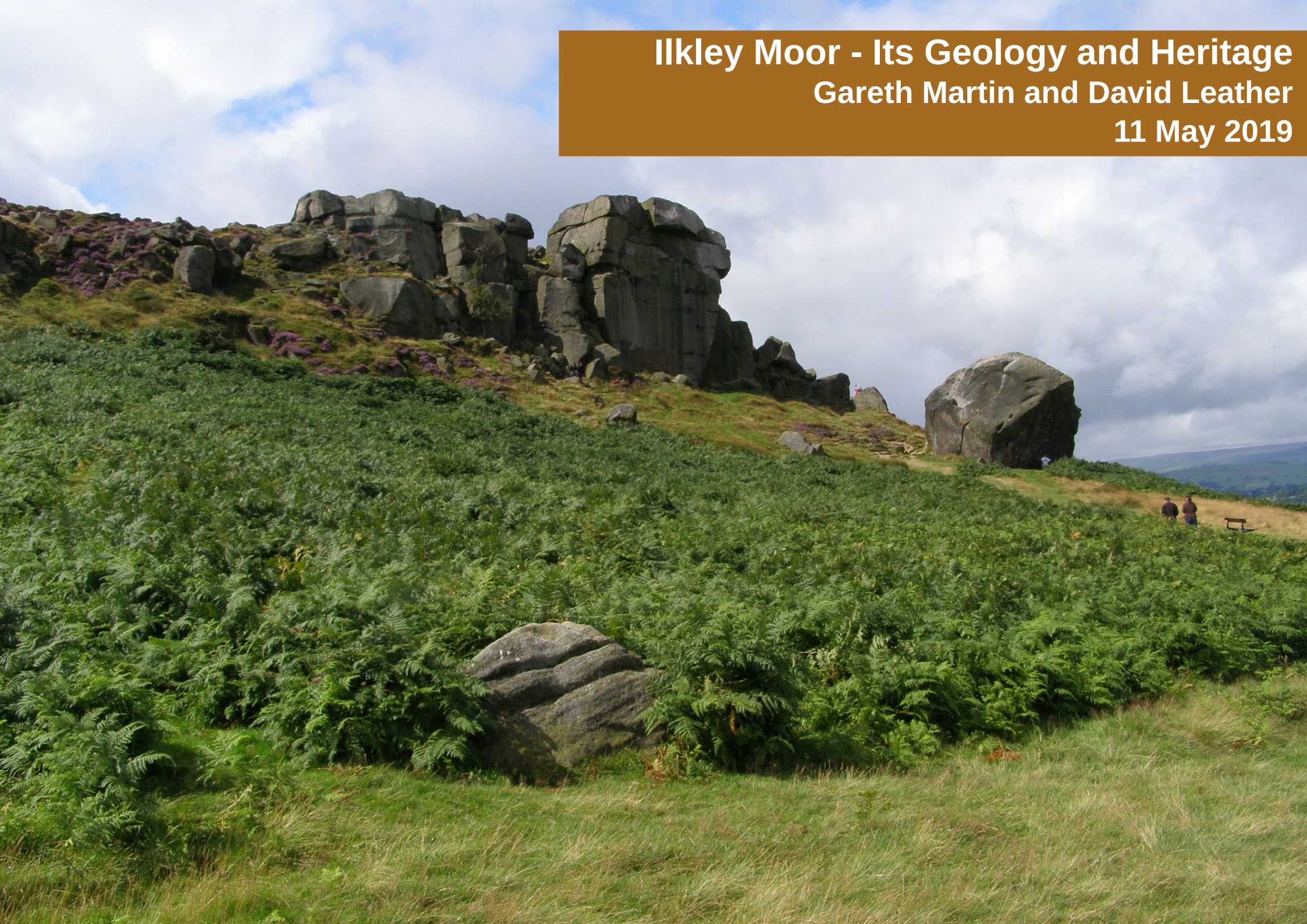
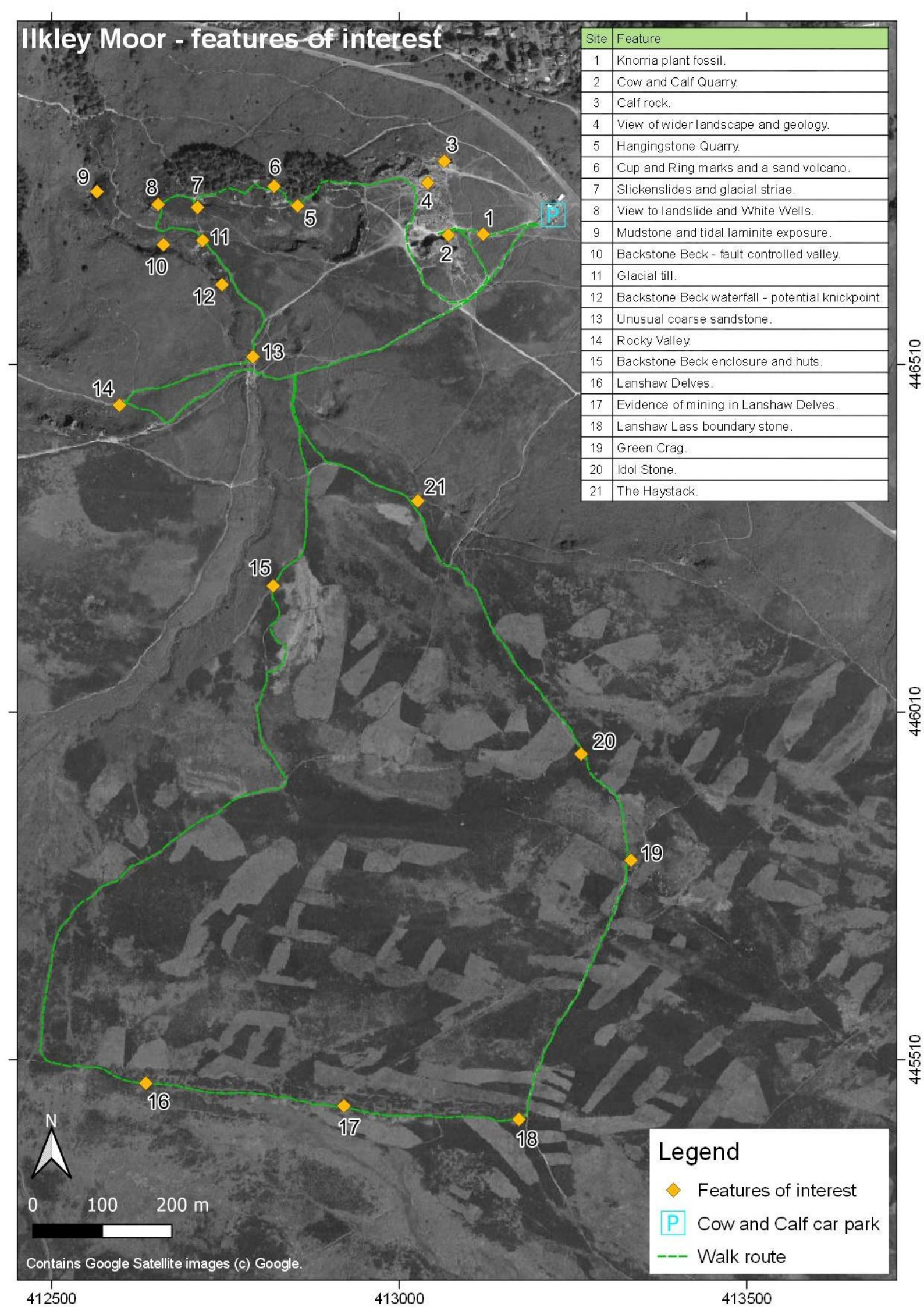
Ilkley Moor - Its Geology and Heritage

Gareth Martin and David Leather

11 May 2019




Ilkley Moor - features of interest
Site | Feature
1 | Knorria plant fossil.
2 | Cow and Calf Quarry.
3 | Calf rock.
4 | View of wider landscape and geology.
5 | Hangingstone Quarry.
6 | Cup and Ring marks and a sand volcano.
7 | Slickenslides and glacial striae.
8 | View to landslide and White Wells.
9 | Mudstone and tidal laminite exposure.
10 | Backstone Beck - fault controlled valley.
11 | Glacial till.
12 | Backstone Beck waterfall - potential knickpoint.
13 | Unusual coarse sandstone.
14 | Rocky Valley.
15 | Backstone Beck enclosure and huts.
16 | Lanshaw Delves.
17 | Evidence of mining in Lanshaw Delves.
18 | Lanshaw Lass boundary stone.
19 | Green Crag.
20 | Idol Stone.
21 | The Haystack.
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Legend
Features of interest
Cow and Calf car park
Walk route
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446010
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412500
413000
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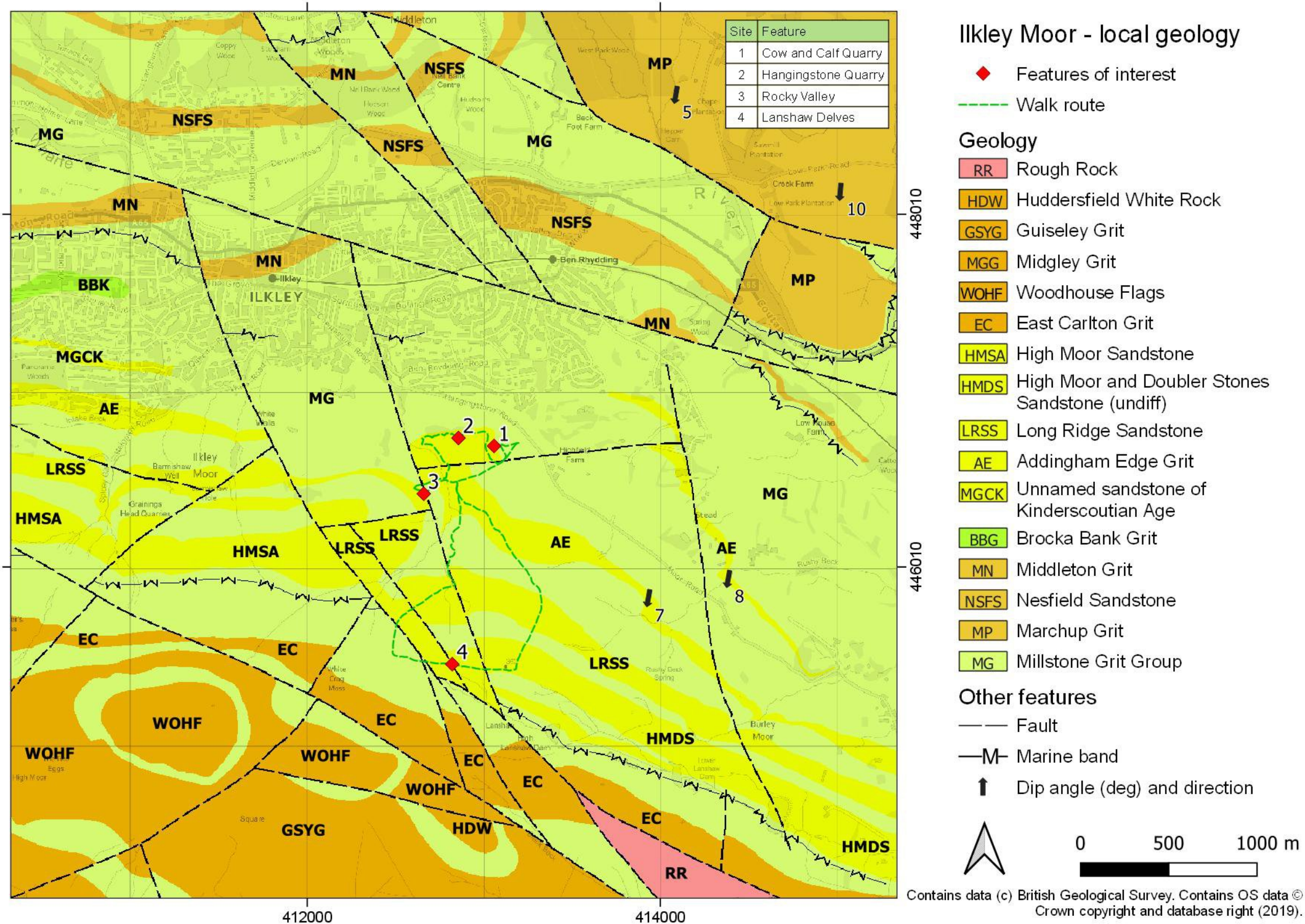
Site | Feature
1 | Cow and Calf Quarry
2 | Hangingstone Quarry
3 | Rocky Valley
4 | Lanshaw Delves
Ilkley Moor - local geology
Features of interest
Walk route
Geology
RR Rough Rock
HDW Huddersfield White Rock
GSYG Guiseley Grit
MGG Midgley Grit
WOHF Woodhouse Flags
EC East Carlton Grit
HMSA High Moor Sandstone
HMDS High Moor and Doubler Stones Sandstone (undiff)
LRSS Long Ridge Sandstone
AE Addingham Edge Grit
MGCK Unnamed sandstone of Kinderscoutian Age
BBG Brocka Bank Grit
MN Middleton Grit
NSFS Nesfield Sandstone
MP Marchup Grit
MG Millstone Grit Group
Other features
Fault
Marine band
Dip angle (deg) and direction
0 500 1000 m
448010
446010
412000
414000
ILKLEY
Ben Rhydding
Middleton
Ilkley Moor
Burley Moor
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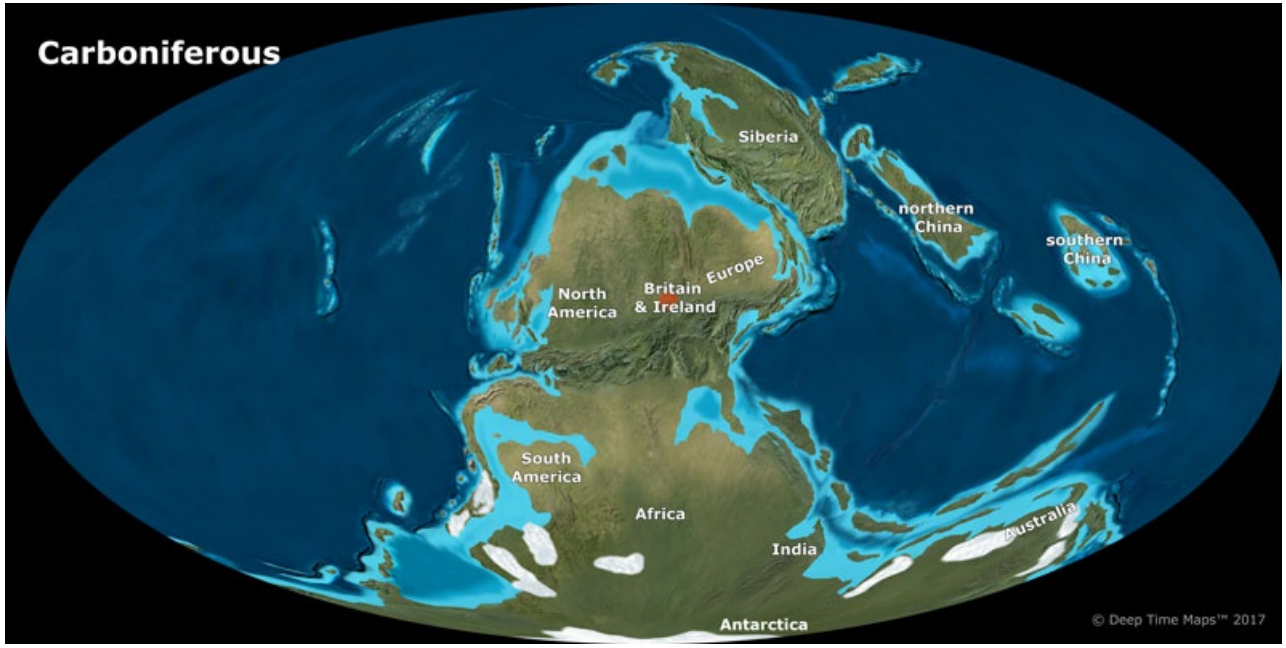
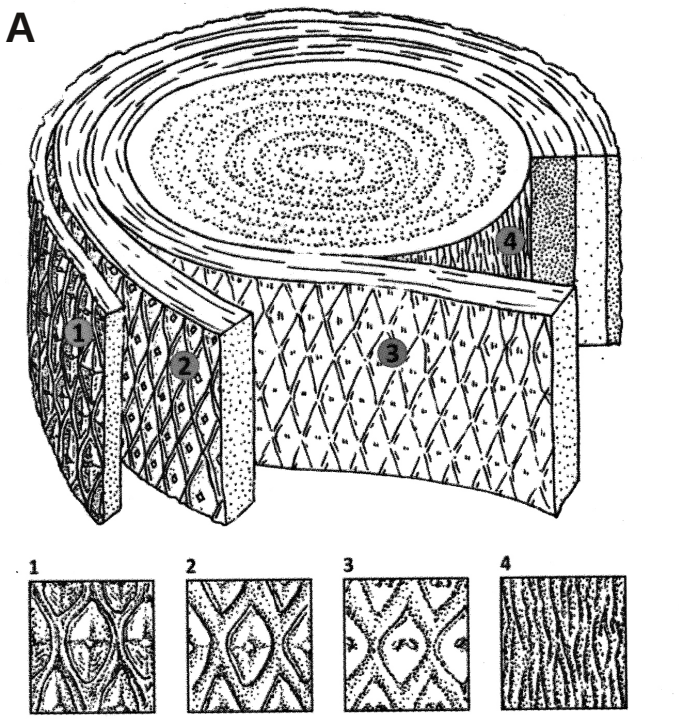
Yorkshire, 318 million years ago



Around 318 million years ago in the Late Carboniferous the “UK” was located at equatorial latitudes (map to left). Evidence from erosion and vegetation indicates that the climate at this time was tropical and humid with high rates of rainfall. The “UK” was part of a large belt of marine and continental sediment deposits, with a large subsiding sea-filled basin, the Pennine Basin, being a key feature of this belt. Ilkley Moor was on the northern shore of this sea Sea level commonly rose and fell as ice sheets melted and froze. Generally sea levels were between 50-100m lower than they are today.

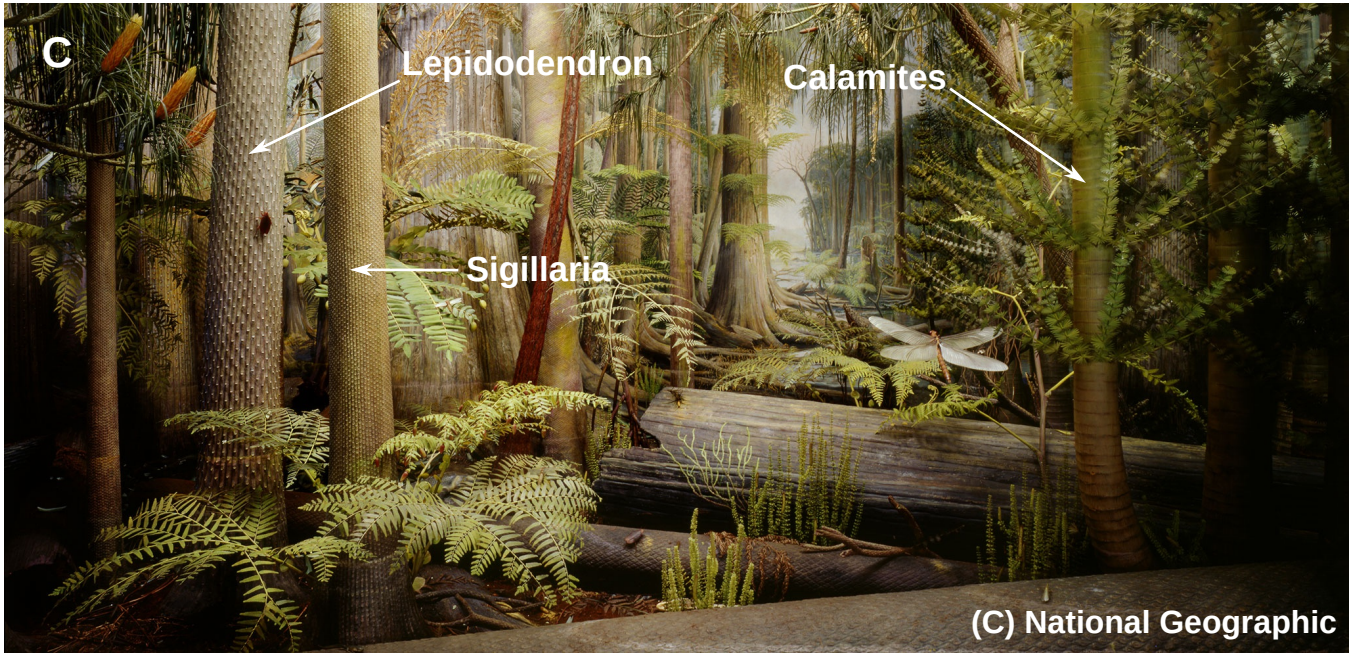
At this time extensive delta systems formed along the coast which were fed by huge rivers, many very similar to the braided river in the image to the right. These rivers flowed southwards, draining a huge mountain range(s) surrounding the “UK”, and deposited up to 1.8km of sediment into the basin. As time marched on through the Carboniferous the huge rivers and deltas remained but sea levels stablised allowing lagoons and lakes to form on and between the deltas, leading to the formation of coal swamps and coal in the Coal Measures rocks which are younger than the rocks we see on Ilkley Moor today (and can be found to the east and south east of Ilkley Moor). The rocks you see on, and around, Ilkley Moor, were laid down during the Namurian stage of the Carboniferous (326-315 million years ago). An outline of the bedrock geology on and around the moor can be found on page 3.

Site 1 - fossil plants



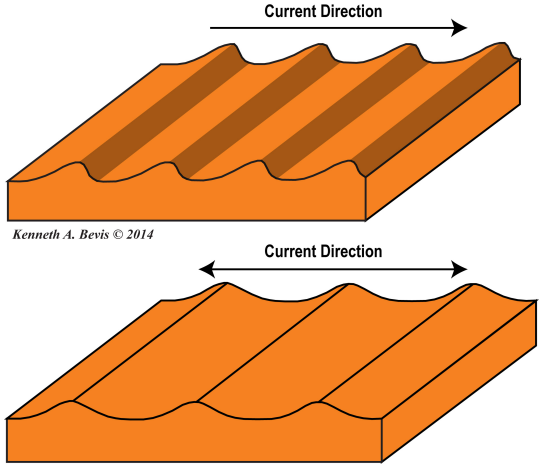
Immediately adjacent to the path from the car park and prior to the entrace to Cow and Calf Quarry, you will find a large boulder containing the imprint of a Late Carboniferous plant fossil (photo B). During the Late Carboniferous, much of the UK was covered in dense forests which were often swampy (photo C). Many of the plants growing at the time in the warm and humid climate were commonly large ferns with relatively soft and pithy interiors with a scaly outer surface, which could grow up to 30m or greater in height. The most famous of these are Lepidodendron, Sigillaria and Calamites, examples of which can be seen in photo C. These forests were of huge economic importance (and climatological importance) as the death, decay and preservation of these vegetation created the coal which has been mined and burned around the Earth.

The fossil you can see in the rock is a beautiful example of Knorria. This is a fossil imprint of the inner pithy layers of a Lepidodendron, which has been decorticated, i.e. the outer layers of bark have been shed (photo A). It is very likely that the fossil of Knorria was swept into one of the many rivers which flowed around this area at the time rather than growing in the river itself. This shows that while we are standing on the remains of a river there were likely to be swamps and forests growing somewhere along the banks.



Site 2 - Cow and Calf Quarry

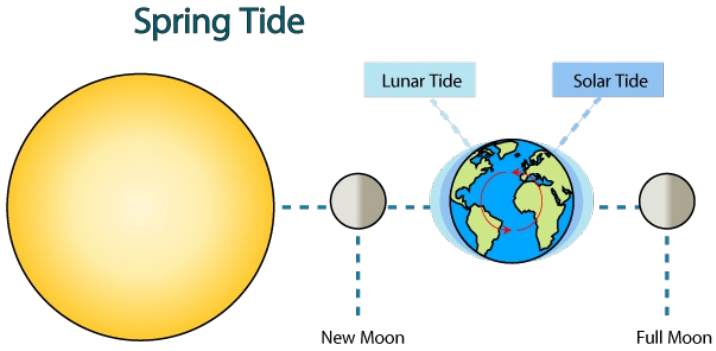
At Site 2 we enter the Cow and Calf Quarry. The rock you can see all around you is the Addingham Edge Grit, a very coarse Namurian sandstone which is between 15-55m in thickness around the area where it outcrops (e.g Cayley Crags, Addingham High Moor and Ilkley Crags). It is made mostly of large grains of quartz, including pebbles, with some feldspars. You will also see lots of cross bedding, which are sedimentary features that show the material which makes up the rock was laid down in relatively large sand dunes on the bed of a river, a braided one like described earlier. Feldspar is quite a weak mineral and weathers easily and is readily destroyed when transported in rivers, so the presence of it in this rock suggests that the source of the sediment to the river which eventually formed the Addingham Edge Grit was fairly local. Using cross bedding measurements taken from the Addingham Edge Grit we can identify that the rivers flowed from the north (as noted earlier), draining a huge eroding mountain range. We can also tell that the river was flowing at a speed of between 0.5-1.0m/s when these cross beds were deposited and was likely several metres deep.

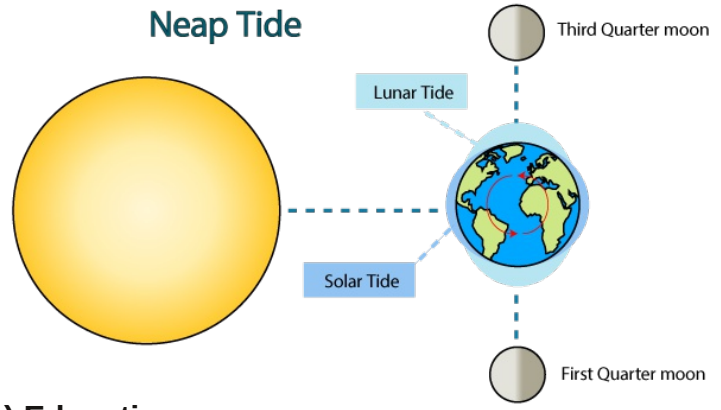


However, things are not all what they appear. As you enter the quarry you can find two features, both beautiful and one very rare. To your left are some ripple marks. Such features are found in both rivers and the sea (think of ripples in sand at the beach) and are formed by moving water currents. Depending on the style of ripple, you can identify the direction of water movement (top right figure). Asymmetrical ripples being formed in a uni-directional current (likely a river) and symmetrical ripples being formed in a bi-directional current (likely a marine environment). It's hard to tell which is which here, although the ripples seem slightly asymmetric. Ripples tend to form in water flows with much lower speeds than the dunes (and cross bedding), here likely less than 0.5m/s.

The other rare feature of interest is the thin laminated sediments located at the right side of the entrance and also in the floor of the quarry entrance. These are tidal laminites. They were originally identified by Dr Neil Aitkinhead within boreholes drilled on the moor and were the first tidally deposited sediments found in England. You can also see laminites in Backstone Beck (Site 9) and at Otley Chevin. The laminites are between 3-15mm thick, comprising of alternating layers of grey-brown siltstone and dark mudstone. The laminae become thicker and thinner in groups of 28, representing the progression of the spring and neap tidal cycles over one 28 day lunar cycle (bottom right figure). The mudstone likely represents the tide slack periods when tidal water was calm, with the siltstone representing flood periods when the tidal water was moving faster. In the Carboniferous, tidal ranges were likely to be 15% higher than they are now as the moon was closer to the Earth (exerting a greater gravitational pull). However, the tidal range was still likely to be small here, (~1m) due to the relatively landlocked location of the Pennine Basin.

The evidence above points to the rocks on the entrance floor of the quarry having been formed at the mouth of the river towards the seaward front of a delta on the shores of the Pennine Basin which was affected by tides, with the rocks higher up in the quarry being formed in the river itself.





Site 3 - The Calf

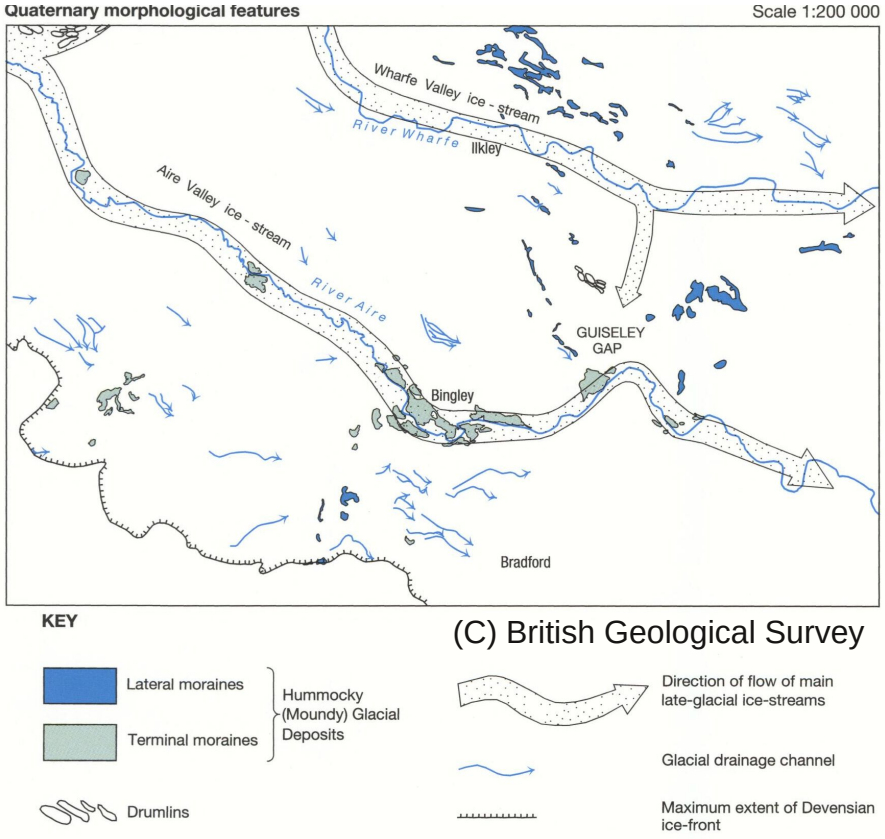
One of the most famous features of Ilkley Moor is the Cow and Calf Rocks. These rocks are formed from the Addingham Edge Grit which makes up the rocks in the Cow and Calf Quarry and the surrounding crags which flank the immediate margins of the southern side of the Wharfe Valley. The most prominent feature at the site is the Calf rock itself. This huge boulder is 8m high and of a similar width. It is located 25m north east and downslope of the crag, called the Cow. The Calf itself sits on a slope of around 17 degrees, which is fairly steep. Estimates of its weight place it at around 1000 tonnes. We can use the composition of the rock and the sedimentological features within the rock (such as cross bedding) to indicate that the Calf was definitely part of the Cow at one point in the past.

So how did the Calf get into its current location? There is the folk tale of Rombald the Giant. He was chased by his angry wife over Rombalds Moor and during this marital pursuit his foot knocked the Calf off the crag. While this tale is certainly entertaining it is not scientifically accurate! During the Last Ice Age (~10,000 – 12,000 years ago) Wharfedale was covered by a large ice sheet which formed during the last major glaciation, called the Dimlington Stadial. There is evidence all around the moor for this glaciation (of which we shall see beautiful examples of later). It is likely that the action of the ice covered the crags by up to 100m and the erosive power of the ice and subsequent weathering as the ice sheet melted and retreated led to the detachment of the Calf from the Cow as a topple rockfall. Looking closely at the Calf, the cross-bedding indicates that the Calf has rotated slightly in a downslope direction. It is likely that the western face of the Calf was attached to the adjacent crag and when it fell it rotated nearly 140 degrees and slid along the hillslope surface. While it is not known for certain, it is likely that the Calf was prevented from tumbling into the valley as it fell onto the margin of the ice sheet in the Wharfe Valley. As the ice melted it was gradually lowered onto the hill side and seems to have moved slightly downslope in a sliding fashion under its own weight, as evidenced by the shallow ridge of material on the eastern front of the Calf.

The top of the Calf has some interesting features of its own, notably rills which were likely formed predominantly by the action of rainfall running off the surface over the course of thousands of years. You can see these on other rocks on Rombalds Moor.

For more information see Neil Aitkenhead's article *"How did the calf get there? Ilkley Moor, and the Cow and Calf Rocks", Geology Today, Volume 19, No. 5, September-October 2003. p179-180*, from which much of the aforementioned information was gleaned.

Site 4 - The Wharfe Valley

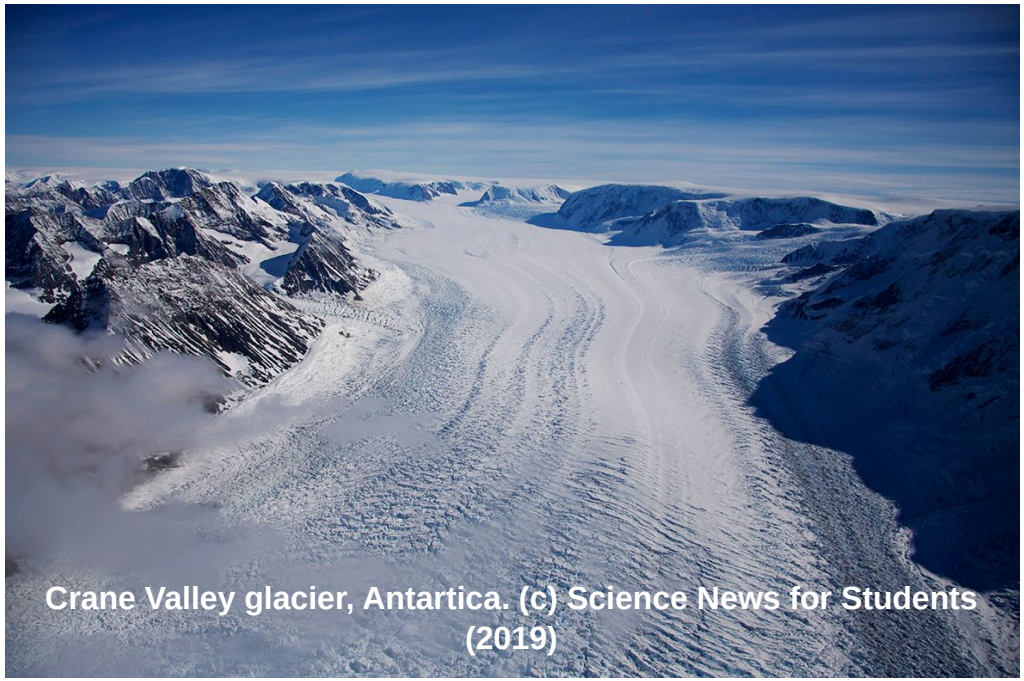


(C) British Geological Survey

The area has likely been affected by glaciations at least three times during the Pleistocene epoch (2.6 million years to 10,000 years ago) of the Quaternary Period. The margin of the final Devensian stage ice sheet likely came as far south as Bradford in this area (picked line in figure above). During the maximum period of ice advance the glaciers would have covered the upland areas and valleys, while at its southern most margin ice was likely only found in the Wharfe and Aire valleys (similar to the glacier in the photo to the right), as faster moving ice streams. Of interest is a smaller ice stream which flowed off from the Wharfe valley ice stream and joined with the Aire valley ice stream, eroding a hanging valley called the Guiseley Gap. Palaeoenvironmental evidence from nearby Bingley Bog in the form of plants and animals showed climate changes caused the glaciers to advance and retreat several times. Features such as moraines and glacial drainage channels (possibly formed by erosion by water flowing under the ice sheet) are found on the surrounding hills, along with extensive glacial sands, gravels, silts and clays in the valley floors.

At site 4 there are excellent views over the Wharfe Valley. From here you can appreciate the action which geology and geomorphology (particularly glacial action and rivers) have had on shaping the landscape. Within the valley, as well as much of the surrounding area, the land is mantled by Quaternary period (~2.6 million years ago to the present day) deposits, including glacial till and moraine, peats, river terrace deposits and alluvium. The Wharfe Valley has been scultped predominantly by the action of glaciers during the last ice age, the landscape remaining relatively unchanged from that time.

Due to the dip of the rocks (~5 degrees in a southerly direction) the slopes on the north of the valley are relatively gentle (a dip slope) while on the south side (where we are standing) the slopes are near vertical (a scarp slope). There is also a large normal fault trending along the axis of the Wharfe Valley, called the Wharfe Valley fault, which shows around 60m of displacement (downthrown to the south). This fault is likely related to the "block and basin" topography of the Early Carboniferous formed from crustal movements and which was later reactivated during the Variscan Orogeny. The fault probably acted to control the orientation of the valley as it evolved.



Crane Valley glacier, Antartica. (c) Science News for Students (2019)

Site 5 - Hangingstone Quarry

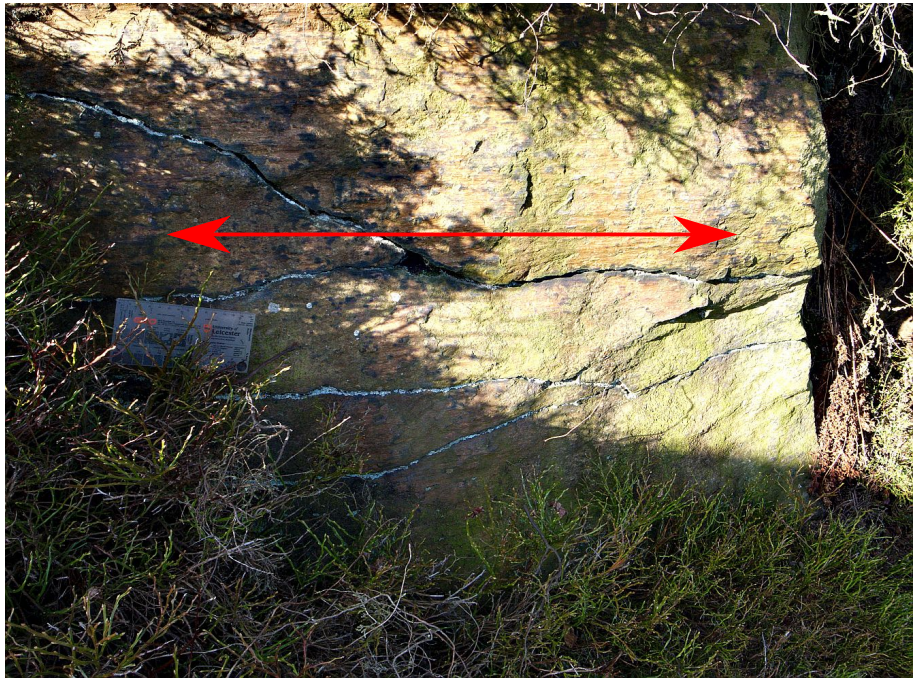
Hangingstone Quarry is a potential source for much of the building stone for many of the older buildings in Ilkley at the time of rapid expansion of the town in the 1800s. At the northern edge of the quarry an old tramway extends from the quarry in a downslope direction, probably to facilitate movement of this stone. During the Second World War the quarry was also used as a location for shooting practice and bullet pit marks can be seen on the eastern wall of the quarry.

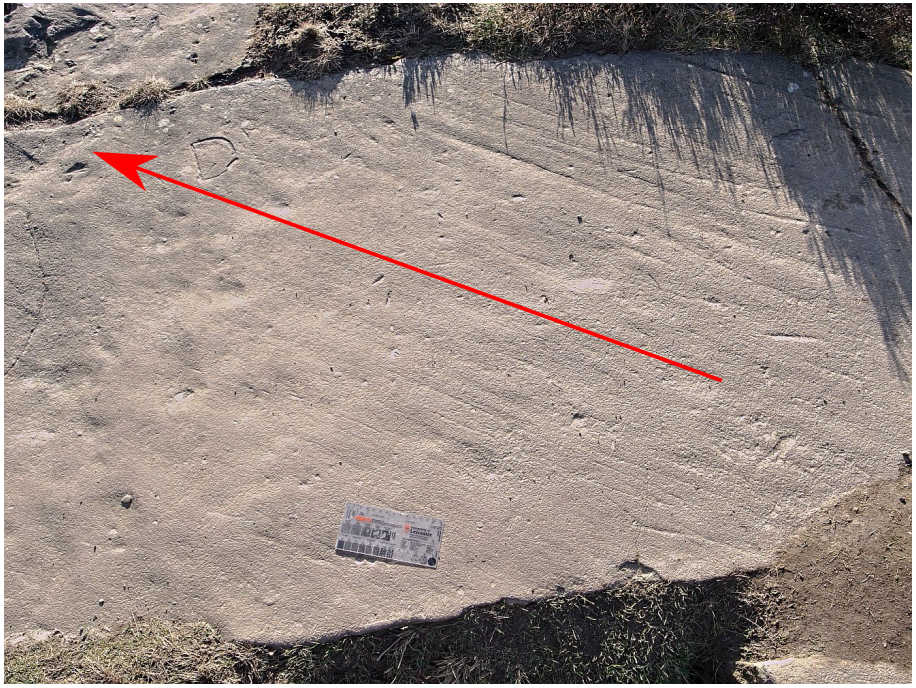
The most astonishing human-made features at the quarry are the Cup and Ring structures which have been carved into the rock (known as petroglyphs, photo to right) by Neolithic and Early Bronze Age people 3500-6000 years ago. These are beautifully clear examples and there are over 400 such carvings on Rombalds Moor. Given the fact they are carved in rock the effort must have been immense, so they were obviously of huge significance to the people at the time. However, this significance is unknown, although religious aspects are commonly stated. On Rombalds Moor many are located in dangerous places and some of the more significant carvings are placed on lines of sight from the smaller carvings. There is no clear chronology to the carvings and the rock art on the moor may indicate it was made to express relationships with the local area.

Visible immediately to the west from the Cup and Ring structures is a block of Addingham Edge Grit which shows highly distorted bedding (photo to left). This bedding indicates an event of sufficient force occurred to move the soft sediment previously deposited by a river. These distortions are known as soft sediment deformation and they are created by the escape of water through dewatering, essentially the very rapid upward migration of water trapped between the pore spaces of the individual mineral particles forming the rock. Such dewatering is commonly caused by rapid squeezing of the sediment, e.g. lots of sediment is deposited very rapidly on a river bed during a flood, slumping or sliding of sediment or by tectonic activity shaking the ground and causing the water to be expelled by liquefaction. The shape of the distortions suggests these may show a sand volcano. The rarity of this feature in rocks around the moor suggests that localised dewatering during a flood event may be the cause.

Sites 6 and 7 - Geological scratch marks

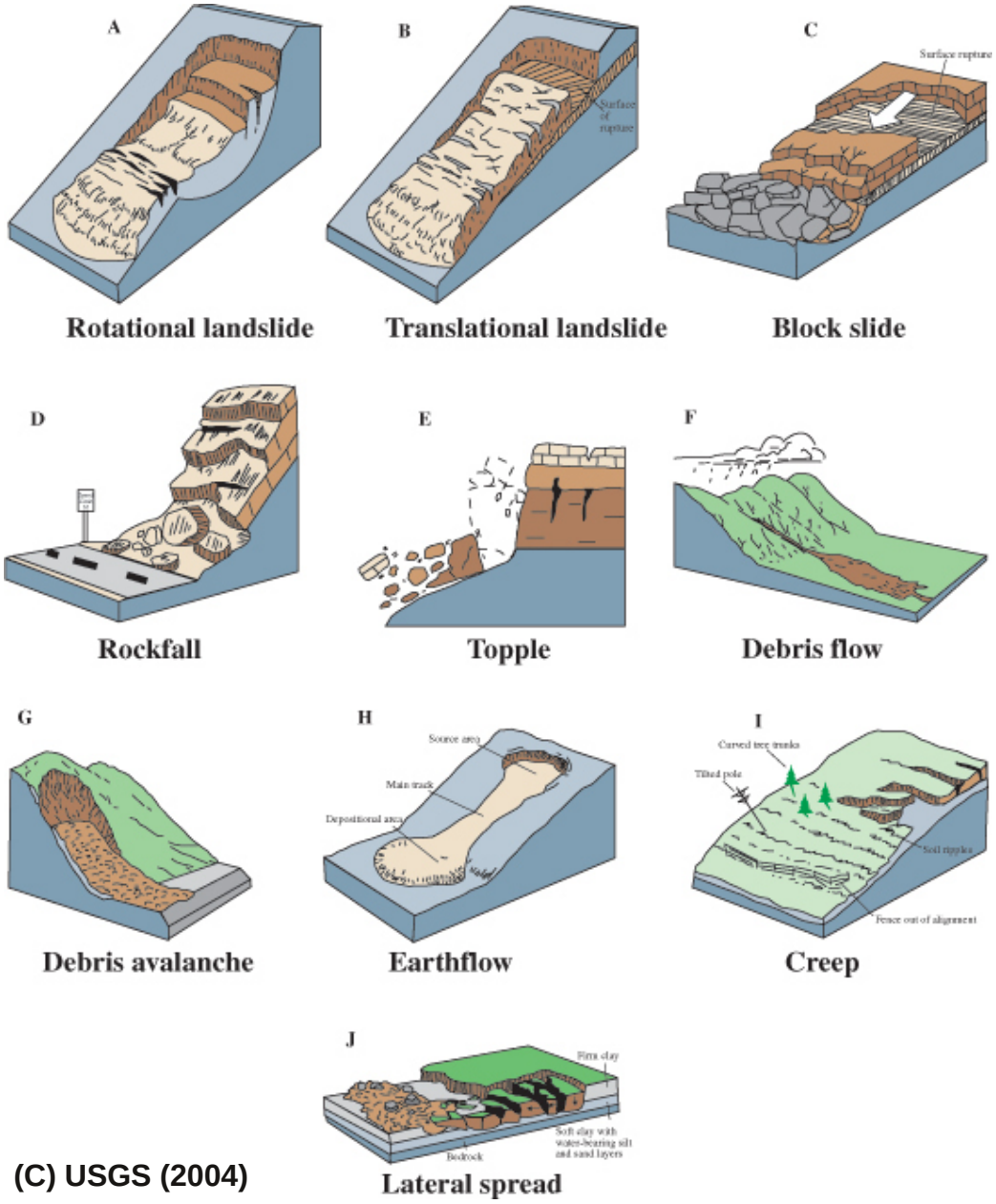
At site 6 you will come across the first of a series of geological scratch marks. On a vertical rock face in the west of Hangingstones Quarry you will see that the rock is an orange-brown colour and is polished smooth. Looking closely at the rock face you will see small lineations in the orange-brown deposits, which all point in a similar direction. The features are called slickensides and they directly indicate that a violent movement of these rocks along a fault plane occured in the past. The slickensides show that the rocks moved in a north-south direction (as shown by the arrows in the picture to the right). We don't know when the fault moved, but as the fault lies within these 310 million year old rocks we know it occurred sometime after they were deposited.





The clearest evidence of the presence and movement of a glacier over the area and down the Wharfe Valley is found at site 7. Here are some of the finest exampes of glacial striae (left) you can see in the UK. These scratches in the rock are caused by fragments of rock and debris of varying sizes which were lodged within the ice and which cut grooves within the rock as the glacier passed over it. The rock itself has been polished by the action of the glacier, showing the erosive power of the ice mass. If you look on the rock you can see striae of different sizes, including one very large gouge. These show the different sized debris present in the base of the glacier. Importantly the striae can be used to show the direction of movement of a glacier. These striae are orientated in an east-west direction parallel to the Wharfe Valley and indicate that the glacier which passed over the rock moved in that direction (indicated by the red arrow). The striations are located 150m above the valley floor, indicating that the glacier was at least this thick. However, we shall see another glacial feature later on which shows the glacier was even thicker.

Site 8 - Landslides and Ilkley



At site 8 you can see a fantastic view over Ilkley, White Wells and the large landslide forming the hillslope above Ilkley (image above). The figure to the right shows the diversity of landslide types which can occur. However, it is likely that the large landslide you can see in the foreground is the toe section of a rotational landslide which is linked to another feature (Rocky Valley) which we will visit shortly.

In the far distance you can also see the classic "bench and slope" topography which is a feature throughout much of West Yorkshire. This is due to differences in the resistance to weathering caused by the presence of hard and resistant sandstones (forming the benches) and weaker mudstones (forming the slopes),

White Wells is the original spa bath and was built around 1700 with several modifications carried out since then. The spa baths themselves are still available to use and "cure all ills"!

(C) USGS (2004)

Sites 9, 10, 11, 12 and 13 - Backstone Beck

As noted previously, the coarse sandstones which characterise much of the geology of Ilkley Moor, and for much of West and South Yorkshire for that matter, are commonly separated by thick deposits of dark grey laminated mudstones. These represent sediment accumulation within deeper marine water within the sea of the Pennine Basin offshore of the deltas. In total, about 1.8km (!) of sediment was deposited in the Pennine Basin in this area.

Although we won't visit this today due to it being difficult for a group to access, an exposure of around 8m in height of these mudstones is visible and can be studied up close at site 9 in Backstone Beck (photo above). The lower part of this exposure is composed of the dark grey mudstones which gradually turn into thin alternating light and dark beds further up the cliff, these upper beds being tidal laminites. This suggests the sea water was becoming shallower towards the top of the cliff. You can also count the tides and see the rock type and colour changes in the laminae much more clearly here than at Cow and Calf Quarry.

Walking further up Backstone Beck more interesting features are revealed. You will see an excellent example of glacial till in the eastern bank (photo above). This material was deposited by the melting glaciers in the area and shows a fantastic jumble of different types, sizes and shapes of rocks.

A waterfall is also present on the beck. Here there is a significant change in channel slope, indicating that it may be a knickpoint which is eroding upslope, possibly in response to the formation of a hanging valley here after the end of the last Ice Age. A fault also runs along the line of the beck and this, acting as a line of weakness, has controlled the path of the watercourse over time. Just upstream of the waterfall, where the footpath to Rocky Valley crosses the river, there is an unusual sandstone which shows dune bedding, however the rock is very coarsely grained, indicating possibly very high rates of river flow when the rock was formed.

The name of Backstone Beck is derived from it being the source of the flat bakestones which historically were used to make the bases of ovens.

Site 14 - Rocky Valley

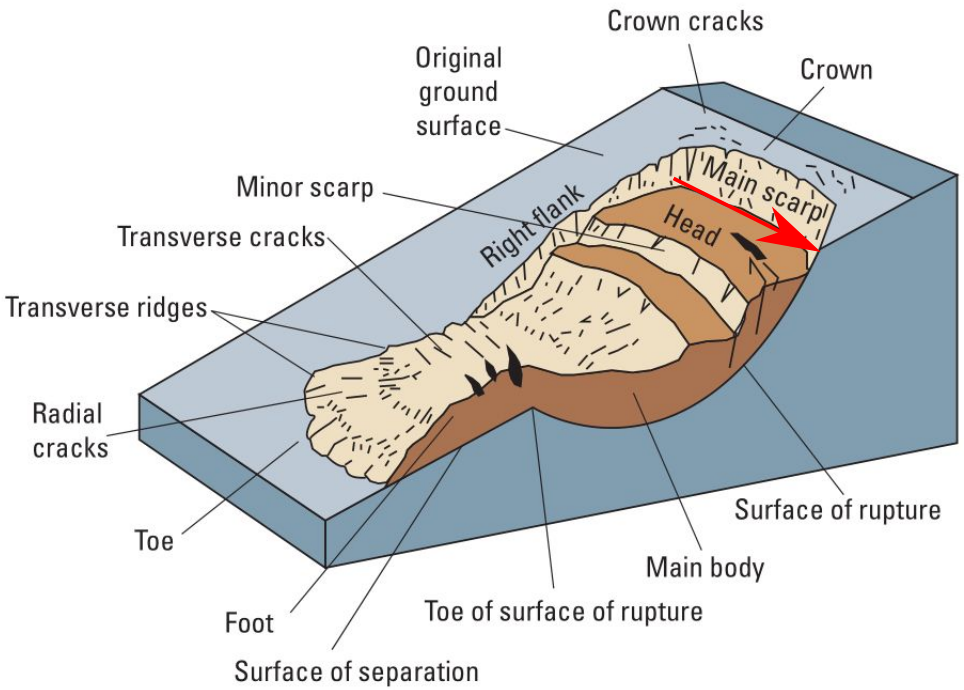


Image (C) Highland and Bobrowsky (2008)

The red arrow in the figure above indicates the location of Rocky Valley in the landslide and the direction of view along the valley shown in the photo to the right. Essentially the valley is located at the top of the rotational slide. The southern side of Rocky Valley (image to right) is essentially the stable part of the land surface which has not slipped downslope (the main scarp), while the northern side is the original land surface which has moved downslope and rotated during the movement of the land surface as a rotational slide (the head). Essentially the southern side of the valley and the point where you stand in the base of the valley is the failure surface indicated on the figure above. From the crest of the northern slope of Rocky Valley (and site 8) you can see the toe of the landslide, represented by the uneven land surface, forming most of the hillslope between the valley to Ilkley below.

The red arrow in the figure above is orientated in the direction of the view of the photo to the left. Rocky Valley is therefore a superb example of a valley created by a large landslide.

Most valleys you will encounter on the land will be formed by the past action of ice and the past and current action of flowing water, for example the Wharfe Valley to the north. Rocky Valley is unusual in that it is not formed by either of these processes. It is infact formed by a landslide. Landslides are effectively the downslope movement of a mass of rock, earth or debris driven by forces acting in a downslope direction (nearly always gravity). They can be caused by a range and combination of different factors acting together, these include heavy rainfall, springs, changes in water level, melting snow, earthquakes, action by humans etc. Landslides can pose a significant problem to future developments, even millennia after they have stopped moving as the landslide surface can remain very unstable.

There are many types of landslide as noted earlier at site 8, however the one which formed Rocky Valley is a type of landslide known as a rotational landslide (image to left). This occurs when a mass of rock or earth fails along a curved failure surface, which is commonly lubricated by something such as water or mudstone. It is likely that melting permafrost after the end of the last ice age contributed to the landslide occuring.

View along Rocky Valley to the west

Site 15 - Enclosures

Ilkley Moor is a treasure trove of prehistoric activity. At site 15 you can see an example of a prehistoric enclosure (photo to left), the Backstone Beck Enclosure. The enclosure (Historic England Scheduled Monument 1012847) is a long curving rubble walled settlement (incomplete on its western side) with two possible hut circles and containing three carved rocks - which vegetation makes difficult to find. These hut circles and parts of the enclosure wall were excavated and partly reconstructed between 1982-1987 by Ilkley Archaeology Group.

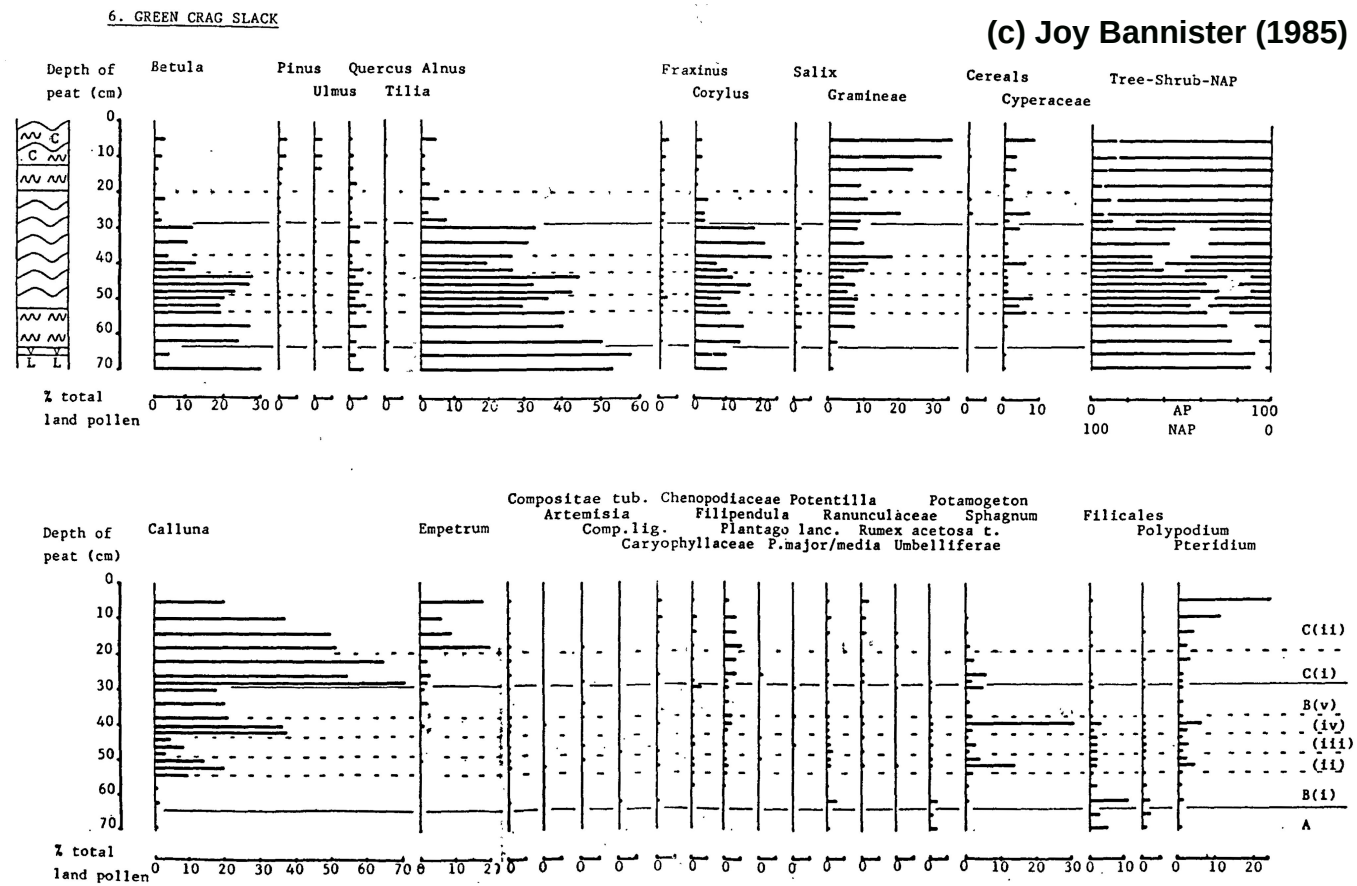
During the excavation and restoration many flint artefacts, including arrowheads and other tools, fragments of pottery and the rim of a jet cup were found. While the hut circles and wall are dated to the later Iron Age at 800-500BC, evidence from several charcoal deposits on the site suggests that the site was being used from the Late Neolithic (3000BC). The use of Backstone Beck Enclosure is not clear, although keeping livestock is possible. Whatever the use the site would have been very impressive and very important to the humans which lived there.

There are other enclosures and walling of a similar age on the moor including the Green Slack Enclosure to the east. The wall is marked on the OS 1:25,000 map but is not easy to trace on the ground. It contains several carved rocks. There are a number of stone circles on the moor such as the well-known Twelve Apostles and the Grubstones Stone Circle but these are too far to visit today. There are also burial monuments such as the round cairn known as the Little Skirtful of Stones and dating from the Bronze Age (the equivalent of round barrows in the lowlands).

Enclosures are common archaeological features and represent a portion of land separated from the surrounding land using walls, fences or earthworks. Their scale varies from small enclosures to much larger ones which encompass many dwellings and other features of importance (photo to right). Their purpose varies, like being agricultural enclosures to hold livestock, identify settlements, have religious or rital significance or have a defensive purpose.

Durrington Walls, Peter Lorimer, Historic England (2013)

The palaeoenvironment of Rombalds Moor



(c) Joy Bannister (1985)

(c) Grainne Mathews

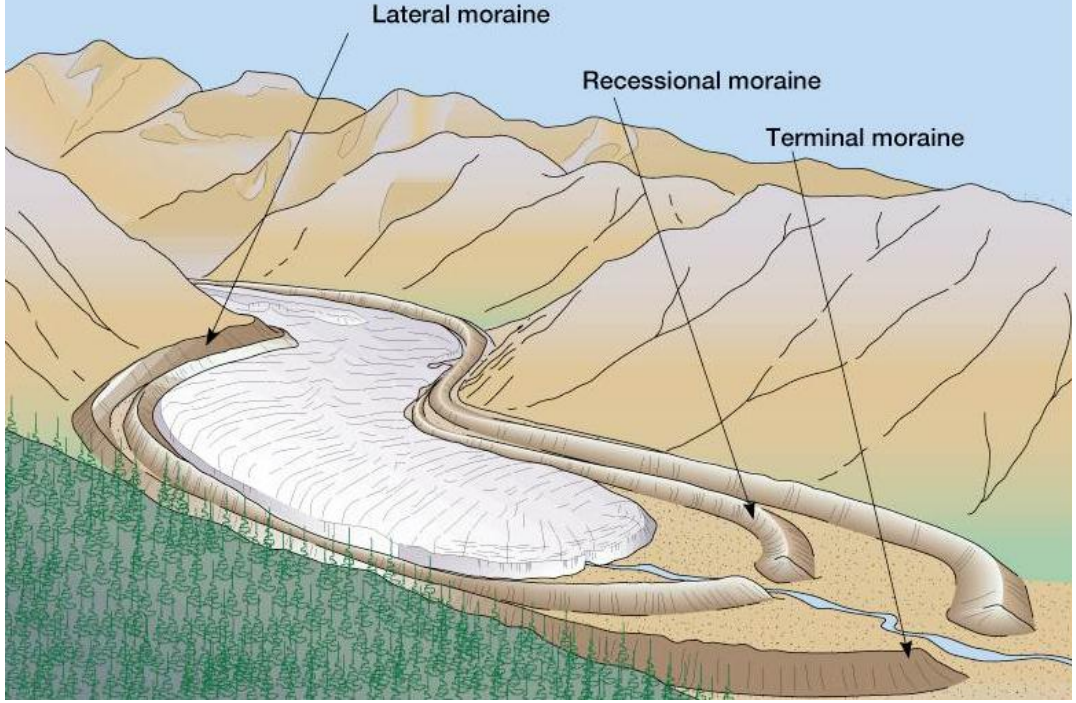
We do have evidence of what Ilkley Moor and Rombalds Moor was like at the time when the enclosure was settled and the cup and ring marks were being carved using palaeoenvironmental reconstruction. We can obtain the required evidence from analysis of pollen and debris trapped in peat bogs on the moors which can be removed and analysed using a technique called coring. The peat in these bogs accumulate over time, with layers being added on top of other layers as vegetation dies and decays. This makes up a vertical sandwich of layers, with the oldest layers of peat at the bottom and the youngest at the top. The peat bogs are therefore a very detailed record of our changing climate and vegetation over the last several thousand years.

Our understanding of the palaeoenvironment of the moor was provided by the detailed research work of Joy Bannister in the mid 1980s. She undertook a range of measurements, one of which was the analysis of the species of pollen present at different depths in the core. The diagram above left shows the percentage of different species of pollen measured at different depths in the core (representing the changing vegetation with time, the present day being near 0cm depth of peat). The data show that at the oldest and deepest point in the core, the pollen is dominated by birch (Betula) and alder (Alnus) tree pollen with some hazel (Corylus). This tree pollen declines from around 1500BC, gradually changing towards the present day with tree pollen becoming near non-existent and grass (Graminea) and heather (Calluna) pollen becoming dominant. The first evidence of agriculture in the area occurs around 650AD when cereal pollens are detected, much later than expected given the presence of humans in the area. Agriculture is minimal and varies with climate and historical events until around 1350AD when it becomes dominant, with grasses and heather colonising after trees are removed. So, around the time of the enclosures the moor was probably densely covered by trees (upper right picture), the enclosure likely being in a clearance in this forest.

Sites 16 and 17 - Lanshaw Delves

As we have seen, much of the current surface topography has been greatly sculpted by the action of glaciers. At site 16 we encounter an unusual feature known as Lanshaw Delves (right). This is a ridge which is approximately 600m long by 40m wide by about 3m high and it trends in an east-west direction parallel to the Wharfe valley. Towards its southern end the moraine changes direction slightly towards the south and this is probably due to the action of a southerly moving ice stream off the Wharfe glacier moving towards the Aire Valley through the Guiseley Gap.

The ridge itself is actually a lateral moraine laid down by the action of a glacier (below). The direction of the ridge is similar to the glacial striae seen at site 7 and this indicates it was lain down by the glacier which was flowing along the Wharfe Valley. Since Lanshaw Delves is located around 225m above the floor of the Wharfe Valley (much higher than the glacial striae) this suggests the glacier which deposited the moraine (and caused the striae) was very thick. Evidence indicates it was around 500m thick around 20,000 years ago.



Lateral moraines (image to left) are formed by debris falling onto the edges of a glacier surface from adjacent crags and cliffs. Lateral debris can also be contributed via other tributary glaciers. This debris is detached by weathering (e.g. frost shattering) or from undercutting of rock faces by the glacier itself and their subsequent collapse (as rock falls). The debris is carried along by the glacier and is left as a ridge when the glacier melts.

Lanshaw Delves is unusual in that it is peppered with depressions and holes. These are delves, small pits dug into the moraine, likely by hand, in order to quarry Carboniferous limestone fragments which form the moraine (along with Carboniferous sandstones, chert, and ironstones). This lime was burnt close by in sow kilns, probably for agricultural purposes. There is no coal or wood on the adjacent moor so it is possible that local coal sources may have been used (e.g. from Baildon Moor?). Interestingly, the nearest source of Carboniferous limestone is 10km to the north west in the upper reaches of the Wharfe catchment, which suggests the material in the moraine has travelled at least this far. The limestone also creates more basic soils, leading to a different vegetation structure around the moraine than on the surrounding moor, which is visibly greener.

Site 20 - Idol Stone

At site 20 you will encounter the Idol Stone. This is one of the most striking petroglyphs on the moor (photo to left).

While most cup and ring marked rocks have one or two cups (the depressions) the Idol Stone has 27 of these cups. They are arranged in parallel lines in groups of six, seven, four and four cups with a number of grooves cut around these groups, particularly the seven cup group which can be seen on the photo to the left. The rock was probably carved in the Late Neolithic.

The Idol Stone is named after the adjacent Idol Rock which is located ~100m away. The rock itself is located downslope of Green Crag which is made of different rock (Long Ridge Sandstone) to that in Cow and Calf and Hangingstones Quarry. The Idol Stone is likely to be made of the same rock.

Its layout bears a resemblance to Mancala, one of the oldest board games in the World (evidence from the Middle East indicating it was played around 6000BC). There is no evidence to link the stone to this board game and, like the other cup and ring structures seen on the moor, it is likely of religous or ritual significance, especially given it potential links to an old collapsed cairn (indicated by the other stones around the Idol Stone).

Further reading

Aitkenhead, N. (2003). How did the calf get there? Ilkley Moor, and the Cow and Calf Rocks", Geology Today, Volume 19, No. 5, September-October 2003. p179-180.

Bannister, J. (1985). The vegetational and archaeological history of Rombalds Moor West Yorkshire. Doctor of Philosophy thesis, University of Leeds, Plant Sciences Department. December 1985. 205pp.

Boughey, K. J. S. and Vickerman, E. A. (2003). Prehistoric rock art of the West Riding. Cup-and-ring marked rocks of the valleys of the Aire, Wharfe, Washburn and Nidd. West Yorkshire Archaeology Services; Leeds.

Bradford District Council, (undated). Walks around cup & ring stones. Guided walk leaflet. 12pp.

British Geological Survey, (2000). Bradford. England and Wales Sheet 69. Solid and Drift Geology, 1:50,000. Keyworth, Nottingham.

Deacon, V. (2018). The Rock-art landscapes of Rombalds Moor, West Yorkshire: Standing on Holy Ground. Doctor of Philosophy thesis, Unviersity of York, Archaeology. 431pp.

Friends of Ilkley Moor, *https://www.ilkleymoor.org/*.

Highland, L.M. and Bobrowsky, P. (2008). The landslide handbook - A guide to understanding landslides. Reston, Virginia. U.S. Geological Survey Circular 1325. 129pp (*https://pubs.usgs.gov/circ/1325/pdf/C1325_508.pdf*).

Leather, D. Ilkely Moor Geology Trail. Wharfdale Naturalists Society.

Leeds Geological Association, *http://www.leedsga.org.uk/*.

Stephens, J.V., Mitchell, G.H. and Edwards, W. (1953). Geology of the Country between Bradford and Skipton. Memoirs of the Geological Survey of Great Britain. England and Wales. HMSO, London. 200pp.

Waters, C.N. (2000). Geology of the Bradford District. Sheet description of the British Geological Survey, 1:50,000 Series Sheet 69 Bradford (England and Wales). 41pp.

Weldrake, D. (2010). Idol Stone: Ilkley Moor. West Yorkshire Archaeology Advisory Service. 2pp. (*https://www.wyjs.org.uk/media/1349/idol-stone.pdf*).

West Yorkshire Geology Trust, *http://www.wyorksgeologytrust.org/*.

Wharfedale Naturalists Society, *http://www.wharfedale-nats.org.uk/*. Wharfedale Naturalists Society, (undated), Natural Trail on Ilkley Moor. Guided walk leaflet.