOTRAIL
- GEOTRAIL / road shared
- River
- Canal
- Railway
- Disused railway
- Disused tramway
- View point
- Fault with direction of downthrow
- Major road
- Minor road
- 1 Interest Point
- P Car Park
- WC Toilets
- i Information
- T Telephone
- PH Public House
- S Shop
- Café

0 — 1 km

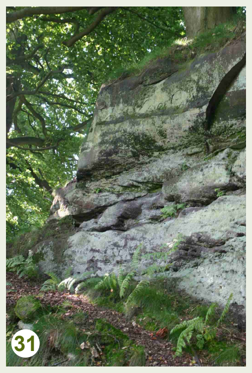


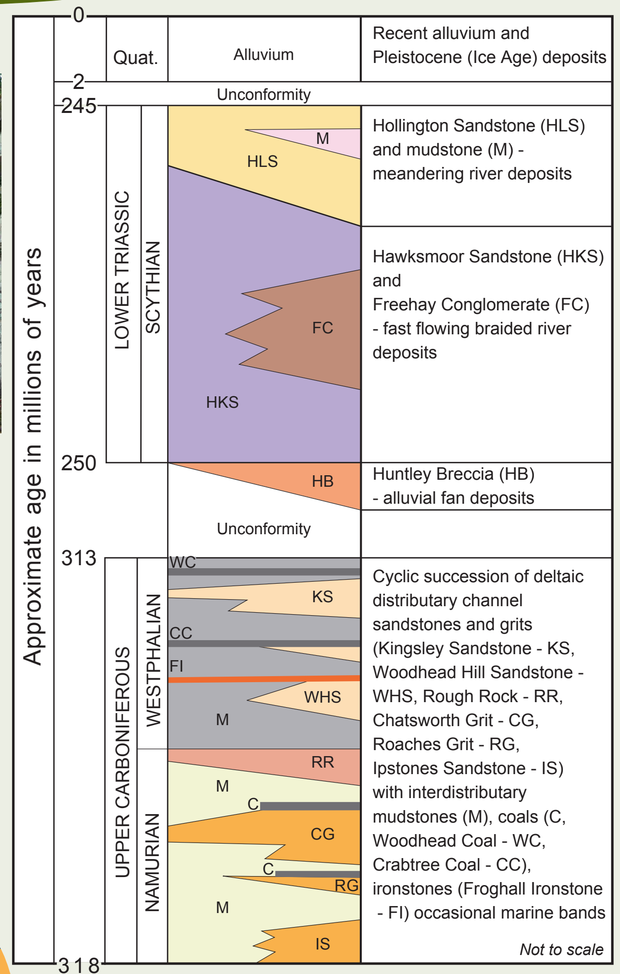
RAMBLER'S RETREAT - TOOT HILL LOOP 28 - 32

From the back of the car park follow the wide path to the left. Beyond a left fork is another exposure of the Hawksmoor Sandstone **28**, a red/brown cross-bedded sandstone with occasional pebbles.

On reaching the main road turn right. Follow the road and bear left onto a path up Rakes Dale **29**, a dry valley. 100 metres after joining a road towards the top of the dale, take a sharp left turn back towards Toot Hill **30** for a panoramic view over the Churnet Valley (**keep away from the edge**). The Hollington Sandstone here is buff/red and contains cross-bedding with small barytes crystals weathering proud. Its greater resistance to erosion than the underlying Hawksmoor Sandstone is responsible for the valley's steep sides.

Take the path downhill westwards. In an exposure on the left **31**, look for the transition from the lower, pebble-rich, Hawksmoor Sandstone to the upper, paler, pebble-free Hollington Sandstone. Continue downhill to the main road where, on the corner **32**, is another exposure of the Hawksmoor Sandstone. Here the cross-bedding can be seen in three dimensions. Return to the Rambler's Retreat via the path past locality **28**.


31



RAMBLER'S RETREAT - HIGHSHUTT 33 - 40

Take the track on the northern side of the valley up Ousal Dale past the site of the smelting mill **33** and fork right along the upper path. Before a bend is an exposure **34** of the Hawksmoor Sandstone.

Note the thin conglomerate, a small fault and honeycomb weathering here. Further exposures with thicker conglomerates occur along this path **35**, **36**.

At the meeting of several tracks take the path upwards on the right to a road at the crest of the hill. A fault runs along the near side of the pond **37** and a pink mudstone unit visible on the far bank is the youngest rock seen on the trail.


39

Follow the road to the T-junction. *An alternative route back to Oakamoor can be made by taking the road to the right.* The trail turns left at the junction and follows the road to Old Furnace **38**. *Here, another alternative route returns to the Rambler's Retreat via Dimmings Dale.* Turn right up Greendale Lane, past the copper and brass workers' cottages **39**, noting the date of construction, to the main road (**take care in crossing**).

Enter Hawksmoor Nature Reserve through the stone entrance. Turn immediately left onto the 'Blue Trail' path to Highshutt along the edge of the reserve. *Alternatively continue straight on, down the 'Orange Trail' for a short-cut to East Wall Farm.* The path to Highshutt emerges from the reserve at a lay-by on a sharp bend in the road. The main entrance to Highshutt Quarry **40** is just downhill along the road on the left. Here the Freehay Conglomerate is exposed, a deposit formerly used for aggregate.


40

HIGHSHUTT - FROGHALL WHARF 41 - 48

Return to the nature reserve and continue along the 'Blue Trail' descending into the Churnet Valley. Turn left onto the track to East Wall Farm **41**. The footpath passes to the left, above the farm. A short detour left above the pond leads to springs where the porous Hawksmoor Sandstone rests on the impermeable Westphalian mudstones. This contact is an unconformity. Return to the farm, the site of a mediaeval iron bloomery, turn left and descend to the Churnet Valley floor **42**. Look out for the tramway from the Woodhead Colliery coming in from the left. Here the valley opens out with gentler slopes as it is flanked by soft Westphalian mudstones. Note the hummocky terrain at the base of the valley slopes caused by landslides. Below a small footbridge **43** the fine grained, yellow/orange Kingsley Sandstone is exposed.


41

The trail stays close to the Churnet, crossing the river, the Uttoxeter Canal and Churnet Valley Railway at Ross Bridge **44** where soft grey Westphalian mudstones occur. The trail rises to a fork **45** where a modern day crescentic landslip scar can be seen exposing grey mudstone. Fork left and look for a gully between the two paths which marks the position of the worked-out Crabtree Coal, and continue to a gate **46**.

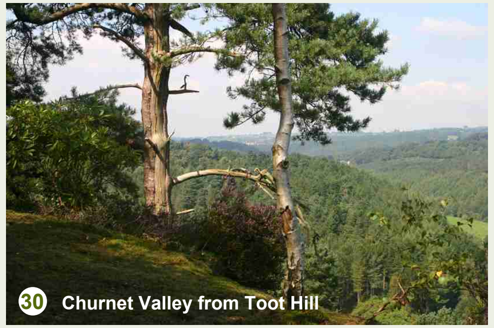
Here the trail crosses a fault, the same as that seen at locality **5**, passing from the Woodhead Hill Sandstone to the Kingsley Sandstone. The valley now becomes gorge-like again with the resistant Kingsley Sandstone in the steep valley sides and softer mudstones in the valley floor. At Ochre Wood **47**, probably a reference to the manufacture of ochre from local ironstones, re-cross the railway (**beware of trains**). Cross the Churnet via Whiston Bridge and continue to Froghall **48**. Turn right along the A52 past Bolton's copper and brass works and then left along the B5053 Ipstones road. Turn right onto the canal path back to Froghall Wharf to finish the trail.


42

Reproduced from Ordnance Survey Mapping with the permission of Her Majesty's Stationery Office, © Crown Copyright 2008, Staffordshire Wildlife Trust License. AL 100032203. Geological Information based upon BGS Geological Map Sheet 124 (Ashbourne & Cheadle, S & D) at 1:50 000 scale with permission IPR/97-19C British Geological Survey © NERC. All rights reserved.

GEOMORPHOLOGY

The Churnet Valley is renowned for its steep-sided and dramatic character and this has led to the area being nicknamed “Little Switzerland”. Today, its sheer size is at odds with the placid misfit river meandering across its picturesque floor. However, during the last Ice Age 18,000 years ago, part of the British ice sheet penetrated the upper part of the Churnet Valley. Torrents of meltwater flowing under the ice and issuing from the glacier margin caused huge amounts of erosion and sediment transport, creating the valley’s present form. Changes in the valley’s width and depth reflect variations in the resistance of the underlying rocks to erosion. The gorge-like sections pass through resistant sandstones and more open areas are floored by softer mudstones. The ice sheet also caused a complete reversal of the river’s direction. Previously, the Churnet flowed north from Froghall to the north of Cheddleton before turning west and joining the Trent drainage system at Endon. When ice blocked this route it forced the river to flow southward and erode its present course.


30 Churnet Valley from Toot Hill


Present day meltwater valley in Greenland

Incision and the creation of the valley’s steep sides led to numerous landslides, particularly in areas underlain by weak mudstones. Down-cutting of the main valley also “rejuvenated” the tributary valleys as they attempted to erode down to the new lower level of the Churnet. Their erosion was not caused by glacial meltwater, but by the action of seasonal snowmelt streams. These flowed across the frozen ground in front of the ice sheet and left a series of dry valleys, which currently have no surface streams.


29 Rakes Dale dry valley

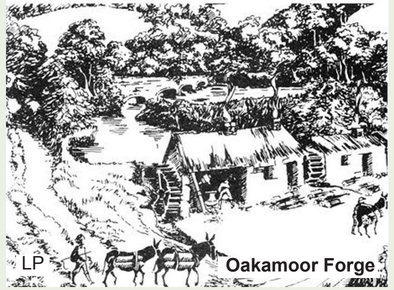
INDUSTRIAL HERITAGE

From the 16th to 19th centuries the Churnet Valley was the scene of intense industrial activity, with furnaces, forges, mills and mines. The underlying bedrock of the valley contained ores of iron, copper and lead, as well as coal, limestone and sandstone. The River Churnet provided water power and the woods provided charcoal. Tramways were constructed to carry limestone from the Caldon Low quarries and local coal and ironstone to the Caldon (1778) 1 and Uttoxeter (1809) 1, 24-27, 44 canals. The Churnet Valley Railway (1849) 24-27, 44, 47, 48 transported industrial sand and copper products from Oakamoor onto the rail network.


Churnet Valley Railway 48

Iron

A medieval iron bloomery existed at East Wall 41 in the 12th-14th centuries. Ironstone from the local Coal Measures was mixed with charcoal and limestone, covered with turf and heated to separate the iron. On cooling, the slag was raked from the iron mass (or pig). An iron forge (hammer mill), using water power, is recorded at Oakamoor 24 in 1573. One of the first iron furnaces equipped with bellows geared from a water wheel was built in 1593 at Old Furnace 38. The Froghall Ironstone seam was mined around Froghall where spoil is still visible 2.



Oakamoor Forge


2 Mine Spoil

INDUSTRIAL HERITAGE

The last use of iron ore was for the production of ochre pigment for paint and dyes at Froghall 48.

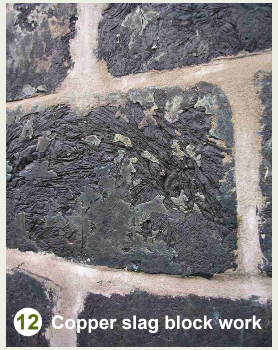

48 Colour works, Froghall Bridge

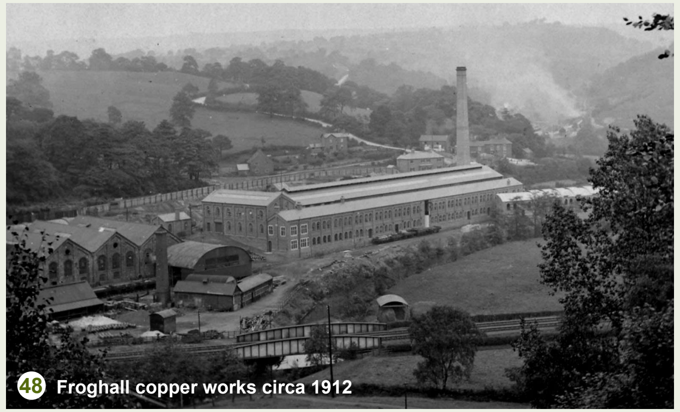

3 Ochre staining

Copper

Copper wire manufacture and brass (copper & zinc) production replaced iron smelting. The Cheadle Brass & Copper Co., was set up in 1734. Extensive mining of copper ore at Ecton in the Manifold Valley required building a new copper smelting works at Whiston (1768) 11. Blocks of copper slag can be seen in local buildings and walls 11, 12. By 1828 most copper wire production was handled at the new mills at Oakamoor 24. A row of terraced cottages built for brass workers can be seen at Greendale 39. By 1834 all copper wire interests had been bought by Thomas Bolton & Son Ltd. of Birmingham and produced at their Froghall factory 48.


12 Copper slag, Whiston


12 Copper slag block work


48 Froghall copper works circa 1912

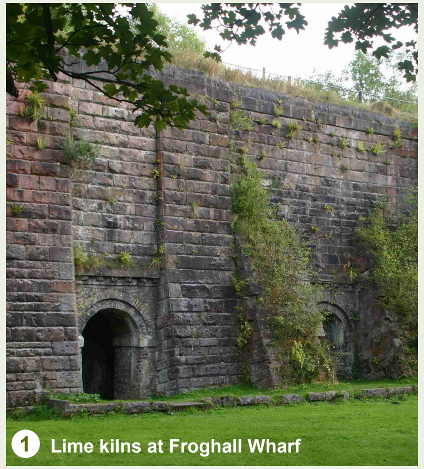
INDUSTRIAL HERITAGE

Lead

For a short time in the mid 1700s, lead mined at Ribden, near Farley, was smelted at the smelting mill in Ousal Dale 33.

Limestone

In 1775 the Caldon Low quarries were leased to Caldon Lime Co. A tramway from the quarries to the Caldon Canal 1 at Froghall Wharf was part of the Canal Act. Several tramway lines were built (1778) 7, (1785) 10, (1804) 11 and (1847) 9. In many places lime kilns can be seen as at Froghall Wharf 1 and Oakamoor 24. These were used to burn limestone to make lime for use in agriculture and construction. The limestone was and continues to be used as a flux in iron smelting and, with mudstone, in the manufacture of cement.


1 Lime kilns at Froghall Wharf

Coal

Coal had long been used as a fuel, though not in early smelters as only charcoal generated the necessary heat. Mine shafts can be seen north of Froghall 2, 5 and this trail follows several former tramways. The Woodhead Tramway from mines near Cheadle to the Uttoxeter Canal is crossed below Gibridding Wood 42.


Disused tramway

Sandstone and Conglomerates

Sand has been extracted from the Rough Rock at Moneystone 14 for glassmaking and the Freehay Conglomerate quarried for aggregates at Highshutt 40 and Croxden. The sandstones are also used widely in the building industry. The Hollington Sandstone for example is used in many Staffordshire buildings including Pugin’s St. Giles Church at Cheadle (1846).


Quarried Rough Rock, Moneystone