

Whence the Rudston Monolith ?

An examination of the most likely source of the rock and its possible transportation routes to Rudston

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Humberside Geologist no. 19

1. Introduction

The plaque below the Monolith in Rudston churchyard says the following:

“... It consists of a slab of Moor Grit Conglomerate as found in a widespread area of the Cleveland Hills inland of Whitby”

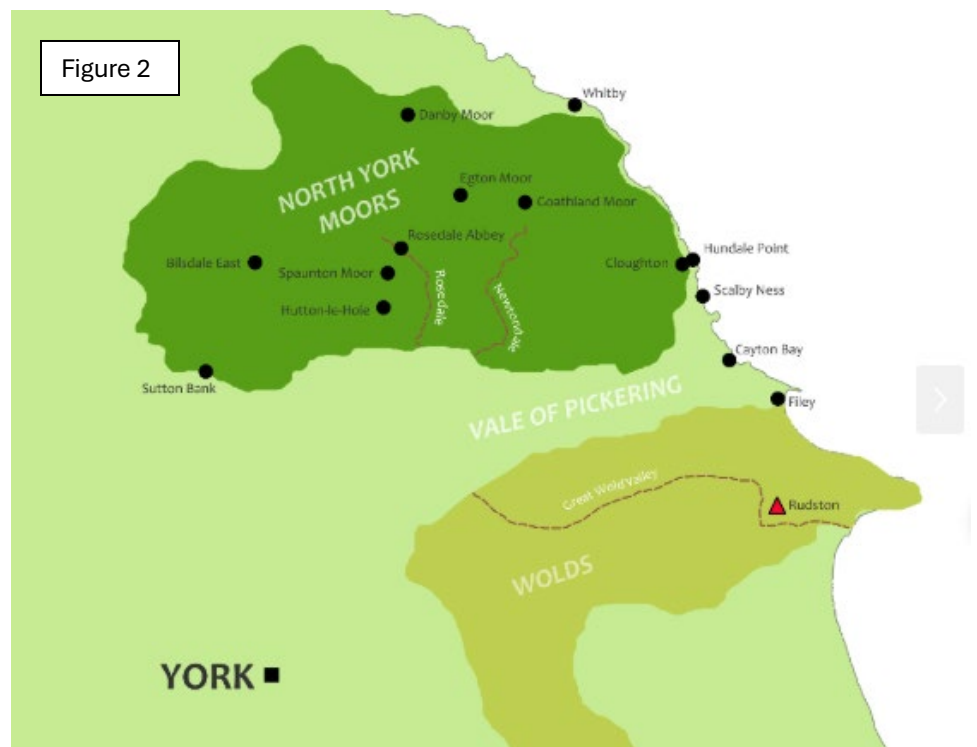


Figure 1

So, where is Rudston, and what is a monolith doing there?

Further, how did it get to the churchyard in a village on the northern side of the Yorkshire Wolds (Figure 1)?

Before attempting to answer these questions, let's set the scene with a sketch map (Figure 2), showing the location of Rudston and its relationship to the other locations visited and examined in this search.



In an attempt to find out more precise location details about “*inland of Whitby*”, a thorough internet search was conducted. All of the location references on the internet either repeat or paraphrase “Cleveland Hills inland of Whitby”, or suggest Cayton Bay, presumably on the basis that Cayton Bay is the nearest source of any type of “gritstone” to Rudston. These internet articles also speculate on how this massive rock was moved from its source location, on or near the North York Moors, to its present location within the Great Wold Valley of the Yorkshire Wolds, either by Neolithic Man or by glacial action. In none of these articles is *any* evidence provided for either the specific source location, or the transportation mode, nor do they question the Monolith’s rock type as a *Moor Grit Conglomerate*.

Thus, our interest was piqued to find out more about all these issues, by site visits to the Moors, studying geological and topographical maps, and by analysing rock samples. This report will explore the following avenues: to confirm the specific rock type of the Monolith and make observations about its four above-ground surfaces, to consider and eliminate other “local” rock types, to examine other slabs on the Moors of the same rock type as the Monolith, particularly the Millennium Stone on Danby High Moor, to provide some insights as to the depositional environment of the Monolith’s rock type, and finally to make a reasoned speculation on the transportation mode and route to Rudston.

2. Geological Characteristics of the Monolith

Our first site visit to Rudston was in August 2024. The slab is about 8 metres tall above ground and up to as much below ground, although there is no evidence of its actual depth. English Heritage says that “*Excavations conducted by Sir William Strickland in the (late) 18th century suggested that the monument may extend as deep below ground as its height above*”. The surfaces of the north and south sides of the slab are similar, as are the east and west sides, but these pairs are quite distinct from one another. The east and west sides are light grey in colour, relatively smooth, but pockmarked by holes or gouges of various shapes and sizes. There is no apparent symmetry to these “holes”. Figure 3 is a view of the lower part of the west side of the slab. At this stage we did not have an interpretation of the holes. No fossils were observed on any of its sides.

The north and south sides are quite different from the east and west, showing signs of lineations, roughly parallel with the height of the slab; see Figure 4. These lineations are interpreted as possible indications of stratigraphic bedding. On these sides, the holes are smaller and appear aligned roughly with the faint bedding. The east/west surfaces are much coarser than the north/south sides and it is much easier to observe (with a hand lens) individual, colourless to white medium-sized crystals, which are subangular to subrounded and very well cemented. All sides of the Monolith were tested with a weak acid solution for carbonate content: there was no fizzing of CO₂, so zero carbonate. These crystals are identified as quartz, and as no



other minerals were observed, this rock is deemed an ortho-quartzite. Close-up photos were taken of various places on the relatively smooth sides of the slab, particularly around the holes. Some of these photos are shown below, as Figures 5.



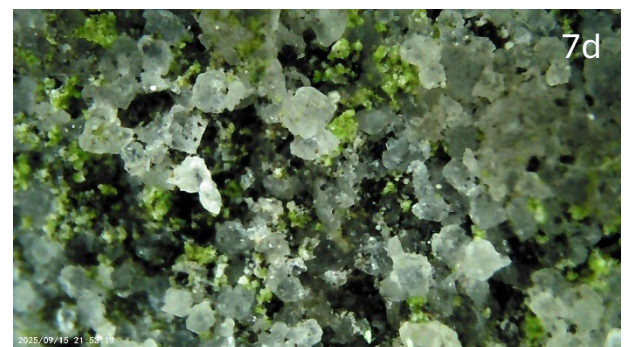
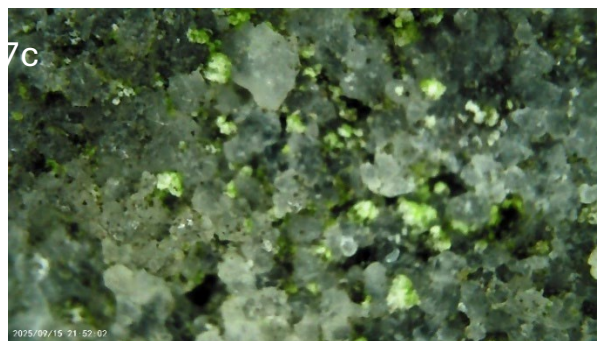
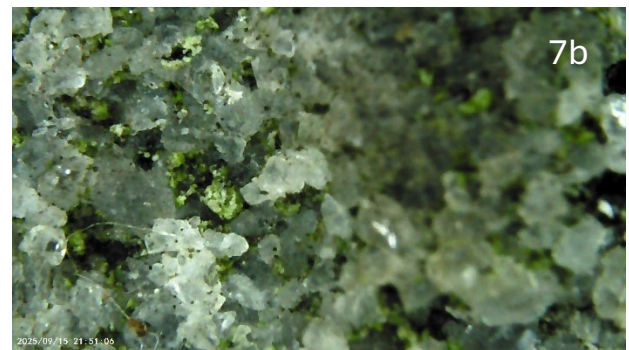
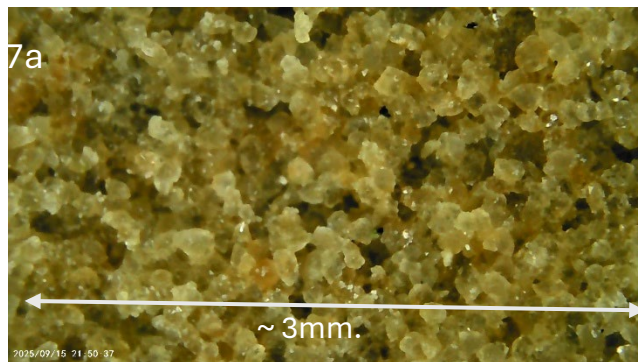
Figures 5

Figure 4

Figure 6 is an enlarged photo of part of the north side of the Monolith, rotated to appear horizontal. This view reinforces our belief that one can observe the depositional bedding of the quartz grains. The holes are generally aligned, though of different sizes, shapes and orientation. In this view, there are no other sedimentary structures, such as cross-bedding, nor any obvious explanation for the holes.



During a later site visit, in December 2025, a digital microscope was used to take very close-up photos at several points on each side of the Monolith. Some of these are shown below, Figures 7.



The discolouration (brown-ish) and the green spots are believed to be weathering and organic growth (mould or moss), which can be expected on exposed rock surfaces at that time of year. By this time, a review had been made of the characteristics of many of the sandstones and gritstones that crop out around the north of England and had concluded that, as the plaque below the Monolith stated, it is indeed a gritstone and most probably the Moor Grit Member of the Middle Jurassic Scalby Formation. It does not, however, look like a typical conglomerate.

The British Geological Survey (BGS) lithological description of Moor Grit is as follows:

“The Moor Grit Member is dominated in coastal exposures by grey, medium- to coarse-grained, occasionally pebbly, trough cross-bedded sandstone, with thin siltstone and mudstone beds; plant fragments and fossil wood casts are common. Inland, in the Hambleton Hills (Powell et al., 1992) it consists of grey to white, fine-grained, orthoquartzitic sandstone, with low-angle cross stratification and planar bedding. “

Our characterization of the Monolith mostly conforms with the BGS description of the “coastal exposure” of Moor Grit, since it is grey and medium-grained, with planar bedding. With this as a starting point, it was then necessary to: (a) eliminate other relatively nearby sandstones or gritstones as contenders, and (b) to try to identify more precisely where on the North York Moors this Monolith might have originated.

3. Shape Characteristics of the Monolith

At up to 15 metres long, the Monolith is massive and longer than any of the other standing stones known in the British Isles. Its top appears to be shaped; whether by human operated tools or by geomorphological processes is unknown. The protective metal cover on the top (Figure 8a) must have been placed there, possibly to protect the top from further weathering. It's noted that the metal cover extends further down on the north and south sides, those sides where the linear bedding is pronounced.

Other examples of gritstone standing stones that apparently have been affected by weathering and rainwater dissolution are the Devil's Arrows (Figure 8b), near Boroughbridge, which have probably been standing upright for about the same length of time as the Rudston Monolith, i.e. about 4000 years. The Devil's Arrows are made from Millstone Grit from West Yorkshire, another almost pure ortho-quartzite. It's possible that its grooves were deepened by rain, including the slightly acid rain that has fallen, for over 200 years, until recently, as a consequence of the considerable amount of coal burning in Yorkshire. It is known that quartz is slightly soluble under acid conditions.



The markings on the smoother sides of the Monolith (Figures 9a & 9b) are interpreted as solution holes and/or the weathering out of the “pebbles” that the BGS lithological description mentions. The presence of these smaller holes, more or less lined up with the bedding planes on the north and south sides, would seem to agree with the pebble theory, though it must be said that no observations have been made of any remaining pebbles, on or within either the Monolith, or in any of the other slabs of Moor Grit that have been examined on the North York Moors, at least to date.

Figure 9a



Figure 9b

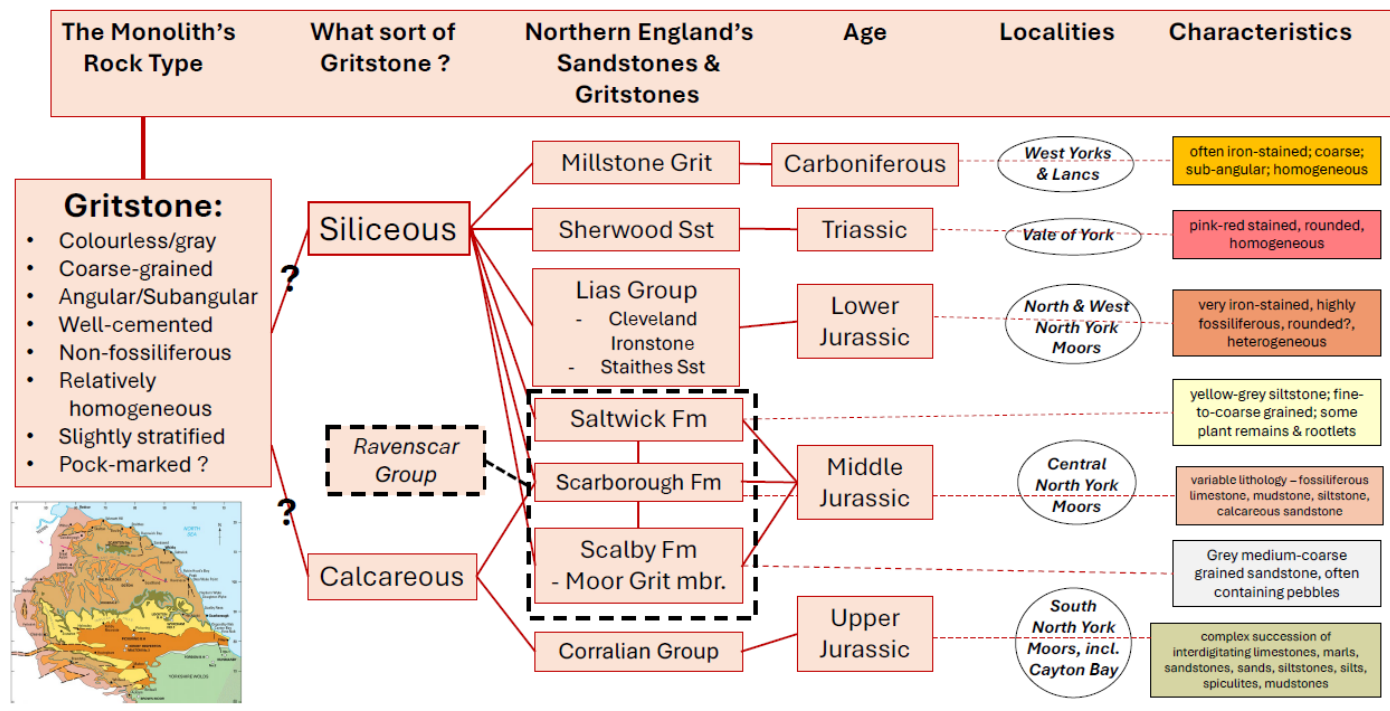


More close-up photos across a range of sizes of the holes were taken in September 2024 to further illustrate them and to try to better understand their origin, Figures 10. It has been noted that the larger and deeper holes appear to be on the smoother sides of the Monolith. If these sides correspond roughly to the depositional bedding planes of Moor Grit’s sediments, an interpretation of these features could be an accumulation of larger rocks or plant debris during a sedimentary hiatus.



4. Jurassic Sandstones and Gritstones in the North of England

The following chart shows most of the more extensive sandstones/gritstones that crop out in Yorkshire, Lancashire and Derbyshire. The objective of this section is to eliminate all but one of them as possibilities as rock types for the Monolith. Many of these rocks are present in and around the North York Moors, whose surface bedrock exposures are exclusively Jurassic in age.



The first “gate” for a sandstone of any degree of coarseness to pass through is the one that distinguishes sandstones that are calcareous from those that are siliceous: this study having conclusively demonstrated that the Monolith’s rock type is *not* calcareous. As it happens, there are calcareous “grits” around Cayton Bay and Filey Brigg, these being the nearest sources of any sort of gritstone to Rudston.

Site visits were made to Cayton Bay and Filey Brigg in June 2024 and December 2025 respectively, to examine the rocks in the cliffs and on the beaches. Our conclusion at Cayton Bay was that any Lower Calcareous Grit (LCG) would be below the glacial till at the top of the cliffs. We did not find any rocks on the beach below the cliffs (Figure 11) that could be positively identified as calcareous. On the Filey Bay side of Filey Brigg are outcrops and cobbles of gritstone that tested positive for carbonate (Figures12). It is felt that these findings eliminate Cayton Bay as the Monolith’s origin.

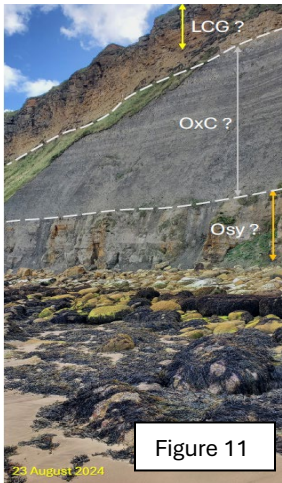


Figure 11



Figure 12a



Figure 12b

Almost all the rock outcrops and subcrops on the North York Moors are of Jurassic age and most of these are sandstones of one type or another. Figure 13 shows that the Upper Jurassic sandstones are all carcareous, which would disqualify any of them being the rock type of the Monolith. This stratigraphic section, reproduced with permission from BGS, is taken from their 1:50,000 geological map, Sheet 35&44, Whitby and Scalby.

Having eliminated the Upper Jurassic, it was the turn of the Lower Jurassic sandstones, with site visits to Skinningrove in August 2024 and Roseberry Topping in May 2025. The main sandstones at Skinningrove are the Cleveland Ironstone (Cdl) and the Staithes Sandstone (Sta), Figure 14.

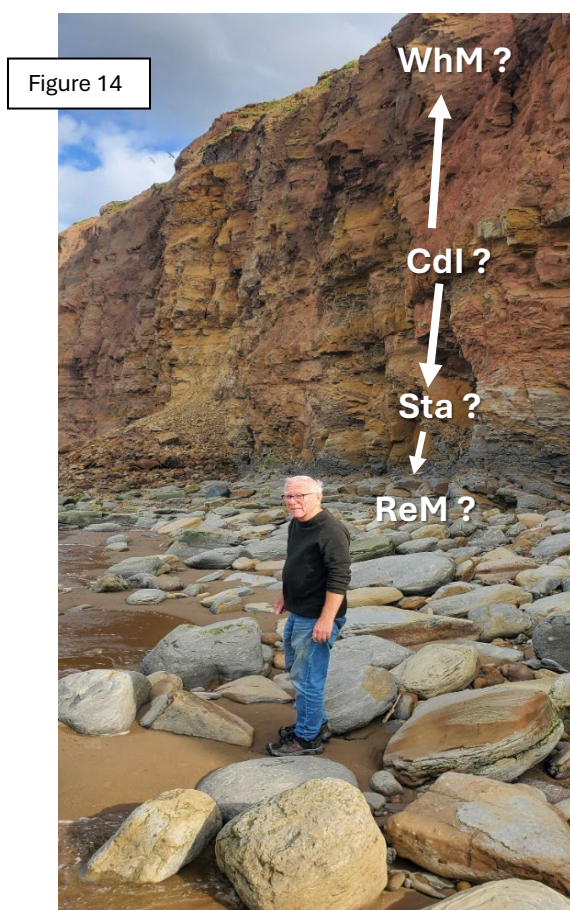


Figure 14

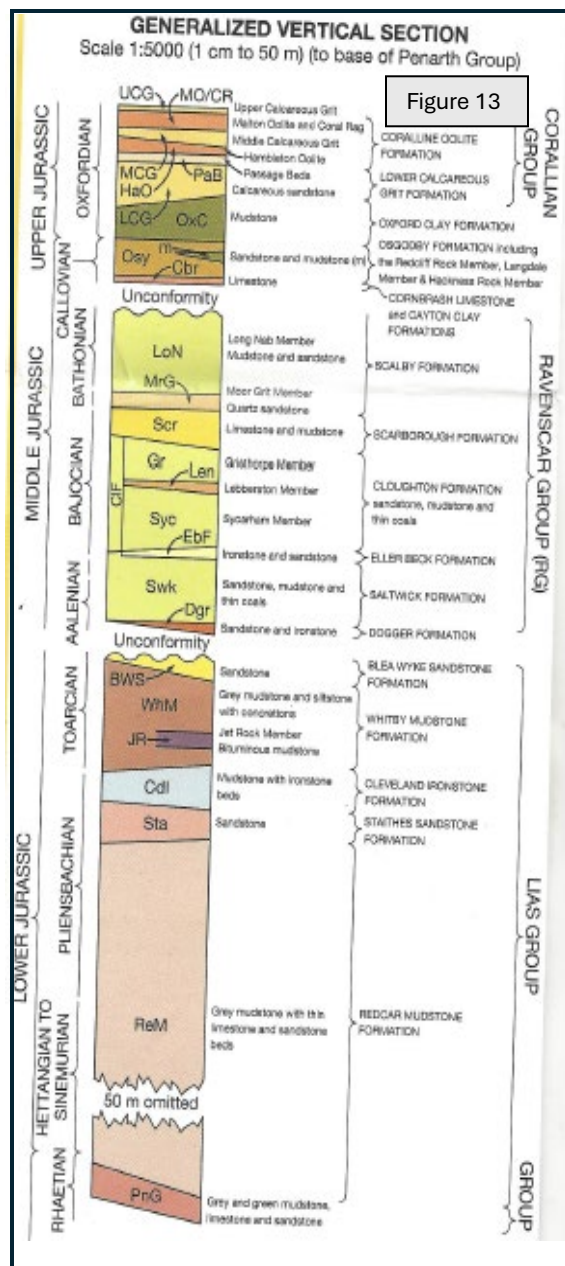


Figure 13

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It was relatively easy to eliminate these rock types on account of their colour, grain size and shape, and on their fossil content, compared with the Monolith's. The large boulders on the beach at Skinningrove in Figure 14 are very likely all of Redcar Mudstone. Figure 15 is a fossil-filled Cleveland Ironstone rock, about 25 cm. wide, from the base of these cliffs.



Figure 15

At Roseberry Topping, the very top (Figure 16) is composed of Saltwick Formation, according to BGS mapping. This unit is apparently all sandstone at Roseberry. It is at the base of the Middle Jurassic. Samples of this sandstone were taken from the middle of the outcrop (Figure 17), and compared with the Monolith at Rudston (Figure 18).



Figure 16



Figure 18

As with the sandstones at Skinningrove, the Saltwick sandstones are in no way comparable with the Monolith's grey, medium-sized much finer-grained, quartz crystals, the Saltwick sandstone being much finer-grained, pale brown in colour and not as homogeneous (Figure 19).

With the Lower Jurassic and the base of the Middle Jurassic now eliminated, there remains the rest of the Middle Jurassic, which is collectively called the Ravenscar Group.

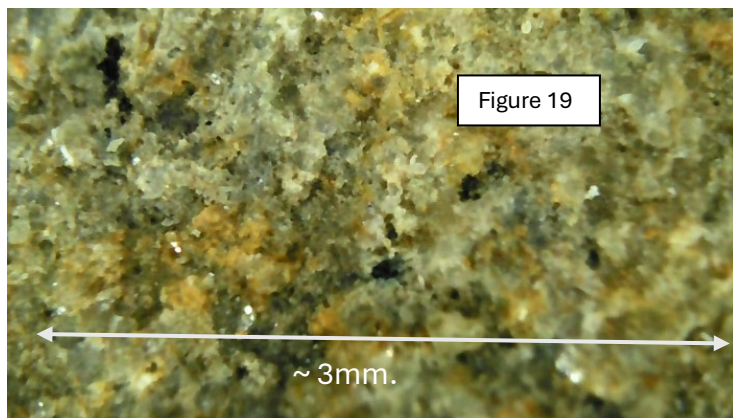


Figure 19

~ 3mm.



Figure 17

samples acquired here

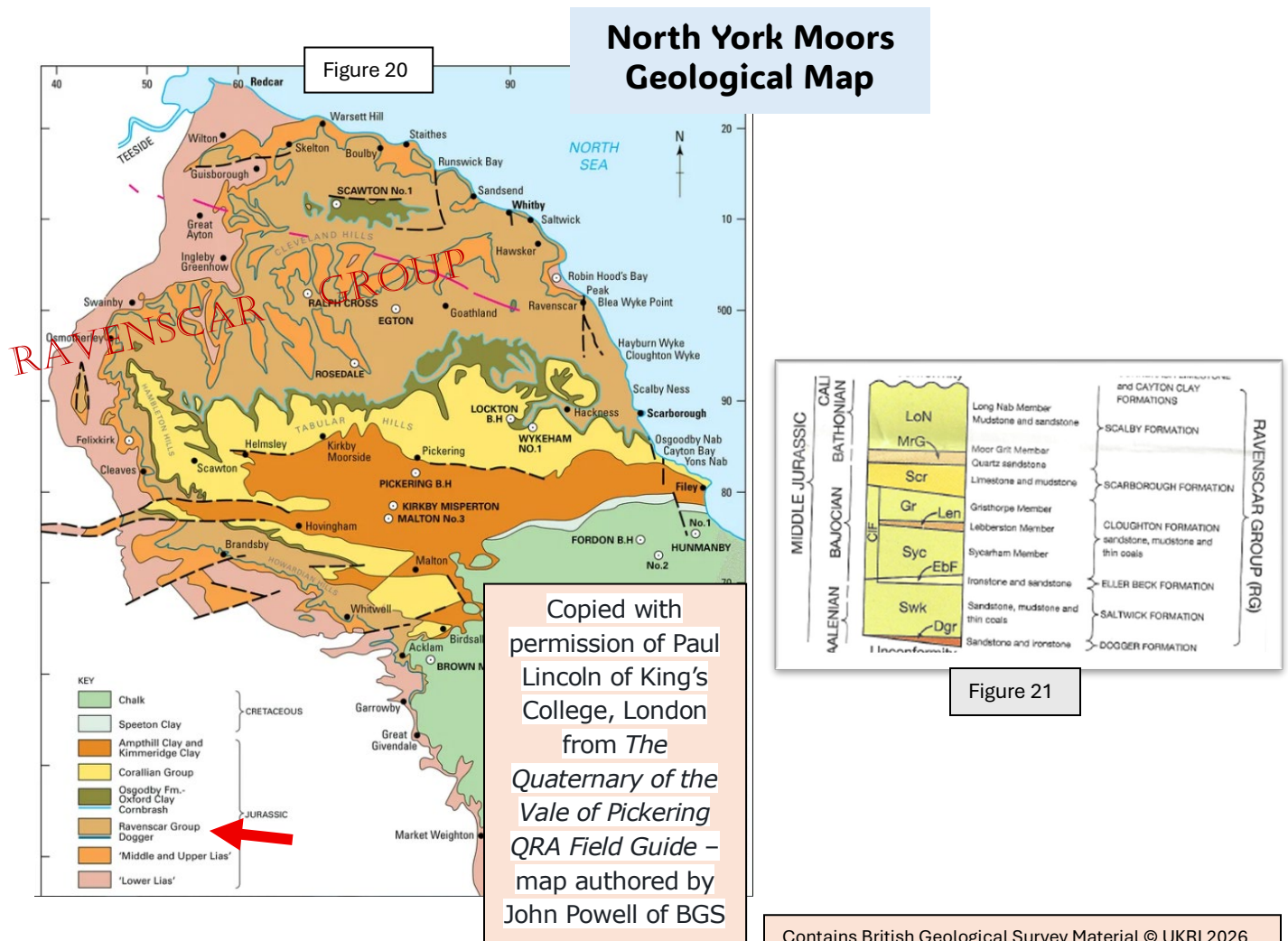
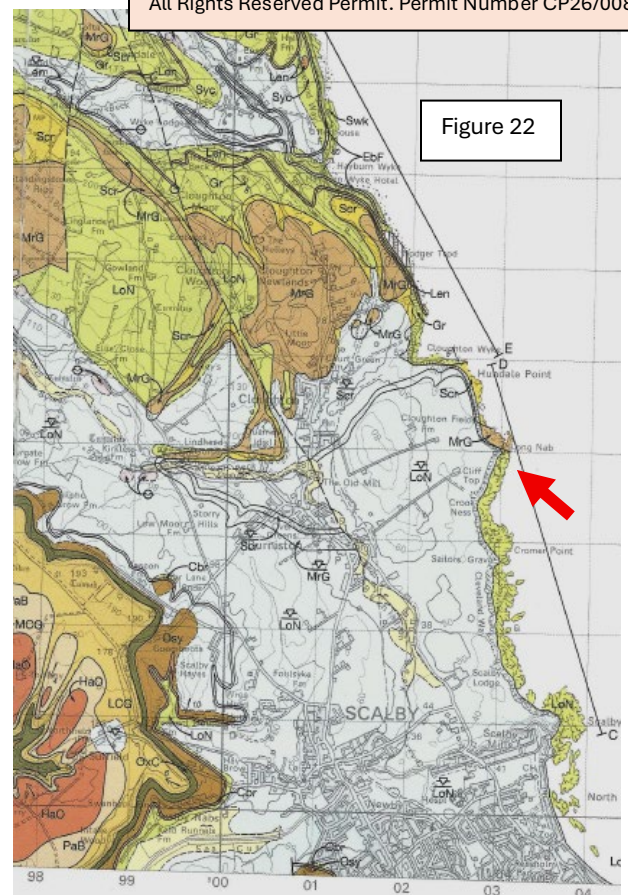


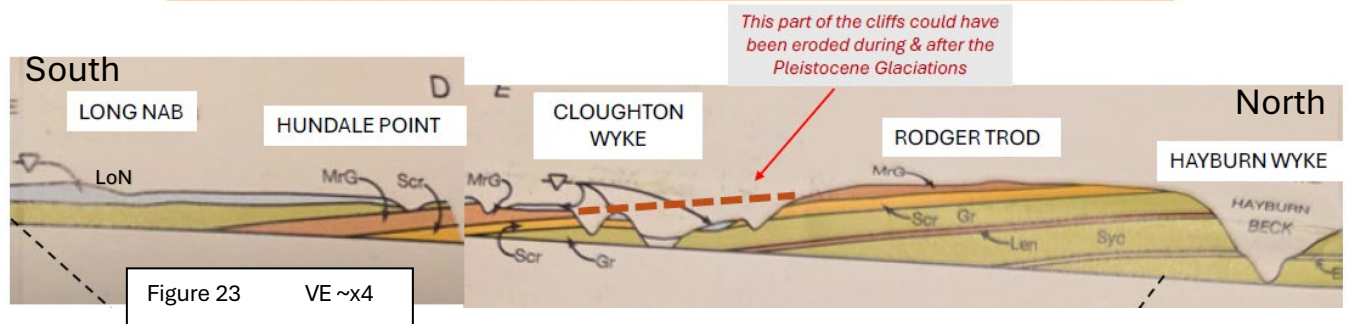
Figure 20 is a generalised geological map of northeastern Yorkshire illustrating how the Jurassic bedrock extends over the whole of the Moors, and in particular that the Ravenscar Group (stratigraphic column in Figure 21) dominates in the northern two-thirds. The basal Saltwick Formation has already been examined; next to be studied up-section was the Scalby Formation, in a site visit to its Type Section at Long Nab/Hundale Point. The southeastern part of BGS 1:50,000 map, Whitby and Scalby (Figure 22), shows how the Scalby Formation is the bedrock from Scarborough northwards, up to five or more kilometres inland from the coast. Much of it is covered by relatively thin glacial till, with the Long Nab (LoN) and Moor Grit (MrG) Members exposed in the cliffs from Long Nab almost to Hayburn Wyke, and at Cloughton Newlands.



A site visit in late June 2025 involved a walk from Burniston, along the Cleveland Way from Long Nab to Hayburn Wyke, passing Hundale Point, to Cloughton Wyke and Rodger Trod. It was not possible to examine the sea cliff sections close-up, but there were locations from which to photograph them, plus several accessible outcrops, and rocks not *in situ*. Figure 23 is a composite of cliff cross-sections from the BGS Whitby and Scalby map, which shows the Long Nab Member and Moor Grit subcropping below the Till at Hundale Point, south of Cloughton Wyke, with the Moor Grit Member at the surface across Rodger Trod.

The whole of the Scalby Formation dips gently southwards, in this line of section. Moor Grit has been eroded at Cloughton Wyke and for about 200 metres to its north, probably by glacial action.

Long Nab to Hayburn Wyke - Cliffs Cross-section



There was an easily accessible outcrop of the Long Nab Member at the edge of the cliff and some loose samples to take away and examine in detail, Figures 24-26.

Proceeding northwards towards Hundale Point gave a good view updip beyond Cloughton Wyke to Rodger Trod (Figure 27).



Figure 24

Site Visit : Long Nab to Hayburn Wyke



Figure 25

On the shore below Long Nab and extending towards Hundale Point there are many large slabs and boulders (Figure 28), presumed to be of Moor Grit, based on the BGS map and cross-section.



Figure 26



Figure 27

The Shore below Long Nab

The BGS map suggests that these large "slabs" are Moor Grit ...



Figure 28

The only piece of Moor Grit that was seen close-up on this visit was an old gate post on the path across Rodger Trod, clearly identified by having the same texture, colour and surface markings as the Monolith, Figure 29. On a follow-up visit in December 2025, another old gate post and a long drystone wall on Salt Pans Road were also identified as Moor Grit, Figures 30 & 31.

Figure 32 is a surface photo using a digital microscope of a block from this wall.

It became clear that there must have been sufficient exposed Moor Grit in the area around Cloughton and Cloughton Newlands for a large volume of this rock to be quarried and utilised as a building stone.



Figure 29



Figure 30



Figure 31

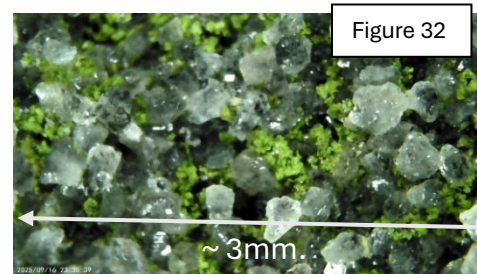


Figure 32

On old topographic maps of Cloughton Newlands there is evidence of a quarry to the southwest of the village, almost in Burniston, which has yet to be investigated as being a former Moor Grit quarry.

However, the BGS 1:50,000 map strongly suggests that the bedrock below the glacial till at the quarry site is indeed Moor Grit.

Figure 33 is an extract from the Ordnance Survey, One Inch, England & Wales, 1872-1914 Series, showing this quarry.

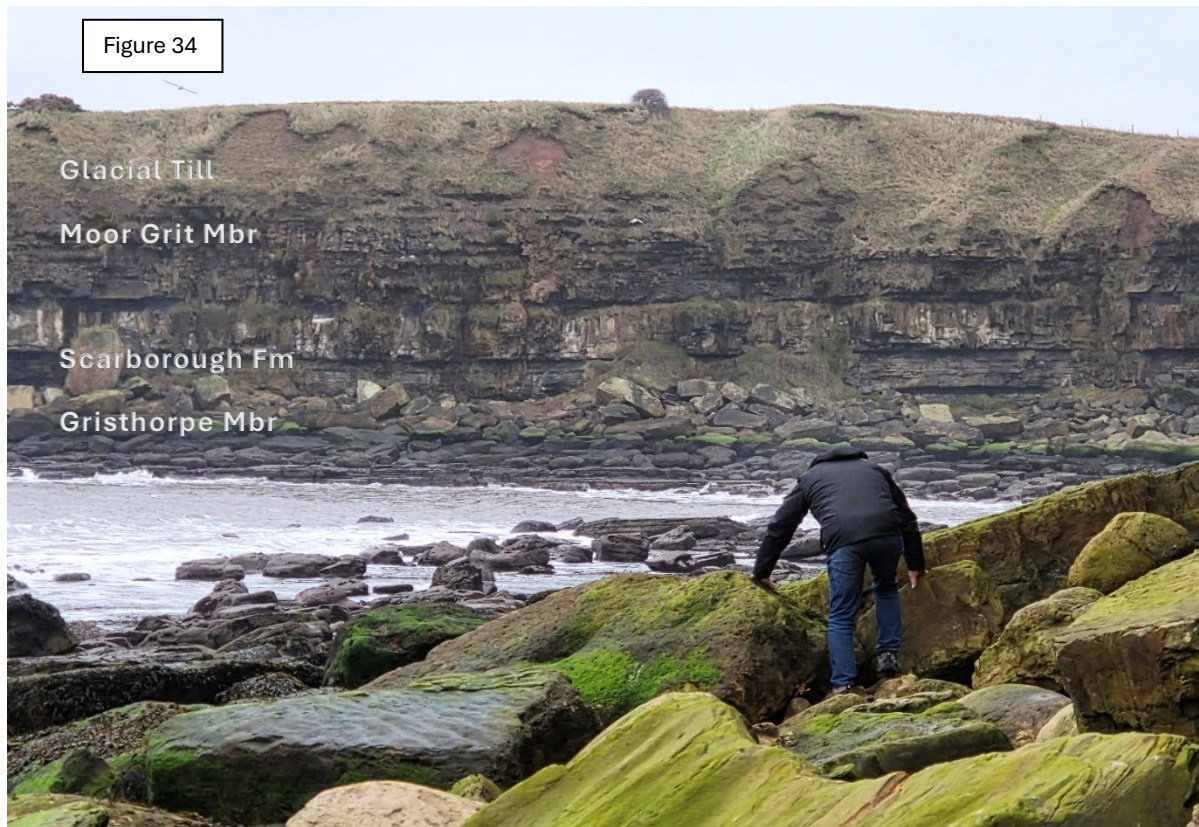


Figure 33

 National Library of Scotland | Leabharlann Nàiseanta na h-Alba
Sheet 44 - Scalby
Surveyed: 1847 to 1849, Revised: 1895, Published: 1897
Size: Sheet ca. 47 x 62 cm (ca. 18 x 25 inches)

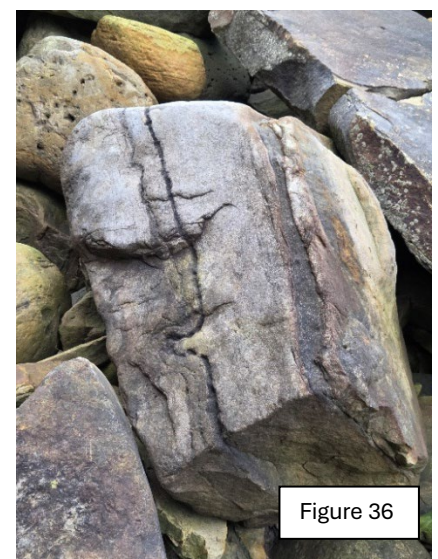
The type section for Moor Grit is between Hundale Point and Long Nab, where BGS describes its thickness as between 8 and 12 metres. On the December 2025 visit, it was not possible to get a close-up view of the cliff section on the north-facing side of Hundale Point, because of difficulty of access to the shore at Cloughton Wyke and the very large, slippery boulders and slabs on the shore.

Nonetheless, from the shore about 100 metres north of the Wyke, an enlarged photo of the cliff of that north side was taken and can be grossly interpreted, as shown in Figure 34. Reference for this interpretation is from *Stratigraphy, sedimentology and palaeontology of the Scarborough Formation (Middle Jurassic) at Hundale Point, North Yorkshire* by S.Gowland and J.B.Riding, in PYGS 1991, v.48, and from the BGS composite cross-section, Figure 23.



Among the rocks at the location of the photo above were two boulders with evidence of fossil wood, fitting with BGS' s Moor Grit description:

"... plant fragments and fossil wood casts are common", though this could also be said of the underlying Gristhorpe Member: Figures 35 & 36.



Given that a considerable volume of Moor Grit must have been eroded from the cliffs across the whole width of Cloughton Wyke, it's probable that these pale grey boulders are Moor Grit.

5. Non-Jurassic Sandstones and Gritstones in the North of England

The other possible Northern England contenders as the rock type of the Monolith are the Triassic Sherwood Sandstone and the Carboniferous Millstone Grit. The Sherwood Sandstone can be eliminated easily, because there are very few outcrops of it in Yorkshire and because of its strong red colouration, in contrast with the Monolith's grey. The only significant local use of Sherwood Sandstone appears to be the building stones of the Roman Fort at Aldborough; Figure 37. The Six-inch OS map, surveyed in 1852, in the National Library of Scotland's digital files, shows a small "Sandstone Quarry" next to the southwest corner of the Roman Walls of the Fort, Figure 38.



Figure 37: Credit English Heritage



Figure 38

Millstone Grit is a much more likely candidate, because it is a true gritstone and because it crops out extensively across West Yorkshire, Lancashire and North Derbyshire. To examine its characteristics, a loose sample of it was collected from next to one of the massive cross-bedded outcrops at Brimham Rocks, about 50 km from the Moors, cleaned up to remove all organic matter, and photographed. From Figures 39-41 it is concluded that Millstone Grit is comprehensively unlike the rock type of the Monolith, on the basis of its colour, grain size, heterogeneity and sedimentary structures.

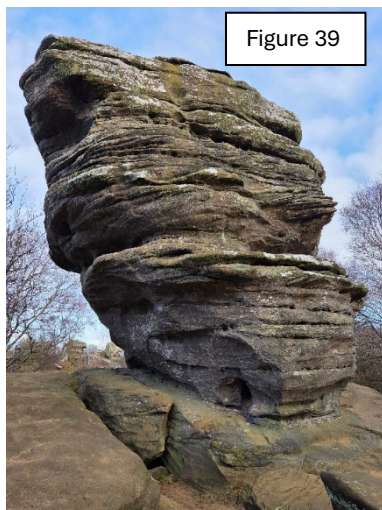


Figure 39

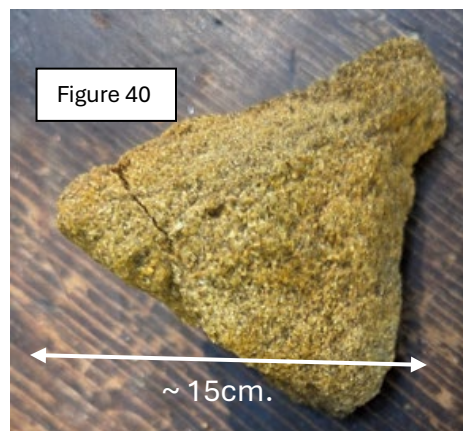
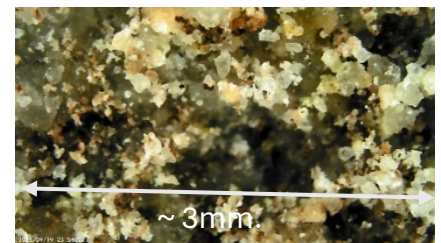


Figure 40

~ 15cm.



Figures 41

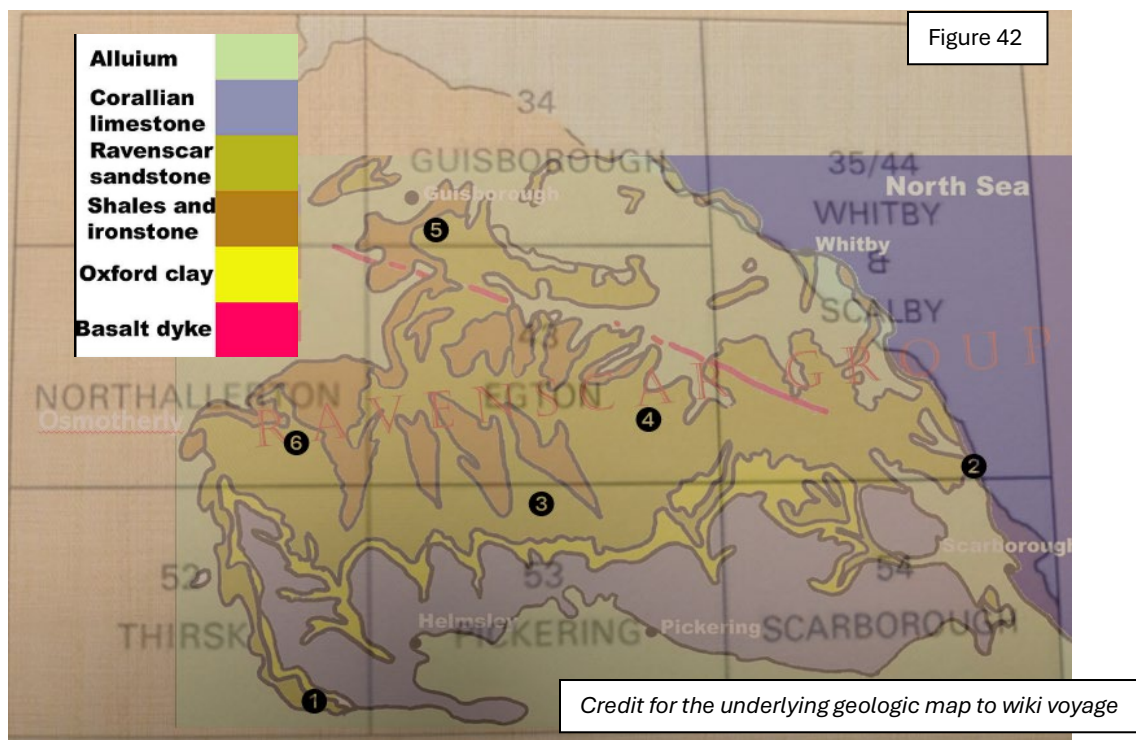


6. Places on the Moors where there are Outcrops or Quarries of Moor Grit

Having established to a high degree of confidence that the Monolith's rock type is Moor Grit, it was then possible to examine BGS 1:50,000 maps across the whole of the North York Moors region, to identify locations where this rock type might be exposed.

First, it must be said that the Middle Jurassic Ravenscar Group is the dominant bedrock across central and northern parts of the Moors, from Ravenscar in the east to Osmotherly in the west. By examining the seven BGS maps covering the Moors, it was decided, as a first pass desktop study, to consider six widely distributed Moor Grit locations, numbered below on Figure 42. These were:

1. Howardian Hills
2. Cloughton area
3. Spaunton Moor
4. Wheeldale Moor
5. near Guisborough
6. Osmotherly Moor



At this point, the only locations where *in situ* Moor Grit had been observed, and those from a considerable distance, was on the walk along the Cleveland Way; this being the slabs on the shore below the eastern cliffs and within the north-facing cliff, both of Hundale Point. However, before deciding where else to explore for exposed Moor Grit, a chance photograph taken by Kendall Louie (personal communication), on the last leg of his hike on Wainwright's *Coast-to-Coast Walk* (the Lyke Wake Walk section), identified a similar but smaller version of the Monolith, Figure 43. This is the *Millennium Stone*. Research into where it originated, confirmed by George Winn-Darley, said it had been taken from Spaunton Moor, with the Millennium inscription carved into it by stonemason Mike Weatherill, before it was erected at its present site on Danby High Moor.

In Kendall's "selfie" from September 2024, and from photographs taken on site visits in June and December 2025, it is very apparent that the Millenium Stone has *all* the rock characteristics of the Monolith, as shown in Figures 43-46.



Figure 43



Figure 44



Figure 45



Figure 46

Thus encouraged, at this point we concentrated our search for another Monolith “look-alike” on or near Spaunton Moor. To do so, BGS’s mapping of the Ravenscar Group throughout the Moors was invaluable.

7. Moor Grit Exposures on Spaunton Moor

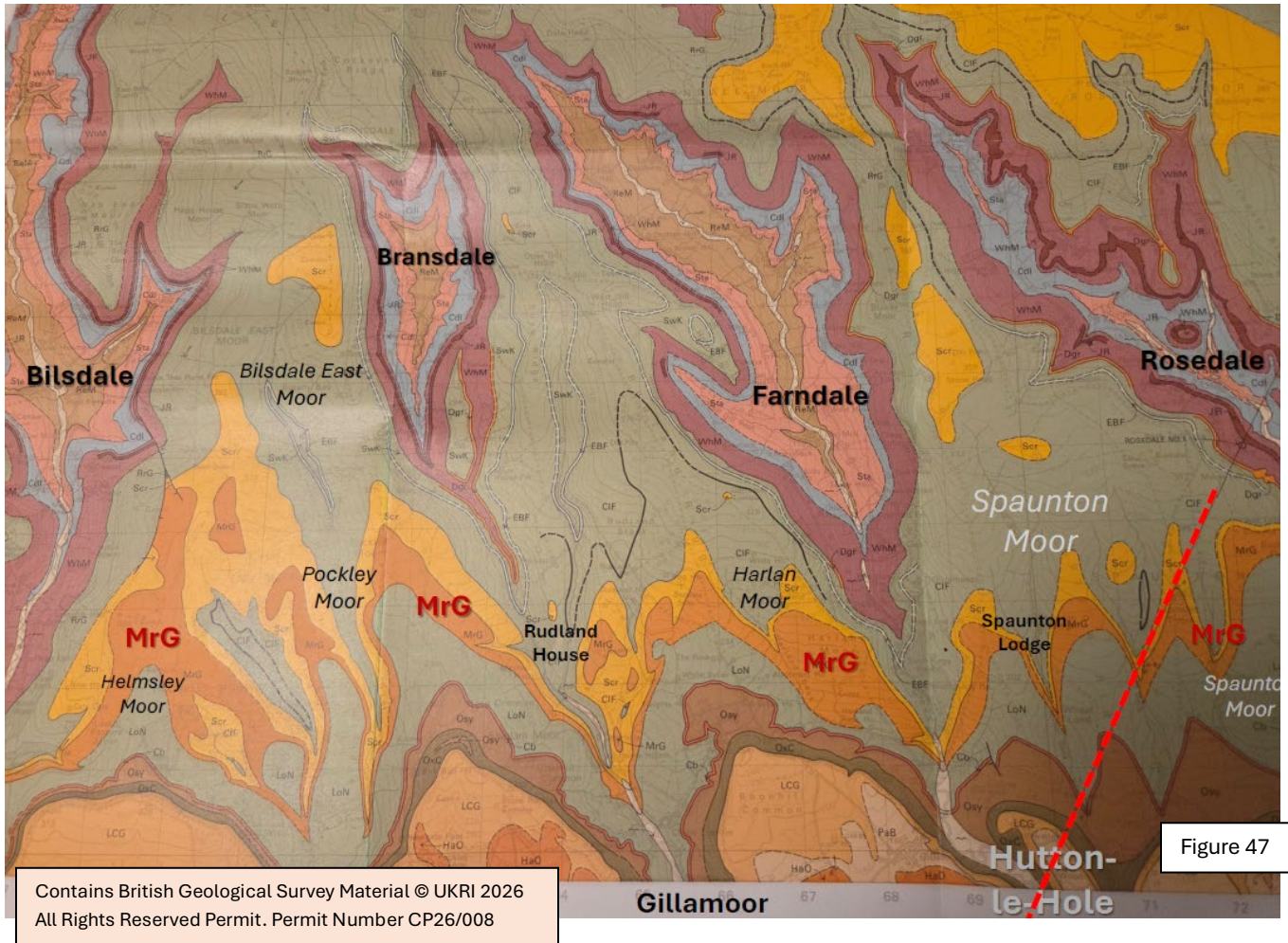
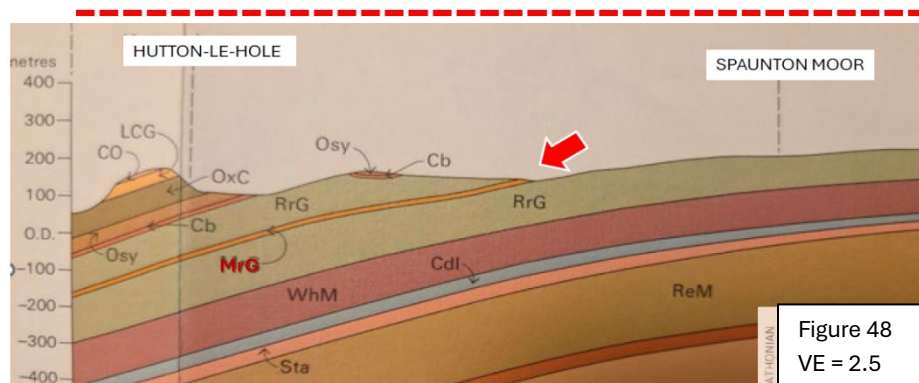


Figure 47

According to part of the BGS map, Egton Sheet 43 (Figure 47), Moor Grit is almost continuously exposed across most of the moorland of the southern part of the North York Moors. These exposures follow a sinuous route, mirroring the topography. The nature of the exposure can be understood by examining the cross-section, Figure 48, extracted from the BGS map.

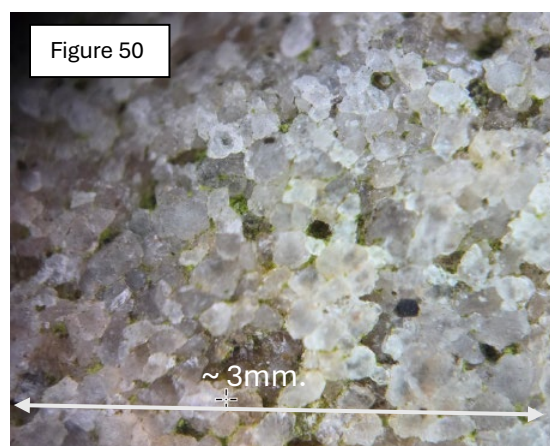


The vertical thickness of Moor Grit is about 10 metres, at most, and it dips gently south, along with the rest of the Ravenscar Group rocks. Where this dip coincides with the local slope of the topography, the exposure will be “stretched out” in some directions, so that it is more widespread.

At this point, the nature of the “exposure” was unknown, especially as the Moors are generally covered with a wet thickness of peat, moss, bracken and heather, often referred to as a “boggy plateau”. It was necessary therefore to visit the Moors to look for exposures manifested as low ridges or edges, as loose slabs, or possibly in shallow quarries.

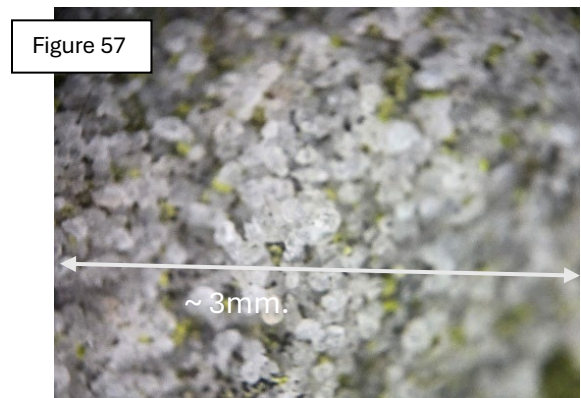
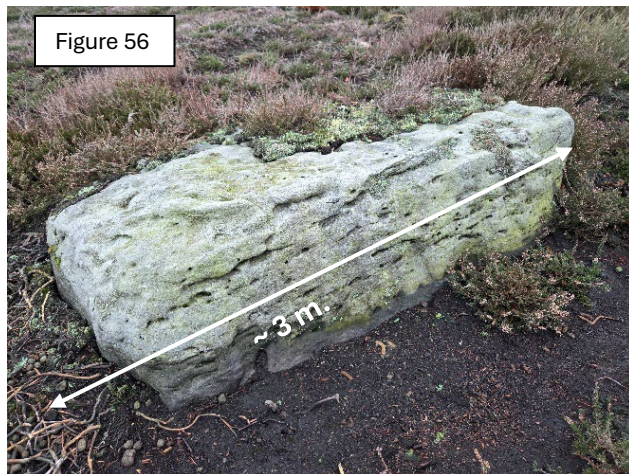
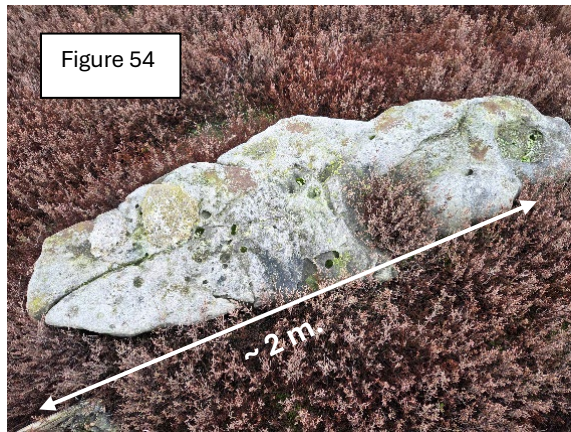
There was also the issue of access to the Moors, there being few public roads crossing them, and those generally being mainly in a north-south direction.

An expedition on 23rd December 2025 went first to Hutton-le-Hole, to assess which of the two roads from that village might be productive, in the available daylight, in finding outcrops or slabs of Moor Grit. While there, it was noted that the village Pinfold had evidently been constructed of Moor Grit. This reinforced our belief that there must be (or have been) easily accessible quantities of Moor Grit locally, for it to have been shaped and used as a building stone, similar to the drystone wall on Salt Pans Road in Cloughton. Figures 49 and 50 are photos of this Pinfold.

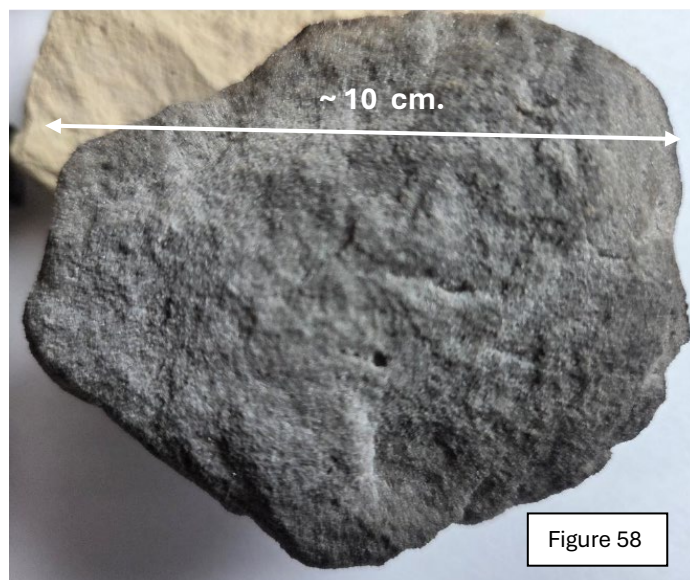


The Egton geological map was then used as a means to identify any Moor Grit exposures on the Blakey Road, Figure 51. About 2.5 kilometres north of Hutton, a large grey coloured boulder was observed by the roadside (noted by a triangle on the map), which proved to be Moor Grit and prompted a search of the moorland to the west of the road, towards Farndale. This resulted in finding many more boulders and slabs of Moor Grit, some of them very large and all of them showing all the usual rock characteristics of the Monolith, except length. See figures 52-57.

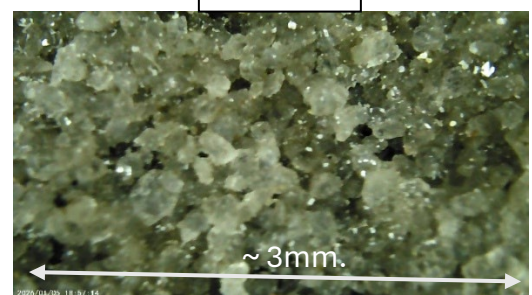




The dark grey rocks on top of the boulder in Figure 55 were found adjacent to it and subsequently were confirmed as Moor Grit. Their darker colour, in contrast with the light grey of the slabs, can be explained by assuming that the slabs were exposed to the elements for hundreds, possibly thousands of years, and have become weathered or bleached. Figures 58 and 59 are photos of one of these dark grey rocks.



Figures 59



After examining this large number of Moor Grit slabs and boulders on the western edge of Spaunton Moor, we concluded that there could be “loose” exposures of Moor Grit at several other locations across this Moor, close to or at where the BGS maps indicate this rock outcropping or subcropping. As to why they are loose and not *in situ*, our working hypothesis is that they were displaced relatively short distances by glacial action, during one or more of the Pleistocene glaciations.

A quick assessment of other possible accumulations of large, loose Moor Grit slabs was made using the Google Earth image of Spaunton Moor. The orange dashed ovals on Figure 60 are where highly zoomed parts of this Moor on GE images show groups of light grey material, which might be assumed to be Moor Grit.

The yellow arrow on the left side of this image is where the Moor Grit slabs west of Blakey Road were found. The orange dashed areas have not yet been explored. Based on this image, the most promising area on Spaunton Moor to find more slabs of Moor Grit, comparable with the size of the Monolith, seems to be within the dashed yellow rectangle, which is on the Redman Plain area of this Moor; see the enlarged Google Earth image, Figure 61.

By zooming in to the Google Earth image, it's possible to identify other areas on Spaunton Moor where there could be many more such boulders and slabs, possibly including much bigger ones ...

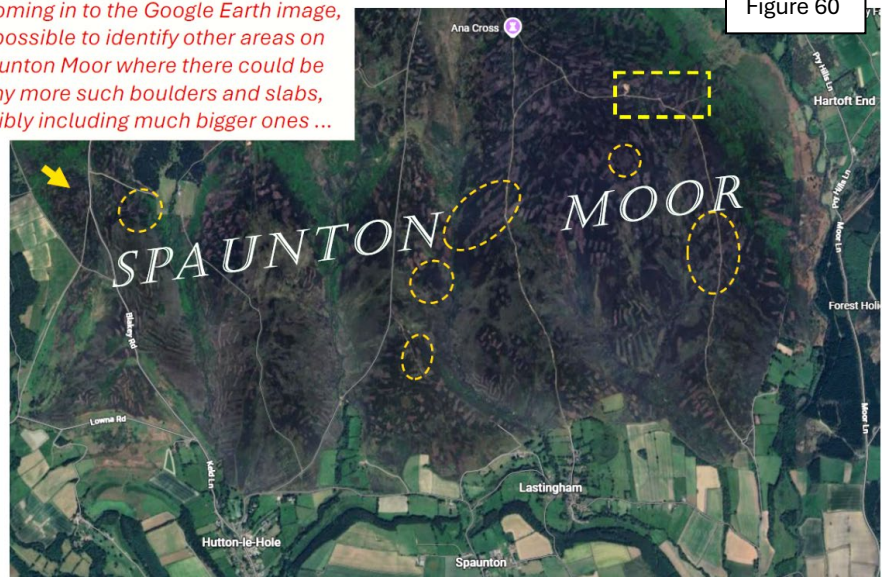


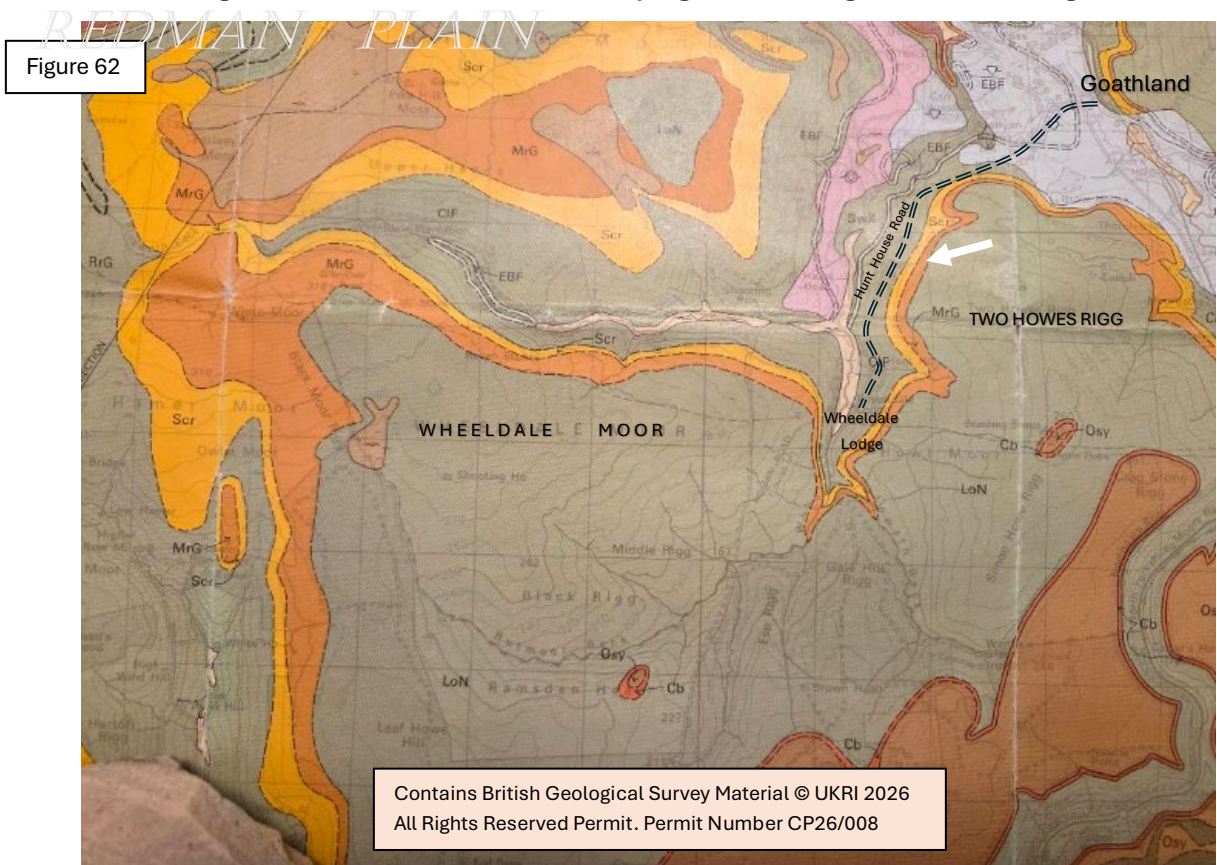
Figure 60



Figure 61

8. Moor Grit Exposure on Wheeldale Moor

The probability of finding more surface exposures on Spaunton and other Moors led us to consider their structural position. It seems more likely to find areas of exposed rock where the Ravenscar Group's dip is close to the topographic slope of the land, or where the outcrop forms an "edge". Of particular interest was the eastern part of Wheeldale Moor, about 12 km northeast of Spaunton Moor. Access to the Two Howes Rigg part of Wheeldale Moor to look for Moor Grit slabs was possible from the road southeast of Goathland, towards Hunt House and Wheeldale Lodge. East of Hunt House Road we observed a low ridge or edge, as might be expected with the harder Moor Grit resisting erosion more than the underlying Scarborough Formation, Figure 62.



The view of the west side of Two Howes Rigg from the road shows a low ridge. By hiking across about 100 metres of boggy moorland, several large slabs of Moor Grit were seen, having the same characteristics that define the other Moor Grit slabs, and the Monolith. See figures 63-66.





Figure 65



Figure 66

Closer examination of one of the large slabs (Figure 67) showed both indications of linear bedding, as within the Monolith, and “trough cross-bedding”, which is an element of BGS’s lithological description of Moor Grit.

Although it would be unwise to generalise from these two locations – Spaunton Moor and Wheeldale Moor - it does seem that large slabs of weathered Moor Grit can probably be found in several places across the Moors.



Figure 67

9. Depositional Environment of Moor Grit

From the extensive literature on the stratigraphy of the Middle Jurassic rocks of the North York Moors, it is clear that most of the depositional environments of sediments of the Ravenscar Group are “paralic”; that is to say, sediments were deposited on the landward side of a coastline, in environments such as deltas, estuaries, coastal swamps and braided rivers. The Moor Grit stands out among the other rocks within the Group for its uniform grey colour, its homogeneous, subangular to sub-rounded exclusively quartz grains, and for the reported fining of its grain size from east to west.

The 8-15 metre thick Moor Grit is the basal member of the Scalby Formation, whose upper and thicker member, at up to 60 metres, is the Long Nab Member. The Scalby Formation is the uppermost unit of the Ravenscar Group and is the youngest of the Middle Jurassic in this area, whose upper surface is an unconformity. It has been estimated that the Scalby Formation as a whole was deposited over a period of about 2 million years (168-166 Ma). Assuming its maximum thickness to be about 80 metres, this implies an average rate of sedimentation of 4 centimetres per 1000 years, which is about the average rate for all of the Jurassic deposits in Yorkshire.

As the lowest unit of the Scalby Formation, Moor Grit sits unconformably, or disconformably, on the underlying shelly mudstone and sandstone of the Scarborough Formation and is thus quite distinct lithologically and hence depositionally from it. Similarly, the overlying Long Nab Member, with its yellowish-grey mudstone, siltstone and thin sandstone beds has a clearly different depositional environment from the Moor Grit, though both are broadly classed as “non-marine”.

What has become known as the Scalby Formation has had a long and interesting history of defining its depositional environment. In 1829 and later in 1875, John Phillips described these paralic and fluvial deposits as the “(Great) Estuarine Series”. This initial description laid the groundwork for the understanding of the non-marine to marginal marine successions of the Cleveland Basin as a whole.

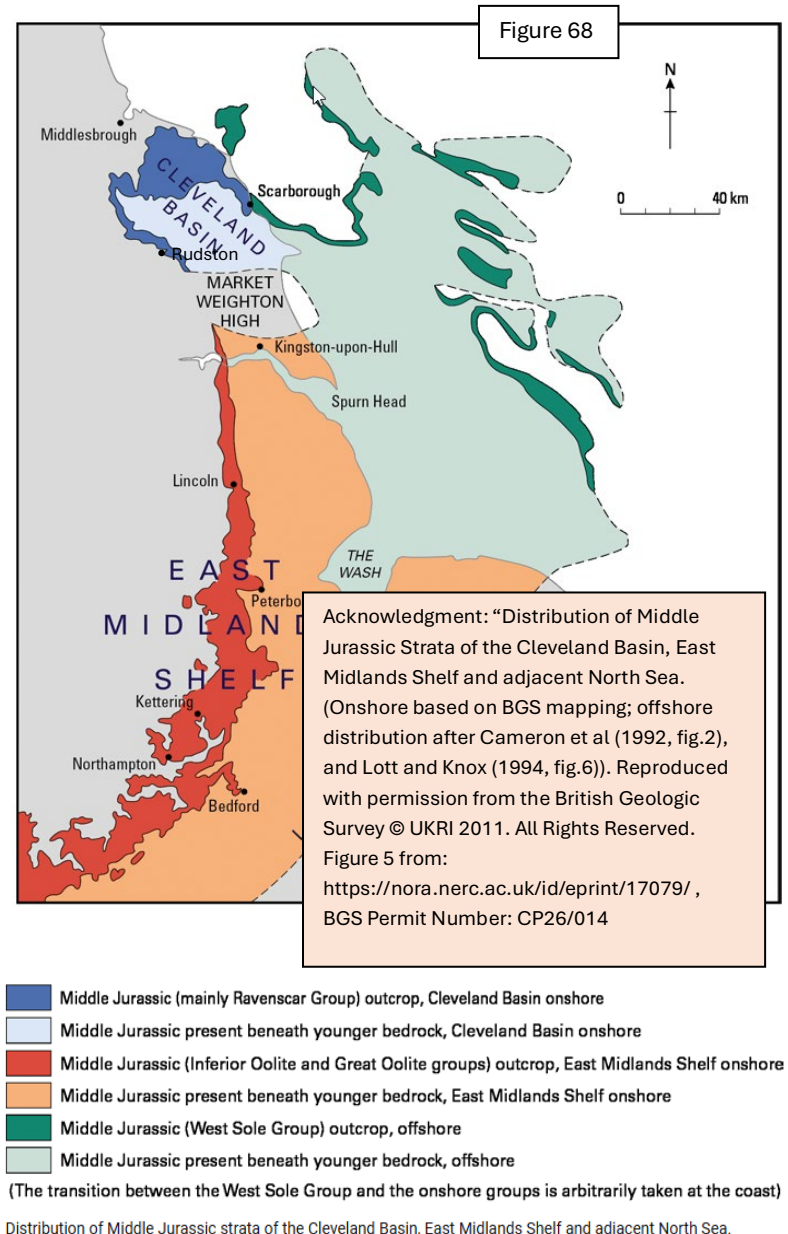
Geological Survey sheets produced in 1885-86 by Charles Fox-Strangways and colleagues highlighted the proto-Scalby Formation as being distinct from what are now known as the underlying Cloughton and Scarborough Formations, (at that time called the “Lower Estuarine Series”), and the overlying marine units like the Cornbrash. In the early 20th century, the term “Deltaic Series” emerged, with Hemingway in 1949 stressing that these units’ depositional environments were deltaic and alluvial floodplain. It was Sylvester-Bradley, also in 1949, who proposed the name Scalby Beds; in 1973 Hemingway & Knox adopted it formally as the Scalby Formation.

Further research in the 1980s and 1990s, such as Riding & Wright in 1989, used palynological and sedimentological analyses to propose a fluvio-deltaic model, with Alexander in 1992 interpreting the Scalby Formation as the result of a braided to meandering fluvial system, with episodes of basin uplift which caused sediment aggradation – the building up of flood plain surfaces when sediment supply exceeds the environment’s transport capacity.

Structurally, the Cleveland Basin as a whole was isolated from other Middle Jurassic depositional areas by the Market Weighton High, a persistent structural feature throughout most of the Jurassic and Cretaceous; Figure 68. During the Middle Jurassic, it has been interpreted that sediment sources were from both in the northeast and the northwest; that’s to say from the Mid North Sea High and the Pennine Uplands, based on current or flow directions, where such can be measured, or estimated from sedimentary structures.

The current interpretation of the Scalby Formation, including the Moor Grit Member, is of sediment sources from the north and northeast, deposited within an alluvial plain and/or braided river system, when sea-levels were relatively low, the river channels and distributaries prograding to the south or southwest. Moor Grit deposits are entirely non-marine; see the reference for Figure 68. This type of dynamic fluvial system lacks tidal signatures, reinforcing the non-marine nature of the deposits.

Within the Moor Grit Member, BGS describes the grain size as medium-to-coarse at the coast, but fine-grained in the Hambleton Hills in the southwest. This variation could support a case for a west or southwest flowing deltaic &/or braided river system. The grain size of the various Moor Grit samples that have been photographed from the Cloughton area, Spaunton Moor and Two Howes Rigg on the western part of Goathland Moor are all judged to be fine-to-medium grained, as are the digital microscope photos of the surfaces of the Monolith and the Millennium Stone themselves.



Describing the Moor Grit Member, BGS says that the grain size is medium-to-coarse at Hundale Point on the coast, but fine-grained in the Hambleton Hills scarp cliff in the far southwest. There are no known BGS reports that describe grain size or shape in the middle of the Moors, between these two sites, which are about 52 km apart. The digitally photographed slabs at Two Howes Rigg and the western part of Spaunton Moor are respectively about 18 and 33 km from the coast.

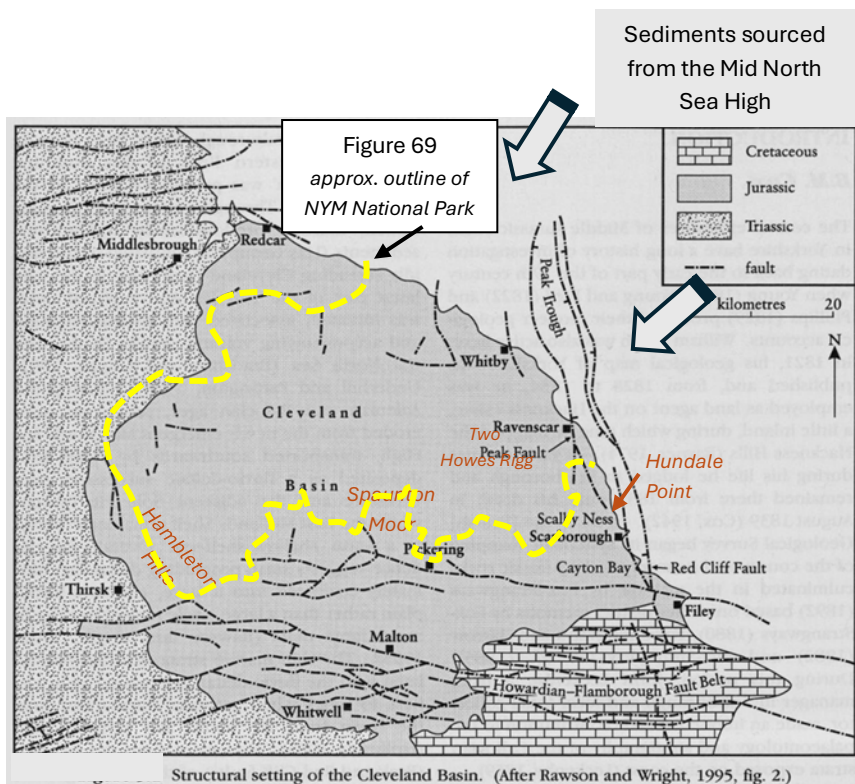
Another very distinct feature of all of the observed Moor Grit slabs, boulders, gateposts and shaped building stones is the consistent grey colour and distinctive mineralogy. The Monolith, Millennium Stone, slabs and boulders on the Moors are all light grey. This is assumed to be because of bleaching or weathering from thousands of years of exposure. The collected samples of rock and the building stones are a much darker grey, yet all of these exhibit the same colourless to pale grey, sub-angular to subrounded grain characteristics when viewed with

a hand lens or with a digital microscope. The rocks stratigraphically above and below the Moor Grit, and in fact throughout most of the Jurassic of the North York Moors, are to a greater or lesser extent brown coloured, suggesting iron staining. The conclusion from all of these marked differences is that the sediments forming the Moor Grit must have had a different source or different depositional/detrital conditions (or both) from the rest of the Jurassic in the Cleveland Basin. Further, Moor Grit appears to be composed exclusively of quartz grains, with no other minerals whatsoever.

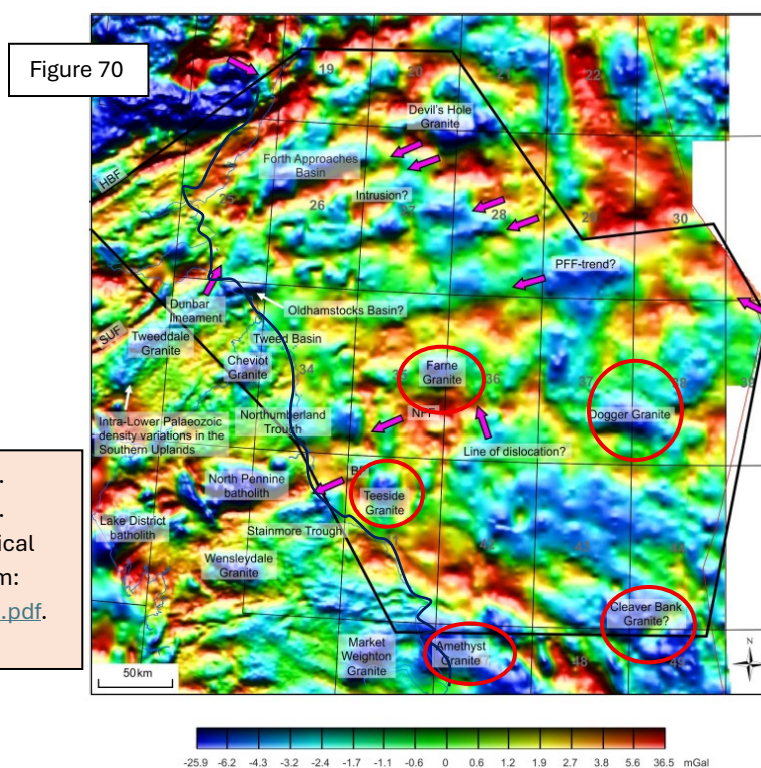
One way to at least partially explain this difference could be to assume that this sediment originated from granitic bodies, believed to be Devonian in age, within the Mid North Sea High (MNSH).

Depositional environment conditions in the whole of the onshore Cleveland Basin (Figure 69) throughout Moor Grit time would have been non-marine; likely a wide alluvial plain with braided rivers spreading across it.

Under this scenario, the sediments in these rivers would have been sourced from the emerging Mid North Sea High, some 50-150 km from the present Yorkshire coastline. Consequently, the medium-to-coarse grain size of what is now the coastal Moor Grit would be more proximal, and that of the Hambleton Hills more distal, to such a MNSH sediment source.



Reference: JNCC British Middle Jurassic Stratigraphy, by BM Cox and MG Sumbler



Acknowledgment – 'Annotated residual gravity image. Magenta arrows indicate selected gravity lineaments. Reproduced with permission from the British Geological Survey ©UKRI 2015. All Rights Reserved. Figure 9 from: <https://nora.nerc.ac.uk/id/eprint/516759/1/CR15119.pdf>. Permit Number CP26/013'

Evidence for granitic plutons associated with the greater Mid North Sea High area has been interpreted from BGS gravity surveys; granite having a lower density than surrounding rocks. Using the Residual Gravity image (Figure 70), an interpretation of these plutons (circled in red) has been made; the implication being that they could have been the source of Moor Grit sediments.

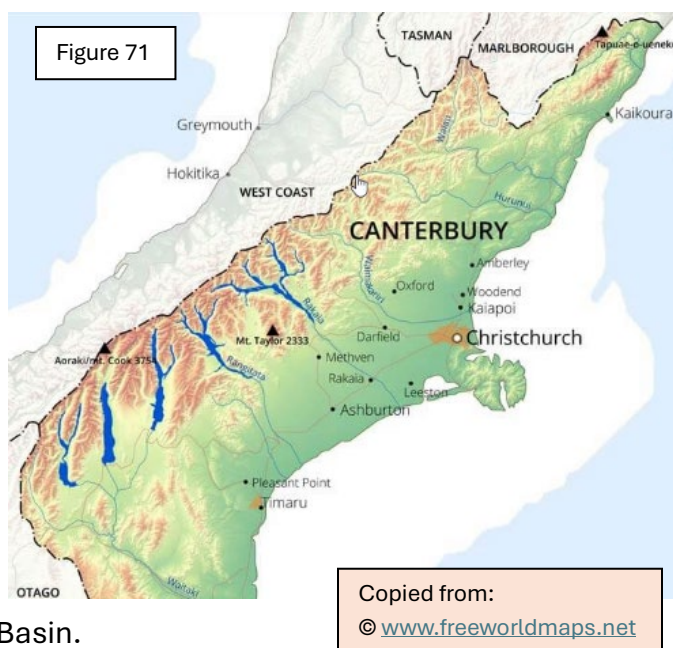
The plutons of interest for shedding into the Cleveland Basin to their west or southwest have been named as the Devil's Hole, Farne, Dogger, Teeside and Cleaver Bank Granites.

A 2009 Shell/Esso exploration well, very likely drilled on the Dogger Granite High, did not discover oil, as anticipated in the Devonian Kyle Limestone, but instead penetrated 13 metres into crystalline basement rocks. Quartz cuttings were reported at the Total Depth (TD) of the well. This quartz could support the notion that this granite, at least, is quartz-rich and could be the source, or one of the sources, of the quartz sediments of Moor Grit in the Cleveland Basin, 150- 200 km to its west. If the other granite plutons are similarly quartz rich, this could provide the reason why the Moor Grit, alone of the Middle Jurassic units in the Basin, is essentially 100% quartz and was sourced from the north and northeast.

To summarise, it appears from a considerable amount of research and wide-ranging analyses, over nearly two centuries, that the Moor Grit was deposited in a relatively high energy, alluvial plain environment, as a delta front top, with meandering or wandering braided river systems, similar to the Canterbury Plains in New Zealand today (Figure 71).

Figures 72 and 73 are aerial photos of such braided rivers on the Canterbury Plains.

Possibly of note is that the Canterbury Plains are about 200 km wide, not dissimilar to the onshore+offshore width of the Cleveland Basin.



Fossil content in the Moor Grit is described by BGS as “sparse”, consisting of occasional plant roots, pollen and spores. The presence of these roots might be explained by some of the sediments having accumulated adjacent to woodland next to the braided rivers. The plant roots observed in the small pale grey boulders near Cloughton Wyke could be examples of these.

BGS also reports the Moor Grit as occasionally “pebbly”. While no pebbles have been seen in the slabs or boulders of Moor Grit found during this project, the presence of “holes” of various sizes and shapes on the slabs’ surfaces might be explained by the pebbles having been weathered out. Certainly, the apparent alignment of the smaller holes with the lineaments/bedding planes on the north and south sides of the Monolith, and on the Cloughton gateposts, could indicate pebbles originally scattered among the quartz grains.



Figure 72

Credit: teara.govt.nz

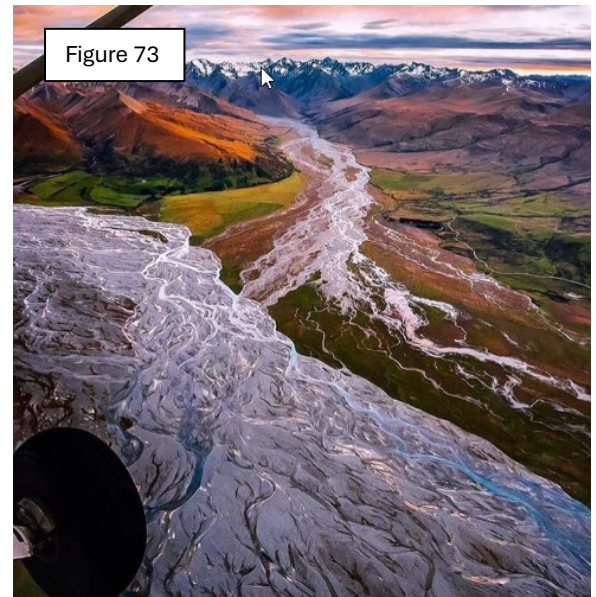


Figure 73

Credit: www.pinterest.com

10. Why Rudston?

It having been established that the Rudston Monolith is a slab of Moor Grit and that Moor Grit can only be found in various locations across the North York Moors, the remaining task is to explain how and why this huge piece of rock ended up being erected on a spur above the village of Rudston, which sits snugly in the Great Wold Valley of the Yorkshire Wolds, miles away from the nearest Moor Grit outcrop. It has been made clear that this could not have happened solely due to glacial processes, so it is concluded that the slab which became the Monolith was moved, approximately 4000 years ago, from its original to its present location by human hand. This is taken as a fact. It is also known that in that period, farming had already become the mainstay of people's lives and that the thin, fertile soil of the chalk uplands, once cleared of any woodland cover, were important areas for settlement. The Yorkshire Wolds was just such an area. Of note is that the nearest Standing Stones to Rudston are the Devil's Arrows near Boroughbridge, some 80 km to the west – these rocks being of Millstone Grit.

From this perspective, given that there is no relevant historical information, the choice of Rudston and a transportation route there from the Moors enter a realm of conjecture and guesswork, aided by studies of ancient and modern topography, and from archaeological discoveries and analysis. But before this, two questions – *Why did they do it ?* and *Why Rudston ?*.

It is not known what the people of the late Neolithic actually believed. However, we do know, because the evidence lies scattered everywhere across these islands, in the form of stone circles, avenues, structures and erections, that there was an apparently common culture underpinning everything they did. It is also clear that these stoneworks were created by people with ideas,

ambitions, tremendous skill and the ability to coordinate huge resources in order to achieve their goals. Archaeologists think that all of this is due to their need for places where the people and their leaders could gather, to perform the rituals which bound their society together.

At Rudston, in the Great Wold Valley, archaeology tells us that the site was the focus of several major earthworks known as cursuses. Three of them were over one kilometre in length and about 80 metres wide, Figure 74. These earthworks may not have been very high and certainly do not seem to have been defensive structures. It is thought that they were possibly used for ritual processions.

Whatever the truth, it looks like the site had great ritual significance. For whatever reason, it is clear that a decision was made to raise a marker of some kind there, that would be visible, over quite some distance, to travellers coming from all directions of the compass. Perhaps this massive stone was erected above the valley because the ritual site was on the valley floor, near where the Gypsy Race now flows?

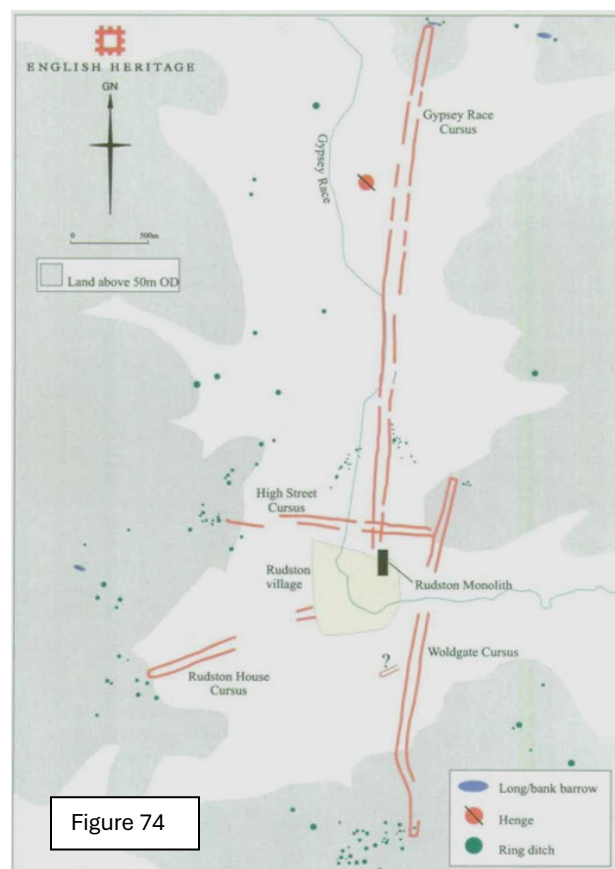
The question of who made the decision is open for discussion. Our own view is that this was not a local but a regional matter, taken by powerful people – leaders –

in an island-wide culture, since erections like this and stone circles are common throughout the

British Isles. Whoever they were, they had the power and the resources to organise and deliver this project. Perhaps there were specialised logistics groups available to do just that ?

Could there have been teams that knew everything there was to know about moving massive slabs of stone over long distances and difficult terrain?

It will never be known. What is known is that a suitable stone was found somewhere on the North York Moors and selected to become the tallest standing stone in Britain. Somehow it was transported to a spur of the Yorkshire Wolds overlooking the ritual site at Rudston. Once there, it was raised up, so that 8 metres of it protruded above the ground. And it is still there.



The Woldgate Cursus – Humberside
NMR Nos: TA06 NE 15&19
© English Heritage, 2002

11. Speculation on Transportation Routes

It is not known exactly where the Monolith came from and probably never will be known. There are no easily recognisable tool-marks on it, although this doesn't mean that there were or are none. It's accepted that hard rocks, particularly those that have splittable bedding planes, can be cracked with wedges, sometimes leaving sharp edges; these are not present on the Monolith, as

we view it today, so the idea that this slab was quarried seems unlikely. In places on Spaunton Moor, the Moor Grit is on the surface, partially covered with peat, soil and heather. The thickness of the outcrop on this Moor is unclear, but since it is a very hard rock, it's probable that it has been on that surface for a very long time. Freeze-thaw actions during the hundreds of thousands of years of the Pleistocene glaciations may have split the outcrop/subcrop into large pieces, though it is of note that the thickness of the slabs generally does not exceed one metre.

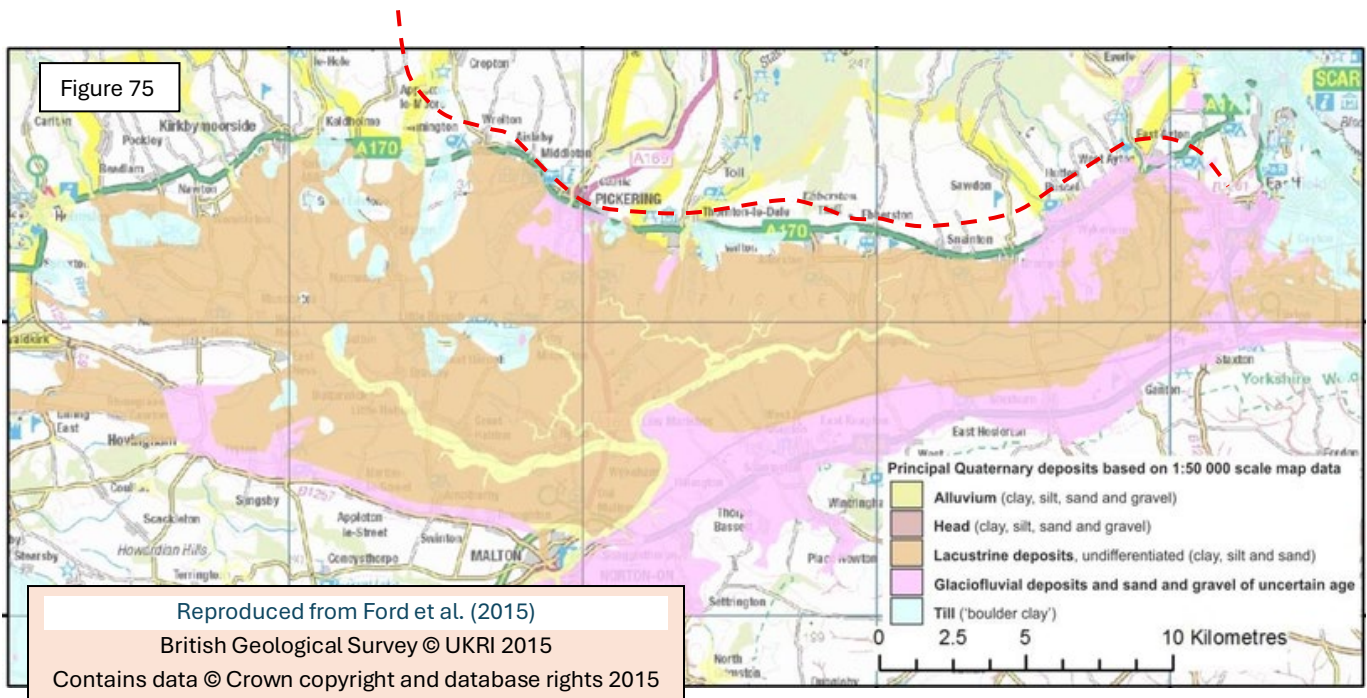
The stratigraphically underlying rocks to Moor Grit are significantly softer and more friable. These may have been moved, slumped or eroded during the glacial and peri-glacial periods, helping to separate these large pieces into slabs, such as are seen on Spaunton Moor and Two Howes Rigg today. If this mechanism of breaking down the Moor Grit outcrops is roughly correct, there remains the strong possibility that more slabs of Moor Grit may be found elsewhere on the North York Moors.

It is assumed that the slab which became the Rudston Monolith was moved using tree-trunk rollers, ropes and a lot of muscle. The actual route from Spaunton Moor might have been dictated by the need to drag or slide the slab down into Rosedale, along the valley of the River Seven, southwards to the northern rim of the Vale of Pickering.

As is well known, during the Devensian ice advance, the Vale of Pickering was blocked at its eastern end by the North Sea Ice Lobe, such that the vale flooded and Lake Pickering formed, apparently persisting from about 21,000 to 15,000 years ago. Sedimentation into the lake over these 6,000 or so years was complex, the eastern ice lobe advancing and retreating several times; water levels varying considerably and sedimentation into the lake coming in different forms, including mini-deltas.

The drainage was also quite complicated, with some water draining eastwards through the Hunmanby Gap, but most of it escaping westwards through what became the Kirkham Gorge, into the Vale of York. What was left, perhaps some 11,000 years before the Monolith's slab was moved, was a huge marsh, above up to tens of metres of sedimentary fill, with scattered ponds and residual lakes. During winters for many centuries after the lake drained, its whole area would have been mostly under water.

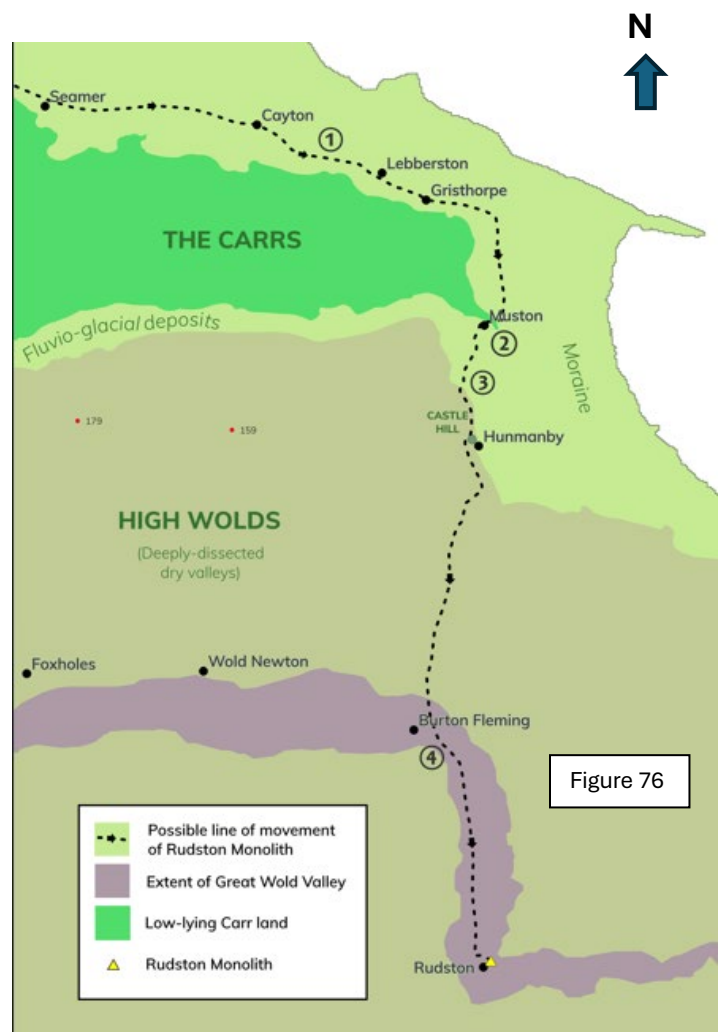
Given this, it seems highly unlikely that the Neolithic people could have transported a 7-8 ton rock across this boggy terrain directly to the scarp of the Wolds on the southern side. Hence it is much more likely that the route they took was along the northern side of the Vale, eastwards. This edge is partly formed of the lower slopes of the Moors and partly of the remnants of the glacial lacustrine and deltaic deposits. To reach a point where the ground would no longer be boggy, a possible route (Figure 75) along this northern edge is being suggested. It would have been more than 20 km long, reaching as far as the eastern moraines left by the retreating ice sheet.



To reach the moraines, field observations and the OS Explorer Sheet 101 provide valuable information in attempting to show on a sketch map just how far they had to go.

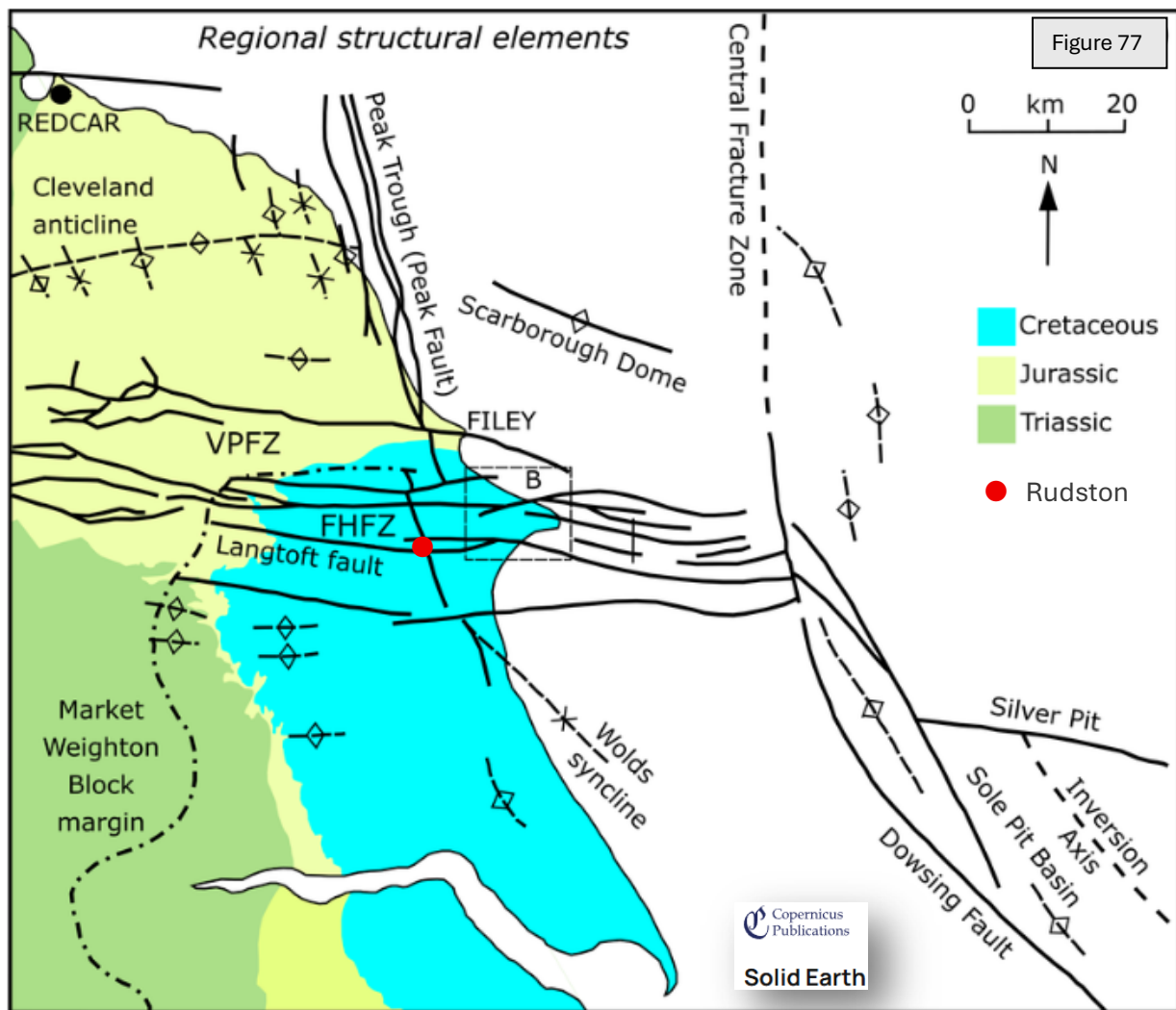
The Anglo-Saxon place-name element “carr” roughly means “marsh”. Research suggests that the lake surface stood at 30 metres above sea Level (asl) for a considerable time. Combining these two elements suggests that the 30m contour line should give a reasonably accurate position for the edge of the carr-land. Later settlements (i.e. Anglo-Saxon), such as Seamer, Cayton, Leebberston and Gristhorpe, sit on slightly higher land, overlooking the carrs. This marshy land would have provided fish, wildfowl & eggs, rushes & reeds (for thatching and rope-making), and summer grazing for livestock.

As illustrated in Figure 76, it is proposed that the slab’s transportation route previewed this line of settlements, perhaps a short distance to their south ①.



The width of the carrs narrows dramatically just to the north of the present-day Muston ②. Immediately east of that village the existing road crosses the Main Drain, which flows into the Hertford River. The width of the marsh here is less than 20m and was possibly where the Monolith was brought across the end of the carrs, to the Wolds.

Their next major task would have been to find a way up the steep scarp slope of the Wolds. As luck would have it, or perhaps it was planned that way, just south of Muston the direction of the scarp suddenly turns north-south and does not resume its previous west-east alignment for about 3 km. The reason for this abrupt change of direction is very likely the effects of a complex fault pattern associated with the Peak Trough/Peak Fault and the Flamborough Fault Belt, see figure 77.



Consequently, the Neolithic removal team had a diagonal route up the slope, giving a much easier gradient up to the top of the chalk hills. Starting at Muston at a present-day elevation of about 45m above sea-level, a narrow road ③ called High Lane takes this route, ascending to the top of the scarp at Castle Hill, at about 100m asl.

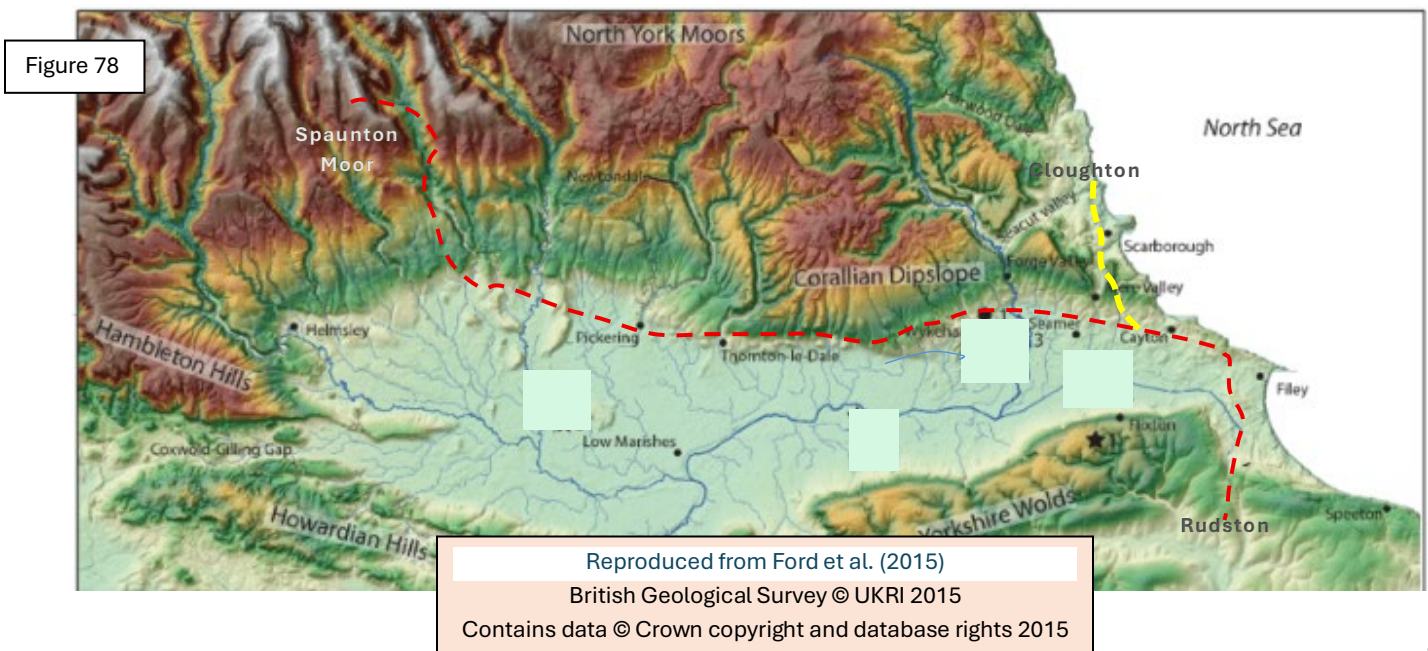
Certainly this lane route would have been actively used during the Saxon period, so it was probably already in use by the late Neolithic, with the landscape thereabouts having been populated even before this time. From this point, just to the west of present-day Hunmanby, the slab team would have been able to move it over low gradients, generally contouring for a few kilometres, before being slid gently downhill in a dry valley, to the present site ④ of Burton Fleming, whose elevation is about 40m asl.

This site is in the Great Wold Valley, which at this point, along with its chalk stream, the Gypsy Race, turns suddenly southwards towards Rudston. This turn may well be another effect of the Flamborough Fault Zone. The Gypsy Race in Rudston is at 25m asl; hence it would have needed only a short climb from there to the flattish top of the spur overlooking the ritual site, to the Monolith's current location at 32m asl.

It is not known how much of the Monolith is below ground, but probably 4 metres and possibly as much as 8m, which would have meant considerable digging; presumably sufficient to ensure the slab's 8 metres above ground was completely stable. After a few metres, after digging through the boulder clay topsoil, the diggers could have penetrated chalk bedrock, although it is possible that they stopped at the level at which the chalk was hit.

While purely a piece of conjecture, it is felt that if the slab came from Spaunton Moor, the route described above would have been the easiest for the Neolithic people, from a practical point of view, and would have passed through, or near to, some long-standing settlements on the way.

However, we have also speculated that a slab this size might have been found in the Cloughton area and transported to Rudston from there; a shorter route than that from Spaunton Moor. It is hoped that further research will continue to evaluate this possibility, and from other locations on the Moors where Moor Grit slabs have accumulated. In Figure 78, the final one, both the Spaunton and Cloughton routes have been dotted in, to leave us with more ideas to explore, and to seek further answers to the question - *Whence the Rudston Monolith !*



12. Provisional Conclusions

- a. The Rudston Monolith's rock type most resembles the basal Moor Grit Member of the Middle Jurassic Scalby Formation.
- b. The Monolith's origin was very likely a slab of Moor Grit, displaced from a location somewhere on the North York Moors.
- c. Based on comparing the grain size and shape of the quartz crystals of the Monolith with Moor Grit slabs on the Moors (almost *in situ*), it is more likely that the Monolith slab came from the south-central or southeastern part of the Moors, rather than the north or the west.
- d. Of the three locations on the Moors that have been examined in some detail, Spaunton Moor is the more likely source of this slab of Moor Grit, which was subsequently moved to Rudston.
- e. Further research is needed to assess more precisely where on Spaunton Moor this slab might have come from and, importantly, whether there could be other locations on the Moors that could have been the Monolith's source.
- f. The slab could not have been transported from the Moors to Rudston completely by glacial action, though it could have been displaced a small distance from its surface outcrop, during and/or after one or more of the Pleistocene Ice Ages,
- g. If Spaunton Moor were the Monolith's origin, a possible transportation route would have been southwards to the northern margin of the Vale of Pickering, then eastwards along this margin to the area of the Wykeham & Seamer Moraines, southwards again past present-day Hunmanby, to Rudston in the Great Wold Valley, thus avoiding the climb up the steep east-facing scarp slope of this part of the Wolds.
- h. The choice of Rudston for the erection of the Monolith was probably because that region was already a site of cultural and spiritual significance in Neolithic times. It was, and is, a relative high point, accessible and visible for long distances in most directions, including from the sites of communities inhabited since Mesolithic times, around the northeastern part of the Vale of Pickering, such as Star and Seamer Carrs.

13. Credits and thanks to:

- Mike Hudson for most of the close-up photos of the Monolith's "holes".
- Andrew & Jane Connor for the site visit to Roseberry Topping, for the photos taken there, and the rock samples of Saltwick Formation collected for comparison with the Monolith.
- Kendall Louie for all the selfies he took and the precise locations he recorded for them.
- Janet Cochrane of the North York Moors Association, for putting us in contact with George Winn-Darley.
- George Winn-Darley of the Spaunton Estate for his advice and direction in finding areas of Spaunton Moor where quantities of Moor Grit can be found.
- Bruce Bilodeau for his stratigraphic expertise in the preparation of the section on Depositional Environments.
- Keith Appleton and Mike Hadley for their reviews and comments on all of this article.

- Dan Clarke for the preparation of the sketch maps of the sites and regions described in this paper, and the slab's speculative route to Rudston (Figures 2 and 76).

14. References

- Page 2 : among the internet sites were *Wikipedia*, *Rudston Parish Council*, *realyorkshireblog*, *Welcome to Yorkshire*, *stone-circles.org.uk*, *The Northern Antiquarian*
- Page 2 : Historic England Official List Entry Number 1013621
- Page 5 : BGS Lexicon of Named Rock Units – *Moor Grit Member*
- Page 13 : the Type Section for the Moor Grit Member is described in the BGS Lexicon (as above) as follows: *Coastal cliff section between Hundale Point [TA 025 948] and Long Nab [TA 028 943], where the boundary between the shelly mudstone of the underlying Scarborough Formation is marked by an erosional disconformity/unconformity with the Moor Grit Member (c. 15 m thick). The latter consists of medium- to coarse-grained, trough cross-bedded sandstone with pebbly laminae; plant fragments are common, along with casts and moulds of drifted logs. Laterally accreted channel-fill bedforms are common (Black, 1929; Hemingway and Knox, 1973; Hemingway, 1974; Nami and Leeder, 1978; Leeder and Nami, 1979).*
- Page 14 : The gross interpretation of the north-facing sea cliff of Hundale Point was guided by the publication *Stratigraphy, sedimentology and palaeontology of the Scarborough Formation (Middle Jurassic) at Hundale Point, North Yorkshire*, by S. Gowland and J. B. Riding in PROCEEDINGS OF THE YORKSHIRE GEOLOGICAL SOCIETY, VOL.48, PART 4, PP 375-392, 1991 and by compositing the schematic cross-sections in BGS 1:50,000 Whitby and Scalby Sheets 35 & 44.
- Pages 24-25 : The summary of the evolution of thinking on the various depositional environments throughout Middle Jurassic time in Yorkshire, from the early 19th century to the present, comes from the Scottish Geology Trust's GeoGuide; specifically from the Introduction to Chapter 5 The Middle Jurassic stratigraphy of North Yorkshire, by B.M. Cox and K. N. Page.
*The original source material for these web pages has been made available by the JNCC under the Open Government Licence 3.0. [Full details in the JNCC Open Data Policy](#) Cox, B.M. & Sumbler, M.G. 2002. *British Middle Jurassic Stratigraphy*. Geological Conservation Review Series, No. 26, JNCC, Peterborough, ISBN 1 86107 479 4.*
- Page 30 : Neolithic ritual sites : several online sources, including *stone-circles.org.uk*, *Rudston Parish Council*, *The Northern Antiquarian* and *Grokikipedia*.
- Page 31 : Lake Pickering's duration : several sources, perhaps the most comprehensive being: *Glacial Lake Pickering: stratigraphy and chronology of a proglacial lake dammed by the North Sea Lobe of the British-Irish Ice Sheet*, by David J. A. Evans, Mark D. Bateman, David H. Roberts, Alicia Medialdea, Luara Hayes, Geoff A. T. Duller, Derek Fabel, Chris D. Clark in *the Journal of Quaternary Science*, first published on 15th January 2016.