Scales Moor

[SD 70 75]–[SD 72 77]

Highlights

Extensive limestone pavements on the limestone bench of Scales Moor, overlooking Chapelle-Dale, are among the finest examples of horizontal pavements in Britain, and include some massive, undissected clints. Below the bare limestone plateau, Twisleton Scars form excellent sequences of terraces, scars, screes and pavements. Deep beneath the plateau, Dale Barn Cave carries drainage from Kingsdale through to Chapel-le-Dale.

Introduction

The Scales Moor pavements lie on the main limestone bench between the southern shoulder of Whernside and the glaciated trough of Chapel-le-Dale (Figure 2.1). With a width of 800 m over a length of nearly 4 km, the bench constitutes one of the largest areas of nearly level limestone outcrop in the Yorkshire Dales karst. Most of its top surface stands at an elevation of just under 400 m, where it is formed on the top beds of the Great Scar Limestone. These are strong, massively bedded, sparry, bioclastic limestones; they are almost horizontal across most of the site, but north of the Ullet Gill fault they dip about 10° north-east (Figure 2.11). Drainage is entirely underground but the only known caves are close to the base of the limestone.

The morphology and solution processes on both the pavements of Scales Moor and the terraces of Twisleton Scars were studied and described at length by Sweeting (1966). Subsequent morphometric studies were carried out by Goldie (1973), and the glacial history of Chapel-le-Dale has been assessed in the light of dated sediments from its adjacent caves (Atkinson *et al.,* 1978; Waltham, 1986, 1990). Dale Barn and the various other caves are described by Brook *et al.* (1994) and Gascoyne (1973).

Description

From Ewes Top to Great Hard Rigg, Scales Moor contains wide expanses of bare limestone, littered with erratic boulders of locally derived limestone and sandstone; there are belts of acidic grassland, but the plateau is devoid of tree or shrub vegetation. On the main pavements, this empty rock landscape is very dramatic (Figure 2.12), but the panoramas soften towards the southern tip at Scar End, where terraced pavements drop to lower levels and are slightly better vegetated in the shelter below the main plateau.

Variations in the pavement surfaces were mapped by Sweeting, who recorded much of the northern part of Scales Moor as a very flat, glacially scoured pavement, dissected by few grikes and very few solution runnels (Sweeting, 1966). Further south much of the bench surface has more mature limestone pavement, with its surface morphology dominated by large clints, deep grikes and excellent runnel development of large rounded rundkarren. Many clints have centripetal runnel systems converging on small potholes which puncture the horizontal limestone surfaces.

There are some very large clints on Scales Moor, with the average lengths in some sample sites exceeding 5 m (Goldie, 1986). The largest clints occur in the pavements just north and south of the Ullet Gill fault, and smaller clint sizes typify the areas south of Ewes Top. This is clearly a function of the spacing of tectonic joints in the limestone, and the southerly decrease may be related to the approach towards disturbed ground along the North Craven Fault (Figure 2.1). Not all these clints are truly massive, as some have a distinctly flaggy top clint while retaining large lateral dimensions. Some pavements at Ewes Top show lamellar weathering of the clints, giving them a flakey appearance, and other clints display honeycomb weathering, especially on their most exposed aspect (Sweeting, 1966).

Twisleton Scars forms a remarkable staircase of rock terraces, descending 150 m from the plateau rim to the base of the limestone, just above the valley floor (Figure 2.11). They form a spectacular sequence of limestone scars, each with an apron of scree along its foot; each scree overlaps onto a veneer of discontinuous glacial till, which has a soil cover and is punctured by small subsidence dolines (shakeholes). The till thins out onto a strip of pavement along the crest of the next scar (Sweeting, 1966). The scars are between 2 m and 15 m high, probably reflecting the spacing between thin shale beds which eased glacial plucking of the overlying beds. Alternatively, the terraces and pavements may have formed simply on the stronger limestone beds, but these commonly underlie the thin shale horizons within the lithologically varied limestone sequence (Schwarzacher, 1958; Waltham, 1971b; Ramsbottom, 1973). Clint dimensions on the terraces are generally 0.8–2.9 m (Goldie, 1976), and there is some tree and shrub cover in the more sheltered sites.

There is no surface drainage on Scales Moor. Rainfall runs into the deep grikes, but after heavy rain streams can be heard and occasionally seen flowing down the bedding planes 1–3 m below the surface of the inclined pavements of Great Hard Rigg. Ultimately all the water finds joints to descend to greater depths. Much of it resurges from the well defined spring line along the base of the limestone (Figure 2.11), but water in the dipping limestone probably flows north-east to join the main drains feeding God's Bridge (Figure 2.13). Dale Barn Cave lies very close to the base of the limestone. Streamways from the two entrance areas carry water from both Kingsdale and Chapel-le-Dale to a confluence almost directly beneath the topographic divide, and then drain to the Dry Gill resurgence (Figure 2.11). Abandoned passages occur above all three entrance areas, mostly at levels no more than 15 m above the streamways.

Interpretation

The main plateau surface of Scales Moor is formed on the top of the Great Scar Limestone at an altitude of about 400 m. It is clear that much of the surface is a stratimorph (Waltham, 1970), as it follows the dip down the inclined pavements north of the Ullet Gill fault. The main horizontal bench also forms part of a conspicuous erosion surface, widely recognized in the Yorkshire Dales (Sweeting, 1950). Present opinion tends towards the lithological explanation of the gross form of the limestone benches in the Dales, and glacial scour has been clearly the dominant process in the most recent stripping of the Scales Moor pavements (Waltham, 1990). Ice flowed from the north-east and was powerfully erosive as it swept up the dipping slabs and then across the horizontal limestone, even though the glaciated trough of Chapel-le-Dale must have acted as an adjacent ice-way.

The most striking areas of pavement on Scales Moor are on the more massive limestones where they were subjected to the most intensive glacial scour, but the solutional features are dominated by rounded rundkarren, whose origins relate to past covers of soil and vegetation. Over many years the position of the contact line between bare limestone and vegetation cover was monitored on a terrace-top site on Twisleton Scars (Sweeting, 1966). After 13 years the grass cover had advanced slightly over the inner part of the pavement, outwards from the till and scree below the upper scar. Rock exposure in the centre of the pavement was unchanged, but the grikes had increased vegetation, and soil depth within them had locally increased by as much as 100 mm.

On Scales Moor, Sweeting (1966) observed limestone surfaces cleared of drift with rock hollows over 800 mm in diameter containing erratics 500–600 mm across. These depressions appear to have existed before the erratics were deposited in them, and were therefore formed before the last glaciation; the implication is that some of the grikes may have a preglacial component to them, and merely continued to evolve since the Devensian glaciation. There is no evidence to support the alternative concept that the hollows were enlarged by solution beneath the drift. An area of limestone freshly exposed in 1947 was re-examined in 1960 having been subject to solutional attack by peaty water (Sweeting, 1966). Some parts of the exposed surface had been lowered by 30–50 mm in this period. At another test site on Scales Moor, solution runnels 70–150 mm deep had been cut into the limestone by waters coming off a peat slope for 13 years. Mean solution rates measured in the area over a wide range of local conditions extrapolate to indicate about 500 mm of surface lowering in the last 12 000 years; the enormous local variations within this average account for the variety of pavement morphology.

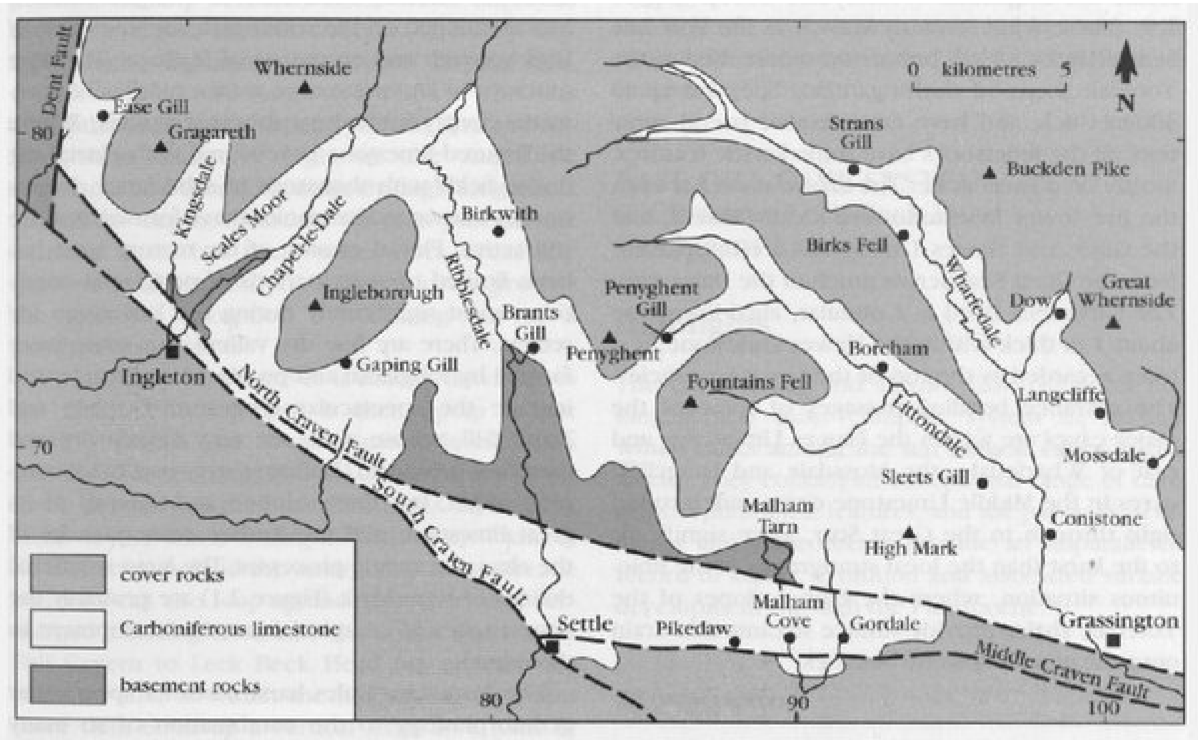
The pavements of Scales Moor suffered modification through the mechanized removal of clints during the 1960s, and surface limestone was used to build sheep folds and other structures in earlier periods (Goldie, 1976). Known areas of Clint removal on Scales Moor became well vegetated with moorland grasses within the following ten years. Scales Moor is also heavily grazed by sheep, which help to confine tree and shrub vegetation to the grikes.

Little is known of the cave drainage beneath most of Scales Moor. Infiltration through the pavements probably descends rapidly to lateral conduits near the base of the limestone; high avens do feed water into the Dale Barn streamways. Patterns of flow are difficult to predict in the horizontal limestones, but drainage occurs from Kingsdale because its floor is nearly 50 m above the level of the base of the limestone exposed in Chapel-le-Dale. Except for some truncated fragments in Ullet Gill, there are no known relict caves at high levels under the fell, though some may have been removed when Twisleton Scars were cut back by the Chapel-le-Dale glaciers.

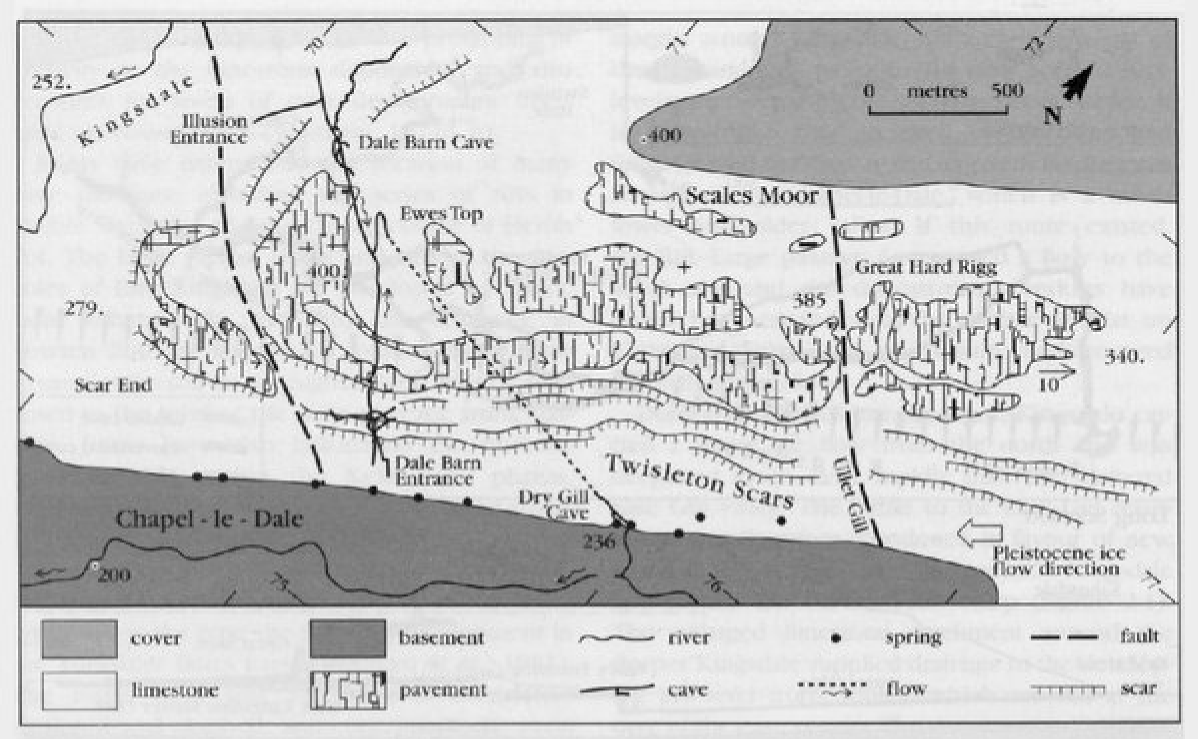
Conclusions

Scales Moor has some of the finest examples of level and gently inclined, little dissected limestone pavements in Britain. Both on the plateau and in the scar sequences, there is a wide variety of pavement types related to glacial plucking and varying joint densities. The karst has been an important research site, yielding data on solution rates, erosion processes and vegetation changes, with wide implications on glaciokarst studies in Britain and elsewhere.

References

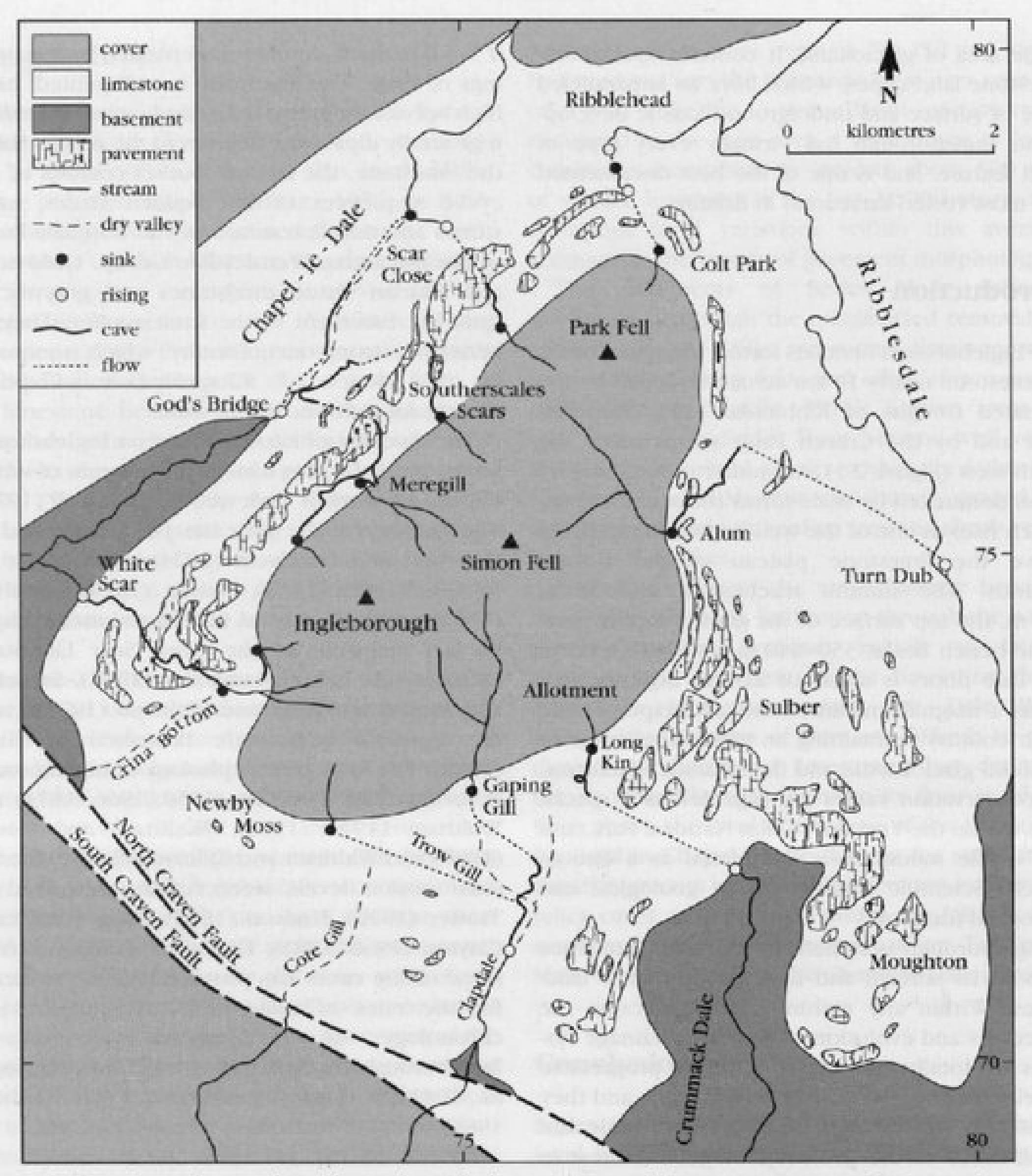


(Figure 2.1) Outline map of the Yorkshire Dales karst, with locations referred to in the text. The Carboniferous limestone shown includes all the Great Scar Limestone (Kilnsey, Cove and Gordale Formations) and also the lower Yoredale limestones (of the Wensleydale Group) where they are hydrologically linked to the Great Scar and are therefore part of the same karst unit. Higher limestones within the Yoredale Series are not marked. Basement rocks are Palaeozoic slates and greywackes. Cover rocks are the Yoredale facies of the middle and late Brigantian Wensleydale Formation and various Upper Carboniferous and Permian clastic formations.



(Figure 2.11) Geological map of Scales Moor. The limestone is the Great Scar Limestone, including the Hawes Limestone. Cover rocks are mainly clastic units in the Wensleydale Group. Basement rocks are Palaeozoic slates and greywackes. Only the larger areas of pavement are marked, and there are thin strips of pavement along the crest of nearly all the scars. Dale Barn Cave lies close to the base of the limestone, about 150 m below the main limestone pavements (cave survey from Northern Cave Club).

(Figure 2.12) The wide expanse of massive limestone pavement on Scales Moor, broken only by the deep rundkarren runnels and erratic blocks of sandstone and limestone. (Photo: A.C. Waltham.)



(Figure 2.13) Geological map of Ingleborough, with the main areas of limestone pavement, the larger dry valleys and some of the main underground drainage routes. The limestone is the Great Scar Limestone, including the Hawes Limestone. Cover rocks are various clastic units and thin limestones in the Wensleydale Group and the Namurian Millstone Grit Group, and Upper Carboniferous clastics south of the Craven Faults. Basement rocks are Palaeozoic slates and greywackes. The only pavements marked are those of good or excellent quality (as defined by Waltham and Tillotson, 1989).