Small-Scale Gravitational Structures, And Similar

This is the last of three papers which 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 the underlying solid rock.

The first two papers dealt with Landslides, and Cambering (Jeans, 2021a and b). This paper discusses the smaller-scale features caused by the action of gravity on the soil:-

- Solifluction lobes
- Soil creep
- Sheep trods

and also illustrates some man-made structures which could be confused with naturally-occurring features:-

- Strip lynchets
- Ridge and furrow

patterns.

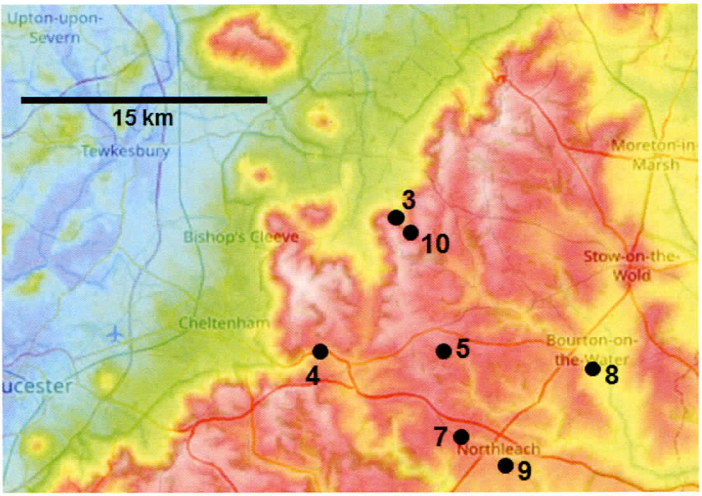

Fig. 1: Map showing location of N. Cotswold examples of structures described. 3 = Little Foxcote (solifluction?); 4 = Dowdeswell (solifluction?); 5 = Salperton (bent tree); 7 = Hampnett (sheep trod); 8 = Bourton on the Water (ridge and furrow); 9 = Northleach (strip lynchets); 10 = Lynes Barn (strip lynchets).

Most of our natural landscape is the legacy of our Ice Age history over the last 2.6 million years (the Quaternary period). It's not just the glaciated mountains of Scotland, Wales and the Lake District that were dramatically altered by the action of ice. The rolling limestone sheepwalks of the Cotswolds were also altered, not by glaciers or ice sheets, but due to the freezing and melting of water in the soil. Since ~15,000yrs BP (before present), the Cotswolds probably suffered little or no permafrost (permanently frozen ground), but seasonal and diurnal freeze and thaw processes would have been important and effective during the Loch Lomond Ice Advance (~13,000 – 11,500 years BP) and even during the Little Ice Age of the 16th – 19th centuries, when winters were particularly cold, summer crop yields fell, and the River Thames periodically froze.

Under these freeze-thaw conditions, downslope mass movement becomes an effective modifier of the landscape, and features range from larger-scale solifluction structures, through smaller downslope movement structures called sheep trods, to the smallest scale soil and frost creep effects. The difference in the occurrence of these features depends on the nature of the surface geology, the scale and steepness of the slope, and the duration and depth of freezing.

The North Cotswolds sites mentioned in the following sections are shown on Fig. 1 (two examples are taken from outside the North Cotswolds for illustrative purposes).

Fig. 2: Solifluction sheets near Eagles Summit, Alaska. (https://en.wikipedia.org/wiki/Solifluction)

Solifluction (otherwise known as 'downhill sludging')

Solifluction is the generic term for the downslope movement of soil and rock under periglacial or tundra conditions. It occurs in summer when the uppermost layer of soil melts, whilst the ground below remains frozen, so that water-saturated sheets of soil and rock debris can slide downhill, forming low-relief arcuate lobes (Fig. 2). These can, admittedly, be difficult to distinguish from the arcuate toes of landslides, though landslides generally have steeper slopes above them.

Fig. 3: Possible solifluction deposit mantling the slope below Little Farmcote, Hailes valley (but see text for caveat).

Indeed, solifluction could rework the downslope toes of older landslides, creating arcuate lobes of 'sludged' material below the original limit of the landslide.

I have been unable to find a clear example of this from the North Cotswolds, probably because the low-relief nature of a solifluction lobe makes its survival as a visible feature after centuries or millennia unlikely – hence the Alaskan example. However, Figs 3 and 4 show structures that may be the result of solifluction from the Cotswolds, though this is not a high-confidence identification.

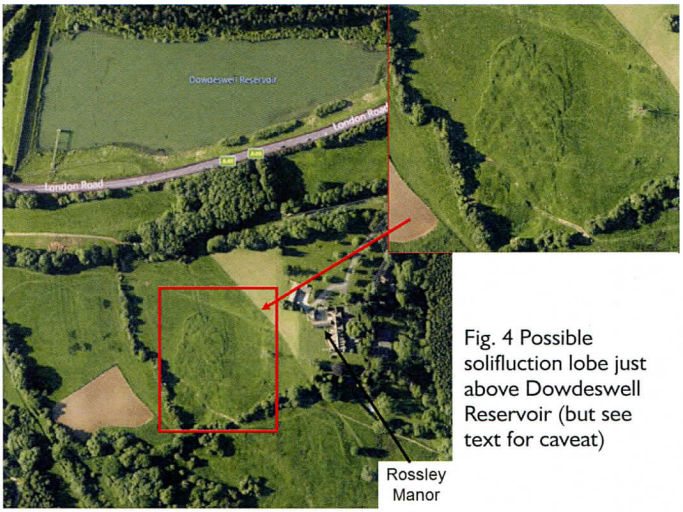

Fig. 4 Possible solifluction lobe just above Dowdeswell Reservoir (but see text for caveat)

Soil creep (or frost creep)

Soil creep can be due to the freezing and thawing of the soil and rock particles on a slope. Upon freezing, the expansion of water to ice carries the soil particles upward, perpendicular to the land surface. Upon melting, the soil particles subside vertically, resulting in a progressive down slope movement.

Creep of rock particles and soil down a slope can also occur under wet conditions, which prevail to the present day. The steeper the slope and the wetter the particles, the more rapid the movement, because the excess water in the pore spaces reduces the internal friction between the particles. Objects within or on top of the layer of soil are also deflected downslope by this movement, resulting in tilted fence posts and curved tree trunks. Indeed, the Salperton example (Fig. 5) must date to the last 30-40 years, judging by the size of the affected tree.

Fig. 5: Deformation of tree trunk due to soil creep, near Salperton.

Fig. 6: Sheep trods on Coombe Hill, above Holywell, near Wotton-Under-Edge. Caused by soil creep on steepish slopes, they form a ribbed pattern of grass-covered steps which roughly contour the slope. Some have been subsequently accentuated by sheep.

'Sheep trods'

On moderate to steep slopes of soil and grass in cool, humid terrains, banks of narrow terraces or anastomosing lines of steps or terracettes can be found (Figs. 6, 7).

However, because these terracettes are often used by cattle and sheep when moving across the hillside, they are also known as sheep trods (or in France, 'sentiers de vaches'). Their origin is believed to result from soil creep and frost and thaw, i.e. animals don't cause them, but they can (and do) accentuate them.

Fig. 7: Sheep trods on south side of Leach valley below Hampnett. The lines of dry grass highlight the 'rippled' nature of the hillside. The leaning telephone pole also illustrates the effect of soil creep.

Fig. 8: Ridge and furrow field pattern south-east of Bourton-on-the-Water.

The above small-scale features are naturally occurring and the result of gravity acting on water-saturated or frozen soil. Confusion is possible with two types of structures which are the result of man's activities during pre-historic to medieval times, namely strip lynchets and ridge and furrow patterns.

Ridge and Furrow

Ridge and Furrow comprises a rippled pattern of rounded ridges and troughs characteristic of Medieval or older open fields (Fig. 8). The pattern was created by ploughing with non-reversible ploughs on the same strip of land, in the same direction, year after year, and they survive to the present day on land that has not been ploughed since. The ridges are parallel, ranging from 3m – 20m apart, and up to 60cm high, although they would have been much higher when in active use.

An excellent description of ridge and furrow mechanics and agriculture is given in Wikipedia (https://en.wikipedia.org/wiki/Ridge_and_furrow).

Strip Lynchets

Strip lynchets are earth terraces found on the side of a hill or valley and they represent ancient field systems or cultivation benches. They date from as early as the Iron Age, and they continued in use, or to be constructed, through Roman times or even later into Medieval times.

They are believed to have been dug by hand across the slope to produce a series of terraces or steps with a flat 'tread' separated from the next 'tread' by a steep 'riser'. They are usually arcuate or crescentic in shape, with maximum dimensions near the middle. The 'treads' can be up to 15m - 30m wide, with 'risers' averaging 1m – 3m in height, and they can extend laterally for 100m – 400m in length. Tiered arrangements are common, with 3-5 benches, sometimes many more.

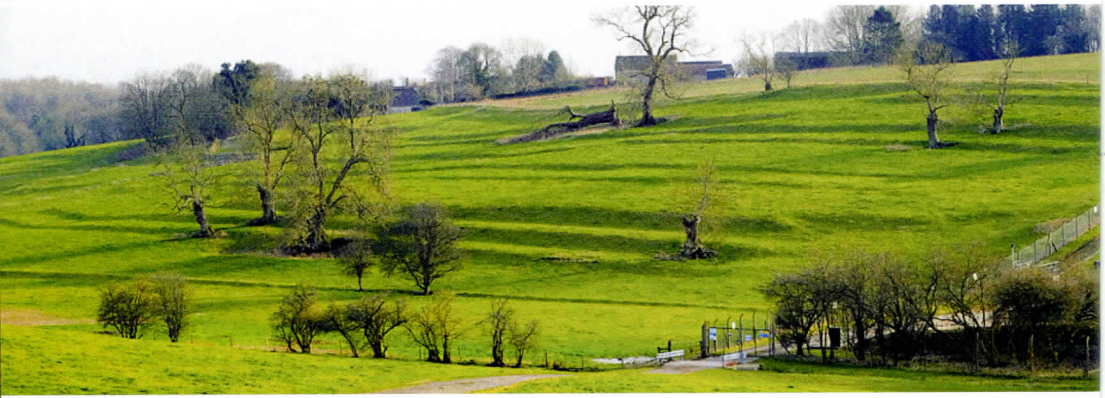

Fig. 9: Strip lynchets on south side of Leach valley just East of Northleach.

They are found on both the slopes of dip-slope river valleys, e.g. Northleach (Fig. 9) and in escarpment valleys, e.g. Lynes Barn (Fig. 10). Some examples are noted on the 1:25,000 OS maps, but there are many more which have not been noted, such as above Roel Farm, and just west of the 'Mitford' church in Swinbrook.

Strip lynchets could possibly be confused with river terraces (to be discussed in a future article) but river terraces are generally much larger features (higher 'risers' and wider 'treads') and they typically extend for kilometres along the sides of river valleys.

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References:

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Jeans, P.J.F. (2021b) Slides, Cambers, Slumps and 'Terraces': Part II, Cambering. Gloucs. Nat. Soc. NL, Sept. 2021.

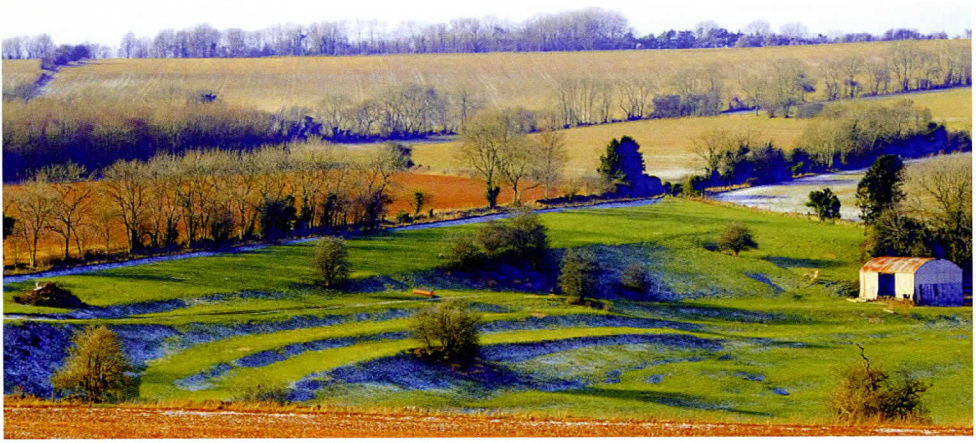

Fig. 10: Strip lynchets just north of and below Lynes Barn.