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Metadata report for the York and Haxby Lithoframe 10-50 model

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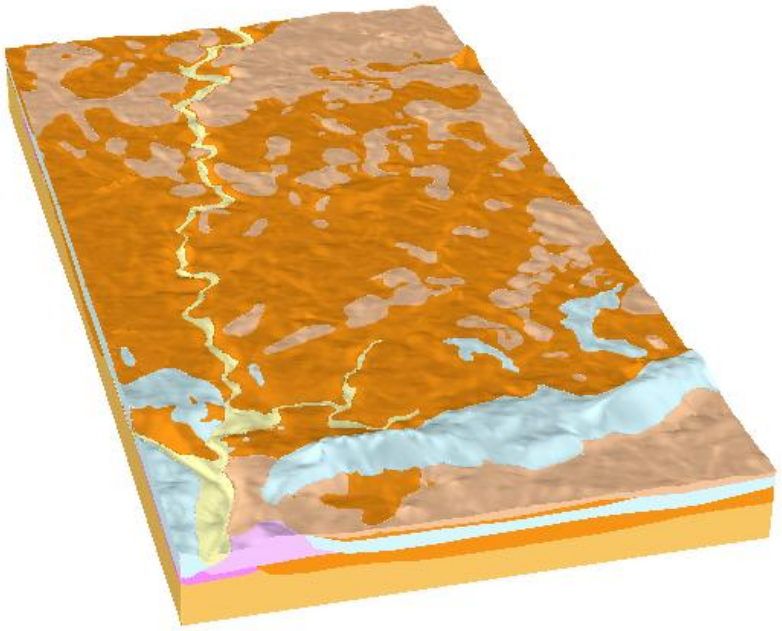
Open Report OR/13/018



BRITISH GEOLOGICAL SURVEY

GEOLOGY & Landscapes PROGRAMME

OPEN REPORT OR/13/018

Metadata report for the York and Haxby Lithoframe 10-50 model

H F Burke and S J Price

Keywords

3D model, York, Haxby, GSI3D, superficial deposits

National Grid Reference

SW corner 460000,450000
Centre point 462500,455000
NE corner 465000,460000

Front cover

3D geological model of York and Haxby, looking towards the north east.

Bibliographical reference

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Foreword

This report is one of the outputs from geological surveying and 3D geological modelling in the Vale of York, and includes a description of a 3D geological model of Quaternary deposits in the York and Haxby area.

Acknowledgements

The authors wish to thank the members of the Vale of York mapping team, who also contributed to this project:

Dr A H Cooper, J R Ford, M Hall and H Kessler

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Summary

This report describes the 1:10 000 scale superficial 3D geological model of York-Haxby, corresponding to 1:10 000 scale sheets SE65NW and SE65SW and within the 1:50 000 scale geological map sheets York (63) and Selby (71). The 3D model was constructed in tandem with a re-survey of the Selby and York geological map sheets. Where possible, geological linework and downhole hole geological data derived from the re-survey was used to constrain the model.

The 3D geological model comprises nine natural superficial deposits ranging in age from Late Devensian to Holocene, and covers an area of 50 km^2. Artificial deposits are not included in the model, although thick deposits of stratified archaeological deposits in addition to modern made ground are known in the area (Weston, 2010). A stratigraphical classification of superficial deposits has been applied according to the scheme proposed by Ford *et al* (2008) for the Selby district. Much of the area is underlain by rocks of the Sherwood Sandstone Group. Bedrock and structural elements, such as faults, have not been modelled in the York-Haxby area, except to represent the base of the 3D geological model to a depth of approximately 35 m below ground level.

The 3D geological model reveals for the first time the distribution, thickness and stratigraphical relationships of Quaternary deposits of the Late Devensian and Holocene. The model reveals that much of the York-Haxby area is underlain by sediments deposited during the advance, stagnation and decay of an ice-sheet flowing into the Vale of York (J Ford et al, 2008). It is thought that the ice-sheet advanced as far as Escrick [SE633 425], where its position is marked by the Escrick Moraine Member. The 3D geological model reveals that the till and related glacigenic deposits of the Vale of York Formation, related to ice advance and decay, overlie older glaciolacustrine sediments of the Hemingbrough Glaciolacustrine Formation. The position of the York Moraine Member may mark a relative stillstand or stagnation of the ice-sheet before it decayed, resulting in the deposition of younger glaciolacustrine sediments of the Alne Glaciolacustrine Formation, which overlies the Vale of York Formation till to the north of the City of York.

Following deglaciation and deposition of spreads of fluvial and aeolian sediments of the Breighton Sand Formation, river courses, including that of the Ouse, were cut into pre-existing glacigenic sediments. Their subsequent infilling is marked by deposits of alluvium belonging to the Ouse and Foss Valley Formations.

1 Modelled volume, purpose and scale

The York-Haxby model covers a 10 km x 5 km area, which includes part of the city of York in the south and Haxby in the north (red outline in Figure 1). This geological model includes superficial deposits and complements 1:10 000 scale geological map sheets SE65NW and SE65SW. The model is suitable for use at resolutions around 1:10 000, and is not recommended for site specific use.

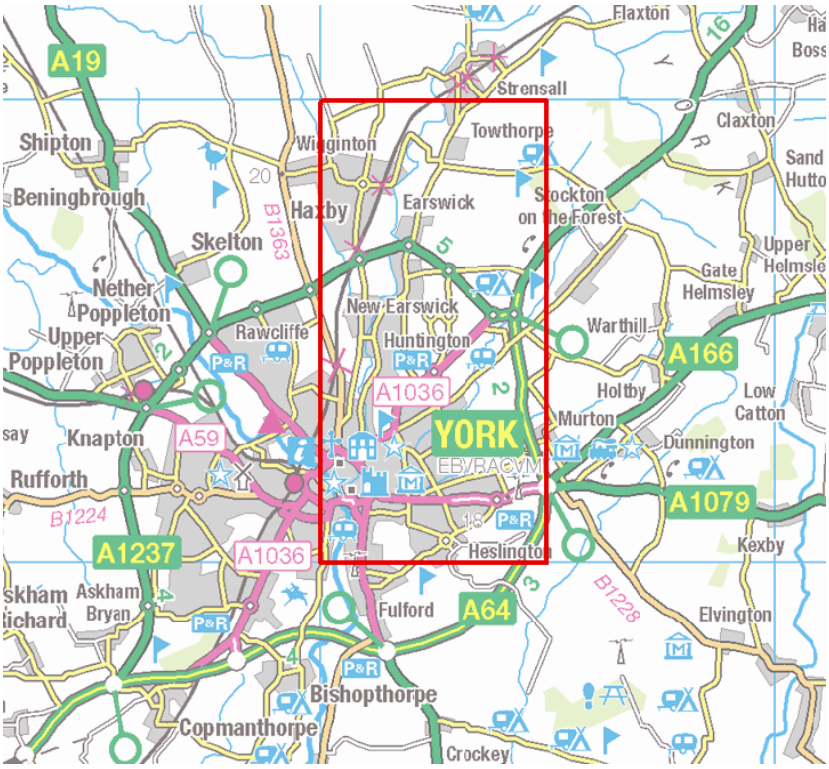


Figure 1 Location of York-Haxby 3D geological model, outlined in red.

The York-Haxby model was created to show the spatial distribution and thickness of natural Quaternary deposits. The geological model includes deposits interpreted to be of Late Devensian age, overlain by younger Holocene age deposits. The interpretation of the 3D geological model contributed to the understanding of the glacial evolution of the Vale of York. The model was constructed at the same time as a field reconnaissance based re-survey of the York 1:50 000 scale geological map sheet (63) at 1:10 000 scale. During this re-survey, the previously named '25 foot drift' was re-classified (Ford *et al*, 2008), enabling the glacial deposits to be separated out into their component lithostratigraphical parts and mapped accordingly. This new lithostratigraphical nomenclature was also used in the York-Haxby model.

The model is available for download for educational purposes via the BGS web site using the link: http://www.bgs.ac.uk/services/3Dgeology/modelInfo/york.html and is a component of the BGS National Geological Model.

2 Modelled surfaces/volumes

Nine Quaternary deposits have been modelled, listed in Table 1, with general descriptions of their compositions. The base of the model is defined by a surface representing the bedrock, included for visualisation purposes only.

Inferred age	BGS LEXICON code	Full name	Lithology
Holocene	fossv	Foss Valley Formation	Alluvial silt, clay and sand with peat, associated with the Fiver Fosse
	ousv	Ouse Valley Formation	Alluvial silt, clay and sand with peat, associated with the River Ouse
	brei	Breighton Sand Formation	Gravelly, silty sand with rare clay
Pleistocene	alne	Alne Glaciolacustrine Formation	Laminated clay and silt with minor sand
	elv	Elvington Glaciolacustrine Formation	Laminated clay and silt with minor sand
	vyork	Vale of York Till Formation	Bouldery, cobbly, gravelly sandy clay
	crhe	Crockey Hill Esker Member	Silty, gravelly sand
	hem	Hemingbrough Glaciolacustrine Formation	Laminated clay and silt with minor sand
	hem_l1	Hemingbrough Glaciolacustrine Formation	Sand lens within Hemingbrough Glaciolacustrine Formation
	gfdu	Glaciofluvial deposits (undifferentiated)	Glacial sand and gravel
Permian-Triassic	ssg	Sherwood Sandstone Group and Mercia Mudstone Group (undifferentiated)	Sandstone and mudstone. Represents base of 3D model for visualisation only.

Table 1 List of modelled units

3 Modelled faults

Two inferred, northeast-southwest trending normal faults are mapped to the south of York, which cut the bedrock across the modelled area, but are not included in the 3D geological model.

4 Model datasets

Derivation and processing of (including date and by whom):

- DTM – Bald Earth DTM, cell size 25m, downloaded in March 2013.
- Rockhead model – not used
- Borehole data – YORK_HAXBY_*BOGE.blg*, downloaded from BGS Borehole Geology database on 22nd February 2007. Priority given to Vale of York borehole coding (content

code DY) which coded superficial deposits and bedrock using the lithological coding scheme of Cooper *et al* (2006). The lithostratigraphical scheme proposed in Ford *et al*, 2008 was used where possible. 434 boreholes were used to construct the cross-sections.

- Geological Map data – unpublished 1:10 000 scale geological linework derived from 1:10 000 field slips, created during the York sheet re-survey, was used to define the distribution of natural superficial deposits that occur at ground surface.
- Interpreted data – downhole borehole geology derived from BGS Borehole Geology database.
- Additional data – downhole geological data recorded in 35 hand auger holes were used in construction of the model. Hand augers were dug to a depth of 1.2 m.

5 Dataset integration

Hand auger data gathered during the field re-survey of 1:10 000 scale map sheet SE65NW was incorporated into the borehole files used to build the model. With a maximum depth of 1.2 m, these auger holes often proved the base of the Breighton Sand Formation, and were particularly useful where gaps existed in the borehole data.

6 Model development log

The southern half of the model was constructed by S Price and the northern half by H Burke, using GSI3D software and following the standard GSI3D workflow. The model was constructed in a superseded version of GSI3D, and was stored in *gxml* format. The cross-sections and envelopes were later imported into GSI3D Version 2.6 and saved as a *gsipr* to enable compatibility with newer versions of GSI3D. In early 2013, the 2012 release of GSI3D was used to refine the model with extra helper sections and to generate a new capping surface using the Bald Earth DTM.

No formal development log of progress or metadata were kept during the model building process.

GVS - A simplified version of the regional Vale of York GVS (Ford *et al*, 2004) was used. This is named *YORK_HAXBY_V3.gvs*.

GLEG – As with the GVS, a regional Vale of York legend file was used in the model, named *YORK_HAXBY.gleg*.

GSIPR - The northern half of the model (1:10 000 map sheet SE65NW) was constructed first, in 2005. This was extended in 2007 to include the northern half (sheet SE65SW). The latest version of the model is named *York_Haxby_Combined_V1_69.gsipr*.

DTM – An extract of the Bald Earth digital terrain model, named *York_Haxby_BaldEarth_25*, was generated within the GSI3D workspace in early 2013. This has a 25 m cell size and forms the capping surface in the model. This is stored within the GSI3D project.

BID – The borehole index file, named *YORK_HAXBY_SOBI.bid*, was downloaded from the BGS corporate database in early 2007. The locations of auger holes were added manually and their grid references were derived from the scanned and geo-registered field slips for SE65NW. Auger holes were named with the format aug_XX_hbu_10_04.

BLG – Borehole logs used in the model are stored in the *YORK_HAXBY_BOGE.blg* file which was downloaded from the BGS corporate database in early 2007. Downhole auger data was added manually by reading depth values from the geological notes on SE65NW field slips.

7 Model workflow

A standard GSI3D workflow for 3D superficial geological models was followed (Kessler *et al*, 2004, 2007), beginning with the coding of boreholes into the BGS *Borehole Geology* database, using the Superficial Deposits Coding Scheme (Cooper *et al*, 2006). This scheme is based on assigning codes to six main lithologies representing clay, silt, sand, gravel, cobbles and boulders. Mixed lithologies are coded according to their relative proportions. For example, sandy clay is coded as 'CS' and gravelly sand clay becomes 'CVS'. Every useful borehole on the York 1:50 000 geological map sheet was coded to aid the positioning of geological lines during the re-survey of the map sheet. The content code 'DY' was used for all Vale of York lithological and lithostratigrphical coding, which was given priority where duplicate Borehole Geology entries occurred.

The next stage was to construct cross-sections and digitise geological correlation lines between boreholes corresponding to each lithostratigraphical unit. Care was taken to ensure that the cross-sections were evenly spaced, whilst using the best borehole data available. A network of roughly north-south and east-west oriented cross-sections was constructed, spaced up to 1km apart.

On completion of all cross-sections, 'envelopes', or coverages, were created to represent the surface and subsurface distribution of each geological unit in the model. Outcrops of units which occur at the surface, such as the Foss Valley Formation, were taken from unpublished 1:10 000 scale geological linework derived from fieldslips completed during fieldwork undertaken between 2006 and 2007. Envelopes defining the distribution of subcrops were defined using information from the cross-sections.

A series of helper sections were then added to aid the model calculation, which were required for linear units, such as the Foss Valley and Ouse Valley formations, and where small outliers of Breighton Sand Formation occurred between cross-sections. Docking sections were added at the boundaries of the model to provide a means of fitting to any new models in the area that are built. In total, 74 cross-sections were constructed.

The York-Haxby model was initially constructed prior to the finalisation of the new York sheet linework, and was later adjusted to fit these unpublished 1:10 000 scale geological lines. Minor amendments were made in the model where mismatches occurred between the boreholes and unpublished geological linework, but are considered too minor and too few to require revising the new geological lines.

8 Model assumptions, geological rules used etc

In the cross-section, boreholes were positioned according to their recorded start heights. Start heights were derived from the NextMap digital terrain model where a borehole had no start height recorded.

The Sutton Sand Formation and Naburn Sand Member have been included with the Breighton Sand Formation as it was difficult to distinguish between these separate deposits in boreholes.

The capping surface for the model is an extract from the corporate Bald Earth DTM. This is a NextMap DTM, replaced with extracts from an Ordnance Survey Landform Panorama DTM in wooded areas. This reflects the true ground surface, as NextMap is not corrected for tree cover.

Geological units which crop at the surface are snapped to the 25m cell size Bald Earth DTM.

A distinctive sand lens in the Hemingbrough Glaciolacustrine Formation was also modelled, proven up to approximately 4m thick in boreholes.

9 Model limitations

Rocks of the Sherwood Sandstone Group are mapped beneath all but the far northeast corner of the modelled area, where the Sherwood Sandstone Group is overlain by Mercia Mudstone Group. However, the Sherwood Sandstone Group and Mercia Mudstone Group have not been subdivided in the model. Two roughly parallel northeast-southwest trending normal geological faults are mapped across the modelled area to the south of York, but due to the Quaternary focus of the model, these were not included. The model has a nominal cut-off depth of -35 m OD.

Artificial ground is not included in the model. However, it is intended that information for artificial ground is enhanced through the inclusion of archaeological deposits thickness data. This approach was tested through the collaborative support of an MSc project with the University of York (Weston, 2010).

Lenses of sand and/or gravel have not been differentiated within glacial till deposits of the Vale of York Formation.

Confidence in the model decreases with depth from the surface because most of the boreholes terminate before they reach rockhead. Therefore, the basal sand and gravel unit may have a wider distribution pattern than shown in the model.

10 Model images

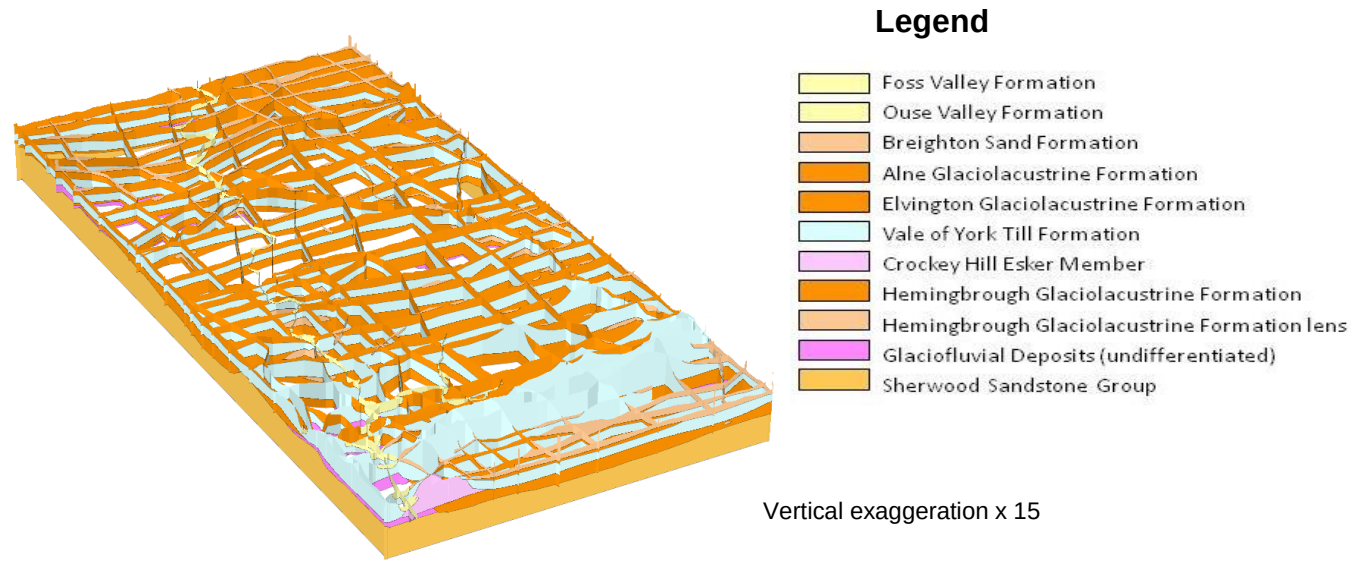


Figure 2 Correlated cross-sections in the York-Haxby 3D geological model, looking towards the northeast

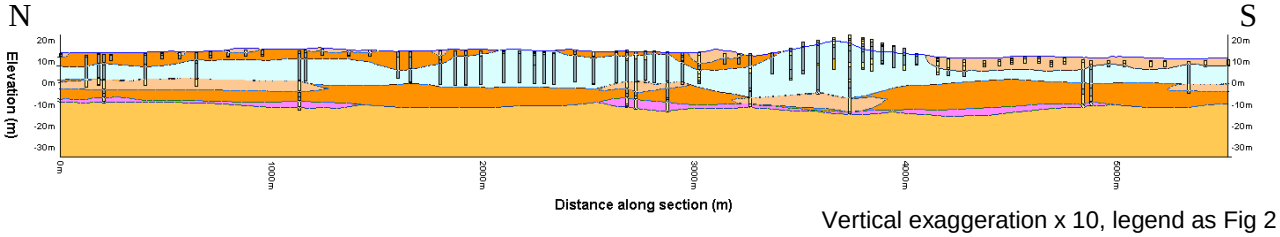
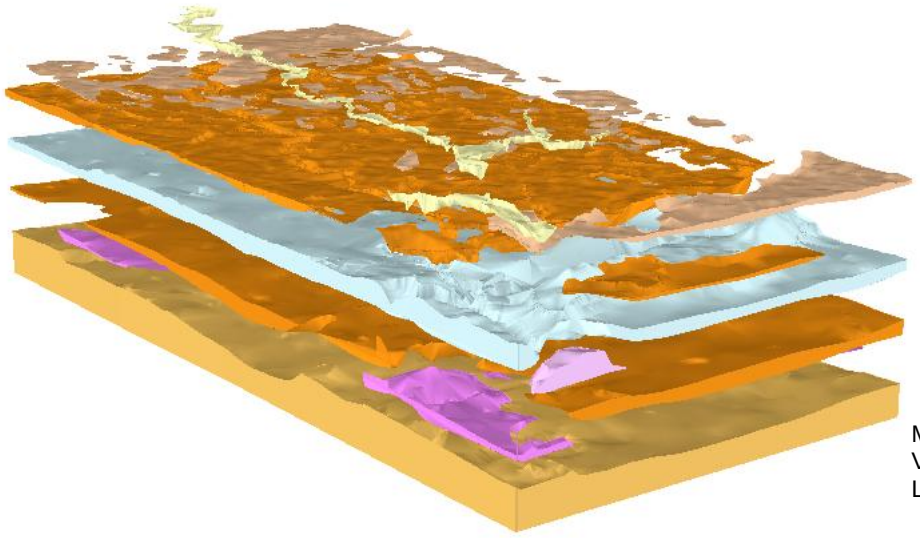


Figure 3 Example north-south cross-section (SE65SW_NS_1) in the York-Haxby 3D geological model



Model viewed from the south-west
Vertical exaggeration x15
Legend as Figure 2

Figure 4 Exploded view of the York-Haxby 3D geological model, looking to the northeast

11 Model uncertainty

Confidence in the model is directly related to the distribution of boreholes used in the cross-sections, the drilled depth of those boreholes, and the level of detail recorded in the corresponding logs. Where clusters of boreholes occurred, only the deepest or most detailed logs were selected. Figure 5 shows the distribution of cross-sections constructed and the location of boreholes used, along with all boreholes recorded in the SOBI database for the area. The borehole distribution map in Figure 5 clearly shows that the greatest confidence in the model is along the A64 trunk road, running north-south to the east of York, the A1237, which forms an arc to the north of York, and the city of York itself. Gaps in the borehole distribution indicate areas of lowest confidence.

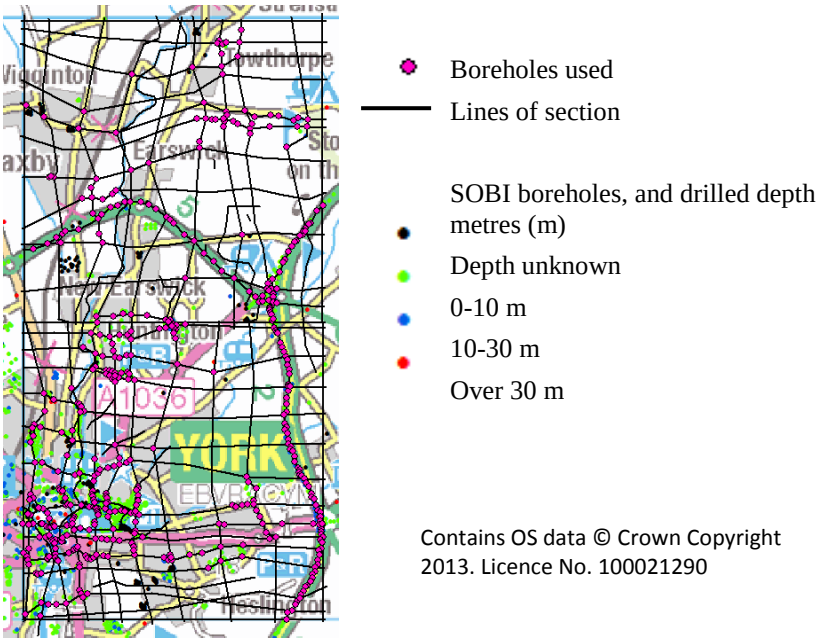


Figure 5 Distribution of cross-sections and boreholes used to construct the model

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British Geological Survey holds most of the references listed below, and copies may be obtained via the library service subject to copyright legislation (contact libuser@bgs.ac.uk for details). The library catalogue is available at: http://geolib.bgs.ac.uk.

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