The Geology of **High Borrowdale**

We talked in the last edition of Conserving Lakeland about a research project looking into the effectiveness of a new landscape stabilisation matting called sisal. We asked Dr Lois Mansfield from the University of Cumbria to give us an overview of the work ahead this year, the thinking behind the approach and a little more detail about the geology of the area and the challenges we face.

In 2002, Friends purchased High Borrowdale in the western extremities of the Lake District. Consisting of 44 hectares (108 acres) of newly planted riverside woodlands, inbye land some of which is hay meadow, intakes and a number of vernacular buildings, the site offers an insight into aspects of a traditional upland farming system. Since this time a wide range of management works have been undertaken to improve the area; one of the more complex challenges has been how to prevent landslides and slips damaging the cowshed and hay meadow areas, a number of which have occurred since 2005 and frustratingly more so since Storm Desmond in 2015.

Various management solutions have been tried to reduce the amount of damage caused by these landslides, but it has become a law of diminishing returns as the number of occurrences has increased. Friends approached the University of Cumbria to develop a joint project, with some support from United Utilities to try and slow or even halt the slips. The classic solutions are to use revetments or employ geotextiles to stop material moving downslope long enough that the land re-vegetates and stabilises. The problem is that the timescale between slips is not long enough to establish vegetation and any management we put in will simply be washed away.

To understand why this is happening, we need to appreciate the stages by which High Borrowdale was formed in the first place; by doing so we should be able to affect a better solution, although as you will see, there are no guarantees when we are dealing with natural processes.

The formation of High Borrowdale

❶ The impermeable geology of High Borrowdale

High Borrowdale has a geology which is generally of an impermeable nature.

❷ A glacier carves a trough using debris carried in the ice

Into this landscape a glacier carved a trough using debris carried in the ice cutting roughly east to west out from the central Lakes, probably around 22,000 to 14,000 years ago.

This eroded material was plastered on the floor of the glacier and lodged on the sides constituting various jumbled sizes, from boulders over 1m to fine clays less than 0.002mm. As the ice retreated from that time, additional debris (till) that the glacier was carrying was dumped into the valley bottom and smeared up the sides to form a tapering thick layer (about 20m deep).

❸ Retreating ice cap forms a raging post glacial river

As the central ice cap of the Lake District melted, valleys like High Borrowdale allowed millions of litres of water to exit and as it did so cut down through the glacial till forming a raging post glacial river.

This river shifted thousands of tonnes of the unconsolidated sediment down into the Lune gorge and out eventually into Morecambe Bay.

❹ As flow decreases a contemporary misfit river is left

Gradually the flow decreased and we were left with the contemporary misfit river from about 10,000 years ago.

This has created a much smaller floodplain within the valley bottom and the river meanders back and forth across the valley bottom regularly undercutting the banks created by the earlier post glacial river.

Other processes responsible for landslips

Whilst this story is classic of many Lake District valleys, there are other processes at work which are responsible for the increasing number of landslips recently.

1 High Spring Line

The first is the existence of a spring line high up on the sides of the south facing slope.

Because the bedrock is impermeable, water is coming out of the ground onto the surface in the allotment land. Until, that is, it hits the tapered till deposits on the sides of valley, and then the water is sinking back into the unconsolidated material saturating it, making it unstable.

2 Removal of ice mass

The next process operating is caused by the removal of the weight of ice 10,000 years ago. As a consequence till smeared on the side of the valley is relaxing and expanding in volume, making it less dense allowing water in between the particles (like crushing a sponge and then letting go). This paraglacial process, known as debuttressing, has an exponential decay operating through the last 10,000 years to the present, but it is still occurring.

3 Increase in storms

A third compounding process is the increased storminess we are now experiencing in the North West due to climate change. Storm Desmond is just one on a long line of winter gales and storms which deluge the upper fells with water. This then increases the ground saturation to a point where it is at field capacity. Water then cannot soak into the ground and instead flows overland. At some point as it comes down the allotment it exploits a weakness in the surface and exposes the soil. We are not sure, yet, what exactly triggers this. It could be the slope angle, or a rock sticking out of the ground, or a bare patch caused by voles... Whatever the trigger is, it allows water to supersaturate the till to a point where gravity takes over and it sloughs down slope as a land slide / mud flow.

The research required

These landslides, are however, not new phenomenon. As we walk down High Borrowdale there are a number of places on both sides of the valley where we can see evidence of past slips. Now lushly vegetated over, these look like fans of gently sloping ground coming out from the bottom of various ravines. Another piece in the puzzle which warrants investigation to determine why some ravines have landslips and others do not. Is variation in vegetation playing a role? Could we manage the vegetation in a particular way?

In the meantime, the landslides continue to occur and as a result we are going to experiment with different geotextiles to see if one type is more effective than another to stabilise the soil. To do this, we are going to peg out coir, jute and sisal matting in some of the less eroded ravines initially. The former two have been used extensively in the UK as a soil stabilisation technique. Sisal is the 'new kid on the block'; but has a unique property the other two do not have, an ability to absorb water into its structure and hold it there. This might just give us the edge to give enough time to stabilise the ravines, whilst continuing our investigations into the regularity of landslides in High Borrowdale to find a more permanent solution, which could of course, be leaving nature to do what it does.

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Work gets underway...

The first foray into High Borrowdale with Sisal occurred on 24th January. High hopes and a group of eager volunteers, we were setting out after some torrential rain and, hindsight is a wonderful thing, the size of the area we planned to cover in Sisal, the gradient of the slope on which we had planned to work proved too much for us to complete the work. We spent the morning stitching Sisal sheets together on site and carrying up to the site of erosion on one of the ghylls behind our barn. Weather conditions and high winds in the area mean that we have to use some heavy duty methods to keep the Sisal in place with rebar and sledge hammers, trying to bury the iron in till and rock filled till. The ground was saturated which meant that footing was also a problem on the steep slopes. Regrettably, we abandoned the task to await better weather conditions in the spring months when we will tackle the task once more. We have to remind ourselves and volunteers that this is a new challenge. Research into better ways of stabilising soil and ultimately providing flood resilience both here and in other properties which may benefit from our research. Failures and reassessments are part of this and our pain will be others gain! We will keep you updated on our next foray into High Borrowdale and hopefully with images of areas carpeted in sisal, jute and coir as we assess different solutions for tackling climate and geology!