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User Guide for the British Geological Survey Blockfields dataset

Open Report OR/19/061



BRITISH GEOLOGICAL SURVEY

OPEN REPORT OR/19/061

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Cairn Toul and Devils Point, Cairngorms. Looking south-west from southern slopes of Beinn Macduibh, blockfield in foreground - P522402.

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Maps and diagrams in this book use topography based on Ordnance Survey mapping.

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Summary

This report presents a description of the *Blockfields dataset* developed by the British Geological Survey (BGS). The dataset provides screening-level data that gives an indication of the geological suitability of the subsurface for the presence of blockfields. The dataset is designed to be used by those involved in the strategic assessment of the subsurface for the management or development of sites in Great Britain. It may be particularly valuable for spatial planners and local authorities who wish to undertake a strategic assessment.

The dataset is derived from a combination of BGS national datasets and the DTM of Great Britain at 5m resolution © Bluesky International Limited elevation data to show the environmental suitability for blockfield presence in Great Britain. The approach was developed by geologists using basic landscape characteristics from a large sample of observed blockfields, and implemented by specialists in geologically derived products at BGS. The purpose of this user guide is to enable those licensing this dataset to have a better appreciation of how this dataset has been created and therefore gain a better understanding of its potential applications and limitations.

Acknowledgements

A number of individuals in the BGS Properties and Resource Analysis Team, Geoanalytics & Modelling and the Engineering Geology & Infrastructure Programmes have contributed to the project and helped compile this report. This assistance has been received at all stages of the study. In addition to the collection and processing of data, many individuals have freely given their advice, and provided the local knowledge. In particular, we thank Jon Lee, Hannah Gow, Russell Lawley, Tim Kearsey, and Clive Cartwright. We are also grateful to Jon Lee, who internally reviewed the GB_Blockfields_v1 dataset and provided valuable feedback.

1 Introduction

Founded in 1835, the British Geological Survey (BGS) is the world's oldest national geological survey and the United Kingdom's premier centre for earth science information and expertise. The BGS provides expert services and impartial advice in all areas of geoscience. Our client base is drawn from the public and private sectors both in the UK and internationally.

Our innovative digital data products aim to help describe the ground surface and what's beneath across the whole of Great Britain. These digital products are based on the outputs of the BGS survey and research programmes and our substantial national data holdings. This data coupled with our in-house Geoscientific knowledge are combined to provide products relevant to a wide range of users in central and local government, insurance and housing industry, engineering and environmental business, and the British public.

The GB_Blockfields_v1 dataset is a Geographical Information Systems (GIS) digital feature layer that is based on a combination of topographical, geomorphological, and geological aspects of the landscape, and shows the relative suitability of geological conditions for blockfield development at or close to the ground surface across Great Britain. This dataset is the first stage of a model based on using common conditions required for the presence of blockfield sites; i.e. bedrock types, topographical conditions, and locations based on known geological histories.

Further information on all the digital data provided by the BGS can be found on our website at <http://www.bgs.ac.uk/products/home.html> or by contacting:

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2 About the Blockfields Dataset

2.1 BACKGROUND

The public need for a greater understanding of sub surface ground conditions continue to grow in light of increased pressure to improve infrastructure and reassess land planning and management appropriately to accommodate for the effects of a changing climate. Planners and developers are under pressure from central government to provide more reliable predictions of the environmental conditions expected along any route or area assessed for potential development. Information about the geological conditions below the surface is required, particularly the identification of areas with a potential for creating greater costs in development and time.

In response to this, The British Geological Survey initiated a programme to produce digital maps that identified and assessed the potential for non-uniform geological properties ('heterogeneities'), produced by Quaternary processes that can affect the surface and shallow subsurface (Lee et al., 2015). Areas where the bedrock has been weakened and disrupted by frost weathering to form *in situ* accumulations of loose blocks will require significant extra resource to manage. Bedrock that is disrupted in this way forms unpredictable ground conditions, which can provide challenges to the development and maintenance of infrastructure in upland landscapes. For the purpose of this dataset, these areas are called Blockfields.

2.2 BLOCKFIELDS

Blockfields are defined as an accumulation of blocks of rock, formed in upland areas by frost weathering; the mechanical disintegration of well lithified rock as the result of repeated freezing and thawing under periglacial conditions (Ballantyne and Harris, 1994). They generally comprise openwork accumulations, on level or gently sloping ground, of angular to subangular blocks of rock over solid or weathered bedrock. According to the BGS Rock Classification Scheme, fine grained detritus and soil are absent from blockfields (McMillan and Powell, 1999). However, Ballantyne (2010) suggests that blockfields may be openwork at surface or comprise a stony diamict of clasts embedded in a matrix of fines (with the component of fines increasing below the surface).

Blockfields in Britain are considered to be predominantly autochthonous, produced through *in-situ* weathering of bedrock with little or no subsequent horizontal movement (Ballantyne & Harris, 1994); therefore, they are generally representative of the underlying bedrock lithology. Blockfields are mostly associated with highly resistant lithologies such as quartzites and granites, which have low primary porosities and are considered non-frost susceptible (Boelhouwers, 2004). In these rocks pre-existing discontinuities (e.g. joints/bedding planes) form planes along which water can penetrate and initiate frost action. In several locations, the size of blocks has been linked to the spacing of discontinuities in underlying bedrock (Boelhouwers, 2004). However, when the spacing becomes too small, blockfield formation becomes less likely. For example, laminated rocks or rocks with a fissile slaty cleavage will be more likely to break down into finer-grained components and form regolith rather than an accumulation of blocks (McMillan and Powell, 1999).

Most blockfields described in the literature have formed on exposed upland plateaus (e.g. Rea et al. 1996; Ballantyne et al., 1998; Goodfellow et al., 2008; Ballantyne, 2010). In general, these areas were either: not glaciated during recent episodes of Quaternary glaciation (existing beyond or above ice sheet limits); or covered by cold-based ice that was largely frozen to the ground surface. In some cases wet-based, sliding ice may have covered blockfields; however, the erosive power must have been insufficient to remove the majority of blocks.

2.3 WHO MIGHT REQUIRE THIS DATA?

The presence of blockfields on a site chosen for development may, if unexpected, incur an added cost and a delay in construction. If the geological suitability for blockfield occurrence is evaluated prior to development, the potential loss in time and cost can be mitigated at the planning stage. The dataset may be beneficial for planning and managing infrastructure developments in upland landscapes.

2.4 WHAT THE DATASET SHOWS?

This dataset is a spatial representation of the suitability of geological conditions for development of blockfields at or close to the ground surface across Great Britain. It is based on a combination of topographical, geomorphological, and geological aspects of the landscape. Used as a proxy for blockfield presence, this dataset could potentially enable project planners, land managers and engineers to be more informed at the planning stage of land development. Blockfields are distinguished as an *in situ* accumulation of blocks of rock, formed in upland areas by frost weathering; the mechanical disintegration of well lithified rock as the result of repeated freezing and thawing under periglacial conditions.

The GB_Blockfields_v1 dataset shows the likelihood of blockfield presence in four class categories; from '1' = No blockfields, through to '4' = High environmental suitability for blockfields to occur. Each Class category is spatially distributed in 50x50 m grid cells.

3 Technical Information

3.1 SCALE

The GB_Blockfields_v1 dataset is produced for use at 1:50 000 scale providing 50 m ground resolution.

3.2 FIELD DESCRIPTIONS

The dataset attribute table (Table 1) shows a class grade (CLASS field) and its associated description (LEGEND field). A third field represents the version of dataset (VERSION).

Table 1. Attribute table field descriptions

CLASS	LEGEND	VERSION
1	No blockfields	GB_Blockfields_v1
2	Blockfields unlikely to occur	GB_Blockfields_v1
3	Moderate environmental suitability for blockfields to occur	GB_Blockfields_v1
4	High environmental suitability for blockfields to occur	GB_Blockfields_v1

The LEGEND descriptions grade the likelihood for blockfield presence from 'No blockfields' to 'High geological suitability for blockfields to occur'.

3.3 CREATION OF THE DATASET

The rules used to estimate the relative geological suitability for blockfield formation are summarised below:

- Is candidate bedrock lithology present.
- Is the slope appropriate.
- Is the location outside Loch Lomond Stadial (LLS) ice cap limit.
- Is the Topographic Position Index (TPI) positive.
- Is location in an appropriate Quaternary domain.
- Has blockfield already been mapped at the location.

The source datasets used for the process include:

- BGS Geology 50k v8
- DiGMapPlus Engineering Properties: Discontinuity V1
- DTM of Great Britain at 5m resolution © Bluesky International Limited., at cell size 50 x 50 m.

3.4 DATASET HISTORY

BGS is continually surveying and resurveying areas of Britain, improving and updating the geological database. These updates are made to BGS Geology 50k annually. As GB_Blockfields_v1 is based upon the most up to date information available, each new version of BGS Geology 50k prompts a new version of GB_Blockfields. BGS is committed to improving GB_Blockfields as more information becomes available. Additional enhancements are made to the datasets for each new version. Below is an outline of the data history of GB_Blockfields.

- **Version 1 (released 2020):** Derived from BGS Geology 50k version 8, and DiGMapPlus Engineering Properties: Discontinuity V1

3.5 COVERAGE

Data is provided to identify each level of likelihood for blockfields to occur in Great Britain. The Isle of Man is not covered by the digital terrain model that is used.

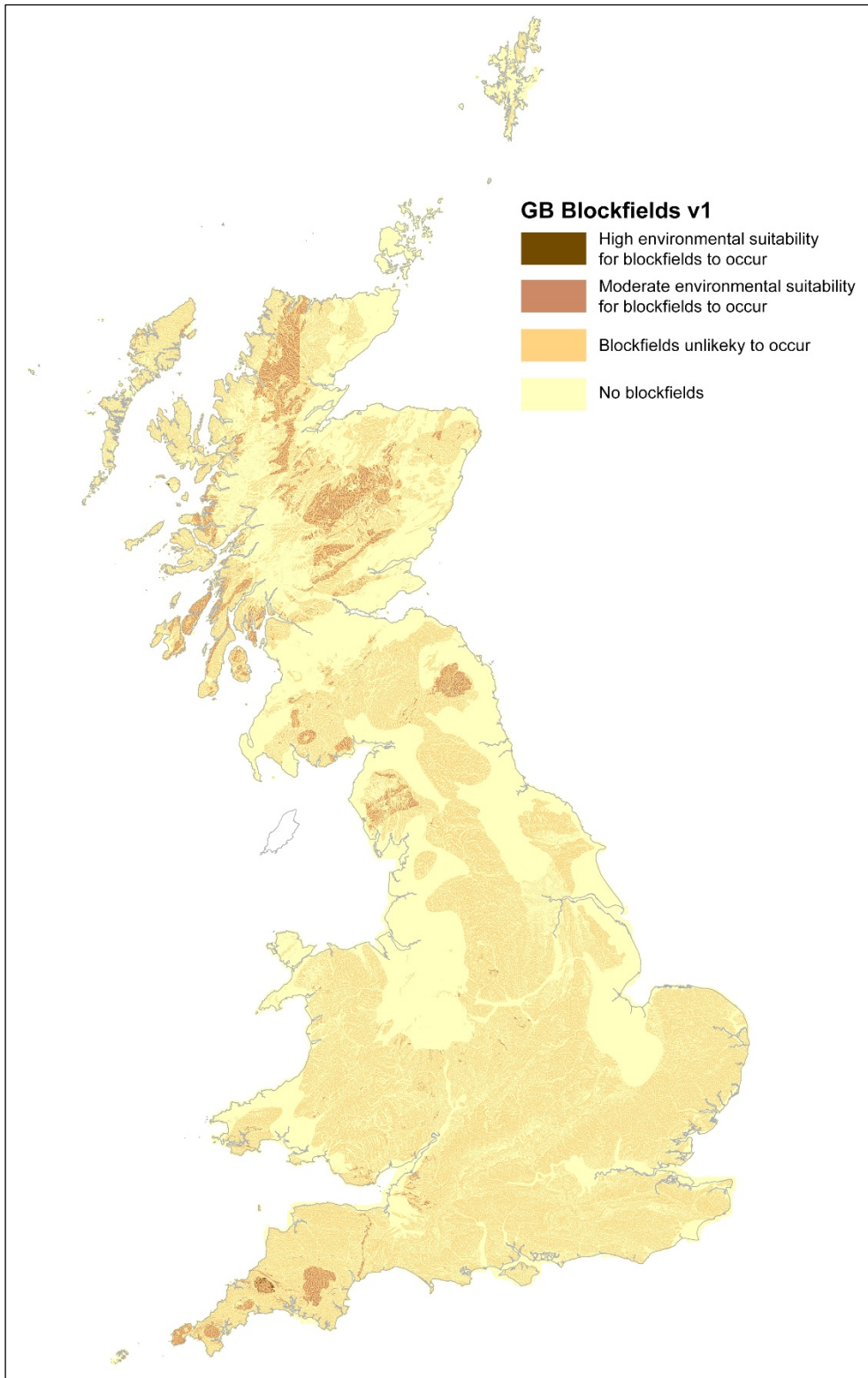


Figure 1. The coverage of the GB Blockfields v1 dataset

3.6 DATA FORMAT

The GB_Blockfields_v1 dataset has been created as vector polygons and are available in a range of GIS formats, including ArcGIS (.shp), ArcInfo Coverages and MapInfo (.tab) on request. More specialised formats may be available but may incur additional processing costs.

3.7 LIMITATIONS

- GB_Blockfields has been developed at 1:50 000 scale and must not be used at larger scales. All spatial searches against the data should therefore be conducted using a minimum 50 m buffer.
- GB_Blockfields is based on, and limited to, an interpretation of the records in the possession of The British Geological Survey at the time the data set was created.
- The classification of all offshore data is based on the presence of the original Digital Terrain Model (DTM) used to create the blockfields dataset. All offshore zones (DTM data is present or not) will be considered to be Class = 'No blockfields'.

4 Licensing Information

The British Geological Survey does not sell its digital mapping data to external parties. Instead, BGS grants external parties a licence to use this data, subject to certain standard terms and conditions. In general, a licence fee will be payable based on the type of data, the number of users, and the duration (years) of a licence.

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When the BGS digital datasets are revised any upgrades will be automatically supplied to the licensee, at no additional cost. Geological map datasets are revised on a periodic rather than on an annual basis, licensees will therefore not automatically receive a new dataset each year unless changes have been made to the data.

These are general comments for guidance only. A licensee of BGS's digital data is provided with full details of the basis on which individual BGS datasets licensed to them are supplied.

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Glossary

Autochthonous (of a deposit or formation) formed in its present position.

Microgelivation micro scale fracturing of rock by the expansionary pressure associated with the freezing of water in planes of weakness or in pore spaces.

BGS Geology 50k the primary geological dataset produced by the BGS previously known as DiGMapGB-50.

References

The 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: <https://envirolib.apps.nerc.ac.uk/olibcgi>.

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