Slides, Cambers, Slumps and 'Terraces': Part 1

This paper, and the next two to follow, form a series which will describe and illustrate Gravitational Structures in the Cotswolds, i.e. those structures which are formed by the action of gravity on the soil and/or on the underlying solid rock. Gravity becomes effective when the strength of the soil or rock is reduced, usually by an excess of pore water, or because the stability of a slope is reduced by the removal of soil and rock from the base of the slope.

Gravitational structures vary greatly in size, and so I will divide them into two groups based on their size:-

Large features: (hundreds of metres to several metres in size)

- Landslides (this paper)
- Cambering, and associated Gulls, Slip Troughs, and Valley Bulges (next paper)

Small features: (ranging from scores of metres to less than a metre) (paper to follow)

- Frost creep and solifluxion flows
- 'Sheep Trods'
- Strip Lynchets *
- Ridge and Furrow *

* Strip Lynchets and Ridge and Furrow structures are man-made, but they are included here because they can be confused with naturally occurring features, and because, in some circumstances, they can provide a means of dating other gravity-induced structures (e.g. landslides, see below).

Fig 1: Simple collapse type landslide, which typically occurs where the oversteepened slope is formed of a roughly homogeneous rock type. (https://www.geotech.hr/en/landslide)

Starting therefore with landslides ....

Landslides occur due to the failure and collapse of a steep slope. This failure can either occur as a wholesale collapse of the rock face (Fig. 1)

or, where a thick, rigid rock layer overlies soft, ductile shales or clays, as a back-rotational collapse of a resistant rock unit capping the slope (Fig. 2).

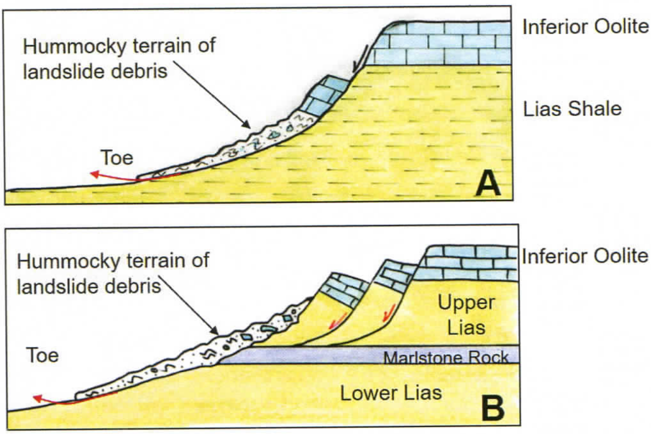

Fig 2: Sketches of typical Cotswolds landslides, highlighting the back-rotation of the slipped blocks and the hummocky downslope terrain. A: landslide caused by weakness of water-saturated Liassic shales (After Farrant et al, 2015). B: landslide collapse, with similar mechanism, but controlled by resistant Marlstone Rock horizon (After Hobbs et al (2012).

Fig. 4: Landslide above the Windrush valley (Dec. 2006), south of Bourton on the Water. Height of the arcuate head scar ~3m. For location see Figs. 5,6.

In the Cotswolds, this latter form is by far the most common, and the collapse is caused by the weakening of the underlying Liassic shales due to an excess of pore water (i.e. after heavy rains) and (during the past Ice Age) by the freezing and thawing of the shales. The shales then become unable to support the mass of the overlying Inferior Oolite limestone and fail along curved slip surfaces, causing a limestone block to drop and back-rotate towards the failure surface.

The detached limestone block can remain relatively intact, but the rest of the displaced material forms a hummocky terrain which terminates downslope as an incoherent mudflow, sometimes with a visible toe.

In many places in the Cotswolds, the presence of the rigid limestone band of the Marlstone Rock provides the detachment horizon for landsliding (Fig. 2B).

It is no coincidence that a tendency to landslide is most likely along spring lines, where water percolating through the limestone hits the underlying impermeable shales and issues as springs at the foot of the escarpment. It is this concentration of water in the upper part of the shales that weakens

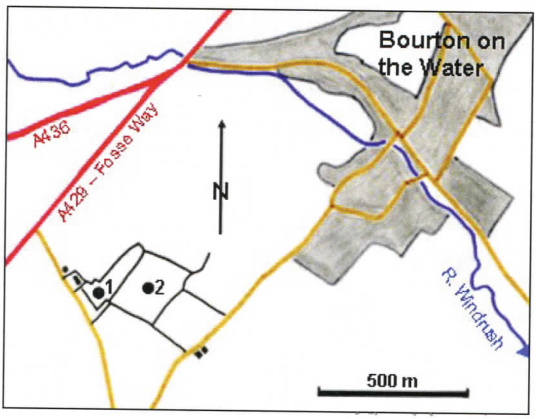

Fig. 5: Location map for the landslips near Bourton on the Water. Location 1 is the 2006 landslide (Fig. 4) and location 2 corresponds to Fig. 6

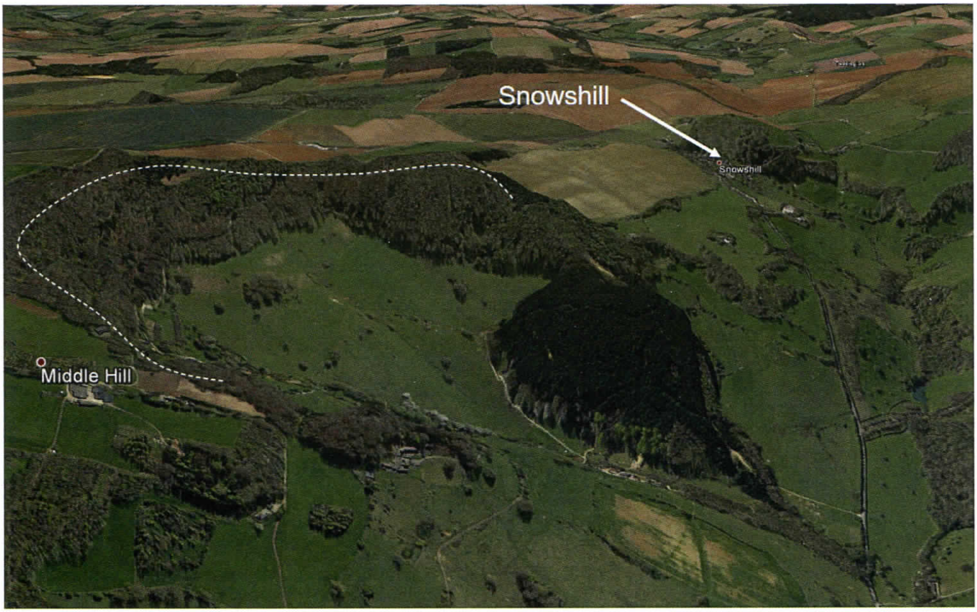

Fig. 3: Google Earth view of a possible landslide on the east side of the valley between Broadway and Snowshill, looking South. The white dashed line highlights the arcuate scarp or slip face, whilst Dulverton Wood (the forested hump in the middle of the slope) could be a block of oolitic limestone detached from the crest of the scarp. The slip face is ~ 1 km in diameter.

the rock and makes it prone to failure.

Landslides in the Cotswolds range in size from hundreds of meters to tens of meters, and in age from the last Ice Age (tens of thousands of years ago) to the present-day. Melt waters and the melting of permafrost at the end of the last Ice Age could have promoted landsliding; whilst the Neolithic deforestation of the Cotswolds consequent upon the beginning of agriculture (thousands of years ago) would have led to increased erosion and slope wash, which could have increased the risk of landslides.

Landslides can be recognised by the concave outline of the slip surface at the head of the landslide and by a hummocky mud and debris apron downslope of the landslide. Depending on the age of the landslide, the slipped, back-tilted, block(s) of limestone may be variously preserved. In most cases they appear to have been eroded and weathered away, suggesting that the landslide is of significant age. Review of the Cotswold scarp on Google Earth revealed several marked arcuate scars (e.g. Fig. 3), but only one possible large back-tilted block. In some cases, however, the remains of possible landslipped blocks could be obscured by the presence of trees, where ground which is too steep for ploughing or mowing has been left as woodland.

By contrast, a smaller, but still significant landslide occurred in December 2006 just south of Bourton on the Water, on the West flank of the Windrush valley (Figs. 4, 5, 6). Of interest is the fact that the difference in slope between the slipped mass and the undisturbed hillside above it shows that the slipped mass has back-rotated towards the slip face.

Fig. 6: Arcuate slumps and landslips obscuring Medieval ridge and furrow field patterns, now only visible at the bottom of the field. This shows that the process of slope collapse has been ongoing for hundreds of years. The immediately adjacent field is the location of the 2006 landslide (Fig. 4). View is to the NW.

Evidence for this landslip has now been removed by the landowner's re-grading of the slope, but the adjacent field clearly shows evidence of long-term landsliding, which can be dated as post-Medieval because the terminal mudflows have buried Ridge and Furrow field patterns, now only visible at the base of the slope (Fig. 6).

Finally, a small landslide located in a field just East of Hawling (GR 072231), and recognised by its arcuate shape, is probably only a year or two old, based on the freshness of the slip face (Fig. 7).

Conclusion

The sites of ancient landslides in the Cotswolds can be difficult to identify with certainty, but the presence of an arcuate scar at the top of the hill, and a hummocky terrain over the lower part of the hill, are good clues. The absence of a back-tilted block of limestone is not necessarily a negative, because it could have been broken up by the sliding motion itself, or by the action of erosion and weathering.

In anticipation of the next article, on cambering, it should be noted that cambering involves the forward rotation of the detached blocks away from the escarpment, and generally results in linear structures parallel to the contours on the hillside, whilst the rubbly lower slope is generally lacking.

I would also like to point interested readers to a good, non-technical paper by the British

Fig. 7: Hawling mini-landslip, with tractor for scale.

Geological Survey (Hobbs et al, 2012). It contains landslide maps covering the whole of the Cotswolds, which might be of interest. They estimate that roughly half of the Upper Lias outcrop area is affected by either landsliding or cambering. Consequently, care needs to be taken by landowners and/or developers to ensure that future construction or engineering work does not disrupt or cut through the frontal mudflows, movement surfaces, or toes of these landslides. Where there is a danger of this happening, remedial work may be required.

In addition, given that landslides are known to be more prone to occur during or immediately following periods of heavy rain, it could be argued that global warming, with its predicted more frequent and extreme weather events, could exacerbate the problems of landsliding in the Cotswolds.

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