British Geological Survey
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Initial report on the Scroggs Cleuch landslide, Lockerbie, December 2006

Physical Hazards Programme

Internal Report IR/06/138

BRITISH GEOLOGICAL SURVEY

PHYSICAL HAZARDS PROGRAMME

INTERNAL REPORT IR/06/138

Initial report on the Scroggs Cleuch landslide, Lockerbie, December 2006

N R Golledge

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Foreword

This report is the published product of a short study by the British Geological Survey (BGS) of the landslide that occurred at Scroggs Cleuch, Lockerbie, over the weekend of 2nd-3rd December 2006. The report is based on data collected during a two hour investigation of the site, as well as an assessment of existing data held in BGS archives. The sites lies on 1:50 000 scale Geological Sheet 10W (Lochmaben) and on the 1:50 000 scale Solway East Special Sheet (British Geological Survey 2006). Survey of the superficial deposits of this area was conducted 1999-2001. This report does not include any assessment of geotechnical properties of the failed material, and should not be used in place of a full geotechnical review.

Acknowledgements

BGS acknowledge with thanks the assistance and cooperation of Dumfries and Galloway Council, in particular Stuart Caven (Senior Technician, Combined Services) and Ray Owen (Business and Development Officer, Architectural and Design Services). All photographs were taken by Brian McIntyre, BGS Photographic Services.

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Summary

This report describes the geological context, form and composition of a small rotational failure in unconsolidated sediments in the bank of Scroggs Cleuch, approximately two miles east of Lockerbie on the B7068 Langholm road. Slippage of the bank resulted in undermining of the road and associated tension cracking. Consequently the road was closed, and may need to be rerouted to avoid potential future hazards. Slippage probably occurred as a result on prolonged and intensive rainfall in the weeks leading up to, as well as immediately prior to, the eventual failure. Elevated pore water pressures throughout the substrate, a raised water table, and undercutting of the bank by the swollen burn are likely to have combined to initiate the collapse.

Date of failure: 2nd / 3rd December 2006

Location: Scroggs Cleuch, near Lockerbie, southwest Scotland

Type of failure: rotational slump in unconsolidated deposits

BGS landslide ID: 15232

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1 Introduction

Prolonged and heavy rain during the latter half of November, and over the weekend of 2nd-3rd December 2006, led to the collapse of a section of the bank of Scroggs Cleuch, near Lockerbie (Fig. 1). Undermining of the road and associated tension cracking rendered the road unsafe and prompted its immediate closure. The following was posted on the Dumfries and Galloway website, 4th December 2006:

Major Landslip Closes B7068 Lockerbie to Langholm Road near Scroggs Bridge.

The B7068 Lockerbie to Langholm Road has been closed today near Scroggs Bridge following assessment of a weekend landslide.

Diversions for local and HGV traffic are being put in place this afternoon. The closure will remain in place until further notice. Urgent investigations into the extent of the necessary repairs are underway.

(http://www.dumgal.gov.uk/dumgal/documents.aspx?id=18441)

[see also http://news.bbc.co.uk/1/hi/scotland/south_of_scotland/6206808.stm]

A visit to the site by a BGS team of geologist and photographer was arranged on 6th December 2006 through Mr. Stuart Caven (Senior Technician, Combined Services) at Dumfries and Galloway Council in Lockerbie. Dr. Ray Owen (Business and Development Officer, Architectural and Design Services) met us at the site.

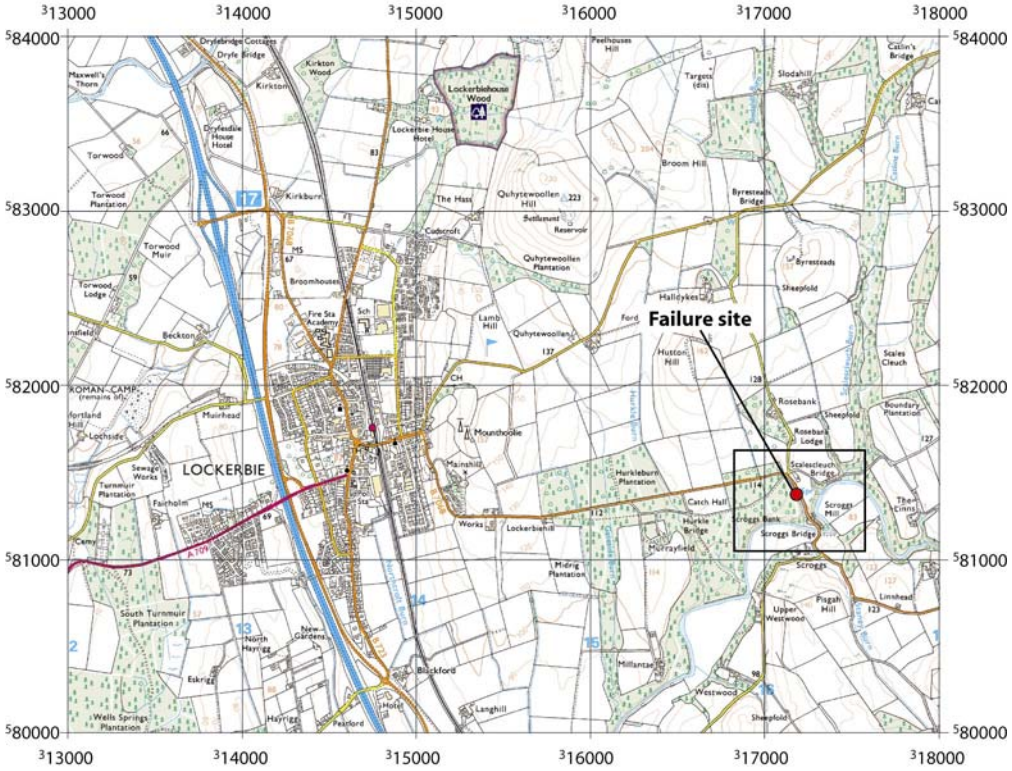

Figure 1. Location of site in relation to wider area. Box shows area covered in Fig. 2.

1.1 FAILURE SITE

The failure took place at [NY16212 81353], on the eastern bank of Scroggs Cleuch. The burn has incised a c.10 m deep gully with steep sides. Slope aspect is 245° (SW). The B7068 runs NNW-SSE along the top of the eastern bank where the failure occurred.

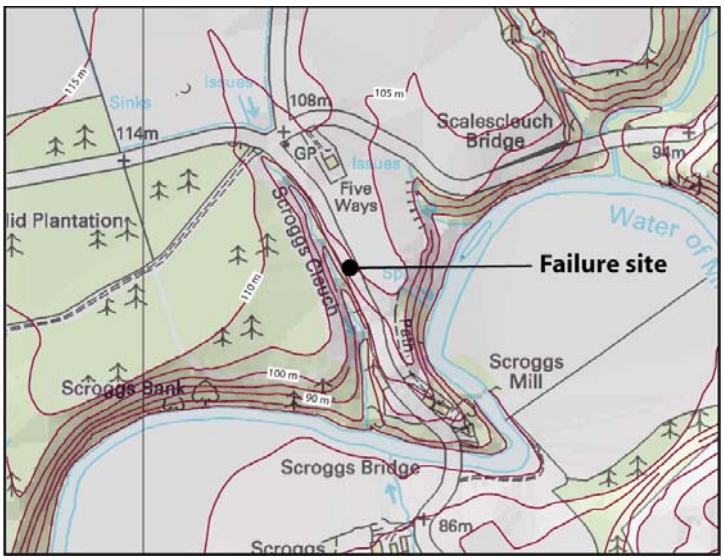

Figure 2. Detail of landslip site.

1.2 GEOLOGICAL CONTEXT

Recent field mapping and interpretation of 1:24 000 aerial photographs of the surrounding area combined with existing data from earlier geological surveys has identified an area of sand and gravel immediately to the east and north of the failure site (Fig. 3). This deposit is likely to be glaciofluvial in origin, and although no exposures have been logged, is likely to be composed of variable amounts of silt, sand and gravel. These components may form discrete beds or may be massive. Clasts are likely to be rounded or subrounded and may range from gravel to cobble grade. The deposit overlies the red, cohesive diamicton that forms the majority of the area. This is interpreted as subglacial till of the Langholm Till Formation, which typically has a firm to very firm matrix of silt and sand, and contains subangular to subrounded cobbles. These cobbles are chiefly Lower Palaeozoic greywacke sandstone and siltstone. The fine grain size of the matrix produces a ‘sticky’ deposit when wet, and a semi-cohesive slurry when saturated.

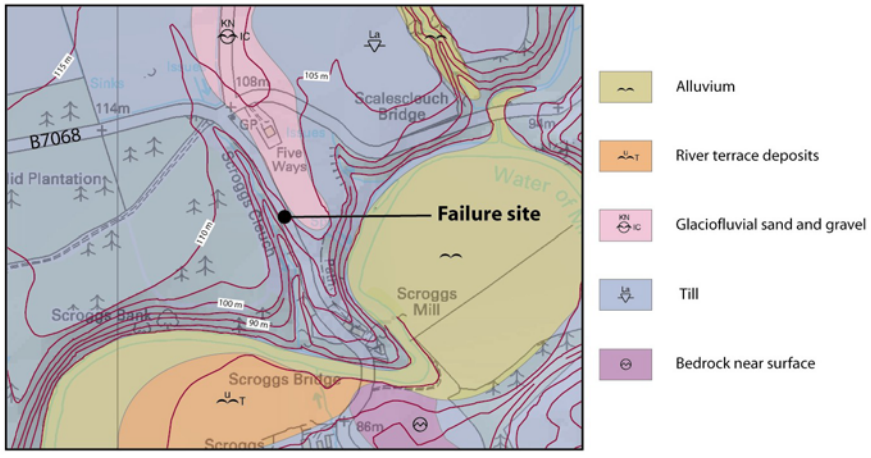

Figure 3. Geological map of the area surrounding the failure site, based on BGS 1:50 000 scale Solway East Special Sheet

2 Description of failure

2.1 SITE

The failure site is densely wooded, and in clearing the road and making the area safe, many of the trees on the failed material had been felled and lay in the gully overlying much of the slipped material. Therefore, access to the slide was only possible at the headscarp and at the toe, and in both cases only at the sides.

2.2 MORPHOLOGY

The 8 m wide headscarp tends from initially sub-vertical to an approximately 55° slope within the top metre. Downslope measurements show a decreasing slope angle towards 17° at the toe. Failure appears to have occurred in the upper 3-5 m of the red-brown silty diamicton (subglacial till) that makes up much of the area. In total the failure site is c. 10 m high from scarp to toe, and approximately 15 m in length (Fig. 4).

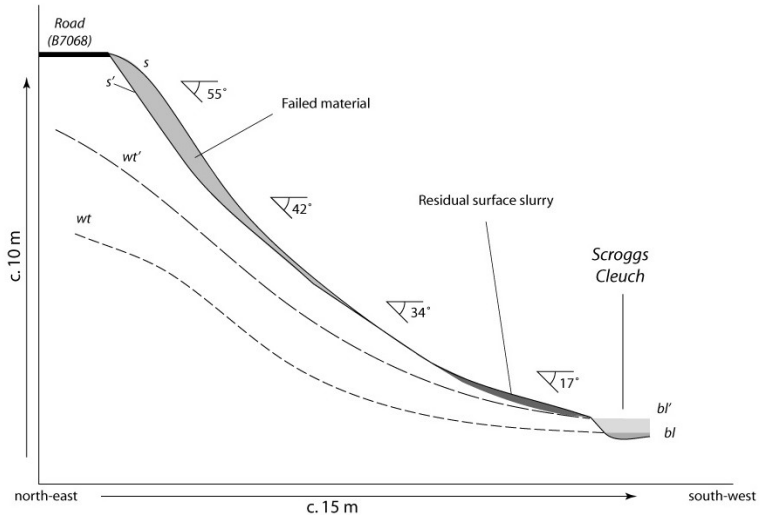

Figure 4. Schematic drawing of the failure site showing slope angles and locations of failed and residual material. wt and wt' represent hypothetical normal and elevated pre-slide water table positions respectively. bl and bl' denote normal and elevated pre-slide water levels respectively, and s and s' are pre and post-failure ground surface approximations. Not to scale.

2.3 GEOLOGY

Marginal portions of the road also failed, and scarp-parallel tension cracks of centimetre-scale width and decimetre to metre-scale length were visible within the tarmac. Evidence of older failures and subsidence of the road edge was also noted to the NNW and SSE of the failure site. Road construction appeared to consist of 80 mm tarmac over 120-150 mm hardcore, directly lain on the glacial substrate. The accessible portion of the headscarp showed abundant root growth throughout the substrate. The presence of tree roots may have aided coherence of the substrate both prior to and during failure.

No loose material was seen in the area of the headscarp, but material accumulated near the toe was clearly disaggregated except where bound by tree roots. At the toe itself, much of the loose material was saturated and formed a slurry. The gully into which the material slumped hosts a narrow burn c. 1 m wide and normally only a few decimeters deep. The banks downstream of the failure site, however, showed signs of oversteepening to a height of 1.3 m above the observed water level, consistent with their having been undercut by a significantly larger volume of water.

This is likely to have been the case along the length of Scroggs Cleuch. The exposed material in the eroded banks proved at one location to be comprised a c. 0.5 m thick surface unit of poorly consolidated red silt and sand with cobbles and organic material, overlying a 0.4 m thick clast-supported cobble diamicton that in turn rested on cohesive, matrix-dominated red diamicton at the water level (Fig. 5).

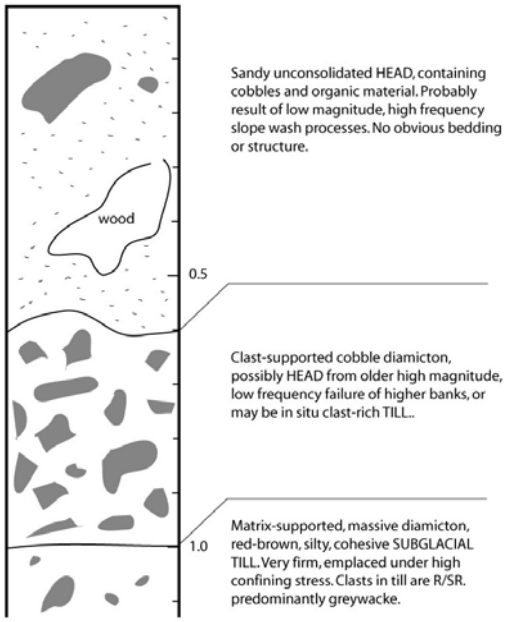

Figure 5. Vertical section through water-level bank exposure c. 10 m SSE of failure site.

2.4 CLASSIFICATION

BGS adopt the classification scheme for landslides suggested by the World Landslide Inventory, largely based upon Varnes (1978) and Cruden & Varnes (1996). This is a morpho-genetic scheme – classifying according to material, failed morphology and (often inferred) mechanism. Failures may occur within rock, debris or earth, and may be composite in form. This scheme allows for over 20 categories of failure to be recorded. The Scroggs Cleuch landslide shows an oversteepened headscarp typical of rotational failures, and many of the foundered trees had rotated towards the headscarp during failure rather than sliding into the burn in a translational slide. This landslide may be best described as a shallow rotational slide in an unconsolidated substrate.

2.5 TRIGGERS OF SLOPE FAILURE

The most likely trigger for the Scroggs Cleuch landslide is the prolonged and intense rainfall that occurred prior to failure. This led to several changes in the immediate area that each formed a component trigger. Prolonged rainfall leading up to failure would have saturated the substrate and raised pore water pressures beyond normal values. Consequently the substrate would have been weakened as a result of lower effective stresses in grain-grain contacts, and more likely to deform under self-weight stress. The sand and gravel mapped immediately north and east of the site may well have acted as an aquifer, storing water and increasing the overall hydrostatic head on the underlying substrate. Greater volumes of groundwater no doubt raised the local water table, and coupled with increased surface runoff led to swelling of the burn. Faster flow of the swollen burn would have engendered bank undercutting and localised collapse, removing buttressing support for the slope higher up. Therefore, it is likely, that failure of the bank arose through a combination of fluid-weakened substrate, an elevated local water table, and undercutting of the bank.

3 Impacts

The road is currently unsafe, particularly for the heavy goods vehicles that serve many of the farms in the area. Consequently the road is closed pending a decision on the nature of remedial works.

References

Most of the references listed below are held in the Library of the British Geological Survey at Keyworth, Nottingham. Copies of the references may be purchased from the Library subject to the current copyright legislation.

CRUDEN, D. M. AND VARNES, D. J. 1996. Landslide types and processes. In *Special Report 247: Landslides: Investigation and Mitigation*, Transportation Research Board, Washington, D.C.

VARNES, D. J. 1978. Slope movement types and processes. In *Special Report 176: Landslides: Analysis and Control*, Transportation Research Board, Washington, D.C.

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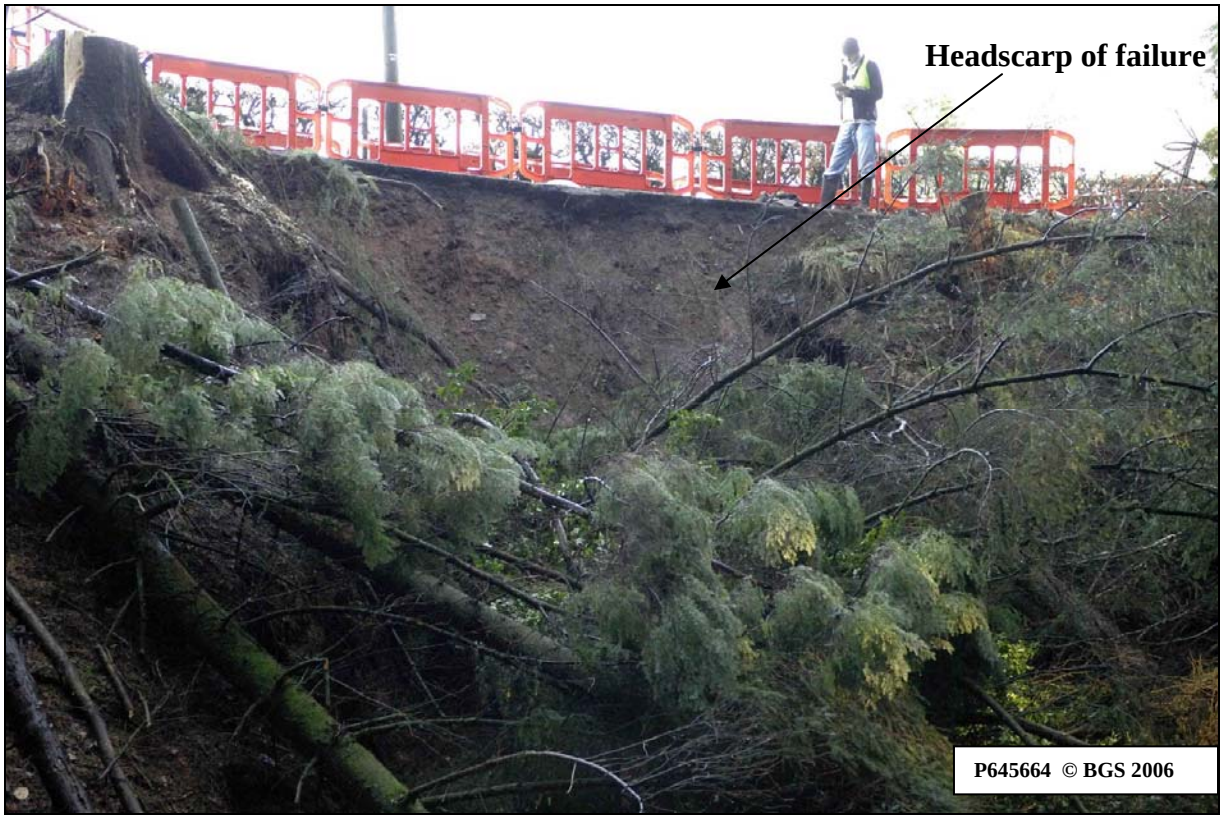
Appendix 1

i) View SSE along section of B7068 near Scroggs Cleuch, showing failure site

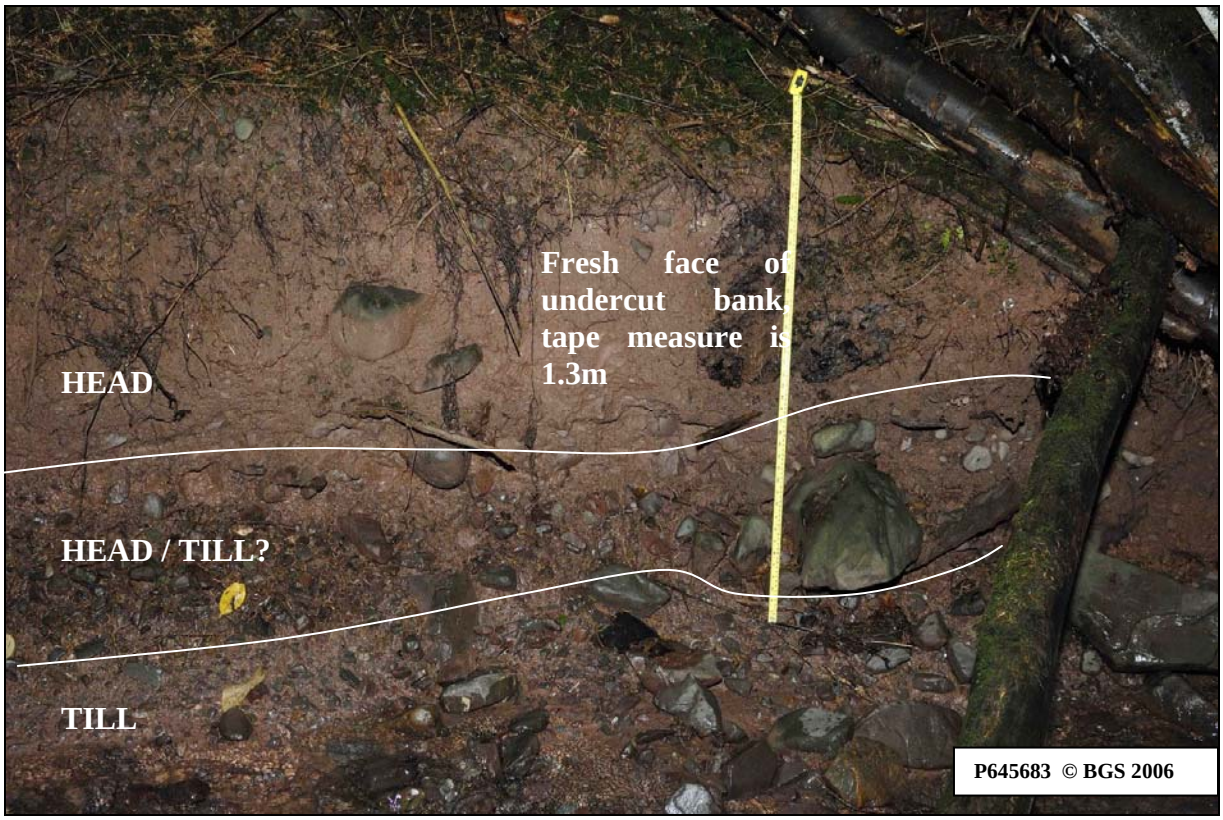
ii) Headscarp of failure, view NNW

iii) Failure scarp of landslide



iv) Fallen and felled trees obscure midsection and toe of landslide

v) Scroggs Cleuch looking SSE from landslide toe. Note undercutting of banks on both sides



vi) Freshly eroded face cut in bank; section as in Figure 5.

vii) Partially dewatered failed material at toe of landslide, incorporating vegetation

viii) Cross-section through toe of landslide, sediment surrounding possibly in situ tree.