The Clouds

[SD 73 99]–[NY 74 00]

Highlights

Three limestone pavements at Stennerskeugh and Fell End Clouds are notable for their location on strongly folded limestones. The structural variety and the consequent range of aspects are reflected in the varied morphologies of the well dissected and well runnelled pavement landscape.

Introduction

The pavements of the Clouds lie at altitudes of 350 -470 m on outcrops of Dinantian Limestone on the north-western slopes of Wild Boar Fell, adjacent to the Dent Fault (Figure 3.1). The exposed limestones are the top beds of the Asbian Great Scar Limestone and also the Robinson Limestone, which is the lowest in the Brigantian shale and limestone sequence. The folding is all within the narrow belt where the western edge of the Askrigg Block is crumpled against the Lake District block across the Dent Fault (Underhill *et al.,* 1988).

Description

Most of the pavements are on the eastern limb of a minor anticline (Figure 3.17), where the limestones dip into the hill at 10–30°. The Great Scar Limestone has the wider outcrop, and is overlain by a thin shale, followed by the Robinson Limestone. The stratigraphy shows some variation along the strike outcrops, but these two limestones form the main pavements, which ease in gradient over the anticline in the Great Scar Limestone. The folded limestones support pavements on many bedding planes with varying aspects to the Devensian ice which swept over them from the south. The lower slopes are masked in scree, head and peat soils. The slopes above the main pavements are formed in the overlying mixed Brigantian rocks of the Alston Group, with low scars, thin strips of pavement, lines of sinkholes and small caves in the thin limestones.

A distinctive form of stepped pavement *(Schichttreppenkarst*) is well developed on Stennerskeugh Clouds where steeply dipping limestones in the higher outcrops form long ridges of narrow pavements sloping to the southeast. clints are large and diamond shaped at the northern end but decrease in size to knife-edge ridges further south. Deep narrow grikes separate the larger clints, and surface solution features include converging rundkarren systems and kamenitzas which vary in shape from elliptical to round. The small, knife-edge clints are separated by shallow grikes, and have both laminar and honeycomb weathering. A few erratic blocks of sandstone lie wedged in the grikes. Further east on Stennerskeugh Clouds, the stepped pavements dip at angles up to 30°, with considerable local variation across the small-scale folds. Long rectangular clints in the north are replaced southwards by narrower knife-edge clints.

Most of the limestone pavements on the west side of the Clouds are on bedding planes dipping west at up to 30°, with joints aligned diagonally to the slope. The clints are generally less than 1 m long and 0.3 m wide. Higher on the fell, the dips lessen over the anticline and some of the exposed limestone beds are more massive, so forming larger clints.

At Fell End Clouds, the strike and outcrops of the beds swing round the anticline which plunges to the south-west (Figure 3.17). The more massive limestones are higher in altitude and lower in the sequence to the north-east. Some of the more thinly bedded limestones produces a shattered surface of felsenmeer, in place of a pavement. The steeper fold limbs have stepped pavements dipping as much as 30°, with small, knife-edge clints between narrow, shallow, V-shaped grikes containing wedged sandstone erratics. Near the highest part of Fell End Clouds, there are some striking embayments in gently dipping limestone over the crest of the anticline. Small scars, 2–3 m high, mark the inner edges of crescentic arcs of pavement with massive, well runnelled clints (Figure 3.18). The inner zones of these pavements,' below the succeeding scar, are scored by large and deep rundkarren; the outer zones, at the top of the scar to the next bed below,

are less well runnelled and are merely well fractured. There is no significant cover of drift or vegetation, and the dominant joints are orientated NNE parallel to the Dent Fault.

Interpretation

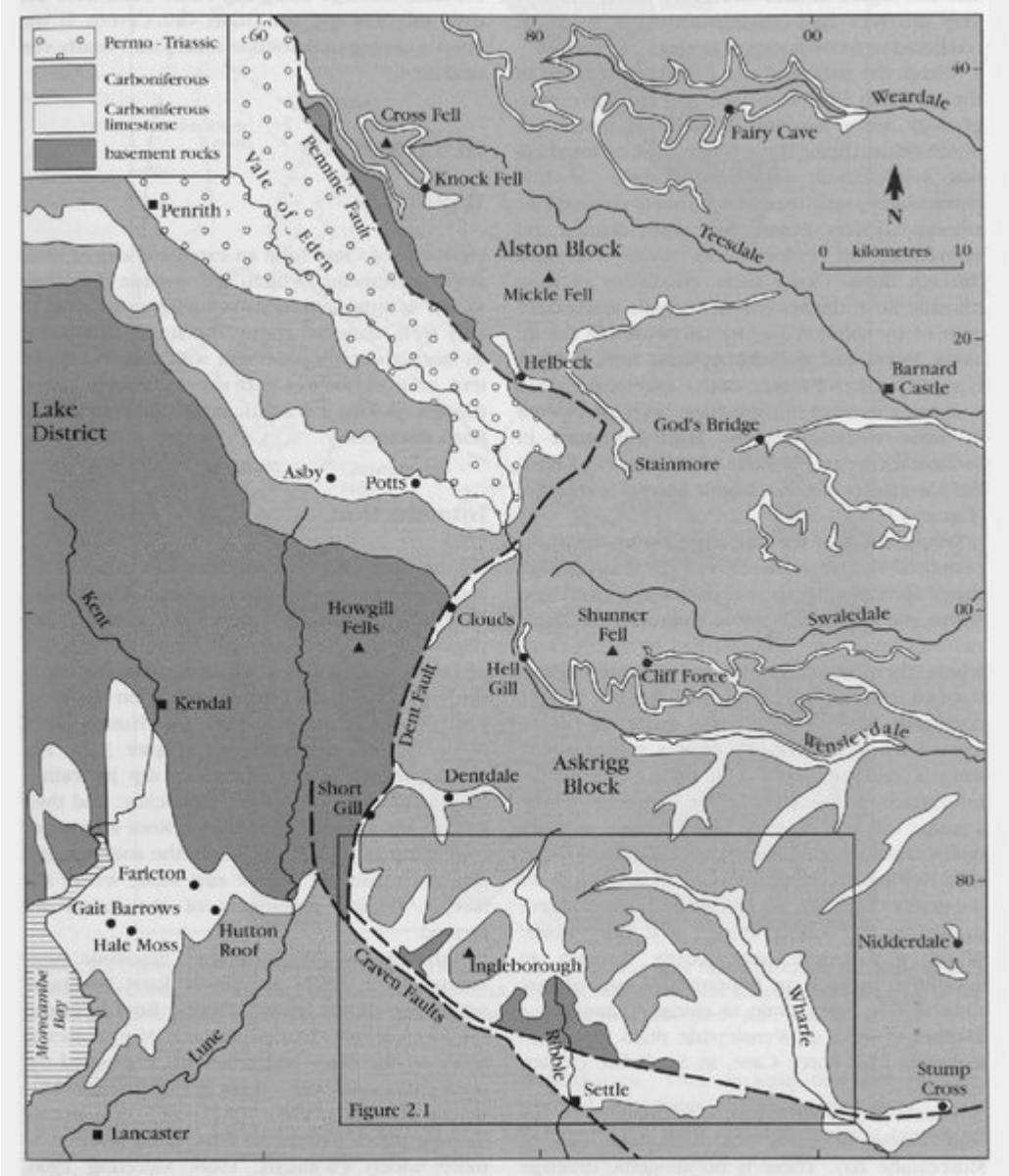
Pavement morphologies at the Clouds are influenced by both lithology and geological structure. Thinly bedded limestones produce shattered surfaces with thin, easily broken Glint tops; debris from these fills the grikes and extends into scree aprons and sheets of felsenmeer. In contrast, thick beds of massive limestone form better pavements; even these are generally well dissected, with relatively small clints, due to the closely spaced tectonic jointing in the disturbance zone adjacent to the Dent Fault. This limits complex runnel development, though many small clints are incised by deep rundkarren of the type inherited from solution beneath a soil and vegetation cover. Low scars, narrow benches, knife-edge clints and areas of stepped pavement are all features dictated by the steep local dips.

An important influence on the morphology of the Clouds pavements was their location close to a Pleistocene ice centre on Wild Boar Fell, immediately to the south-east. The scale of scour from such a nearby and small ice source may not have been great (Mitchell, 1994), and the Clouds pavements may have escaped severe glacial scour. This would explain the presence of the very mature rundkarren in front of the small scars near the top of Fell End Clouds. At this site the pavement edges have not been plucked and scoured to form the smooth scar edges typical of much of the Pennine glaciokarst; instead they have partly bevelled slopes from one bed to the next, with weathered and runnelled limestone preserved on the inclined bedding planes in the protected troughs below the next scar. This karren distribution contrasts with the typical Pennine case where the deeper karren are in the more exposed sites above the scar edges. The Fell End Clouds scars face north, so that the ice advanced down over them, and the well dissected pavements in their lee may retain some elements of early Pleistocene erosion not removed by Devensian ice.

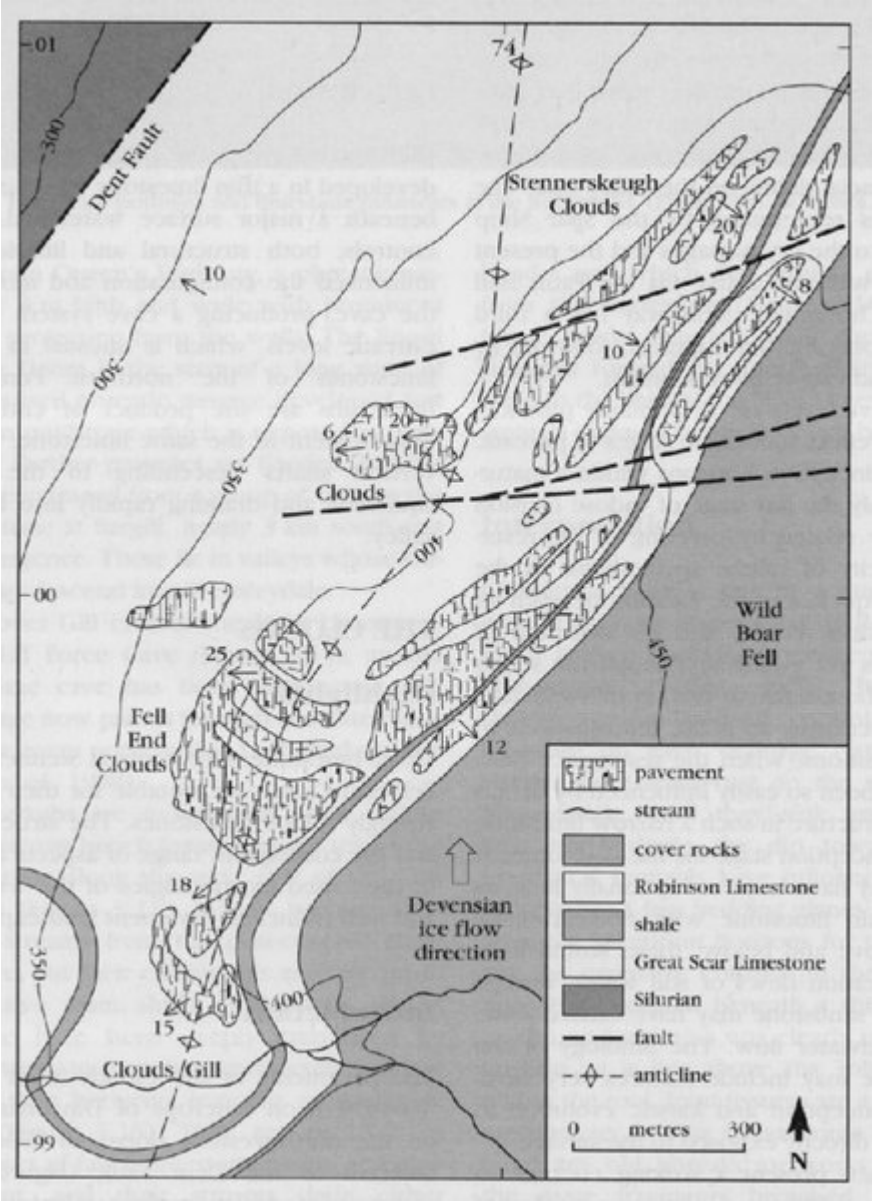
Conclusions

The Clouds contains a fine range of well dissected pavements demonstrating the influences of structure and lithology on the details of karst morphology. The combination of tight folds and closely spaced fractures provides a geological environment for the pavements which is unique within Britain. The site was close to a basal ice shed in the Pleistocene, which resulted in some elements of the landform features surviving from before the Devensian.

References



(Figure 3.1) Outline map of the karst regions in the northern Pennines, with locations referred to in the text. The other Carboniferous rocks are the non-carbonates of the Orton Group and Yoredale facies of the Dinantian, and the Namurian, but they include thin bands of limestone with lesser karst features not shown on this map. The Carboniferous limestone includes the Dinantian Great Scar Limestone, the Yoredale limestones with significant karst, and the Main or Great Limestone of Namurian age. The basement rocks are Lower Palaeozoic non-carbonates. Details and locations in the southern Dales are shown in (Figure 2.1).



(Figure 3.17) Outline map of the limestone pavements of the Clouds. The position of the anticline axis is only approximate. Cover rocks are the alternating sequence of shales and thin limestones which follow in the Alston Group.

(Figure 3.18) Crescentic scars in strong beds of limestone folded over the anticline crest on Fell End Clouds. Pleistocene ice moved from right to left, leaving deeply tunnelled pavement in the immediate lee of the scars. (Photo: H.S. Goldie.)