11 The Jurassic, Tertiary and Quaternary around Great Ayton and Roseberry Topping, Cleveland Hills

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Purpose

To examine the Lower and Middle Jurassic sedimentary succession and the Tertiary Cleveland Dyke intrusion in the area around Great Ayton and Roseberry Topping; to investigate how this rock sequence, together with the late Quaternary glaciation of the area, controls the form of the landscape.

Logistics

This is a gentle full-day excursion covering 12.5 km. Numerous recognized paths and bridleways allow the route to be easily altered, shortened, lengthened or taken in reverse order. Park in Great Ayton, near the Tourist Information Office [NZ 563 107], or at the Gribdale Gate car park [NZ 593 110], which is usually used for visits to the Cook Monument. Theft from cars is a serious risk at more remote sites. If travelling by train, Great Ayton station [NZ 575 108] is on the line from Middlesbrough, via Nunthorpe and the Esk valley, to Whitby. There are toilets, cafes and pubs in Great Ayton, but no other facilities en route.

Maps

O.S. 1:50 000 Sheet 93, Middlesbrough & Darlington; O.S. 1:25 000 Outdoor Leisure Sheet 26, North York Moors, Western Area (preferred); B.G.S. 1:63 360 Sheet 34, Guisborough.

Geological and geomorphological background

The area is on the western edge of the steep Cleveland Hills escarpment (Cleveland: in the Orkneyinga Saga *Klifland* or *Clifa-land* 'district of cliffs'), a classic piece of escarpment country with steep north- and west-facing slopes composed of softer Lower Jurassic rocks (in part Liassic shales) capped by more resistant Middle Jurassic sandstones. Roseberry Topping, a prominent landmark throughout the Cleveland Basin, is an erosional outlier, where the Middle Jurassic sandstone (Ravenscar Group) is detached from the main plateau. This Lower to Middle Jurassic sedimentary succession dips gently towards the south-southeast. Where the sandstones form the parent materials, acid soils characterize the upland plateaux, producing the heather moorland that is so characteristic of the North York Moors.

Although the Liassic sediments on the scarp slope are generally softer shales, the Middle Lias does include two more durable rock formations: the Staithes Formation and the Cleveland Ironstone Formation. Both form minor bench-like features and escarpments on the scarp slopes.

The intrusion of the Cleveland Dyke some 59 Ma ago has had a strong influence on the local landscape. This hard tholeiitic dyke (part of the dyke swarm from the Mull volcanic centre) forms the core of the west-northwest trending Langbaugh Ridge, visible from Great Ayton and Roseberry Topping. A local source of road metal, this dyke has been extensively quarried in the past too years or so. The dyke is about 25 m wide near Great Ayton and seems to have been regionally injected as a series of *en echelon* segments. In the Cliff Ridge Quarry near Great Ayton there is some evidence that the dyke was injected in leaves, separated by sediment screens; the Liassic dyke wall rocks have undergone incipient contact metamorphism.

Evidence for glaciation in the region takes the form of tills, glaciofluvial sands and gravels and lacustrine silts and clays on the lower slopes and in the valley bottoms. Additionally, glacial meltwater channels, located in anomalous positions without a drainage catchment, have been recognized and used as evidence to determine the slope of the glacier surface

and the pattern of ice wastage. This evidence is attributed to the Dimlington Stadial of the Late Devensian Glaciation, when glaciers extended southward in eastern England to the region of the Wash, reaching their maximal extent about 17 000 ^{14}C yrs BP. Ice probably melted from the region sometime between about 16–15 000 ^{14}C yrs BP (Catt in Ehlers & Rose, 1991)

This ice failed to cover the higher parts of the Cleveland Hills, but was responsible for infilling the valley bottoms, reducing the relative relief of the region and significantly changing the valley bottom topography, producing many buried valleys throughout northeast England.

Although not glacierized during the Dimlington Stadial it is probable that the higher slopes were overridden by ice at some time earlier in the Quaternary, as resistant erratic pebbles have been recorded from the plateau surfaces of the Cleveland Hills. There is, as yet, no evidence to estimate the age of this earlier glaciation(s).

People have had a long-term influence on the landscape in this part of the Cleveland Hills. Mesolithic, Neolithic, Bronze and Iron Age peoples settled the region, helping to create the present-day 'grouse moor' landscape of the upland areas by forest clearance. Their presence is evidenced by well-defined ridge routes as well as numerous defensive sites, enclosures, field patterns, clearance cairns and burial tumuli. Monastic sheep farming created grange communities with associated field holdings, and medival iron smelting using local iron ores also added to the wealth of the Abbey or Priory. Sedimentary iron ore extraction (from the Cleveland Ironstone Formation) in the 19th century, by opencast and deep mine methods, has left a visible legacy of industrial archaeology. Large-scale Alum Shale workings have also left their mark on the Cleveland Hills landscape. Jet mining from the Upper Lias Shales (Mulgrave Shale Member) in the i gth century was more localized but the extraction bell pits can still be seen.

Excursion details

From the Tourist Information Centre, Great Ayton [NZ 563 107], walk northwards along Newton Road. Note that the older properties in the village are built of a fine-quality reddish-brown sandstone with characteristic worked chevron tooling. One of the sources for this Middle Jurassic building stone can be visited at Locality 8. Also note the Tile Yard Pub, an indication that pan tiles were locally manufactured from glacial lake clays.

Locality 1 [NZ 563 114], at the junction with the A173.

Look north to the very evident Langbaugh Ridge, the core of which is the Tertiary Cleveland Dyke. Differential erosion of the softer Lower Liassic sediments from around this dyke has resulted in this prominent feature which stretches west-northwest into the Tees Basin. Tills mask the bedrock on either side of the ridge. Langbaugh Ridge has been extensively quarried for roadstone [NZ 555 123]–[NZ 564 120]

Continue up the A173 to the summit of the ridge and take the bridle road east-southeast towards Cliff Ridge Wood and Roseberry Topping.

Locality 2 [NZ 566 119]

Just before crossing the railway bridge, stop to contemplate the magnificent view of Roseberry Topping to the northeast (Figure 11.2). The stepped profile of this Teesside landmark is easy to interpret, with the more resistant parts of the Jurassic succession (chiefly sandstones and ironstones) producing the cap rock and scarp edge bench features. The cliff to the south of the hill with the area of disturbed ground in front results from a spectacular rotational landslide, generated on Liassic shales with the feature accentuated by mining and stone quarrying. Continue into the deep roadstone workings in Cliff Ridge Wood.

Locality 3 [NZ 570 118]–[NZ 576 116]

The deep ravines through this wooded ridge result from extensive extraction of the dyke rock for road metal. Large blocks of the tholeiite, containing large crystals (phenocrysts) of feldspar set in a fine-grained matrix, can still be seen scattered

throughout the workings. In some areas of the south wall minor leaves of the dyke, with associated sediment screens, may still be viewed *in situ*. All the wall rocks of the dyke show incipient contact metamorphism and these more indurate sediments form the sheer walls and pinnacles. ***(This locality can be dangerous, with sheer drops masked by trees and shrubs; there is also the danger of falling blocks from the wall areas.)***

The dyke has been intruded into Lower Jurassic sediments. Approaching from the west the first sediments encountered are the silty shales of the Ironstone Shales (Lower Pliensbachian; Upper Redcar Mudstone Formation). These shales with nodule horizons are characteristic of the upper part of the Lower Lias; they tend to be poorly fossiliferous but occasional bivalves and the characteristic ammonite *Androgynoceras (davoei* Biozone) may be found.

Eastwards, the sediments become more silty and eventually grade imperceptibly into the silts and sandstones of the shallower-water deposits of the Staithes Formation (Middle Lias; Upper Pliensbachian). It is difficult to view these sediments *in situ* as they often form the upper levels of the quarry ravines. However, numerous fallen blocks show these marine impure sandstones to be richly fossiliferous with common Middle Lias bivalves such as *Pseudopecten, Protocardia, Pseudolima, Liostrea* and *Pholadomya* as well as numerous belemnites and the brachiopod *Tetrarhynchia*. More rarely, the index ammonite *Amaltheus* might be found *(margaritatus* Biozone), and brittle stars. The fossils almost always occur as natural moulds as the rock has been decalcified.

Return westwards to the start of the ravine area and take a path to the right to join the public right of way through the woods to the north of the quarry area.

Locality 4 [NZ 572 118]

At the top of the hill are the remains of the winding house and incline for the mineral line from the Roseberry Ironstone Mines. Continue due east towards Airy Holme Farm (Airy = Norse/Irish for 'shieling', i.e. summer pasture residence) where a southeastward-sloping glacial drainage channel formed during the melting of the last ice sheet. Just before the first house, turn north-northwest up the marked right of way along the field boundary towards Roseberry Topping. Note the prominent bench feature between Roseberry Topping and Cliff Ridge Wood, formed by the sandstones of Middle Lias Staithes Formation [NZ 574 121]

Under favourable conditions the continuation of the mineral line may be seen diagonally cutting the field to your left, crossing the path at [NZ 576 119] and continuing to the east in a shallow cutting. Near here, erratic boulders, hand cleared from the fields, may be seen in heaps at the field boundaries. They include the distinctive Shap Granite from Cumbria, indicating ice flow from that region, across the Stainmore gap of the Pennines, to the lower Tees valley and Cleveland. Ultimately the ice moved southwards and across the eastern side of the Cleveland Hills and North York Moors.

Continuing northeast towards Roseberry Topping, the path (at about 230 m OD) starts to skirt the eastern edge of the landslip and has been in part stepped using Middle Jurassic flaggy sandstones, some of which have small tridactyl theropod dinosaur prints on the top surfaces. Note the large and jumbled blocks of sandstone on the disturbed ground to the west. To the southeast are areas of vegetated abandoned quarries and isolated pits in the field nearby, where sedimentary ironstones of the Cleveland Ironstone Formation (Middle Lias) have been extracted. The steep path towards the summit of Roseberry Topping crosses the horizon of the Mulgrave Shale Member (Whitby Mudstone Formation, Upper Lias), marked by small bell pits for jet in the heather to the east of the path. Occasionally small pieces of jet may be found in this vicinity.

At the head of the landslip the fine cliff formed of trough cross-bedded sandstone (Saltwick Formation; Middle Jurassic) may be examined by traversing westwards from the path. These massive beds, which include slump structures, intraformational conglomerates and ironstone concretions, are underlain in places by Middle Jurassic Roseberry Topping Plant Bed (channel fill deposits) containing the cycads *Nilssonia, Ptilophyllum, Thinfeldia* and *Zamites,* and stems of the horsetail *Equisetites*. These plant beds should not be damaged in any way.

Locality 5, Roseberry Topping [NZ 579 126]

On a clear day Roseberry Topping, capped by the Middle Jurassic sandstone outlier, affords fine views of the Eston Hills and Teesside to the north, the Cleveland Hills escarpment to the southwest, and Eskdale and the North York Moors to the southeast. The ridge formed by the Cleveland Dyke intrusion can be seen stretching out west-northwest into the Liassic and Triassic lowlands with their cover of glaciogenic sediments.

Walking east on the ridge path (Cleveland Way) between Roseberry Topping and Newton Moor you can see to the south uneven grassed terrain, the working areas (with remains of the mineral railway) associated with the Roseberry ironstone workings [NZ 584 124]

Some 2 km to the southeast, at the same geographical and geological level, is the even larger area of disturbed ground of the Ayton Banks Mines. Here the overlying Alum Shale Member (Whitby Mudstone Formation, Upper Lias) was also exploited as feed stock for alum production. The extensive exploitation of the sedimentary iron ores of the Cleveland Ironstone Formation (Middle Lias) in the area is witnessed by many mine adits and opencast workings.

Locality 6 [NZ 587 128]

Before the Cleveland Way reaches the edge of the escarpment it passes over a series of earthworks. Some of these are of recent origin — sandstone quarries for local walling. However one deeper excavation cutting north–south across the watershed may be a defensive ditch.

The route now follows the Cleveland Way southwards along the edge of the escarpment which is capped by deltaic sediments of the Middle Jurassic (Saltwick Formation). These sediments form a prominent feature, now largely masked by conifer plantations.

Locality 7 [NZ 593 119]

Here views may be had of the escarpment with a spring line at the junction between the sandstones and the underlying Upper Lias shales. A prominent quarry on the escarpment [NZ 589 127] may have provided good quality building sandstone (from a discrete channel fill facies) for local buildings. The bulk of the Middle Jurassic sandstones capping the escarpment and dip slope of Newton and Great Ayton Moors are of poor quality, soft and thin-bedded with interleaves of clay. This is a classic area of modern grouse moor management, with strips of heather cover being burnt off in rotation to provide new heather growth for the grouse to eat. This technique of controlled burning often exposes evidence of occupation of these upland areas and the area to the east of the Cleveland Way along the ridge has numerous examples of burial monuments, field boundaries and enclosures, and cairn fields (piles of stone collected from field areas).

At the northern edge of High Intake Plantation the route may be varied. Continue directly to Locality 9 via the conspicuous group of three cist burial chambers with associated enclosures [NZ 595 114], or take one of the many sheep tracks eastwards across the moor towards the quarry complex marked on the O.S. map (Locality 8). A well-trodden path follows the valley side between the Great Ayton Moor and the quarry.

Locality 8 [NZ 600 115]

The quarry here is large and has been worked as a source of good building sandstone from one of the Middle Jurassic channel infills (Saltwick Formation). The importance of this quarry is in its superb illustration of quarrying methods and stone dressing (possibly 18th and 19th century). Only the thick beds (3–6 m) of best-quality stone have been worked; the overburden of poor-quality, inter-channel, soft, silty sandstones with coal lenses having been ignored or scraped off. The massive sandstones (cross-bedded in places) seem to have been worked without the use of explosives, and many of the remaining working faces show extensive tool marks produced when levering out the blocks. This quarry seems to have been abandoned in production and many half-dressed blocks of ashlar can be seen, with the possible remains of stone-based working tables (bankers). The dressed ashlar blocks have the characteristic chevron finish as seen in Great Ayton and elsewhere in Cleveland and the North York Moors. Fine views of Lonsdale and the Esk valley may be had from the quarry top.

Leave the quarry by the rutted trackways that skirt the hill to the southwest. Pass by a very large Iron Age ditched rectangular enclosure and a smaller enclosure nearby [NZ 599 133]

This pathway also passes a smaller sandstone quarry at [NZ 595 112] (other sandstone quarries may be seen above the car park at [NZ 592 111] and [NZ 591 109].

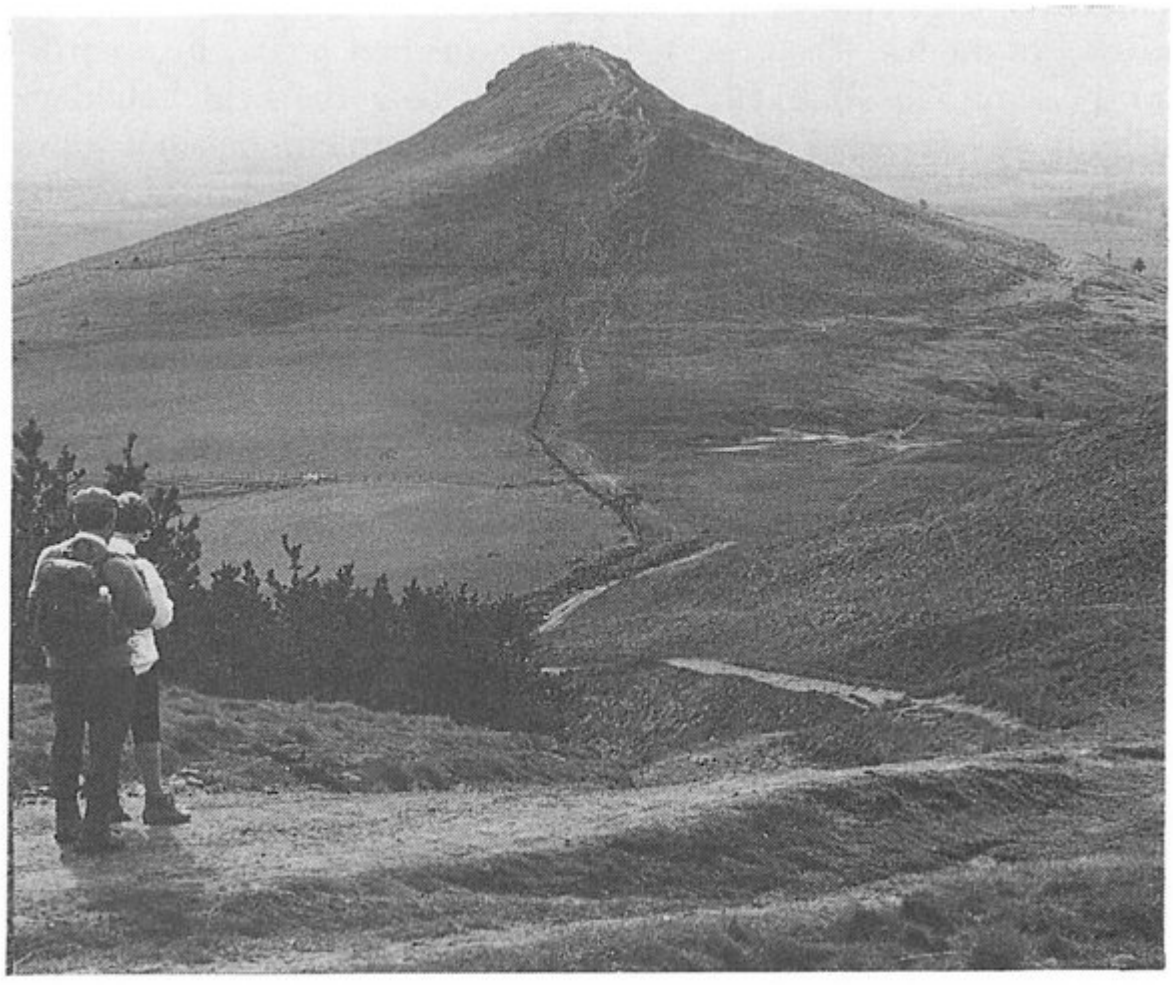
Locality 9 [NZ 594 112]-[NZ 594 111]

Where this minor track reaches the well-developed track near a small beck, follow the stream bed downhill. In the stream section thin-bedded sandstones of Middle Jurassic age are underlain by a thick sequence of shales. Some disturbed ground on this junction together with loose blocks of ironstone suggest that the Dogger Formation (Aalenian, Middle Jurassic) may have been worked by opencast methods at this locality. Occasional finds of *Dactylioceras commune* in the shale sequence at [NZ 594 111] indicate the presence of the Alum Shale Member (Whitby Mudstone Formation; Upper Lias).

The track then passes through the col known as Gribdale Gate [NZ 592 110] which is believed to have been used by meltwater drainage during the wastage of the last ice sheet, and may have been formed by meltwater erosion at an earlier time in the Quaternary. Join the road near the car park [NZ 583 110]

Note that the tracks from the sandstone quarries head towards Great Ayton. A gentle downhill road leads back to the station or Great Ayton, with views of the Ayton Bank iron mines and Alum Shales workings on your left.

Bibliography



(Figure 11.2) Roseberry Topping (Locality 5), viewed from the east. Photo : J. Senior.