Gait Barrows

[SD 482 775]

Highlights

Gait Barrows is an extremely important limestone pavement site, being the finest of the many pavements on the low limestone hills east of Morecambe Bay. It is distinguished for its botanical and zoological features, as well as for its wide range of karstic surface landforms.

Introduction

The pavements at Gait Barrows are on the gentle southern slope of a low limestone hill south-east of Arnside (Figure 3.1). They are developed on a fault block of Carboniferous limestone of Asbian age which has a southerly dip of about 3°. The limestone is thickly bedded, and some sparite beds reach 3 m in thickness. The whole site lies at altitudes under 50 m, and was scoured by Devensian ice from the Lake District (Rose and Vincent, 1986c).

An extensive literature about Gait Barrows is primarily concerned with the botany, with passing references to the geomorphology. The site has been described as the single most important limestone pavement in Britain for its richly varied flora (Ratcliffe, 1977; Ward and Evans, 1976). The quality of the pavements gives Gait Barrows almost equal geomorphological importance (Ashmead, 1974a; Goldie, 1986), and Rose and Vincent have studied the spring waters (1986a) and the kamenitzas (1986b) of the site.

Description

The Gait Barrows pavements contain an exceptional range of morphologies within an area of less than a square kilometre. The density of vegetation cover varies considerably and defines three zones within the site (Figure 3.5). The outer zone is thickly wooded, and covers about half the area of the limestone outcrop; the two inner zones contain the open pavements, and have shrubs and trees scattered thinly over them, rooted 'in the grikes or on patches of soil on the limestone surface.

The most important part of the site is the central exposure (Figure 3.5), with three expanses of massive, open pavement, undisturbed by any clint removal, on a few beds of limestone locally as thick as 3 m. Massive clints are up to 30 m long, with clean surfaces on limestone scored by thin mineral veins (Figure 3.6). They slope gently to the south, and slight flexures in the regional dip produce broad undulations in the pavement. The small-scale karst landforms include a great range of kamenitzas, at varying stages of development, immature but deep grikes which commonly do not intersect, and pedestals of protected limestone beneath erratic boulders. Some kluftkarren grikes are more extensive, and some are concentrated along zones of tectonic fractures. There are also many of the small, sharp-edged rillenkarren solution grooves on the edges of some of the clints. The pavement has many small erratics of Namurian sandstone, including some wedged in the grikes.

Around the central area of open, massive pavement, there are several areas of more broken and dissected pavement (Figure 3.5). Some of these are in their natural state on more fractured limestone, while others are artificially stripped; these expose bedding planes from which the top bed of clints has been removed within the last 100 years, revealing some of the subsurface morphology. There are also areas where removal of the original pavement was distinctly scrappy, and clint blocks were left loose, tilted or overturned, providing different faces exposed to modern subaerial erosion.

The third zone of the Gait Barrows limestone is densely vegetated. The rock surfaces are completely covered by ground vegetation, including mosses and low flowering plants, so that their morphology is extremely difficult to see. Close examination shows that these areas are well dissected pavement with large clints; beneath the organic cover, the

dominant morphology is that of well rounded rundkarren. Good, intact pavement with a largely rectilinear pattern of grikes lies east and west of the central area. Many clints are a few metres in length, though they are often narrow due to the local dominance of any one major joint set. Some areas towards the southern boundary with the peatlands have clints which are smaller and produce many naturally loose blocks of limestone.

Interpretation

These pavements are formed on limestones close to sea level which were overrun by sediment-laden Pleistocene glaciers spreading over lowland plains. Any erosional effects on the limestone landforms by high sea levels during the Pleistocene have not survived the Devensian glaciation. The excellent quality of the Gait Barrows pavements is a function of both the massive limestone beds at surface level and also the aspect which the site presented to ice erosion. The gentle southerly dip combined with the southward flow of the glaciers to maximize the scale of ice plucking on the lee of the hill, so leaving the cleanest of rock surfaces ripe for subsequent solutional fretting. The main pavements have large, bare clints on the massive limestone beds, separated by kluftkarren grikes which are largely postglacial in origin. Some grikes have significantly greater widths, which suggest that they have a component of preglacial solutional opening, and these contain large numbers of small erratic blocks of Namurian sandstone.

Kamenitzas are numerous on the central area of massive pavement. They probably started to form soon after the Devensian ice retreat, but their water chemistry shows that they could form within only a fraction of Holocene time (Rose and Vincent, 1986b). Their solution environment, and consequent morphology varies under the influence of plant growth, ice formation and other factors. All the kamenitzas at Gait Barrows are formed over calcite veins in the limestone (Rose and Vincent, 1986b). It is not clear how the veins have become the loci for kamenitza development; they may have provided mechanical weaknesses scoured into hollows by overriding ice, or their mineralogical contrast may have become the focus of solution and cavity inception. Ultimately further solution on the veins beneath the pools creates fissures which drain the ponds and terminate the kamenitza enlargement. The pavements are also penetrated by small, deep potholes and elongate fissures, again on the mineral veins. Their shapes contrast those of the circular kamenitzas, but they also collect pool water and plant material which enhances their deepening; they ultimately coalesce into kluftkarren.

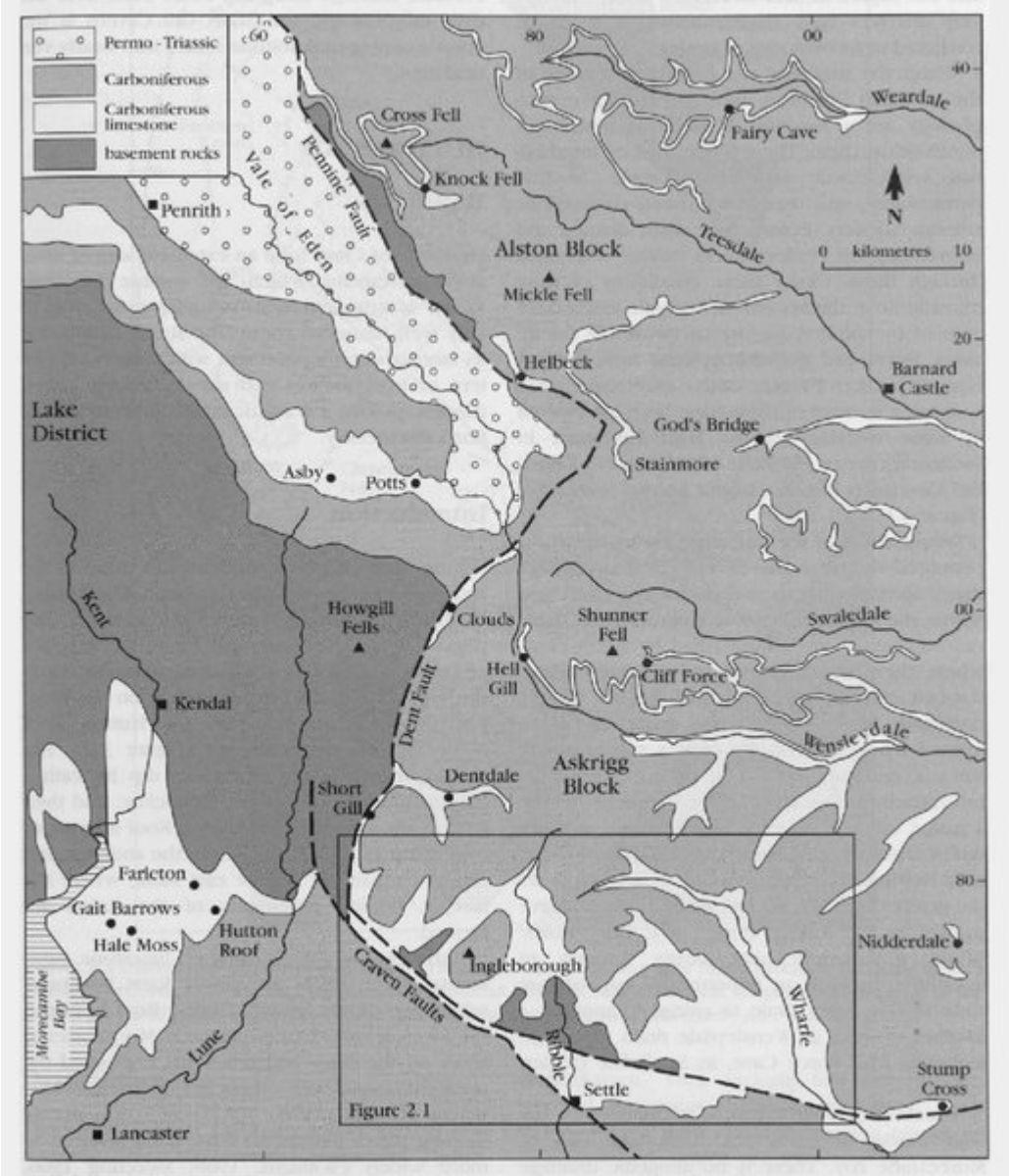
On the massive central pavements, islands of shrub and tree vegetation are rooted in organic soils; beneath and around these the limestone is scored by the rounded runnels of rundkarren which are typical of subsoil solution. Elsewhere on the site, less permeable, inorganic soils lie on uncorroded limestone which they have protected from solution. The influence of plants on limestone solution is also shown by the spring waters on the site. The solute loads of these vary directly with the proportion of soil and vegetation cover within their catchments (Rose and Vincent, 1986a); the lowest solute load is in the spring issuing from the downdip end of the main open, bare pavements (Figure 3.5). The springs do not discharge clastic sediments and no large conduits are known under the site.

Around the main intact pavements, large areas of broken rock outcrop are the result of removal of the top bed of limestone clints for the garden rockery trade (Ward and Evans, 1976; Goldie, 1986). The freshly exposed bedding planes are developing new solution features, where they are not being covered over by evolving vegetation and soil. Shallow depressions, some scalloping and sharp rillenkarren are forming on some of the stripped surfaces which have remained bare.

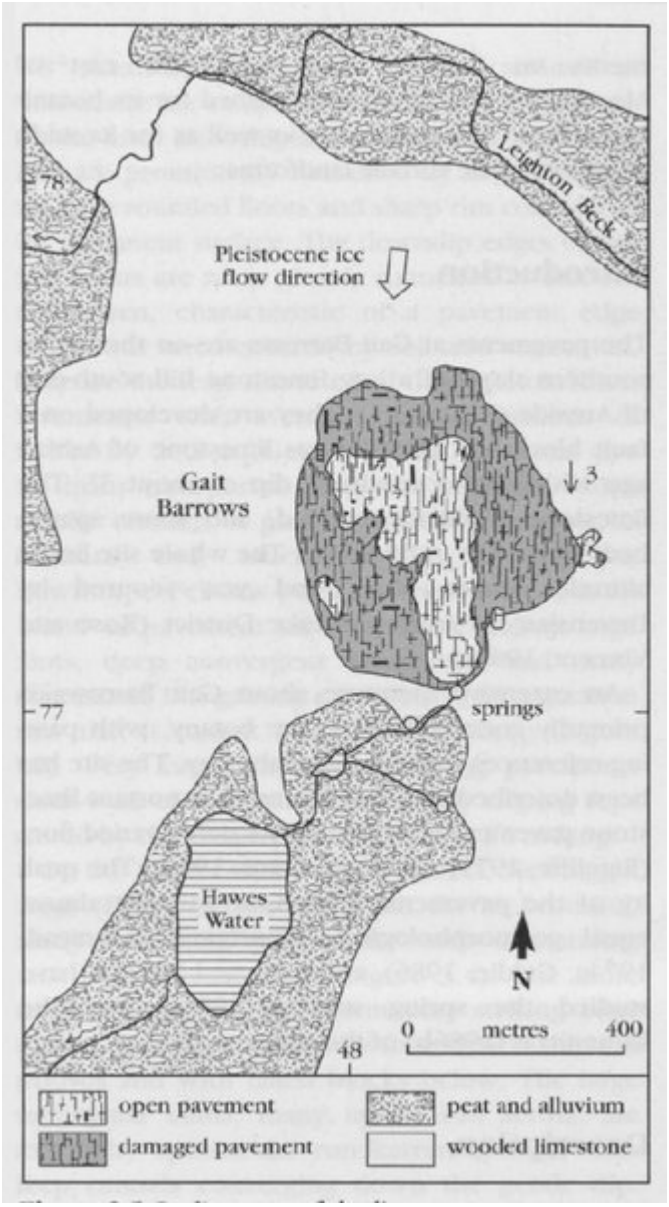
Conclusions

Gait Barrows has limestone pavements of exceptional quality, lying at low altitude and partly covered by vegetation; the large expanses of bare clints are of national and international repute. The coastal lowland environment is in contrast to that of the many pavements at high altitude in the Yorkshire Dales karst, but the morphological contrasts are slight. Within the site, the small-scale karst landforms show considerable variation, which is influenced by lithology, aspect and post-glacial evolution. Notable are the many kamenitzas at various stages of development, which are all located on mineral veins in the limestone.

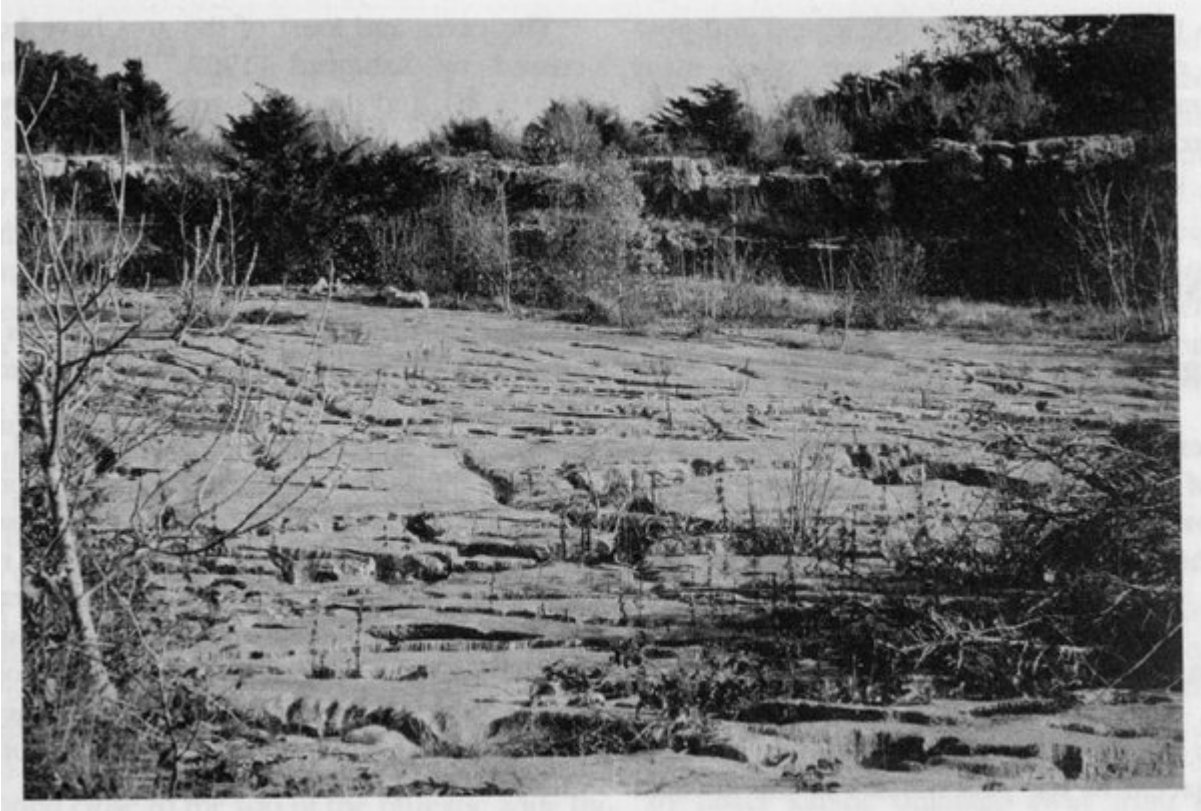
References



(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 3.5) Outline map of the limestone pavements on Gait Barrows.



(Figure 3.6) The very large clints in the central open pavements on Gait Barrows. (Photo: A.C. Waltham.)