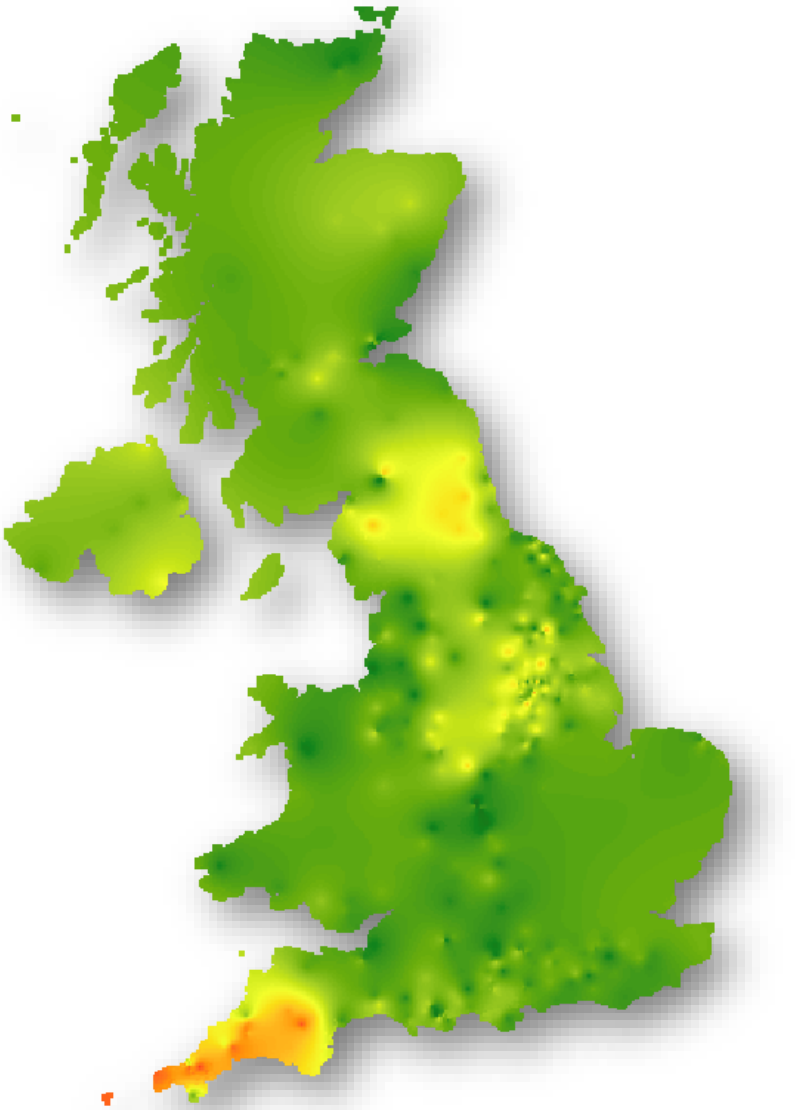

BGS INFORMATICS, DECARBONISATION AND RESOURCE MANAGEMENT

# User Guide: BGS Heat Flow V1 (United Kingdom)

Open report OR/25/013

British Geological Survey

BRITISH GEOLOGICAL SURVEY

INFORMATICS & DECARBONISATION AND RESOURCE MANAGEMENT

OPEN REPORT OR/25/013

# User Guide: BGS Heat Flow V1 (United Kingdom)



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Keyworth, Nottingham British Geological Survey 2025

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*British Geological Survey offices*

**Nicker Hill, Keyworth,**
**Nottingham NG12 5GG**

Tel 0115 936 3100

**BGS Central Enquiries Desk**

Tel 0115 936 3143
email enquiries@bgs.ac.uk

**BGS Sales**

Tel 0115 936 3241
email sales@bgs.ac.uk

**The Lyell Centre, Research Avenue South, Edinburgh EH14 4AP**

Tel 0131 667 1000
email scotsales@bgs.ac.uk

**Natural History Museum, Cromwell Road, London SW7 5BD**

Tel 020 7589 4090
Tel 020 7942 5344/45
email bgslondon@bgs.ac.uk

**Cardiff University, Main Building, Park Place, Cardiff CF10 3AT**

Tel 029 2167 4280

**Maclean Building, Crowmarsh Gifford, Wallingford OX10 8BB**

Tel 01491 838800

**Geological Survey of Northern Ireland, Department of Enterprise, Trade & Investment, Dundonald House, Upper Newtownards Road, Ballymiscaw, Belfast, BT4 3SB**

Tel 01232 666595
www.bgs.ac.uk/gsni/

**Natural Environment Research Council, Polaris House,**
**North Star Avenue, Swindon SN2 1EU**

Tel 01793 411500 Fax 01793 411501
www.nerc.ac.uk

**UK Research and Innovation, Polaris House, Swindon SN2 1FL**

Tel 01793 444000
www.ukri.org

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# Foreword

The British Geological Survey (BGS) is a world-leading geological survey, focusing on public-good science for Government and research to understand earth and environmental processes.

We are the UK's premier provider of objective and authoritative geoscientific data, information and knowledge to help society to:

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- be resilient to environmental hazards

We provide expert services and impartial advice in all areas of geoscience. As a public sector organisation, we are responsible for advising the UK Government on all aspects of geoscience as well as providing impartial geological advice to industry, academia and the public. Our client base is drawn from the public and private sectors both in the UK and internationally.

The BGS is a component body of the Natural Environment Research Council (NERC), part of UK Research and Innovation (UKRI).

### DATA PRODUCTS

BGS produces a wide range of data products that align to Government policy and stakeholder needs. These include baseline geological data, engineering properties and geohazards datasets. These products are developed using in-house scientific and digital expertise and are based on the outputs of our research programmes and substantial national data holdings.

Our products are supported by stakeholder focus groups, identification of gaps in current knowledge and policy assessments. They help to improve understanding and communication of the impact of geo-environmental properties and hazards in Great Britain, thereby improving society's resilience and enabling people, businesses, and the government to make better-informed decisions.

# Acknowledgments

This report is the published product of a study by the British Geological Survey (BGS) to create a digital dataset suitable for describing near surface heat flow for the United Kingdom. The methods used to derive the data were determined by a team of specialists with a broad range of expertise, including geophysics, geothermal, statistical modelling and spatial analytics. A large number of individuals within BGS have contributed to the dataset over several decades, notably staff who delivered the 1970-1980s geothermal programme and most recently K Rollin and J Busby. This user guide was written by R Lawley with editorial input from A Monaghan and D Boon.

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# Summary

The British Geological Survey (BGS) heat flow model version 1 (United Kingdom) is derived from a catalogue of legacy heat flow data points and ground-heat modelling. The model portrays heat flow as a continuous modelled surface, interpolated between observation and estimation points. Heat flow data is typically used to determine temperatures beneath the ground surface, and model how much thermal energy may be recovered from or stored within. The dataset is presented in three forms:

1) as a raster model covering the extent of the United Kingdom (UK), each cell of the raster model defined by a square polygon of area 4km$^2$ (2km per side) attributed with heat flow as milli-Watts per square metre (mWm$^{-2}$)
2) as a cellular, vector grid. Each raster cell/ record in the model is defined by a square polygon of area 4km$^2$ (2km per side) describing heat flow as milli-Watts per square metre (mWm$^{-2}$). This model directly vectorises the raster model.
3) as an alternative cellular vector grid: BGS Heat Flow V1_ Hex (United Kingdom), represented by hexagonal polygons of area 2.6 km$^2$ (1 Km side length) describing summarised (minimum, maximum and average) heat flow per cell as milli-Watts per square metre (mWm$^{-2}$). This model spatially resamples the raster data.

The v1 release is based on legacy data and models last summarised in Busby et al. (2009). It does not incorporate the approximation of a regional paleoclimate correction presented in Busby and Terrington (2017). Users should note the limitation that the heat flow values presented in this model are underestimated, which would result in underestimation of geothermal resources at depth.

This user guide provides the information required to enable the reader to understand and use this BGS product.

# 1 Introduction

Since June 2019, the UK Government has committed to reducing the UK's net greenhouse gas emissions by at least 100% by 2050 compared with 1990 levels (BEIS,2021). This strategy coupled with the Energy Security bill (2021 and 2023) has encouraged the use of heat pumps for domestic and commercial heating/cooling of buildings. Ground Source Heat Pumps (GSHP), have been an established technology for many years, but until recently, have not been widely used in Great Britain. GSHP systems extract heat from the subsurface either via groundwater pumped from boreholes ("open loop"), or from the ground itself (closed loop) where the exchangers are installed into boreholes. Typically, GSHPs extract heat from between 10 m to 400m below ground level.

Deeper geothermal boreholes from which heat can be used directly, or from which power (electricity) can be generated are also of increasing interest for decarbonisation and decentralisation of energy supply.

Key to installing an efficient GSHP or deeper geothermal infrastructure is an understanding of natural heat flow in the subsurface; this dataset describes a model of heat flow for the United Kingdom. As more GSHP and deeper geothermal systems are installed over the next decade and more data become available, this model will improve in terms of resolution and precision.

The geothermal potential of the UK was investigated by a programme funded by the UK government and the European Commission that ran from 1977-1994. It comprised three elements: an appraisal of heat flow, an investigation of the potential of hot brines in deep sedimentary aquifers that might be suitable for electricity generation or direct use applications, and an investigation of petro-thermal granites that might be exploited as Hot Dry Rock (HDR) reservoirs. The results have been summarized in Burley et al (1984), Downing and Gray (1986), Rollin (1987), BGS (1988), Parker (1989, 1999) and Barker et al. (2000).

The version of the heat flow model presented here was created from a revised collection of borehole data in 2009 (Busby et al, 2009, also included in Busby et al., 2011, Busby 2014). This version does not include the first approximation of a regional paleoclimate correction in Busby & Terrington (2017). Users requiring the more recent research should contact BGS enquiries.

There is a fairly uniform background field of around 52 mW $m^{-2}$ (Busby et al. 2009). Areas of increased heat flow are associated with the radiogenic granites in southwestern England (mean value of 117 mW $m^{-2}$) and the buried granites of northern England. Values are also above the regional background over the batholith in the Eastern Highlands of Scotland. The average UK geothermal gradient is 26 °C $km^{-1}$, but locally it can exceed 35 °C $km^{-1}$ (Busby et al. 2009.

## 1.1 WHAT THE DATA SHOW

This dataset shows heat flow model relating to geological conditions beneath our feet. The information can be used to assess the potential for closed and open loop ground source heat pumps across, or deeper geothermal assessments, across the United Kingdom. The attribution and spatial data underpinning the model are that which is described and shown by Busby et al (2009, 2011, 2014). Users should note that these publications contain a simplified contour map image of the heat flow model described here.

The information is presented as either:

- a raster model (continuous surface),
- a vector-based, square, cellular grid (side length 2km, area c.4 $Km^2$), or
- a vector-based, hexagonal, cellular grid (side length 1km, area c.2.6 $Km^2$)

Each raster/vector cell is attributed with a modelled estimate of heat flow in $mWm^{-2}$.

Coverage in this dataset is for the United Kingdom (see Figure 1). The underpinning heat flow data (as points) is also available separately from the v1 digital release of the legacy geothermal catalogue (BGS, 2024).

Figure 1 Coverage of the Heat Flow V1 (United Kingdom) model. Coastline: Contains OS data © Crown copyright and database right 2024

## 1.2 WHO MIGHT REQUIRE THE DATA

The data will be of use to organisations in the public and private sectors who need to understand the potential to deploy ground source heat pumps or deeper geothermal for heating/cooling. The dataset is for specialist use (i.e. GSHP engineers, installers, geothermal experts, researchers and heat management specialists). Users requiring a more simplified assessment of the potential for GSHP and other forms of geothermal energy can access summary information from the BGS website.

The BGS carries out updates and amendments to the underlying databases as part of its national remit to acquire, model and publish relevant geological information for public good. This model is the first published release and is based on the 2011 model described by Busby et al (2011).

# 2 Case study: Determining locations suitable for Ground Source Heat Pumps

In this case study we review the use of the heat flow model within a portfolio of data and online tools to assess suitability of closed loop GSHP to meet a net zero strategy for heating and cooling of a public sector property portfolio.

## 2.1 THE PROBLEM

Heat decarbonisation of public assets is one of the greatest challenges the public sector faces. Typically, asset managers are trying to compare alternative heat resourcing from a range of net zero options and deployment of GSHP is commonly seen as 'challenging' because of the complexity and paucity of data available in the early stages of any strategic review. Asset managers need to be able to quickly understand whether GSHP is worth a 'closer look', and how well it may compare with alternative options.

## 2.2 THE CHALLENGE

The perceived disadvantage of deploying GSHP during initial considerations for net zero, is often due a lack of prior knowledge about the technology, false assumptions about installation and running costs (and the costs of the alternatives), and significantly, the uncertainty of ground conditions at locations across Great Britain (and their role in recovering ground heat). Resolving the 'initial hurdles' of information for GSHP is critical to getting this technology more widely considered at an early stage in Net Zero projects. What is needed is a simple way to assess the fundamental metrics that influence ground heat: heat flow, thermal properties of the ground, accessibility to the heat resource (via drilling), and an estimation of the costs of a 'collector array' of sufficient size, within the available footprint of the project.

## 2.3 THE SOLUTION

The heat flow model is suitable for professionals making an initial feasibility assessment for GSHPs. It is a simple map coverage that highlights the modelled flow of subsurface heat; GSHP designers and installers need to consider heat flow (along with other metrics) in order to estimate power (in the form of heat), that can be collected via boreholes. It is designed to be used alongside of range of other national data relating to GSHP.
The dataset described here has been integrated into a screening toolkit on behalf of NHS (England) by the Energy Systems Catapult, the toolkit enables NHS asset teams to rapidly assess the potential for using GSHP at their sites.

# 3 Methodology

## 3.1 OVERVIEW

The Heat Flow V1 (United Kingdom) model is derived from a dataset of 212 heat flow measurements augmented by 504 heat flow estimates previously published in a series of reports and papers: Lee et al., 1987; Downing and Gray, 1986; Rollin, 1987; Rollin et al., 1995; Barker et al., 2000, Busby et al, 2009, 2011, Busby 2014).

Temperature measurements were originally published in the UK geothermal catalogue (Rollin, 1987). This contains 3057 subsurface temperatures from 1216 sites, 567 of which are from wells with depths greater than 1 km. The catalogue also contains 4694 thermal conductivity measurements of core samples and formation chippings from 113 sites.

The heat flow model was originally created using a range of surface modelling software available between 1987 and 2011. Typically, many early software packages did not utilise projected coordinate systems (e.g. interpolations were made in a non-earth projection). The original versions of the current model were converted from proprietary formats sometime in the early 1990's and compiled as an ESRI GRD format with a British National Grid projection, around 2001.

The model has been converted to other raster and vector formats (using ESRI ARCGIS) and is typically supplied as a GeoTiff. The grid/raster is based on a 2 km x/y dimension (using a British National Grid projection).

The grid/raster has been converted to vector cellular grids using the tessellation toolkit available in ESRI's ArcPro3.2 GIS. The vector layers are supplied as either:

- a 2 km by 2 km square cell tessellation (to mimic the content of the original grid/raster model.
- a 1 km sided hexagon cell tessellation (area 2.56 $km^2$), designed to provide a resampled version of the original model

The vector tessellations do not add any new input data to the model, and both vector grids rely entirely on the original interpolation for their results. The square tessellation is a simple vectorisation of the raster model. The marginally smaller hexagon based cellular grid offers slightly better resolution of areas where there are rapidly changing values of heat flow between neighbouring cells, it is a spatially resampled version of the raster model.

## 3.2 SOURCE DATASETS

The Heat Flow V1 (United Kingdom) model is based on a compilation of published research reports and papers (see above), and data derived from the 4th edition of the Geothermal Catalogue (Rollin 1987). The first digital release of this legacy information has been published, see BGS (2024), and can be downloaded from the BGS website. However, some legacy data points did not have permissions to be included; this is not the complete heat flow dataset underpinning the heat flow model.

# 4 Technical Information

This section provides more detailed information on the Data Product, its content, and advice on best use as well as highlighting some important considerations.

## 4.1 SCALE

The data are provided as a raster (interpolated grid), or as a tessellated vector grid of polygons. The 2km by 2km raster/vector polygons cover 4km$^2$ with a side length of 2Km. The tessellated hexagon-based dataset has a surface area of 2.56km$^2$ (each side of the hexagon is 1km in length).

The smallest resolution offered by the hex cell layer is 2.56 km$^2$, but this layer is a direct resampling of the original 4km$^2$ dataset (see also section 3 Methodology).

## 4.2 COVERAGE

The dataset covers the United Kingdom (that is, England, Scotland, Wales and Northern Ireland). Coverage for the dataset is shown in Figure 1.

## 4.3 ATTRIBUTE DESCRIPTION

The raster data set is supplied as a standard GeoTiff and as such, the heat flow value is presented in most GIS platforms as a numerical float 'value'.

The vector polygon attribution is described in Table 1 below.

**Table 1** Attributes of the Heat Flow V1 dataset.

| Field name | Description |
|---|---|
| GRID_ID or UUID* | Grid Identifier (Square Cell vector) or Unique ID (Hexagonal cell vector) Alpha numerical identifier for the vector polygon. E.g. AC-888 |
| HF ** | Heat Flow. A numerical value from 36 to 136 (a null value/-9999 denotes no data). Units are milliWatts per square metre (mW m$^{-2}$) |
| HF_min † | Heat Flow. The minimum value from the original Heat Flow dataset for this cell. Values range from 36 to 136 (a null value/-9999 denotes no data). Units are milliWatts per square metre (mW m$^{-2}$) |
| HF_max † | Heat Flow. The maximum value from the original Heat Flow dataset for this cell. Values range from 36 to 136 (a null value/-9999 denotes no data). Units are milliWatts per square metre (mW m$^{-2}$) |
| HF_mean † | Heat Flow. The mean value from the original Heat Flow dataset for this cell. Values range from 36 to 136 (a null value/-9999 denotes no data). Units are milliWatts per square metre (mW m$^{-2}$) |
| VERSION | Version of the model, e.g. HEAT_FLOW_VERSION1_UK' |
| * | The GRID_ID identifies the square cell unique reference and UUID identifies the Hexagon cell unique reference |
| ** | This field is only available in the 2km by 2km square cell vector layer |
| † | This field is only available in the 1km Hex cell vector layer |
| | Nb – the geotiff (raster) dataset will only show a heat flow value (HF) |

### 4.4 DATA FORMAT

The Heat Flow Version 1 (United Kingdom) model is available as a raster in GeoTiff format, and also as a vector cellular grid in (ESRI) Shapefile and Geopackage formats are available.

### 4.5 DATASET HISTORY

This is the first published version of Heat Flow Version 1 (United Kingdom) model.

### 4.6 DISPLAYING THE DATA

The data is numerical, based on an interpolated range from 36 to 136 mW $m^{-2}$. It does not need any specific parameters for map display. Users wishing to show the estimated heat flow as a colour map can utilise **any** graduated colour scheme (within their GIS software) that spans the full range of the data provided.

Users should note that the data was originally created using legacy modelling software between 1987 and 2011. Early modelling software typically utilised non-earth coordinate systems (i.e. unprojected), and the UK model was processed to use British National Grid Projection sometime in the early 1990's (having previously been made without any underpinning coordinate reference system).

# 5 Licencing the data

### 5.1 BGS LICENCE TERMS

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. If you have any doubts about whether your proposed use of the BGS data will be covered by a BGS digital licence, the BGS Intellectual Property Rights (IPR) section will be happy to discuss this with you and can be contacted through the following email address: iprdigital@bgs.ac.uk BGS IPR will usually be able to provide reassurance that the licence will cover individual user requirements and/or to include additional 'special conditions' in the licence documentation, addressing specific requirements within BGS's permitted usage.

### 5.2 DATA AVAILABILITY VIA A WEB MAP SERVICE

To encourage the use and re-use of this data we have made it available under the Open Government Licence www.nationalarchives.gov.uk/doc/open-government-licence/version/3/, via a web map service and subject to the following acknowledgement accompanying the reproduced BGS materials: "Contains British Geological Survey materials © UKRI [year]".

This dataset falls under BGS' OpenGeoscience portfolio of datasets and services. OpenGeoscience provides a wide range of freely available geoscience information allowing users to view maps, download data, access web services and browse our archive of photos, maps and memoirs. The services available under OpenGeoscience include:

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Please refer to OpenGeoscience, see www.bgs.ac.uk/Opengeoscience for more information and a full listing of datasets and services available under this service.

### 5.3 DATA ACKNOWLEDGMENTS

Please use the following acknowledgements when ***using*** the Heat Flow Version 1 (United Kingdom) dataset:

**Heat Flow Version 1 (United Kingdom), licenced data**: 'Derived from BGS Digital Data under Licence (*cite your licence number here*) British Geological Survey © UKRI. All rights reserved.'

The data product and user guidance may be cited in publications as follows:

British Geological Survey (2024): Heat Flow Version 1 (United Kingdom). British Geological Survey. (Dataset).

## 5.4 CONTACT INFORMATION

For all data and licensing enquiries please contact:
BGS Data Services
**British Geological Survey**
Environmental Science Centre
Keyworth
Nottingham
NG12 5GG
Direct Tel: +44(0)115 936 3143
Email: digitaldata@bgs.ac.uk

# 6 Limitations

## 6.1 DATA CONTENT

The Heat Flow V1 (United Kingdom) model is a compilation of observed and modelled data derived from previously published and unpublished maps and archive information. The models are based upon the interpolation of evidence available at the time.

Users should note that publications with a heat flow map image of the UK or GB (Busby et al. 2009, 2011, Busby 2014) this is a simplified contour map of the heat flow model described here.

The heat flow model does not include the first approximation of a regional paleoclimate correction as outlined in Busby & Terrington (2017) and references therein. This limitation means that the heat flow values presented in this model are underestimated, which would result in underestimation of geothermal resources at depth.

## 6.2 SCALE

The data are provided as a raster (interpolated grid), or as a tessellated vector grid of polygons.

The 2km by 2km raster/vector polygons cover 4km$^2$ with a side length of 2Km.

The tessellated hexagon-based dataset has a surface area of 2.56km$^2$ (each side of the hexagon is 1km in length).

The smallest resolution offered by the hex-cell layer is 2.56 km$^2$, but this layer is a direct resampling of the original 4km$^2$ dataset (see also section 3 Methodology).

## 6.3 ACCURACY AND UNCERTAINTY

Users of this data should be aware that this is an interpolated model of heat flow across the United Kingdom. The results of the model should be considered as indicative. The interpolated data is presented as raster or vector data with a 2km-by-2km cell footprint. The model is derived from 212 ‘observed’ heat flow calculated data points and a further 554 ‘estimated’ heat flow calculated data points, with uneven spatial distribution. The age of this dataset and its original derivation from legacy records, predates the use of modern geostatistical methods at BGS, and so no uncertainty modelling (of the inputs) is available.

Back interpolation of the input data against the modelled surface (to compare input values with interpolated outputs) indicates that all but 16 ‘observed’ heat flow data points are completely honoured by the model. Of those 16 inputs, 9 locations are affected by being close proximity to other data points (i.e. they are sited within the spatial resolution of a single raster cell), a further 6 records are modelled to within 5% of the input value. Of the estimated data points, 194 samples are affected by being in close proximity to other input values location and further 323 are modelled to within 5% of the input value. It is not uncommon for areas of higher data density to exhibit greater differences between the input/output values (as a result of interpolating to ‘mean values’ for collocated inputs). Areas of low-density input data are more likely to be honoured by the interpolation methods available at the time.

Users should note that the data was originally created using legacy modelling software between 1987 and 2011. Early modelling software typically utilised non-earth coordinate systems (i.e. unprojected coordinate outputs). The UK Heat Flow model was converted to a British National Grid Projection sometime in the early 1990’s. Borehole location information used for the input data will have utilised a combination of British National Grid and Latitude/Longitude coordinates (each derived from a range of methods in use up to that period of time). It is not known whether deeper records have been corrected for borehole deviation (i.e. borehole coordinates are assumed to be fixed to the surface location of the borehole). We do not hold information for any records that may have utilised early GPS coordinates (derived prior to location corrections /improvements).

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Future releases of this dataset will include additional data points, documented interpolation methods, new metrics for uncertainty and will incorporate alternative coordinate reference systems.

### 6.4 ARTEFACTS

The heat flow information been interpolated from data of differing ages, locations, lithologies and methods. As a synthesis of data, interpolated over an area as large as The United Kingdon there may be data artefacts created by the combination of input data, the interpolation method used and the limitation of the sample size, compared with the natural variance of heat flow across our environment.

The 1km Hexagon tessellation vector layer has been directly resampled from the original 2km by 2km model. The values of minimum, maximum and mean heat flow have been derived computationally from the original interpolated surface as a means to improve visualisation of the information in areas of higher data density (no additional data has been used in the creation of the hex-cell grid, and no new interpolation method has been used).

The observational methods and modelling processes are largely computationally derived, but users should understand that this is a model of heat flow and not a specific representation of observations.

The original heat flow model lacks data for the Orkney and Shetland Islands. These islands are represented by a single observed heat flow measurement of 46 $mWm^{-2}$. The original gridding software used to create the raster model did not extrapolate northwards to Shetland, and so the raster/grid/geotiff lacks any data for Orkney and Shetland. The vector model has been populated with a nominal heat flow of 46 $mWm^{-2}$.

### 6.5 DISCLAIMER

The use of any information provided by the British Geological Survey (‘BGS’) is at your own risk. Neither BGS nor the Natural Environment Research Council (NERC) or UK Research and Innovation (UKRI) gives any warranty, condition, or representation as to the quality, accuracy or completeness of the information or its suitability for any use or purpose. All implied conditions relating to the quality or suitability of the information, and all liabilities arising from the supply of the information (including any liability arising in negligence) are excluded to the fullest extent permitted by law. No advice or information given by BGS, NERC, UKRI or their respective employees or authorised agents shall create a warranty, condition or representation as to the quality, accuracy or completeness of the information or its suitability for any use or purpose.

# 7 Frequently asked questions

The questions and answers below have been provided to address potential issues relating to how the product can be used or how it can be interpreted. If you have any additional questions, please contact digitaldata@bgs.ac.uk

**Q:** What does this dataset show?
**A:** This dataset portrays an interpolated model of summary data which outlines the heat flow through the subsurface for the United Kingdom.

**Q:** What scale are these data provided at?
**A:** Data are provided as raster (normally a GeoTiff) or vector cells 4km$^2$ area, and side length of 2km.

**Q:** How accurate is this dataset?
**A:** The database is based on 212 'observed' heat flow calculations and a further 504 'estimated' of heat flow calculations derived from previously published research. This is a relatively sparse dataset for national coverage, but new data is being acquired by BGS as part of our ongoing research into geothermal energy.

**Q:** How often will this dataset be updated?
**A:** The background database is amended and updated over time. It is intended that the heat flow model will be updated and republished on an episodic basis (typically 2-4 years).

**Q:** In what formats can the dataset be provided?
**A:** The dataset can be provided as a GeoTiff, ASCII grid, or as a coverage of vector polygons. BGS normally supplies data in ESRI *SHP format but can also supply QGis Geopackages and MapInfo TAB format.

**Q:** Can I access the underlying data?
**A:** The underlying heat flow data can be reviewed in the Geothermal Catalogue here: https://www2.bgs.ac.uk/nationalgeosciencedatacentre/citedData/catalogue/05569ed5-db0e-4587-807c-58e39ee240fa.html?_ga=2.120694285.444736648.1725035139-1121370896.1725035139. Further information can also be acquired from within the cited references given in this user guide. This model (and the underpinning data) are scheduled for improvement over the next few years as more GSHP systems are deployed in the wider effort to meet net-zero targets for renewable sources of energy.

**Q:** Can I use this dataset as part of a commercial application?
**A:** Please refer to the licencing terms supplied alongside the dataset. For further queries regarding the licensing terms of our products, please contact digitaldata@bgs.ac.uk.

# Glossary

| Term | Explanation |
|---|---|
| **ArcGIS** | Geographic information system (GIS) software for working with maps and geographic information maintained by the Environmental Systems Research Institute (ESRI). |
| **ASCII grid** | American Standard Code for Information Interchange (ASCII) data format for the storage of raster data. The ASCII raster format can be used to store cell based or raster information. The basic structure of an ASCII grid has the header information at the beginning of the file followed by the cell value data. |
| **Attribute** | Named property of an entity. Descriptive information about features or elements of a database. For a database feature like census tract, attributes might include many demographic facts including total population, average income, and age. In statistical parlance, an attribute is a variable, whereas the database feature represents an observation of the variable. |
| **Bedrock** | The main mass of rocks forming the earth, laid down prior to 2.588 million years ago. Present everywhere, whether exposed at the surface in rocky outcrops or concealed beneath superficial deposits, artificial ground or water. Formerly called solid. |
| **Conductivity** | The degree to which a specified material conducts electricity or heat. |
| **DTM (Digital Terrain Model)** | Digital elevation model (DEM) that incorporates the elevation of important topographic features on the land. |
| **Extrapolate** | Process of constructing new data points outside a discrete set of known data points. It is similar to the process of interpolation, which constructs new points between known points, but the results of extrapolations are often less meaningful, and are subject to greater uncertainty. |
| **Flow rate** | Rate at which groundwater moves through rock. |
| **Geographical Information System** | Geographic Information Systems (GIS) provides accurate information, assistance, support, and maintains and creates information to aid in the development of maps and data analysis. |
| **Geology** | The study or science of the earth, its history, and its life as recorded in the rocks; includes the study of geologic features of an area, such as the geometry of rock formations, weathering and erosion, and sedimentation. |
| **Geospatial data** | Data that has a geographic component to it. This means that the records in a dataset have locational information tied to them such as geographic data in the form of coordinates, address, city, or postcode. |
| **GeoTiff** | The GeoTIFF format embeds geospatial metadata into image files such as aerial photography, satellite imagery, and digitized maps so that they can be used in GIS applications. |
| **Lithology** | Rocks maybe defined in terms of their general characteristics of appearance: colour, texture and composition. Some lithologies may require a microscope or chemical analysis for the latter to be fully determined. |
| **Metadata** | Data about data or a service. Metadata is the documentation of data. In human-readable form, it has primarily been used as information to enable the manager or user to understand, compare and interchange the content of the described data set. In the Web Services context, XML-encoded |

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| | (machine-readable and human-readable) metadata stored in catalogues and registries enables services to use those catalogues and registries to find data and services. |
| **Modelled** | Constructing a set of parameters to form a framework, populating with data and programmatically interpolating a surface by extrapolating across areas with no usable data. |
| **OpenGeoscience** | OpenGeoscience is a free service where you can view maps, download data, scans, photos and other information. https://www.bgs.ac.uk/opengeoscience/ Open data is data that is available to everyone to use, access and share. |
| **Permeability** | The term permeability, used in a general sense, refers to the capacity of a rock to transmit water. Such water may move through the rock matrix (intergranular permeability) or through joints, faults, cleavage or other partings (fracture or secondary permeability). A stricter definition of permeability is that it is a measure of the relative ease with which a porous medium can transmit a fluid under a potential gradient. It is the property of the medium only and is independent of the fluid. Commonly, but imprecisely, taken to be synonymous with the term Hydraulic Conductivity which implies the fluid is water. |
| **Porosity** | The ratio of the volume of the interstices to the total volume of rock expressed as a fraction. Effective porosity includes only the interconnected pore spaces available for groundwater transmission; measurements of porosity in the laboratory usually exclude any void spaces caused by cracks or joints (secondary porosity). |
| **QGIS** | A free and open-source cross-platform desktop geographic information system (GIS) application that supports viewing, editing, and analysis of geospatial data**.** QGIS was until 2013 known as Quantum GIS. |
| **Radiogenic** | A material, effect or process created radioactive decay |
| **Resolution** | Resolution expresses the size of the smallest object in a spatial data set that can be described. It refers to the amount of detail that can be discerned. It is also known as granularity. |
| **Rockhead** | The point of contact between Bedrock and Quaternary units. The 'ground level' before the Quaternary deposits were laid down. |
| **Scale** | The relation between the dimensions of features on a map and the geographic objects they represent on the earth, commonly expressed as a fraction or a ratio. A map scale of 1/100,000 or 1:100,000 means that one unit of measure on the map equals 100,000 on the earth. |
| **Shapefile** | The shapefile format is a geospatial vector data format for geographic information system software. It is developed and regulated by Esri as a mostly open specification for data interoperability among Esri and other GIS software products. |
| **Sedimentary** | Rocks that originated from the broken up or dissolved and re-precipitated particles of other rocks. Examples include clay, mudstone, siltstone, shale, sandstone, limestone and conglomerate. Sedimentary rocks cover more than two-thirds of the Earth's surface. They are formed from the weathering and erosion products of rock material, which have been transported (usually by water or wind), redeposited and later consolidated. |
| **Spatial data** | Data describing anything with spatial extent, i.e. size, shape or position. In addition to describing things that are positioned relative to the Earth, spatial data may also describe things using other coordinate systems that are not related to position on the Earth, such as the size, shape and positions of cellular and sub-cellular Spatial Things described using the 2D or 3D Cartesian coordinate system of a specific tissue sample. |
| **Superficial** | The youngest geological deposits formed during the most recent period of geological time, the Quaternary. They date from about 2.6 million years ago to the present. |

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| **Vector** | A representation of the spatial extent of geographic features using geometric elements (such as point, curve, and surface) in a coordinate space. |

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