Alport Castles, Derbyshire

[SK 142 914]

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Introduction

The Alport Castles are a massive landslide complex, the most prominent elements of an extensive landslip complex affecting at least 0.85 km^2 along the eastern (west-facing) side of Alport Dale near Ladybower in the Peak District (Figure 5.14). Alport Dale is one of several valleys incised in the sandstone plateau of the Dark Peak, here by up to 200 m. Landslipping is very extensive in this part of the Pennines (cf. Johnson, 1965; Stevenson and Gaunt, 1971; Johnson and Walthall, 1979), and the geological controls on its incidence are particularly evident here. This site is notable for its array of distinct slip-masses and slumps in varying stages of intactness, attitude and distance travelled, extending in places to the River Alport.

Description

Landslipping on the steep valley-sides in the 'Millstone Grit' areas of the Pennines commonly occurs where competent sandstones overlie less competent shales. Here, the River Alport rises on the Bleaklow plateau of Shale Grit (Kinderscoutian R1 stage of the Namurian, Upper Carboniferous). About 1.5 km above this site, it begins to cut down through the Mam Tor sandstones (Kinderscoutian). It eventually reaches the underlying Edale Shales (Alportian (H2) stage of the Namurian Period). These are predominantly mudstones, though sandstones occur, and include exceptionally weak pyritic shales studied at Mam Tor (Near and Curtis, 1981). Immediately the river enters them, the valley-sides 'become covered with huge landslips formed of masses of the Shale Grit which have slid down from the hilltops above' (Green *et al.,* 1887; (Figure 5.14)). The weakness of these Edale Shales is evidenced by deep crumpling revealed in dam trenches in the adjacent valleys (Thompson, 1949) and at Rowlee Bridge nearby. The strata are here nearly level, with a slight eastward tilt.

The Alport Castles site is one of the largest landslip complexes in the district (Figure 5.15), and has been studied by Johnson and Vaughan (1983). It divides into two sectors (Figure 5.16): a main (northern) sector, where landslipping encroaches into the plateau rim along a bold craggy scar, and where the prominent 'Castles' are located; and a secondary (southern) sector, where the source scar is a less significant feature running across the upper valley-side.

Northern sector

Three main rock-masses have broken away from the rim of Alport Moor (Units A–C), leaving a scar which above Unit B reaches 68 m to the narrow boulder-filled trench floor. The scar here comprises a 30 m vertical sandstone crag above a talus slope and the rift-trench, which is of unknown original depth (Figure 5.17). These units are substantially intact, and prominent enough to be named on the 1:25 000 map as Birchin Hat, The Tower, and Little Moor. The extent of downslope movement and tilting varies considerably (see (Figure 5.18)). Unit A displays 100 m travel and forward rotation by 7°; Unit B displays 130 m travel and considerable backward rotation to leave a sharp crest; while Unit C has only descended 5 m, with a slight valley-ward tilt.

Little Moor (Unit C) is much the largest, about 300 m long (valley-parallel), leaving a deep wedge-shaped bay encroaching into the plateau by some 200 m from the inferred original valley rim. It has moved out by about 70 m, creating a trench 18 m deep which contains several back-tilted slices of rock. Some of these appear to be small rotational slips off the scar, with others produced by backward rotation from the rear of the slipped mass. Open tension fissures up to 8 m deep have begun to dissect the mass, which on its southern side has disintegrated into low chaotic ruckles below a degraded grassy return scarp. A ridge halfway down the steep outer slope appears to be formed by forward rotation, and with similarly tilted blocks on the outer face of Unit B suggests tensional stress on the plateau rim either before or during mass movement. The Tower (Unit B) is almost as long at 200 m, but has left a much shallower encroachment into the plateau. Its pinnacle is 30 m high, the crest reducing southwards to 10 m high as it splits into triple fins with 3 m deep trenches. Birchin Hat (Unit A) is only 100 m long, with a more rounded character; it has split to give 3–5 m anti-scarps (Figure 5.17). The source scar is here well below the valley rim, so that there is a steep grassy slope above the crag.

The rim is essentially intact except above Little Moor, where a 1.5 m furrow runs up to 15 m behind the plateau rim, a proto-slip extending 16 m into the plateau has dropped down by 0.5 m, and a lineament with linear pool lies 45 m in. These indications of incipient or latent failure extend over a length of 300 m.

Below the three 'castellations' a broad swale crosses most of the northern sector. Now partly infilled, it is partly drained by small streams, but below The Tower there is a large depression with ponds. This depression is impounded by another slipped mass, Unit D, which is about 300 m long. Its summit is of the Shale Grit, which constitutes the rim, and it presents an uphill edge 15 m high to the swale. There are tension hollows across its top, and multiple sub-metric antiscarplets down its dipslope.

The lower slopes (Area E) comprise a semi-coherent slip mass which presents an uphill edge 5 m high to a shallow transverse depression. Its surface is generally smooth, with several 1 m antiscarps. It bulges to narrow the valley appreciably, but although the slide toe steepens into a 15–25 m bluff above the river, which meanders in a flood plain upstream of this site, the river does not appear to have been significantly dammed or displaced. Conversely, fluvial erosion of the toe has caused minor undercutting without removing much of the material or re-activating sliding. Mam Tor strata are exposed on the surface and in the river cuts, and while individual elements appear intact, their varying inclinations show them to be much deformed by slide movements.

On the south flank of this slip complex (Units D and E), there is a distinctly different zone (F) headed by a small secondary scar. This is the product of more recent slumping, where saturation by impeded drainage has led to disintegration and in one part of the lower slope an 'earthflow'. The scar reveals Mam Tor beds which dip steeply backwards, suggesting that prior failure of the midslope had predisposed it to more complete collapse. The slump reaches the river, where erosion has produced an 8 m cliff in stiff structureless debris containing < 300 mm sandstone clasts, which contrast with the very weak thin flaggy mudstones revealed in the 'slipped bedrock' cuts, immediately upstream.

Southern sector

The wedge scar above Little Moor (Unit C) angles down the valley slope and then wanders across it discontinuously and at much reduced height. The main slipped mass (Unit G) is 300 m long at the scar foot, from which it is separated by a 60 m-wide swale. Streams rising in this depression descend either side of the slip mass, which broadens to over 400 m at its steep outer edge, from where minor earthflows or mudslides have descended. The surface of Unit G is undulating, with several ridges and vales parallel to the contours. A further failure increment, Unit H, has descended a short distance from the acute wedge scar of Whitefield Pits (similar to that on the opposite side of Alport Dale — (Figure 5.14)). This forms the southern limit of the extant landslip complex, but immediately to its south the plateau rim is indented by a bowl which sharpens the angle of Alport Dale and Woodlands Valley, and appears to be an older landslip cavity with irregular terrain below.

Between areas F and G there is an amorphous zone of disturbed ground with blocky debris strews (area J), not recognized by Johnson and Vaughan (1983) as a distinct slip mass, but which appears to have descended from the rhomboidal space defined by the outer edge of Little Moor and the degraded angle of the source scar. The lower slopes beneath Units G–J are largely concealed by forestry, but their hummocky character suggests considerable disintegration and mobilization, followed by substantial consolidation. Only below area J does the slippage reach (and possibly deflect) the river. At Unit H slide debris is seen to over-run periglacial 'head' deposits.

Interpretation

The extensive landslipping here clearly reflects a combination of deep valley incision and geology, with weak strata exposed in the valley floor at the base of the failed slope. The preservation of very large masses of former plateau in varying degrees of intactness reflects the competence of the upper sandstone strata and the gradual nature of their translation. Little Moor (Unit C) is one of the largest known individual slipped masses, with an area of 0.06 km^2 that despite deep fissuring is substantially coherent. Its rhomboidal shape probably relates to a source cavity controlled by near-vertical joint orientations diagonal to the trend of the escarpment. Those units that have travelled further tend to be more disintegrated, but all bear signs of splitting along quite closely spaced NW–SE-trending joints.

Sequence of failure

The sequence in which the various units failed and separated from each other is unknown, and several scenarios and permutations can credibly be proposed. Johnson and Vaughan (1983) suggest that the failure began with displacement by rock-mass creep in the lower slope, with land-slipping developing retrogressively toward the plateau edge as successive displacements took place. Similarly, landslipping would have extended laterally as failure in one part of the hillside removed support from the adjacent slopes. The varying locations of the source scars at different elevations up the valley side, on the rim, and encroaching into the plateau, lend weight to this incremental view, as do the distinctly separate Units A and H on either flank. However, the process may not simply be one of upward and lateral propagation. For example, the apparent 'fit' of Unit D between Units A (Birchin Hat) and B (The Tower), and the continuity of the scar above and between them, suggests that this unit is a much longer travelled slip mass. Unit D may thus have released at the same time as A and B and merely travelled further, with Unit E below being a subsequent subdivision. Alternatively, the swale across the northern sector, which presents a fairly continuous uphill scarp, could indicate an initial midslope rupture embracing Units D and F, which then provoked upward propagation. This interpretation could indeed be extended to embrace the entire suite of mid-slope units from D to G, without implying that all commenced moving in unison. However, the greater degradation of the most enigmatic area J might suggest that failure originated here, with the outer face of Little Moor either being intact plateau rim at that time, or part of a whole central sector (Units C/Fj) which failed at depth *en masse,* with the lower parts becoming more disaggregated, breaking away, and slipping and slumping to the slope foot.

Depth and mode of failure

The depth to which failure extends is equally unclear. The size of the coherent masses, and the heights of the scar and the trench walls, suggest depths certainly reaching 30–50 m (allowing for trench infilling) and possibly 60–80 m, a scale comparable with large slope deformations in the Highlands (see Chapter 2). However, the lateral margins are low, although Johnson and Vaughan (1983) suggest this is because of outward, as well as downward, spreading of the lower parts. Neither the position nor the nature of the basal failure surface can be readily determined, without geotechnical investigation. It seems unlikely that concave sliding surfaces could readily develop in the sandstones which comprise most of the landslip complex, and even less than a through-going planar surface could shear cleanly across the grain of joints and bedding. Although concave rotational failure is more feasible in the weak shales, these only crop out at the very foot of the slope and dip gently into it; while they may have helped mobilize the lower slopes, they seem unlikely to have influenced the higher parts of the complex some 150–200 m above (cf. Mam Tor, where they extend more than halfway up the slope). If mass movement is predominantly within the Mam Tor sandstones and the base of the Shale Grits (Figure 5.16), a zone of crush and deformation stepping down through the strata might be envisaged rather than a simple shear surface; this can more readily develop where weaker and stronger strata are intercalated. Above this zone of weakness, tension stresses would develop until rock masses gradually parted from the plateau along sub-vertical joints and slipped away. This process would account for the remarkable intactness of such large translated masses, and for the highly variable degree of both backward and forward rotation. Indeed, Johnson and Vaughan (1983) single out the gentle dip of the strata into the hillside, which normally predisposes against failure, as the main reason for the scale of the movement units.

They also divide the landslip complex into zones of depletion and accumulation, following Varnes (1978), whereby the latter zone stands proud at a higher level than the original (pre-failure) ground surface (Figure 5.18). This can arise either by debris over-running the intact lower slope, or by the landslip mass bulging out under compression. The latter must apply here, if failure has propagated from the slope foot, leaving no original ground surface in place; the antiscarped character of Area E attests to such compression. Johnson and Vaughan (1983) place the transition along the 'swale', such that Unit D lies within the accumulation zone. Indeed, this is clearly seen on the north flank, where the source scarp turns downhill beside Birchin Hat and neatly transmutes into a flank rampart near the forest edge (cf. Benvane GCR site report, Chapter 2).

Groundwater and failure morphology

Johnson and Vaughan (1983) recognize a strong morphological contrast between the upper and lower slopes, but suggest that this is a geological difference between massive sandstones above, giving rise to angular masses with castellated crags and scarps, and mudrock below, with smooth rounded ridges and wide troughs up to 100 m in amplitude. However, if most of the slip complex is in Mam Tor sandstones and Shale Grits, other factors must be found. The emergence of numerous streams from springs and seeps along the midslope (Figure 5.16) indicates that the lower valley-side is not free-draining despite rock-mass failure extending to the slope foot. The failed masses in the midslope area would become saturated, and thus liable both to superficial slumping and flowing, and to more pervasive degradation (even so, they have barely reached the slope foot, and have not gained sufficient momentum to become a landslide dam). By contrast, the upper units are dry today, and their arrested descent may indicate rapid dewatering at the time of failure. The band of incipient failure along the rim indicates where upward propagation had initiated vertical fracturing, with some slight settlement but with insufficient lubrication for movement.

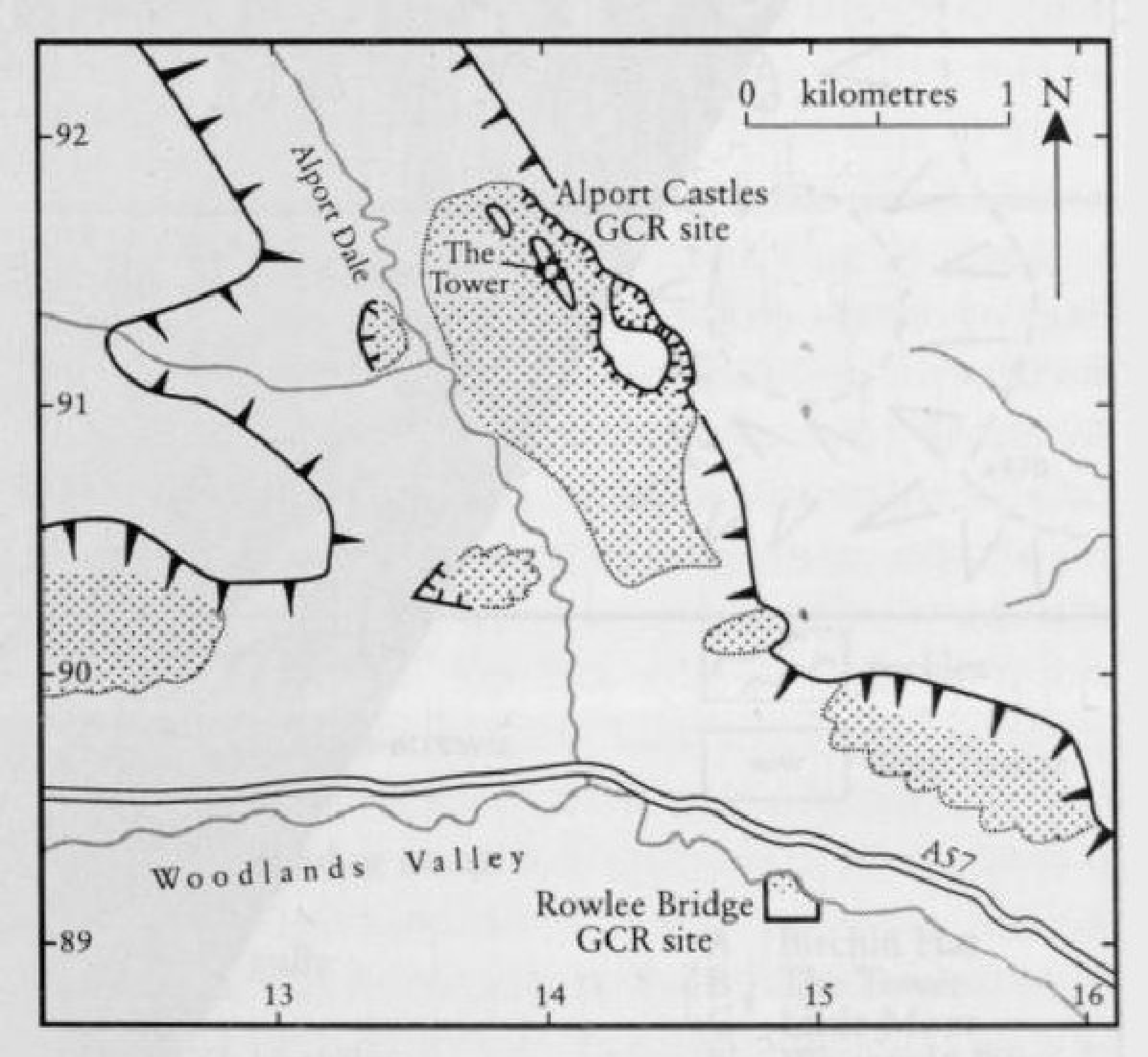
Age of failure

It is reasonable to infer a Holocene age for most if not all of this complex. The relative freshness of much of the upper morphology implies lack of periglacial attrition, although the top 5–8 m of the scarp above The Tower is a battered grass slope in thinner or deep-weathered strata (an unusual hazard requiring fencing). The overriding of periglacial head by Unit H has been noted, and pollen from a small peat lens in the slide toe suggests that the flows are not more than 8300 years old (Johnson and Vaughan, 1983). However, this need not preclude a history of landslipping here and in the vicinity earlier in the Quaternary. Alport Dale has a fluvially incised character in its upper reaches on the Bleaklow moors, but widens and straightens at the slide locus; the extent to which erosion by local glacier ice has played any part in slope destabilization merits further exploration in the Pennines.

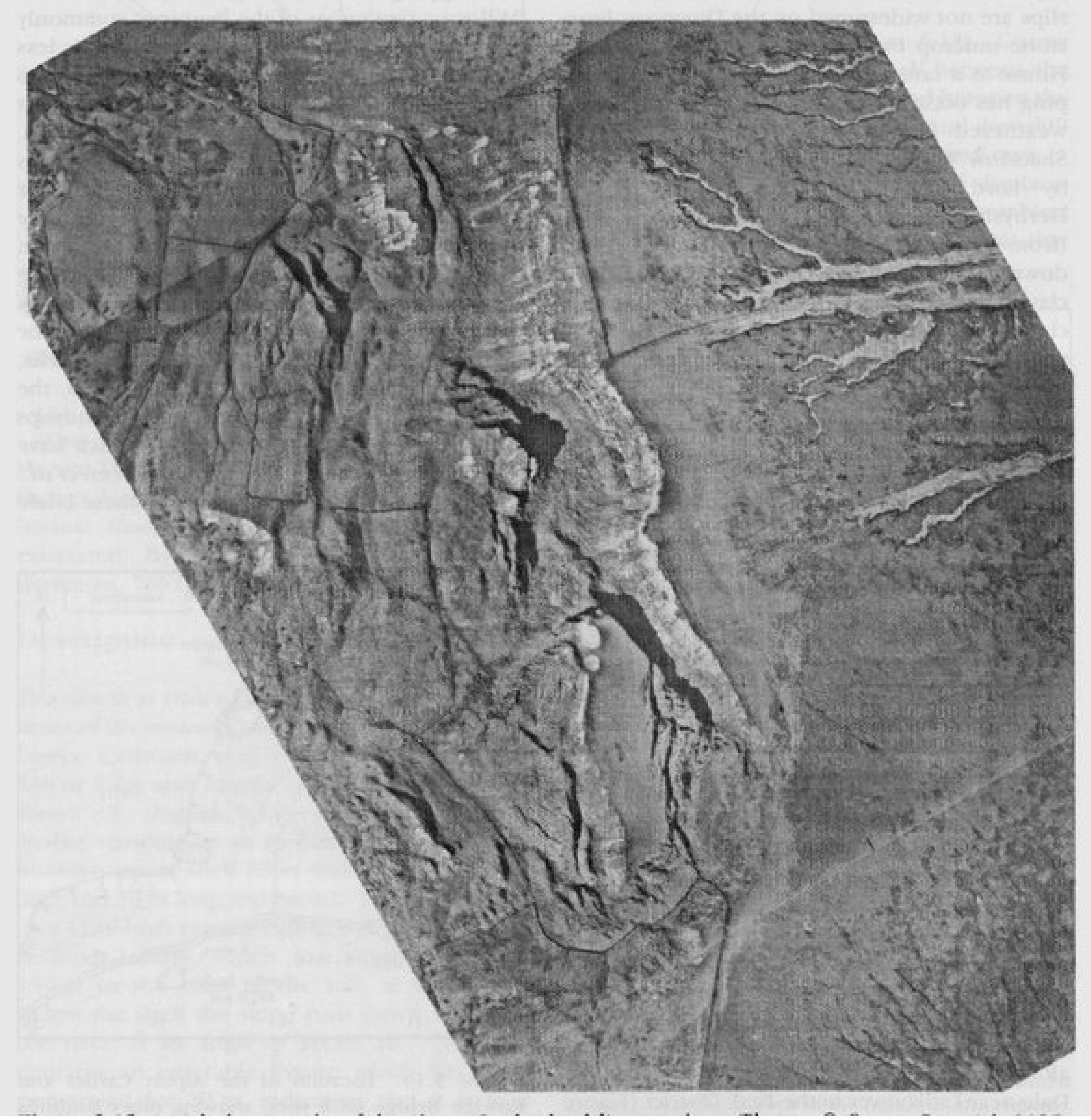
Conclusions

Alport Castles is one of the largest landslip complexes on the sedimentary lithologies of inland Britain. It is particularly remarkable for the size and relative intactness of its individual movement units, some of which are striking and well-known landscape features. It clearly displays geological controls on both its location and its topography. The depth to which failure extends, the nature of the translation surface or zone, and the sequence of evolution are largely unknown, and Alport Castles presents excellent opportunities for further research of wider relevance in the Pennines. The model of upward propagation, after rupturing in weak strata exposed by valley incision, has been applied here and may account for the freshness of the uppermost units and the boldness of the main scar, which attains an exceptional 60 m plus in height. The scale of encroachment into the plateau by up to 200 m at Little Moor, with signs of further incipient extension, exemplifies the contribution of bedrock mass movement to valley widening, with local rates of scarp retreat vastly in excess of those yielded by all other slope processes. This is far from being an isolated case (cf. Beinn Fhada, Chapter 2; Trotternish Escarpment, Chapter 6), and represents an extensive suite of such slope failures in the vicinity and in similar lithological contexts across the Dark Peak and farther north in the Pennines.

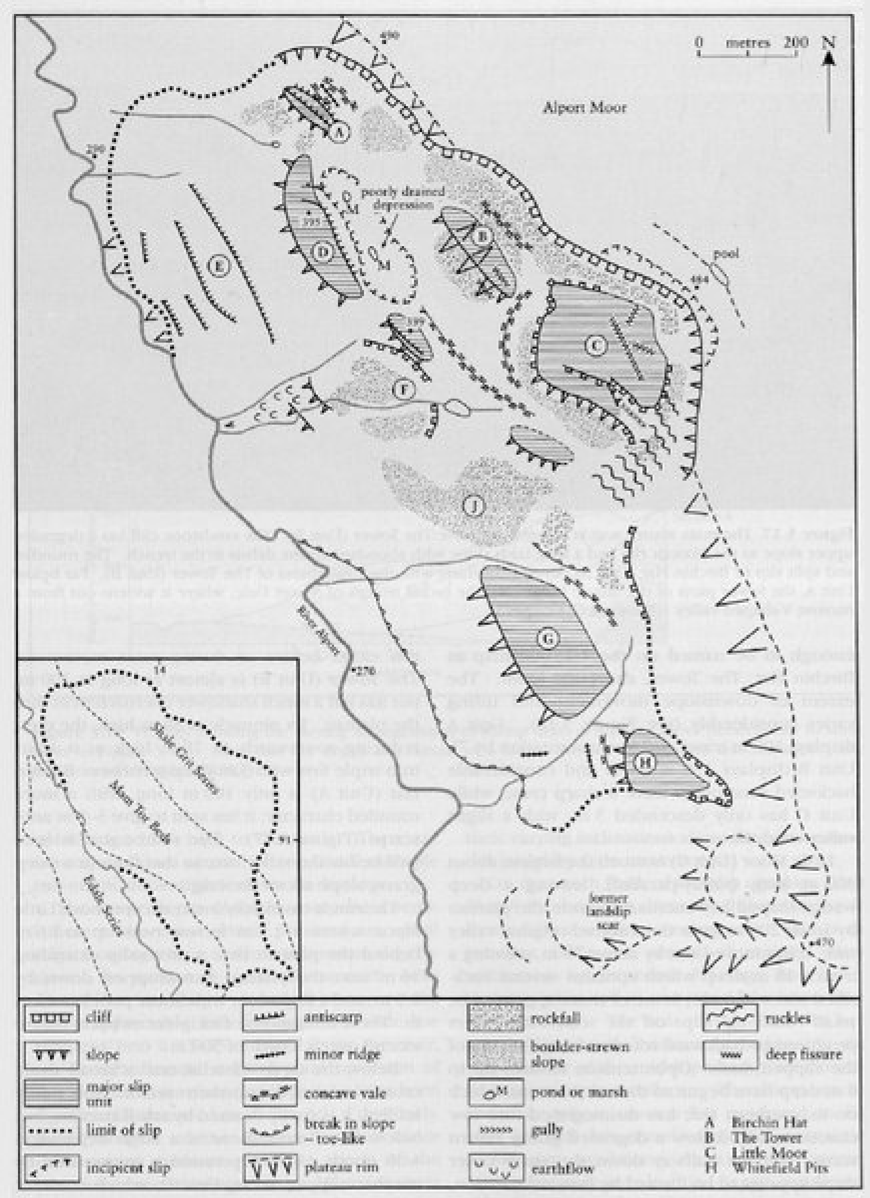
References



(Figure 5.14) Location of the Alport Castles and Rowlee Bridge GCR sites, showing other landslips (stippled) and scars (spiked' lines) in the vicinity

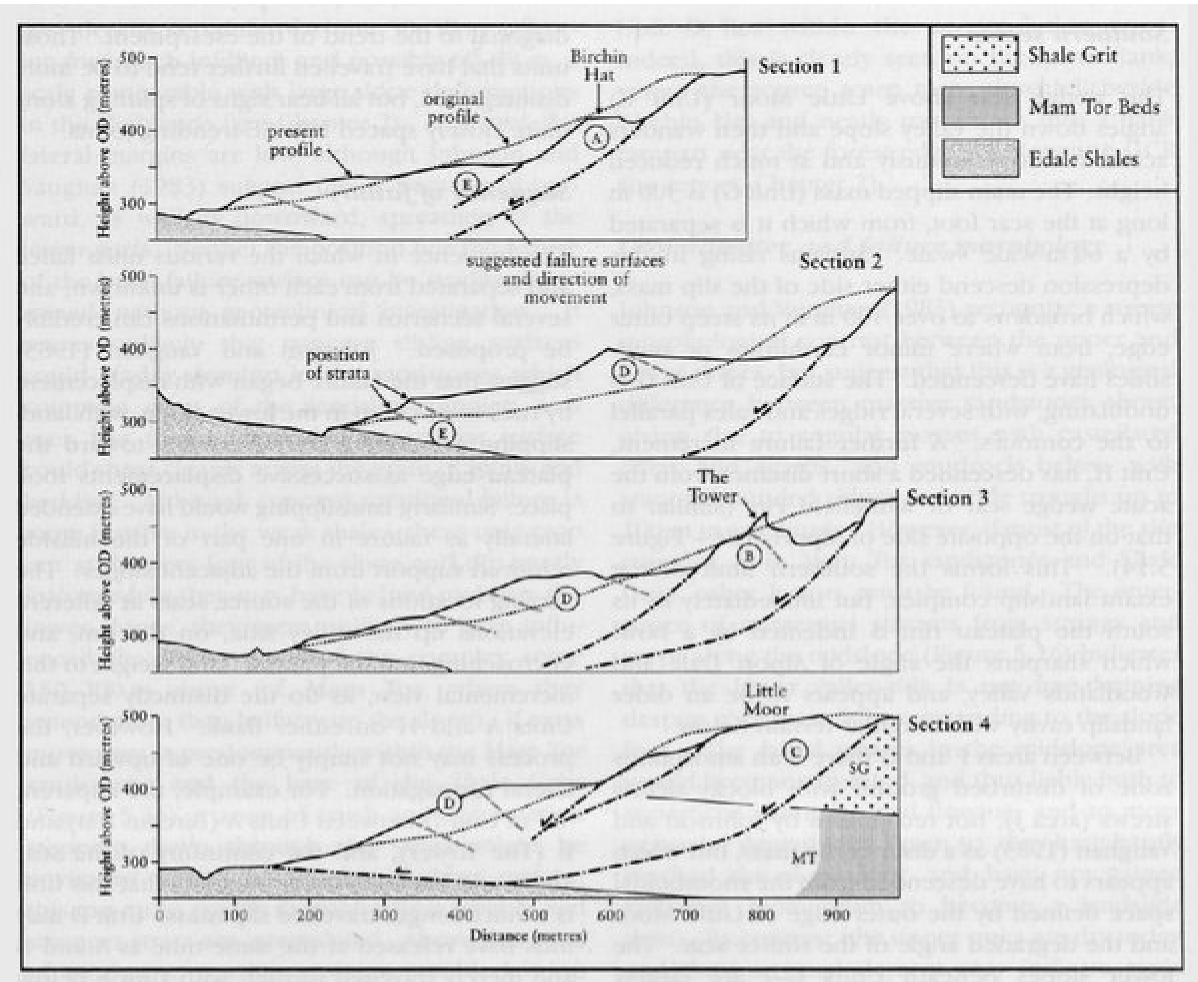


(Figure 5.15) Aerial photographs of the Alport Castles landslip complex. (Photos: Crown Copyright/MOD. Reproduced with the permission of the Controller of Her Majesty's Stationary Office.)



(Figure 5.16) Morphological map of the Alport Castles landslip complex, identifying the main slip units described in the text, and indicative geology. The source scar transgresses the original valley rim above Units B and C, but daylights below it elsewhere. After Johnson and Vaughan (1983).

(Figure 5.17) The main source scar at its greatest above The Tower (Unit B). The sandstone cliff has a degraded upper slope to the plateau rim and a long talus slope with abundant coarse debris in the trench. The rounded and split slip of Birchin Hat (Unit A) beyond contrasts with the ruggedness of The Tower (Unit B). Far below Unit A, the lower parts of the failure bulge into the broad trough of Alport Dale, where it widens out from a narrow, V-shaped valley. (Photo: R.G. Cooper.)



(Figure 5.18) Profiles showing the varying arrangements of slump units at Alport Castles (letters refer to slump units in (Figure 5.16)). Note that the depth and nature of a failure surface or zone are not surmised. After Johnson and Vaughan

(1983).