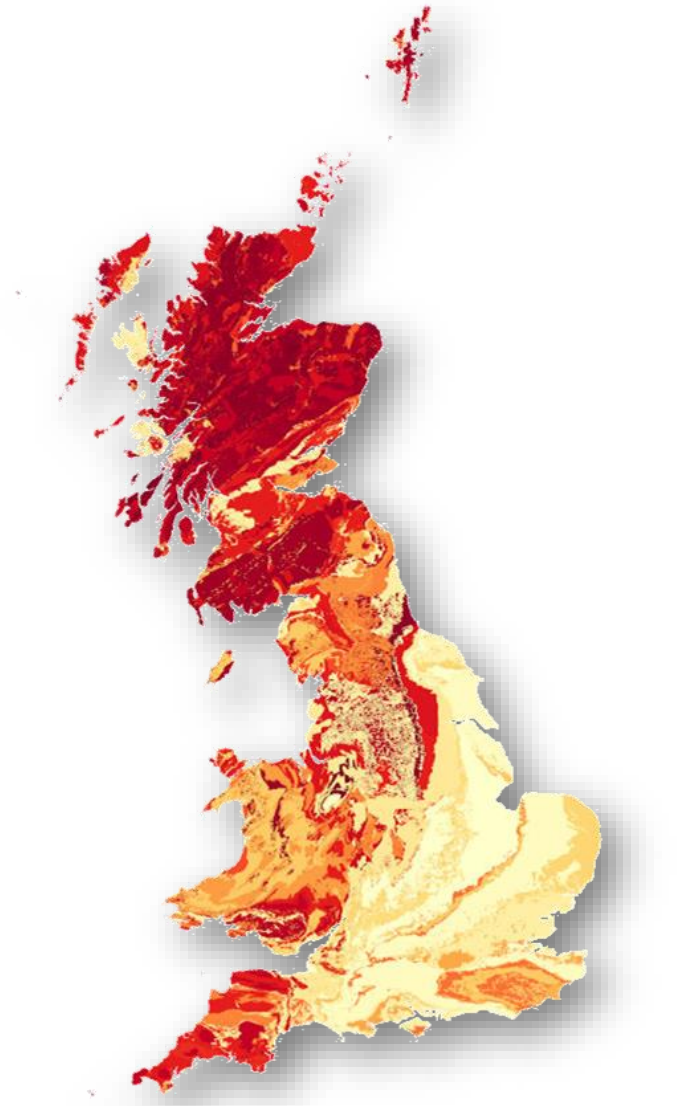

BGS INFORMATICS, DECARBONISATION AND RESOURCE MANAGEMENT

User Guide: BGS Thermal Properties V1 (Great Britain)

Open Report OR/25/014

British Geological Survey

BRITISH GEOLOGICAL SURVEY

BGS INFORMATICS, DECARBONISATION AND RESOURCE MANAGEMENT

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Keyworth, Nottingham British Geological Survey 2025

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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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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 thermal properties of bedrock at or near surface for Great Britain. 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 I. Gale, K. Rollin and J. Busby. This user guide was written by R. Lawley with editorial input from Dr. A. Monaghan and Mr D. P. Boon.

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Summary

The British Geological Survey (BGS) Thermal Properties dataset is derived from a programme of work commissioned in 2004 by the Carbon Trust to assess the suitability of BGS geological records for site characterisation when installing ground source heat pumps (GSHP). The dataset portrays a range of information relating to the thermal characteristics of bedrock – defined here by the 1:250 000 scale digital geological map (BGS DiGMapGB 250 V4). The information is presented as a vector polygon coverage for the extent of Great Britain (GB). Each record in the dataset describes the lithology, age, Thermal Conductivity, Thermal Diffusivity, Specific Heat Capacity and Density of the rock units. The information is summarised from a wider programme of work that has been developed since the late 1970's and includes published information from laboratory measurements and deep-drilling observations.

The information provided in this User Guide is intended to provide a quick start guide to using and understanding the BGS Thermal Properties dataset V1 (Great Britain).

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) and a series of incentive schemes (RHI, BUS, PSDS) has encouraged the uptake of geothermal or ground source 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 with only a few thousand systems installed annually. GSHP systems extract low grade heat from the subsurface either via groundwater pumped from boreholes ("open loop"), or from the ground itself (closed loop) via conductive heat transfer where plastic pipes, or loops, are installed into vertical boreholes. Typically, GSHPs extract heat from between 10s to 400m below ground level.

Deeper geothermal boreholes from which medium grade 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.

The design of an efficient GSHP or deeper geothermal infrastructure requires an good understanding of thermal properties of the ground, often termed 'soil' by engineers, but in the UK environment this includes loose soils and hard rocks, and everything in between; this dataset describes a model of thermal properties of bedrock for Great Britain. As more GSHP and deeper geothermal systems are installed over the next decade and as more data become available from research in the lab and field, this model can be iteratively improved in terms of spatial resolution, accuracy and precision.

The geothermal potential of the UK was initially investigated by a program 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 (1986a, b), Rollin (1987), BGS (1988), Parker (1989, 1999) and Barker et al. (2000).

Since the initial investment in geothermal research, BGS has developed a broader ongoing research area for ground heat (in all forms) and actively supports public and private sector projects concerned with utilising the subsurface for heating, cooling, interseasonal thermal energy storage, and power (electricity generation).

The information presented here was compiled by BGS to support its GeoReports service for GSHP installers (Gale, 2004 and 2005). The model is created from a revised 1:250 000 scale digital geological map supplemented with thermal properties derived from a range of borehole and laboratory observations (including data derived from the early geothermal projects). An earlier version of the model, utilising elements of the BGS 1:625 000 scale map was first documented (in a non-spatial form) in 1984 (Burley et al, 1984) and again in 1987 (Rollin, 1987).

1.1 WHAT THE DATA SHOW

This dataset shows thermal properties relating to the bedrock beneath our feet. The information can be used to assess the energy transfer potential of the ground for geo-exchange, mainly for closed loop ground source heat pumps, energy piles, heat storage schemes, other subsurface infrastructure, and deeper geothermal assessments, across the United Kingdom. The attribution and spatial data underpinning the model are that which is described and shown by Rollin (1987) and Gale (2004, 2005).

The information is presented as either:

- a vector-based, irregular polygon coverage at 1:250 000 scale
- a vector-based, hexagonal, cellular grid (side length 1km, area c.2.6 Km^2)

Each raster/vector cell is attributed with a range of geological properties including modelled values for thermal conductivity, thermal diffusivity, specific heat capacity and bulk density.

Coverage in this dataset is for the Great Britain (see Figure 1). The underpinning thermal property data used to create the estimated values is largely informed by the online geothermal catalogue data (as point data).

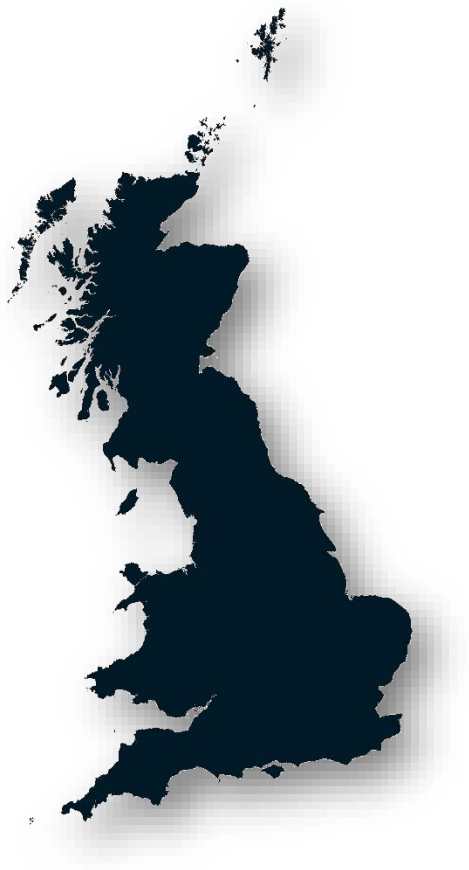

Figure 1 Coverage of the Thermal Properties V1 product. Coastline: Contains OS data © Crown copyright and database right 2024

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 or model the potential to deploy ground source heat pumps or deeper geothermal for heating/cooling. The dataset is for specialist use (i.e. GSHP designers, HVAC and civil 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 2004 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 Thermal Properties V1 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 UK public sector property portfolio.

2.1 THE PROBLEM

Heat decarbonisation of public assets is one of the greatest challenges the public sector faces because roughly half of the carbon emissions generated by a UK organisation or homeowner in 2025 are from space heating and hot water using fossil fuel boilers. Estate managers are trying to compare alternative heat resourcing from a range of net zero options to remove a CHP plant or replace ‘end of life’ boilers, and deployment of GSHP technology 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 technology would be an option at their site, and how well it may compare with the counterfactual (e.g. Gas or Air Source Heat Pumps).

2.2 THE CHALLENGE

The perceived disadvantage of deploying GSHP as part of a n organisations net zero pathway, is often due to a lack of technology awareness and experience, with added uncertainty around the time frames for planning consents, levels of disruption during installation, high upfront capital costs, unclear operational running costs and pay back periods, and lack of knowledge around life expectancy of the different system components (ground loop pipes and heat pumps). Uncertainty about ground conditions and long-term sustainability and reliability of the heat source is major barrier to investment. Resolving the ‘initial hurdles’ of information for GSHP is critical to getting this technology more widely considered at an early stage in Decarbonisation projects. What is needed is a simple way to assess the fundamental metrics that influence availability of ground heat: principally the geothermal heat flow, thermal properties of the ground, accessibility to the heat resource (ease of drilling and loop installation), and an estimation of the costs of a ‘collector array’ of sufficient capacity to meet design loads, within the constraints of the land available for drilling works.

2.3 THE SOLUTION

The Thermal Properties V1 model is suitable for professionals making an initial feasibility assessment for GSHPs. It is a simple map coverage that highlights the modelled variation in thermal conductivity, specific heat capacity and thermal diffusivity of bedrock layers. GSHP designers and installers need to consider heat transfer (along with other practical and economic factors) to estimate the sustainable thermal energy extraction rate (W/m) of a borehole and optimal depth of drilling given the local ground conditions. The model is designed to be used alongside and in conjunction with a range of other national data relating to GSHP (e.g. heat demand mapping and heat network zoning).

The dataset described here has been integrated into a screening toolkit on behalf of NHS (England) by the BGS and the Energy Systems Catapult. The toolkit enables NHS Trust energy and sustainability managers to rapidly assess the theoretical heating capacity of a closed loop GSHP system utilising available parcels of land at their site.

3 Methodology

3.1 OVERVIEW

The standard BGS Geology 250K Version 4 bedrock map has been attributed with basic thermo-physical properties comprising, thermal conductivity, specific heat capacity and density. From these parameters, thermal diffusivity has been calculated and attributed using long-established equations.

3.1.1 Geological domains and thermal properties

Typically, the age and lithology of a rock or soil fundamentally controls its engineering, geochemical and geophysical properties. For most BGS geological maps, attribution is on the basis of the LEX-ROCK (or more lately LEX-RCS) code provided for each geological unit. This code combination describes the lithostratigraphic name for the rock and its lithology (based on the BGS Rock Classification Schemes, or RCS) and reflects how the rocks were identified and differentiated at time of survey and map compilations. There are 1102 unique LEX-ROCK combinations available in the BGS Geology 250 V4 bedrock map. However, we do not hold enough thermal property measurements to fully statistically represent all of those combinations across the full range of UK crustal stress and temperature conditions. However, thermal properties are more closely controlled by lithology or rock type; therefore, it has been possible to reprofile the map data to consider primarily lithology (of which there are only 85 unique Rock codes) and a much-simplified geological age, in this case the 'System' age (also known as geological period) of the rock (e.g. 'Devonian'). Using this combination of lithology and age provides 206 unique codes, and this is more appropriate to statistically resolve the thermal property data. The code combinations are presented in appendix 1.

3.1.2 Thermal conductivity

The thermal conductivity of a material is the quantity or maximum flow of thermal energy transmitted per unit area, per unit temperature gradient, in unit time under steady state conditions. It is the main mechanism for transfer of heat from the interior of the earth to the surface and for transfer of heat from solar warming downwards into the earth. Its SI units of measurement are $Wm^{-1}K^{-1}$ and often denoted as Watts per meter per one degree change in Kelvin.

Thermal conductivity can be derived from laboratory measurements of representative samples, it can also be derived (at a formation scale) computationally from geophysical logging datasets or mineralogy data.

Just like geology, the bulk thermal conductivity can vary significantly laterally and horizontally in the crust. The mineralogical composition of the rock or deposit, it's porosity and density, and the nature of any saturating fluids in fractures will primarily control the bulk thermal conductivity. In general, increasing porosity will decrease the thermal conductivity of a geological unit, but this effect is reduced if the rock is water saturated. Therefore, for sedimentary rocks the primary control on thermal conductivity is porosity, the mineral make-up of the sedimentary rock and the extent of saturation. For volcanic and metamorphic rocks porosity is also the main influence on thermal conductivity, but matrix porosity is often low so the porosity is generally in the form of open fluid-filled fractures. Superficial materials such as glacial till present the greatest challenge to determining thermal conductivity due to their range of lithological heterogeneity as well variable degree of saturation and thickness; for this reason, the Thermal Properties V1 model is based upon bedrock information only. Users requiring information about thermal properties for superficial materials should contact enquiries@bgs.ac.uk.

3.1.3 Specific Heat Capacity

The specific heat capacity of a material is the quantity of heat (Joules) that must be added to one unit of mass (kg) of the material in order to cause an increase of one unit in temperature (Kelvin). Its units of measurement are $J.kg^{-1}K^{-1}$.

Specific heat is affected by lithology type and porosity, especially where the porosity is occluded by water.

3.1.4 Density

The density of a material is the ratio of its mass to its volume. Its SI units of measurement are $kg.m^{-3}$.

Rock densities are generally derived from laboratory measurements of representative samples. Relative bulk densities of rock units can also be derived from geophysical logging (Neutron Density).

3.1.5 Thermal diffusivity

The thermal diffusivity of a material is a measure of the heat transfer rate or ability of a material to conduct thermal energy relative to its ability to store thermal energy (it is the ratio between thermal conductivity of a material and its heat capacity). Its units of measurement are m^2s^{-1}.

3.2 CREATING THE TESSELLATED HEXAGON COVERAGE

The 1:250 000 vector dataset has been converted to a vector cellular grid using the tessellation toolkit available in ESRI's ArcPro3.2 GIS. The vector cellular grid is supplied as a 1km-sided hexagonal cell tessellation (each cell has an area of $2.56km^2$), designed to provide a resampled and easier to use version of the original BGS 1:250 000 polygon-based model.

The hexagon based cellular grid offers a summary of the geology which is driven by the most spatially dominant bedrock type encountered within the area of the hexagon. A range of numerical values for each thermal property is provided – typically in the form of Minimum, Maximum and area-weighted average. The attribution of the 1:250 000 scale and hex-grid versions of the data are given in Table 1 and 2 below.

3.3 SOURCE DATASETS

The Thermal Properties V1 model is based on a compilation of the following:

- BGS Geology 250k v4 geology map (bedrock),
- BGS Geology 625k V1 geology map (superficial),
- a collection of published research papers (outlined above) and,
- the 4th edition of the UK Geothermal Catalogue (Rollin 1987).

The first digital release of the legacy UK Geothermal Catalogue has been published, see Fellgett & Monaghan (2024), and can be downloaded from the BGS website: https://webapps.bgs.ac.uk/services/ngdc/accessions/index.html#item184577 .

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 for users.

4.1 SCALE

The Thermal Properties V1 dataset is intended for use at 1:250 000 scale and largely created from data cartographically captured at that scale, as such the underlying bedrock geological linework is considered accurate to +/- 250m.

4.2 COVERAGE

The Thermal properties V1 dataset has coverage for Great Britain and the Isle of Man. Coverage for the dataset is shown in Figure 1. Northern Ireland is served by the Geological Survey of Northern Ireland (GSNI).

4.3 ATTRIBUTE DESCRIPTION

BGS supplies Thermal Properties mapping in two vector formats:

a) the higher resolution Thermal Properties V1 dataset, with a working scale of 1:250 000, with attribution shown in Table 1 below, and
b) the summarised Thermal Properties V1 Hex dataset, based on tessellated polygons of c.2.56 km^2 area, with attribution shown in table 2 below.

Table 1 Attributes of the Thermal Properties V1 GB dataset.

FIELD	DESCRIPTION	EXAMPLE
OBJECTID	Unique identifier for polygon	20319
LEX	The lithostratigraphic code for the rock	SSG
ROCK	The rock code for the rock type	SDST
LEXICONDES	Descriptive lithostratigraphic name for the rock	SHERWOOD SANDSTONE GROUP
ROCKDESC	Descriptive lithology type for the rock	SANDSTONE
AGE	Generic age code for the rock (based on the system age code)	PU
MIN_AGE	Minimum geological age code for the rock	TD
PARENT	Parent lithostratigraphic unit for the rock	NRS
STAGE	Geological ‘stage’ name for the rock	NA
SERIES	Geological ‘series’ name for the rock	TRIASSIC
SUBSYSTEM	Geological ‘subsystem’ name for the rock	NA
SYSTEM	Geological ‘system’ name for the rock	PERMIAN
ERATHEM	Geological ‘erathem’ name for the rock	PALAEOZOIC
EONOTHEM	Geological ‘eonothem’ name for the rock	PHANEROZOIC
THERMC	The thermal capacity of the rock ($Wm^{-1}K^{-1}$)	3.03
DENS	The density of the rock ($g.cm^{-3}$)	2.65
SHEAT	The specific heat capacity of the rock ($kJ.kg^{-1}K^{-1}$)	0.84
TDIFF	The thermal diffusivity of the rock ($m^2 \cdot day^{-1}$)	0.1176
VERSION	The version/title identifier for the dataset	THERMAL_PROPERTIES_V1_GB

Table 2 Attributes of the Thermal Properties V1 (hex) GB dataset

FIELD	DESCRIPTION	EXAMPLE
UUID	Unique identifier of each hexagon	84032
GEOL_DESC1	A verbose description summarising the superficial geology found in the 1km sided hexagon.	Dominant superficial cover is: Glacigenic Deposits (49% coverage), along with: Alluvial Deposits (24%).
GEOL_DESC2	A verbose description summarising the dominant bedrock geology units found in the hexagon.	Dominant bedrock is: LOCHABER SUBGROUP-PSAMMITE AND SEMI-PELITE (33% coverage), along with: AILNACK PHYLLITE AND LIMESTONE FORMATION-PSAMMITE, PELITE AND METALIMESTONE (24%),
GEOL_DESC3	Continuation of the description summarising the less dominant bedrock geology found in the hexagon.	(continued): MORTLACH GRAPHITIC SCHIST FORMATION-PELITE, GRAPHITIC (23%), CORRYHABBIE QUARTZITE FORMATION-QUARTZITE (18%), additional minor bedrock units occur.
MINTC	The minimum thermal conductivity found in the hexagon ($Wm^{-1}K^{-1}$)	3.1
MAXTC	The maximum thermal conductivity found in the hexagon ($Wm^{-1}K^{-1}$)	4
WTAV_TC	The area-weighted mean thermal conductivity found in the hexagon ($Wm^{-1}K^{-1}$)	3.8
MINTD	The minimum thermal diffusivity found in the hexagon ($m^2 \cdot day^{-1}$)	0.1137
MAXTD	The maximum thermal diffusivity found in the hexagon ($m^2 \cdot day^{-1}$)	0.1629
WTAV_TD	The area-weighted thermal diffusivity found in the hexagon ($m^2 \cdot day^{-1}$)	0.154
MINSH	The minimum specific heat capacity found in the hexagon ($kJ.kg^{-1}K^{-1}$)	0.78
MAXSH	The maximum specific heat capacity found in the hexagon ($kJ.kg^{-1}K^{-1}$)	0.86
WTAV_SH	The area weighted specific heat capacity found in the hexagon ($kJ.kg^{-1}K^{-1}$)	0.84
MIND	The minimum bulk density found in the hexagon (Mg/m^3)	2.72
MAXD	The maximum bulk density found in the hexagon (Mg/m^3)	2.79
VERSION	The version/title identifier for the dataset	THERMAL_PROPERTIES_V1(HEX)_GB

4.4 DATA FORMAT

The BGS Thermal Properties V1 dataset is available as a vector GIS dataset with attribute values relating to geological description and thermal properties. The dataset comprises polygon data in (ESRI) Shapefile format (SHP). Other formats such as QGIS Geopackage and MapInfo (TAB) are available.

4.5 DATASET HISTORY

This is the first published version of the digital Thermal Properties V1 dataset.

4.6 DISPLAYING THE DATA

The data is alpha-numerical, providing classifications of geological materials in terms of age, lithological type and thermal properties (shown as numerical values). Typically, the geological information can be portrayed with **any** colouration. An example colour lookup table is provided with the dataset for the purpose of showing the Thermal Conductivity values as a colour ramp (and lyr/gpkg files are also supplied). The thermal properties attribution does not need any ***specific*** parameters for map display. Users wishing to show these values as a colour map can utilise **any** graduated colour scheme (within their GIS software) that spans the full range of the data provided.

5 Licencing the data

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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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- reproduce extracts from the data up to A3 for use in external analogue (paper/hard copy) or non-query able electronic (e.g., secured .pdf) format: to meet a public task duty; fulfil a statutory requirement; and/or as part of academic or other non-commercial research.

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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.

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5.2 DATA AVAILABILITY VIA A WEB MAP SERVICE

To encourage the use and re-use of this data we have made The hex grid variant of the dataset 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]".

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- Publications
- Scanned records
- Data collections
- Software

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 Thermal Properties V1 dataset:

Thermal Properties V1 dataset, 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): Thermal Properties V1 dataset. British Geological Survey. (Dataset). https://doi.org/10.5285/def961e0-3432-4af8-a09a-a489c845af54

5.4 CONTACT INFORMATION

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6 Limitations

6.1 DATA CONTENT

The Thermal Properties V1 dataset 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.

6.2 SCALE

The data are provided as irregular vector polygons, or as a tessellated vector grid of polygons.

The 1:250 000 scale vector polygons have been captured with a cartographic accuracy of +/- 250m.

The tessellated hexagon-based dataset has polygons with 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, this layer is a direct resampling of the 1:250 000 scale dataset (see also section 3 Methodology).

6.3 ACCURACY AND UNCERTAINTY

Users of this data should be aware that this is a compilation of simplified geology at 1:250 000 scale and estimated/modelled values of thermal properties (based on laboratory and downhole observations). The results of the model should be considered as indicative. 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.

Users wishing to update or modify this model for their own purposes, should consider acquiring the original point dataset from the legacy geothermal catalogue to create a new interpolation.

Future releases of this dataset will include new metrics for uncertainty and will incorporate alternative coordinate reference systems.

6.4 ARTEFACTS

The Thermal Properties V1 dataset been compiled from data of differing ages, locations, lithologies and methods. As a synthesis of data across Great Britain there may be data artefacts created by the combination of input data, the methods used to collate observed values and the limitation of the sample size, compared with the natural variance of thermal properties and geological materials across our environment.

The 1km Hexagon tessellation vector layer has been directly resampled from the original 1:250 000 scale model. The values of minimum, maximum and mean values for the thermal properties have been created using standard ESRI ArcGIS tools for spatial analysis.

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 a compilation of summary data which outlines the thermal properties of bedrock through the subsurface for Great Britain.

Q: What scale are these data provided at?
A: Data are provided as vector polygons at a 1:250 000 scale, or as tessellated vector cells 2.56km^2 area, and side length of 1km.

Q: How accurate is this dataset?
A: The database is based on xxx estimates of thermal properties (derived from previously published research), compiled alongside the BGS Geology 250k bedrock map. 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 technologies.

Q: How often will this dataset be updated?
A: The background database is amended and updated over time. It is intended that the Thermal Properties V1 dataset 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 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: Many of the underlying thermal properties data can be reviewed in previously published papers (outlined above). Some data is also available 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.

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.

Appendix 1

SYSTEM	LITHOLOGY	TCOND $Wm^{-1}K^{-1}$	DENS Mgm^{-3}	SHC $kJkg^{-1}K^{-1}$	TDIFF m^2day^{-1}
UNDIFF	ACID ROCK, UNDIFFERENTIATED, COARSE-GRAINED	3.27	2.62	0.84	0.1284
NA	ACID ROCK, UNDIFFERENTIATED, COARSE-GRAINED, METAMORPHOSED	2.9	2.65	1	0.0946
SILURIAN	ACID ROCK, UNDIFFERENTIATED, COARSE-GRAINED, METAMORPHOSED	2.9	2.65	1	0.0946
UNDIFF	ACID ROCK, UNDIFFERENTIATED, FINE-GRAINED	3	2.65	0.84	0.1164
UNDIFF	AGGLOMERATE	3.2	2.7	0.83	0.1234
NA	AMPHIBOLITE AND HORNBLENDE SCHIST	2.75	2.88	0.84	0.0982
DEVONIAN	ANDESITIC LAVA	2.35	2.75	1	0.0738
ORDOVICIAN	ANDESITIC LAVA	2.5	2.75	1	0.0785
SILURIAN	ANDESITIC LAVA	2.5	2.75	1	0.0785
DEVONIAN	ANDESITIC TUFF	2.35	2.75	0.9	0.082
SILURIAN	ANDESITIC TUFF	2.5	2.75	0.9	0.0873
PERMIAN	ANHYDRITE ROCK	5.06	2.96	1	0.1477
CARBONIFEROUS	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] CHERT, INTERBEDDED	1.79	2.6	0.92	0.0647
CAMBRIAN	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] CHERT, INTERBEDDED	2.18	2.61	0.92	0.0784
SILURIAN	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] CONGLOMERATE,	2.18	2.65	0.92	0.0773
CRETACEOUS	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] LIMESTONE, INTERBEDDED	1.67	2.2	0.9	0.0729
JURASSIC	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] LIMESTONE, INTERBEDDED	1.8	2.3	0.9	0.0751
TRIASSIC	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] LIMESTONE, INTERBEDDED	2.1	2.28	0.9	0.0884
CARBONIFEROUS	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] LIMESTONE, INTERBEDDED	2.45	2.62	0.9	0.0898
TRIASSIC	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] SANDSTONE AND	2.46	2.55	0.89	0.0937
PERMIAN	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] SANDSTONE AND	2.5	2.55	0.89	0.0952
JURASSIC	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	1.76	2.4	0.89	0.0712
CRETACEOUS	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	1.77	2.45	0.89	0.0701
PALAEOGENE	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	1.8	1.9	0.89	0.092
PERMIAN	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	1.9	2.6	0.89	0.0709
TRIASSIC	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	1.97	2.38	0.89	0.0804
SILURIAN	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	2.4	2.68	0.89	0.0869
ORDOVICIAN	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	2.4	2.72	0.89	0.0857
NA	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	2.5	2.6	0.89	0.0933
CARBONIFEROUS	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	2.56	2.6	0.89	0.0956
CAMBRIAN	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	2.6	2.65	0.89	0.0952
DEVONIAN	ARGILLACEOUS ROCKS AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	2.89	2.65	0.89	0.1059
JURASSIC	ARGILLACEOUS ROCKS, UNDIFFERENTIATED	1.3	2.4	0.92	0.0509
PERMIAN	ARGILLACEOUS ROCKS, UNDIFFERENTIATED	1.77	2.57	0.92	0.0647
PALAEOGENE	ARGILLACEOUS ROCKS, UNDIFFERENTIATED	1.79	1.98	0.92	0.0849
CARBONIFEROUS	ARGILLACEOUS ROCKS, UNDIFFERENTIATED	1.79	2.6	0.92	0.0647
TRIASSIC	ARGILLACEOUS ROCKS, UNDIFFERENTIATED	1.87	2.52	0.92	0.0697
CRETACEOUS	ARGILLACEOUS ROCKS, UNDIFFERENTIATED	2.18	2.09	0.92	0.098
SILURIAN	ARGILLACEOUS ROCKS, UNDIFFERENTIATED	2.18	2.65	0.92	0.0773
ORDOVICIAN	ARGILLACEOUS ROCKS, UNDIFFERENTIATED	2.18	2.74	0.92	0.0747
CAMBRIAN	ARGILLACEOUS ROCKS, UNDIFFERENTIATED	2.18	2.61	0.92	0.0784
NA	ARGILLACEOUS ROCKS, UNDIFFERENTIATED	2.5	2.65	0.92	0.0886
DEVONIAN	ARGILLACEOUS ROCKS, UNDIFFERENTIATED	2.89	2.65	0.92	0.1024
PERMIAN	BASALTIC LAVA	1.8	2.72	0.88	0.065
ORDOVICIAN	BASALTIC LAVA	2.3	2.8	0.88	0.0806
UNDIFF	BASIC ROCK, UNDIFFERENTIATED, COARSE-GRAINED	3	2.93	0.88	0.1005
NA	BASIC ROCK, UNDIFFERENTIATED, COARSE-GRAINED, METAMORPHOSED	2.5	2.88	0.9	0.0833
CAMBRIAN	BASIC ROCK, UNDIFFERENTIATED, COARSE-GRAINED, METAMORPHOSED	2.5	2.88	0.9	0.0833
UNDIFF	BASIC ROCK, UNDIFFERENTIATED, FINE-GRAINED	3	2.88	0.88	0.1023
DEVONIAN	BRECCIA	2	2.65	0.86	0.0758
PERMIAN	BRECCIA	2	2.6	0.86	0.0773
TRIASSIC	BRECCIA	2	2.6	0.86	0.0773
CARBONIFEROUS	BRECCIA	2	2.7	0.86	0.0744
NA	CALCAREOUS PELITE AND CALC-SILICATE	3.6	2.78	0.9	0.1243
NA	CATACLASITES	2	2.7	0.86	0.0744
CRETACEOUS	CHALK	1.67	2.2	0.88	0.0745
JURASSIC	CHERT	2.8	2.65	0.88	0.1037
CARBONIFEROUS	CHERT	3.5	2.67	0.88	0.1287
NEOGENE	CONGLOMERATE	2.4	2.45	0.86	0.0984
PALAEOGENE	CONGLOMERATE	2.4	2	0.86	0.1206
TRIASSIC	CONGLOMERATE	2.4	2.3	0.86	0.1048
PERMIAN	CONGLOMERATE	2.4	2.5	0.86	0.0964
ORDOVICIAN	CONGLOMERATE	2.4	2.72	0.86	0.0886
SILURIAN	CONGLOMERATE	2.6	2.7	0.86	0.0967
DEVONIAN	CONGLOMERATE	2.7	2.55	0.86	0.1064
CARBONIFEROUS	CONGLOMERATE	2.7	2.7	0.86	0.1005
NA	CONGLOMERATE	2.7	2.7	0.86	0.1005
PERMIAN	CONGLOMERATE AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	2.4	2.43	0.86	0.0992
PALAEOGENE	CONGLOMERATE AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	2.4	2.1	0.86	0.1148
DEVONIAN	CONGLOMERATE AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	2.5	2.7	0.86	0.093
CARBONIFEROUS	CONGLOMERATE AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	3	2.72	0.86	0.1108
ORDOVICIAN	CONGLOMERATE AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	3.2	2.73	0.86	0.1178
UNDIFF	DIORITIC - ROCK	2.35	2.75	1	0.0738
CAMBRIAN	DOLOMITE, LIMESTONE AND CHERT, INTERBEDDED	3.6	2.68	0.95	0.1222
CAMBRIAN	DOLOMITIC ARGILLACEOUS ROCKS AND SUBORDINATE SANDSTONE, INTERBEDDED	2.72	2.7	0.92	0.0946
DEVONIAN	DOLOMITIC ARGILLACEOUS ROCKS AND SUBORDINATE SANDSTONE, INTERBEDDED	2.89	2.69	0.92	0.1009
PERMIAN	DOLOMITISED LIMESTONE AND DOLOMITE	3.59	2.52	0.95	0.1296
CARBONIFEROUS	FELSIC LAVA	2	2.7	0.95	0.0674
SILURIAN	FELSIC LAVA	2	2.7	0.95	0.0674
ORDOVICIAN	FELSIC LAVA	2	2.7	0.95	0.0674

CARBONIFEROUS	FELSIC TUFF	2.8	2.7	0.9	0.0996
SILURIAN	FELSIC TUFF	2.9	2.7	0.9	0.1031
ORDOVICIAN	FELSIC TUFF	2.9	2.7	0.9	0.1031
DEVONIAN	GNEISS	2.9	2.85	0.84	0.1047
NA	GNEISS	3.01	2.8	0.84	0.1106
NA	GNEISS, RE-METAMORPHOSED	2.9	2.75	0.84	0.1085
UNDIFF	GRANITIC - ROCK	3.27	2.65	1.1	0.0969
TRIASSIC	HALITE	4.6	2.42	0.9	0.1825
UNDIFF	INTERMEDIATE ROCK, UNDIFFERENTIATED, COARSE-GRAINED	2.7	2.67	1	0.0874
NA	INTERMEDIATE ROCK, UNDIFFERENTIATED, COARSE-GRAINED, METAMORPHOSED	2.9	2.78	0.85	0.106
UNDIFF	INTERMEDIATE ROCK, UNDIFFERENTIATED, FINE-GRAINED	2.7	2.68	1	0.087
DEVONIAN	LAVA AND TUFF, UNDIFFERENTIATED	2	2.75	0.9	0.0698
NEOPROTEROZOIC	LAVA AND TUFF, UNDIFFERENTIATED	2	2.75	0.9	0.0698
ORDOVICIAN	LAVA AND TUFF, UNDIFFERENTIATED	2	2.74	0.9	0.0701
NA	LAVA AND TUFF, UNDIFFERENTIATED	2	2.7	0.9	0.0711
PALAEOGENE	LAVA AND TUFF, UNDIFFERENTIATED	2	2.75	0.9	0.0698
CARBONIFEROUS	LAVA AND TUFF, UNDIFFERENTIATED	2.7	2.72	0.9	0.0953
CARBONIFEROUS	LAVA OR EXTRUSIVE IGNEOUS ROCK [UNDIFFERENTIATED]	1.8	2.72	0.95	0.0602
DEVONIAN	LAVA OR EXTRUSIVE IGNEOUS ROCK [UNDIFFERENTIATED]	1.8	2.75	0.95	0.0595
PERMIAN	LAVA OR EXTRUSIVE IGNEOUS ROCK [UNDIFFERENTIATED]	1.8	2.72	0.95	0.0602
PALAEOGENE	LAVA OR EXTRUSIVE IGNEOUS ROCK [UNDIFFERENTIATED]	1.8	2.75	0.95	0.0595
SILURIAN	LAVA OR EXTRUSIVE IGNEOUS ROCK [UNDIFFERENTIATED]	2	2.74	0.95	0.0664
ORDOVICIAN	LAVA OR EXTRUSIVE IGNEOUS ROCK [UNDIFFERENTIATED]	2	2.74	0.95	0.0664
NA	LAVA OR EXTRUSIVE IGNEOUS ROCK [UNDIFFERENTIATED]	2	2.75	0.95	0.0661
PALAEOGENE	LIMESTONE	1.9	2.2	0.89	0.0838
CRETACEOUS	LIMESTONE	2	2.2	0.89	0.0883
JURASSIC	LIMESTONE	2	2.48	0.89	0.0783
SILURIAN	LIMESTONE	2.5	2.72	0.89	0.0892
TRIASSIC	LIMESTONE	2.54	2.42	0.89	0.1019
CARBONIFEROUS	LIMESTONE	2.9	2.72	0.89	0.1035
ORDOVICIAN	LIMESTONE	2.9	2.7	0.89	0.1043
DEVONIAN	LIMESTONE	3	2.68	0.89	0.1087
JURASSIC	LIMESTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED	1.82	2.48	0.89	0.0712
TRIASSIC	LIMESTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED	2.2	2.4	0.89	0.089
CARBONIFEROUS	LIMESTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED	2.56	2.58	0.89	0.0963
DEVONIAN	LIMESTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED	2.7	2.6	0.89	0.1008
JURASSIC	LIMESTONE AND [SUBEQUAL/SUBORDINATE] CONGLOMERATE, INTERBEDDED	2	2.45	0.89	0.0792
JURASSIC	LIMESTONE AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	2.05	2.4	0.89	0.0829
NEOGENE	LIMESTONE AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	2.05	2	0.89	0.0995
ORDOVICIAN	LIMESTONE AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED	2.72	2.72	0.89	0.0971
CARBONIFEROUS	LIMESTONE AND MUDSTONE, INTERBEDDED	2.35	2.68	0.89	0.0851
CARBONIFEROUS	LIMESTONE, ARGILLACEOUS ROCKS AND SUBORDINATE SANDSTONE, INTERBEDDED	2.45	2.65	0.89	0.0898
CARBONIFEROUS	MAFIC LAVA	2	2.77	0.95	0.0657
ORDOVICIAN	MAFIC LAVA	2	2.77	0.95	0.0657
CARBONIFEROUS	MAFIC TUFF	2.5	2.7	0.88	0.0909
NA	MARBLE AND CALC-SILICATE	3.5	2.7	1	0.112
NA	MELANGE	2.8	2.72	0.9	0.0988
NA	METABASALT, CALCAREOUS PELITE AND CALC-SILICATE	2.2	2.85	0.9	0.0741
ORDOVICIAN	METABASALT, PSAMMITE AND PELITE	2.2	2.8	0.9	0.0754
ORDOVICIAN	METACONGLOMERATE	3.3	2.7	0.9	0.1173
NA	METACONGLOMERATE	3.3	2.7	0.9	0.1173
NA	METADIAMICTITE	3	2.67	0.9	0.1079
NA	METAMORPHOSED IGNEOUS ROCK	2.9	2.75	0.8	0.1139
ORDOVICIAN	METAMORPHOSED IGNEOUS ROCK	2.9	2.75	0.85	0.1072
NA	METAMORPHOSED LAVA	3.9	2.75	0.86	0.1425
NA	METAMORPHOSED LAVA AND TUFF	3.9	2.75	0.86	0.1425
NA	METAMORPHOSED LIMESTONE AND DOLOMITE	3	2.75	0.9	0.1047
NA	METASEDIMENTARY ROCK	3	2.7	0.86	0.1116
UNDIFF	MICROGABBROIC - ROCK	2.2	2.85	0.82	0.0813
UNDIFF	MICROGRANITIC - ROCK	3.2	2.68	0.82	0.1258
NA	MIGMATITES	3.4	2.68	0.85	0.129
JURASSIC	MUDSTONE, BITUMINOUS	1.3	2.25	0.88	0.0567
NA	MYLONITE	2.8	2.7	0.86	0.1042
ORDOVICIAN	MYLONITE	2.8	2.72	0.86	0.1034
ORDOVICIAN	PELITE	2.9	2.75	0.86	0.1059
NA	PELITE	3.25	2.75	0.86	0.1187
NA	PELITE AND SEMI-PELITE	3.1	2.76	0.86	0.1128
NA	PELITE, GRAPHITIC	3.1	2.74	0.86	0.1137
UNDIFF	PORPHYRY	3.2	2.69	0.86	0.1195
NA	PSAMMITE	3.8	2.7	0.86	0.1414
NA	PSAMMITE AND PELITE	3.5	2.74	0.86	0.1283
NA	PSAMMITE AND SEMI-PELITE	3.4	2.75	0.86	0.1242
NA	PSAMMITE, PELITE AND METALIMESTONE	3.7	2.79	0.86	0.1332
DEVONIAN	QUARTZITE	3.8	2.72	0.78	0.1548
NA	QUARTZITE	4	2.72	0.78	0.1629
NA	QUARTZITE, SEMI-PELITE AND PELITE	3.6	2.72	0.86	0.133
ORDOVICIAN	RHYOLITIC LAVA	3.3	2.75	0.86	0.1206
QUATERNARY	SANDSTONE	2.1	2.1	0.84	0.1029
JURASSIC	SANDSTONE	2.23	2.5	0.84	0.0917
NEOGENE	SANDSTONE	2.33	2.1	0.84	0.1141
PALAEOGENE	SANDSTONE	2.35	2.25	0.84	0.1074
CRETACEOUS	SANDSTONE	2.59	2.4	0.84	0.111
PERMIAN	SANDSTONE	3.03	2.65	0.84	0.1176
TRIASSIC	SANDSTONE	3.1	2.55	0.84	0.125
NA	SANDSTONE	3.2	2.6	0.84	0.1266
DEVONIAN	SANDSTONE	3.28	2.65	0.84	0.1273
CARBONIFEROUS	SANDSTONE	3.34	2.6	0.84	0.1321

SILURIAN	SANDSTONE	3.4	2.68	0.84	0.1305
ORDOVICIAN	SANDSTONE	3.4	2.7	0.84	0.1295
CAMBRIAN	SANDSTONE	3.4	2.65	0.84	0.132
JURASSIC	SANDSTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED	1.95	2.25	0.84	0.0891
PALAEOGENE	SANDSTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED	2.2	2.1	0.84	0.1078
CRETACEOUS	SANDSTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED	2.32	2.35	0.84	0.1015
ORDOVICIAN	SANDSTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED	2.71	2.68	0.84	0.104
SILURIAN	SANDSTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED	2.72	2.72	0.84	0.1029
CAMBRIAN	SANDSTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED	2.72	2.7	0.84	0.1036
DEVONIAN	SANDSTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED	2.82	2.45	0.84	0.1184
TRIASSIC	SANDSTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED	2.85	2.58	0.84	0.1136
CARBONIFEROUS	SANDSTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED	2.9	2.59	0.84	0.1152
PERMIAN	SANDSTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED	2.9	2.5	0.84	0.1193
NA	SANDSTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED	3	2.62	0.84	0.1178
JURASSIC	SANDSTONE AND [SUBEQUAL/SUBORDINATE] LIMESTONE, INTERBEDDED	2.1	2.45	0.84	0.0882
CRETACEOUS	SANDSTONE AND [SUBEQUAL/SUBORDINATE] LIMESTONE, INTERBEDDED	2.4	2.2	0.84	0.1122
CAMBRIAN	SANDSTONE AND [SUBEQUAL/SUBORDINATE] LIMESTONE, INTERBEDDED	2.8	2.65	0.84	0.1087
ORDOVICIAN	SANDSTONE AND [SUBEQUAL/SUBORDINATE] LIMESTONE, INTERBEDDED	2.8	2.7	0.84	0.1067
JURASSIC	SANDSTONE AND CONGLOMERATE, INTERBEDDED	2.5	2.45	0.84	0.105
SILURIAN	SANDSTONE AND CONGLOMERATE, INTERBEDDED	3	2.65	0.84	0.1164
DEVONIAN	SANDSTONE AND CONGLOMERATE, INTERBEDDED	3.35	2.72	0.84	0.1267
NA	SANDSTONE AND CONGLOMERATE, INTERBEDDED	3.35	2.72	0.84	0.1267
PERMIAN	SANDSTONE AND CONGLOMERATE, INTERBEDDED	3.4	2.5	0.84	0.1399
SILURIAN	SANDSTONE AND CONGLOMERATE, INTERBEDDED	3	2.65	0.84	0.1164
DEVONIAN	SCHIST	2.9	2.78	0.86	0.1048
NA	SCHIST	2.9	2.78	0.86	0.1048
CARBONIFEROUS	TUFF	2.1	2.72	0.85	0.0785
PERMIAN	TUFF	2.1	2.7	0.85	0.0791
PALAEOGENE	TUFF	2.1	2.7	0.85	0.0791
DEVONIAN	TUFF	2.2	2.73	0.85	0.0819
SILURIAN	TUFF	2.3	2.75	0.85	0.085
ORDOVICIAN	TUFF	2.3	2.74	0.85	0.0853
NA	TUFF	2.5	2.75	0.85	0.0924
ORDOVICIAN	TUFF AND LAVA, UNDIFFERENTIATED	2.3	2.76	0.85	0.0847
NEOPROTEROZOIC	TUFF AND LAVA, UNDIFFERENTIATED	2.8	2.78	0.85	0.1024
UNDIFF	ULTRABASIC GROUP	2.4	2.95	0.85	0.0827
NA	ULTRABASIC ROCK, METAMORPHOSED	2.9	2.85	0.86	0.1022
CAMBRIAN	ULTRABASIC ROCK, METAMORPHOSED	2.9	2.85	0.86	0.1022
NA	VEIN COMPLEX	3.4	2.72	0.8	0.135

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 conduct 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 Geo TIFF 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 (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 known until 2013 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.

Vadose	The vadose zone is also termed the unsaturated zone and represents the shallow subsurface between the soil and the local groundwater level. This zone exhibits changing levels of saturation.
Vector	A representation of the spatial extent of geographic features using geometric elements (such as point, curve, and surface) in a coordinate space.

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.

Barker, J. A., Downing, R. A., Gray, D. A., Findlay, J., Kellaway, G. A., Parker, R. H. and Rollin, K. E. (2000). Hydrogeothermal studies in the United Kingdom. Quarterly Journal of Engineering Geology and Hydrogeology, 33, 41-58.

BGS (1988). Geothermal Energy in the United Kingdom: review of the British Geological Survey's Program 1984-1987. British Geological Survey, Keyworth.

Burley, A.J.; Edmunds, W.M.; Gale, I.N.. (1984) Investigation of the geothermal potential of the UK, catalogue of geothermal data for the land area of the United Kingdom. British Geological Survey, 161pp. (WJ/GE/84/020) (Unpublished)

Busby, J., Kingdon, A.; Williams, J. (2011) The measured shallow temperature field in Britain. Quarterly Journal of Engineering Geology and Hydrogeology, 44 (3). 373-387. https://doi.org/10.1144/1470-9236/10-049

Busby, Jon. (2014) Geothermal energy in sedimentary basins in the UK. Hydrogeology Journal, 22 (1). 129-141. https://doi.org/10.1007/s10040-013-1054-4

Busby, Jon; Terrington, Ricky. (2017) Assessment of the resource base for engineered geothermal systems in Great Britain. Geothermal Energy, 5 (1). 18, pp. https://doi.org/10.1186/s40517-017-0066-z

Department for Business, Energy & Industrial Strategy (2021). Build Back Greener. London, UK. ISBN 978-1-5286-2938-6.

Downing, R. A. and Gray, D. A. (eds.) (1986a). Geothermal Energy – The potential in the United Kingdom. HMSO, London

Fellgett, M.; Monaghan, A.A. (2024) User Guide: BGS UK Geothermal Catalogue first digital release, legacy data. Nottingham, UK, British Geological Survey, 32pp. (OR/23/060) (Unpublished).

Lee, M. K., Brown, G. C., Webb, P. C., Wheildon, J. and Rollin, K. E. (1987). Heat flow, heat production and thermo-tectonic setting in mainland UK. Journal of the Geological Society, London, 144, 35-42.

Parker, R. H. (1989). Hot Dry Rock geothermal energy. Phase 2B Final Report of the Camborne School of Mines project, Volumes 1 and 2. Pergamon, Oxford.

Parker, R. H. (1999). The Rosemanowes HDR Project 1983-1991. Geothermics, 28, 603-615.

Rollin, K. E. (1995). A simple heat-flow quality function and appraisal of heat-flow measurements and heat-flow estimates from the UK Geothermal Catalogue. Tectonophysics, 244, 185-196.

Rollin, K. E., Kirby, G. A., Rowley, W. J. and Buckley, D. K. (1995). Atlas of Geothermal Resources in Europe: UK Revision. Technical Report WK/95/07, British Geological Survey, Keyworth.