



DAVID BOON & STEVE THORPE

# BGS tools in ground source heating systems design



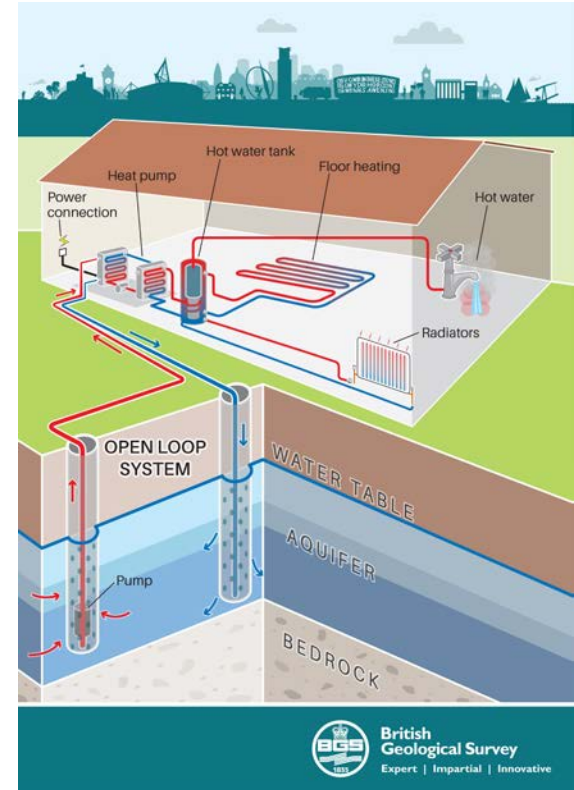
British  
Geological  
Survey

# Overview of today's talk

- Why consider geology in a GSHP project
- What BGS data is available to you
- GeoIndex – your access point
- Other map data
- 3D model data
- Screening Tools
- Dig-To-Share – unlocking more data
- Advanced geomodelling tools for cross sections – Groundhog Desktop

# Why and how to consider geology

- Successful GSHP design requires knowledge of ground conditions: seasonal heat source, geology/soils, thermal properties, hydrogeology, drilling/ground hazards (Artesian, karst voids, ground instability, soil/water contamination, mines, UXO)
- The British Geological Survey (est.1835) is the nations supplier of subsurface **data & information**
- Paper & digital maps (GIS, **Web Map Services**, .3Dpdf), borehole records, **3D models**, technical reports, thematic layers (e.g. superficial thickness).
- **Screening Tool for large Open Loop GSHP**
- **GeoReports** service: borehole prognosis, geology, hydrogeology/expected yield and water chemistry, thermal properties, drilling/geo-hazards





# Research topics at BGS

- ‘Shallow’ (<400m) and ‘Deep’ geothermal energy
- Resource/energy storage potential, source temperature surveys, microbiology, monitoring & system performance
- Thermal and mineralogical properties analysis on cores
- Experimental field research sites: [UKGEOS](#) (TRT-DTS)
- International Research Networks:
  - [IEA HPT](#) - Technology Collaboration Programme on Heat Pumping Technologies (*annual national & International meetings*)
  - [MUSE](#) - *investigates urban shallow geothermal resources and management; 14 European Surveys*
  - [Geothermal-DHC](#) - research Network for Including Geothermal Technologies into Decarbonized Heating and Cooling Grids
  - [BritGeothermal](#) – focus on deep geothermal



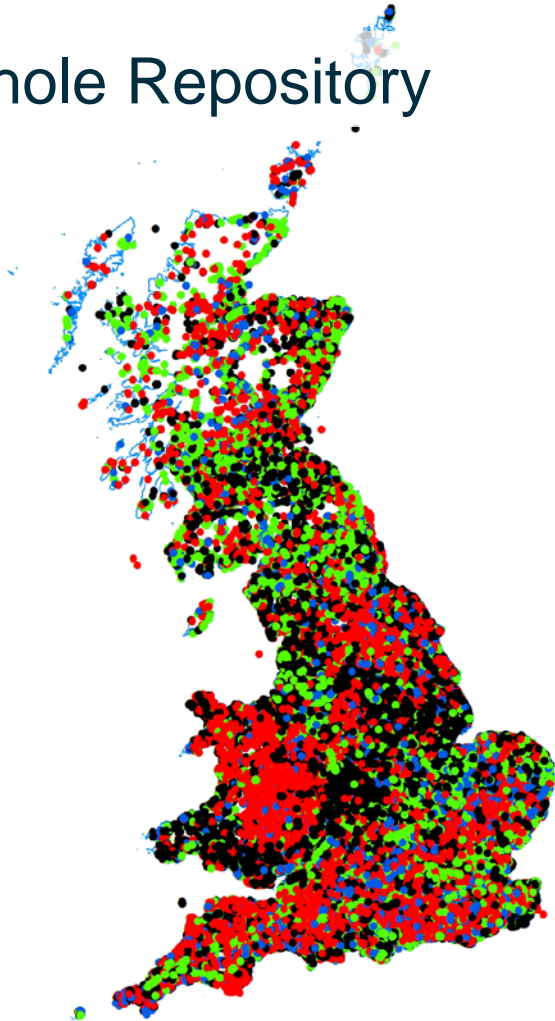
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731166



BGS Data for you

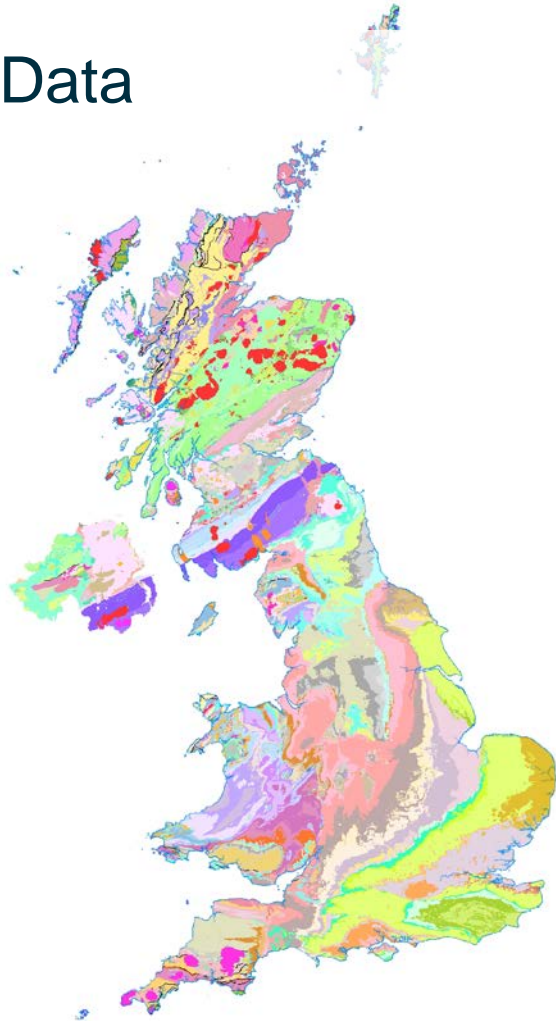


# BGS Borehole Repository



- Boreholes form a large part of BGS' collection
- Key input into Ground Model; geology/lithology, water levels, past experience
- 150 years of data collection.
- Without continued donations the collection loses its effectiveness
- Numerous borehole sources e.g.
  - Drilling companies
  - Water well drilling
  - Geothermal (could we do more together?)
  - Infrastructure projects
- Location, depth, drilling method

# BGS Map Data



- Digital Geological Map of GB - 1:10 000 to 1:625 000 scale
- 4 themes: bedrock, superficial, mass movement, artificial
- DiGMapGB-50
- 1:50 000 product (DiGMapGB-50) has 99% coverage of GB
- 10,000 lithological descriptions





## Data

### Welcome to the Onshore GeoIndex

To begin click on 'ADD DATA' to add a new layer to the map and zoom to a location using the 'Enter location' box.

The Onshore GeoIndex is now mobile friendly, opening with a simplified user interface on a smartphone or tablet.

**ADD DATA**

SHOW LEGEND

# GeoIndex – your first port of call

## Available Layers

Filter by: Topic (All)

- + North Midlands Magnetic: PSGRAV
  - + North Midlands Magnetic: RTP
  - + North Midlands Magnetic: RTP\_1VD
  - + North Midlands Magnetic: TILT
  - + North Midlands Radiometric: KTh
  - + North Midlands Radiometric: POT
  - + Natural England Special Protection Area
  - + Natural England Site of Special Scientific Interest
  - + Natural England National Nature Reserve
  - + Natural England National Park
  - + Natural England Area of Outstanding Natural Beauty
- Surface**
- + Ordnance Survey Terrain 50 DTM
  - + Ordnance Survey Terrain 50 Hillshade
  - + Ordnance Survey Terrain 50 Slope
  - + Ordnance Survey Terrain 50 Aspect
  - + OS Terrain 50 curvature
  - + OS Terrain 50 plan curvature
  - + OS Terrain 50 profile curvature

Click to add/remove map layers







Enter location



Data

Welcome to the Onshore GeoIndex

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ADD DATA

SHOW LEGEND

# GeoIndex – your first port of call



British Geological Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

Version 2.0.0

BGS ID: 233937 : BGS Reference: SK63SW94

British National Grid (27700) : 461000,331440

[Report an issue with this borehole](#)

<< < Prev Page 1 of 2 > Next >>

105

## Norwest Holst Soil Engineering Ltd

Borehole No. SK 63 SW 94 6

Sheet 6100 3/44

Keyworth

Nottinghamshire County Council

Method of Boring Percussion

Depth of Borehole 150mm

Ground Level 62.10

Date 24/8/82

Description of Strata	Legend	Depth Below G.L. (m)	O.D. Level (m)	Casing Depth at Sampling	Sampling and Coring	"N" R.Q.D. %	Case Progress
Firm, brown, silty, sandy, fine rounded, gravelly CLAY with roots	[Symbol]	0.50	61.60		0.50	(50)	
firm orange-brown, silty, fine sandy CLAY.	[Symbol]						
brown and grey-green, clayey, slightly silty, highly to completely weathered MUDSTONE, stiff to very weak, very highly fractured, (Zone III/IVa Keuper Marl).	[Symbol]	1.85	60.25		1.50	(61)	
	[Symbol]				2.50	(80)	
	[Symbol]				4.00	(100)	





## Data

Welcome to the Onshore GeoIndex

To begin click on 'ADD DATA' to add a new layer to the map and zoom to a location using the 'Enter location' box.

The Onshore GeoIndex is now mobile friendly, opening with a simplified user interface on a smartphone or tablet.

ADD DATA

SHOW LEGEND

# GeoIndex – your first port of call

Filter by: Topic (All) ▾

### Available Layers

Boreholes

- + Borehole scans [?](#)
- + AGS Boreholes [?](#)
- + Opencast coal prospecting sites [?](#)
- + Water wells [?](#)
- + Site investigation reports [?](#)
- + Drillcore [?](#)
- + Samples [?](#)
- + Onshore hydrocarbon wells [?](#)
- + Geophysical logs [?](#)
- + Well water levels [?](#)
- + Aquifer properties [?](#)
- + Geochemistry [?](#)

Deposited Data

- + Deposited Data – point locations [?](#)
- + Deposited Data – polygon locations [?](#)

Digital geological map data 25000 scale

- + Digital geological map data 25000 scale [?](#)
- + Classical areas geological maps 25000 scale [?](#)
- + Digital geological map data 10000 scale [?](#)
- + Paper national grid maps 10000 scale [?](#)
- + County maps 6inch [?](#)
- + Technical reports [?](#)

Photographs

- + Geoscenic Photos [?](#)

Hydrogeology

- + Hydrogeology 1:625,000 scale [?](#)

Hydrogeology Wales

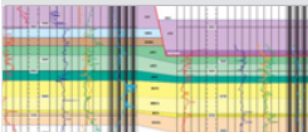
- + Groundwater Vulnerability Wales: Superficial Deposits [?](#)
- + Groundwater Vulnerability Wales: [?](#)

Click to add/remove map layers



Processing time of data deposited through the portal is likely to be delayed due to the current situation surrounding the coronavirus, please bear with us during this challenging time.

Our data



Data search

Our products

OpenGeoscience

Earthwise

National Geological Repository

National Geoscience Data Centre

NGDC index

Cited data

Data management

Deposit data

Depositing and accessing AGS and geotechnical data

National Hydrocarbons Data Archive

Premium data services

Data licensing

## Deposit data with NGDC

The **National Geoscience Data Centre** (NGDC) collects and preserves geoscientific data and information, making them available to a wide range of users and communities. NGDC is recognised as the NERC Environmental Data Centre for geoscience data.

Please use the NGDC data deposit application (portal) to deposit digital files with NGDC.

### NGDC Data Deposit Portal

Data donations should comply with the following NGDC terms and conditions and guidelines:

- NGDC terms and conditions 372 KB pdf
- NGDC remit
- Good data deposit guidelines
- Acceptable formats list
- NGDC data value checklist 92.2 KB pdf
- Depositing sample analysis data 406 KB pdf
- Data sharing agreements

The benefits of depositing your data with NGDC are:

- We are a long standing, funded NERC Environmental Data Centre
- We provide professional accession, ingestion and data management
- Our data contribute to a national geoscience resource
- We undertake secure data storage and long term digital data continuity
- Our data are accessible via multiple delivery channels
- We provide persistent identifiers and digital object identifiers (DOIs) supporting scientific publication

If you have AGS files to submit you can now pre-validate them [using this facility](#).

### Contacts

For further details, please contact [ngdc@bgs.ac.uk](mailto:ngdc@bgs.ac.uk).



# Depositing Data

- BGS readily accepts any form of data
- Most data is boreholes and this can be in reports or digital data
- Simple process to send us your data using our portal
- All we ask is that you provide some information about the data to make it useful to others

#### geotechnical data

- NGDC contacts
- Relocating UKCS core

#### External links

- NERC Open Research Archive (NORA)
- The Association of Geotechnical and Geoenvironmental Specialists (AGS)
- Oil and Gas Data UK
- International Organization for Standardization (ISO)
- The National Archives
- Nuclear Decommissioning Authority (NDA)
- UK Carbon Capture & Storage Research Centre (UKCCSRC) Archive

#### Share this page

<https://www.bgs.ac.uk/services/ngdc/guidelines.html>



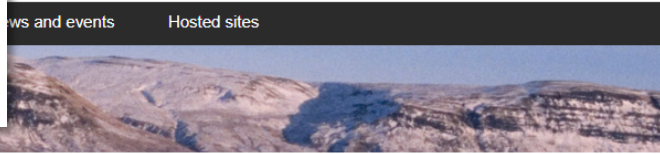
BGS DATA

GeoIndex provides  
access to many of BGS'  
data



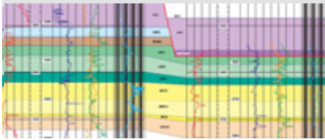


# “Traditional” Map Data



Home > Our data > OpenGeoscience > Maps > Geological Survey of England and Wales 1:63,360/1:50,000 geological map series, New Series > Map record details

## Data



OpenGeoscience

BGS maps portal

Quick links

Latest available published 1"/1:50 000 maps

Most recently published England and Wales 1"/1:50 000 maps

Most recently published Scotland 1"/1:50 000 maps

## Maps by region

Great Britain

England and Wales

Scotland

Ireland, up to 1905 only

Small scale (non-series) maps

## Maps by subject

Geological maps

Geological sections

Geophysical maps

Geochemistry

Hydrogeology

Small scale (non-series) maps

## Map record details

Map series	Geological Survey of England and Wales 1:63,360/1:50,000 geological map series, New Series
Sheet number	126
Sheet title	Nottingham.
Map type	Solid and Drift
Scale	1:63 360
Publication year	1954
Author statement	Original Geological Survey on the one-inch scale by W.T. Aveline. E. Hull. T.R. Polwhele. W.H. Holloway, and A.J. Jukes-Browne. Published on Sheets 71 N.E. (1858, additions 1879), 71 S.E. (1855, additions 1879), and 70 (1886). Old Series. Resurveyed on the six-inch scale in 1903-5, by B.S.N. Wilkinson, G.W. Lamplugh, W. Gibson, W.B. Wright, and R.L. Sherlock. C. Fox-Strangways and G.W. Lamplugh. F.R.S. District-Geologists.
Published statement	Published with Drift 1908. Reprinted 1954. Print code: 750/54.
View map	<a href="#">View map</a>   <a href="#">Buy direct from BGS Bookshop</a>   <a href="#">Request a paper map or scanned copy</a>

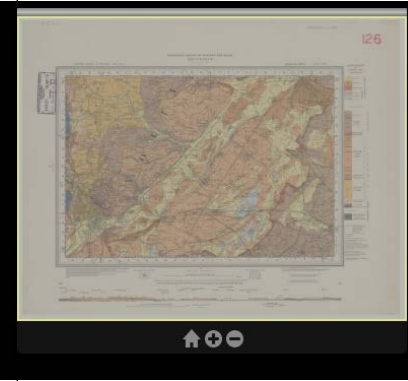
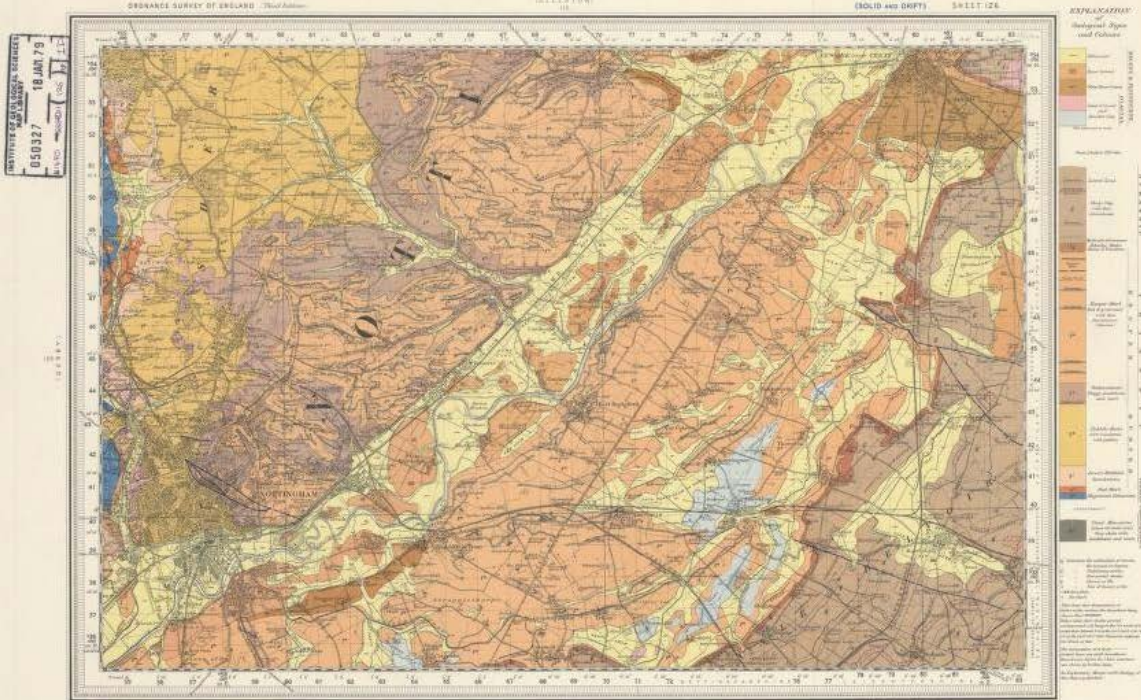
## Terms of use

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Please be aware that separate terms will be supplied with digital or hard copy versions of the map purchased via the BGS Bookshop.

GEOLOGICAL SURVEY OF ENGLAND AND WALES.  
NOTTINGHAM

(SOLID AND DRIFT) S.S. 126

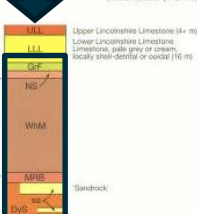


- Different vintages & scales
- Different types – eg. Bedrock & Drift, Superficial
- Different geological terms & stratigraphy.
- For up-to-date terminology please refer to BGS Lexicon
- Faults and structure
- Cross sections





PERMIAN TO JURASSIC  
Scale 1:2000 (1 cm to 20 m)



UPPER LINCOLNSHIRE LIMESTONE (U+)  
Upper Lincolnshire Limestone (U+)  
Lower Lincolnshire Limestone (L-), pale grey or cream, locally shell-strewn or oolitic (16 m)

GRANTHAM FORMATION (GrF)  
Mudstone, grey, minor sandstone (4 m)

NORTHAMPTON SAND FORMATION (NS)  
Sandstone, grey, ferruginous (4 m)

WHITBY MUDSTONE FORMATION (WhM)  
Mudstone, pale grey or blue-grey, micaceous (20 m)

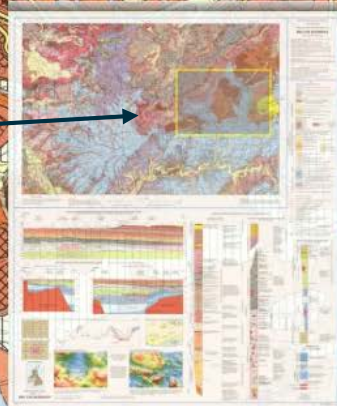
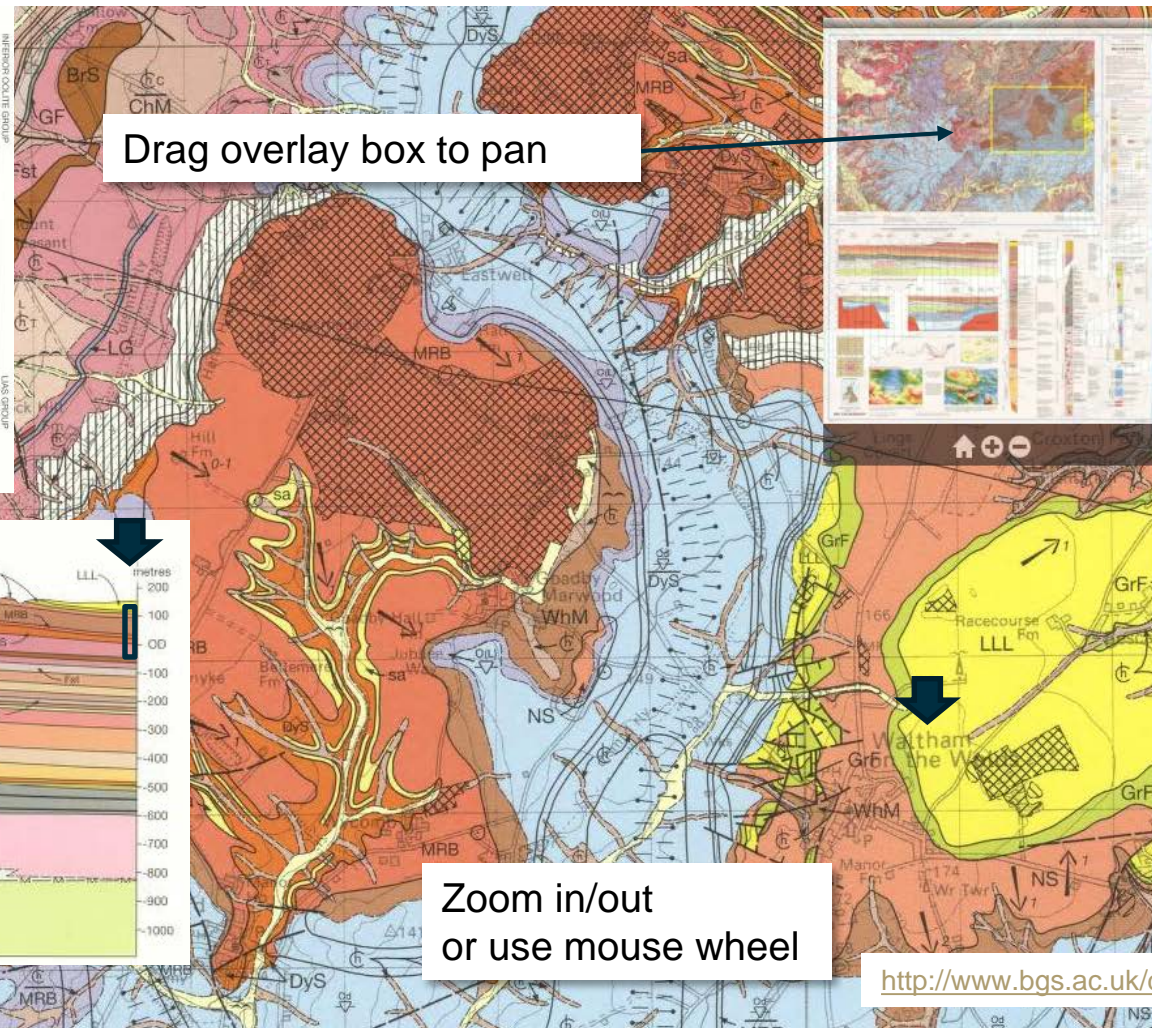
SANDROCK (MRB)  
Sandstone, grey, micaceous, topsoiliferous with beds of sandstone (4 m to 25 m)

MARLSTONE ROCK FORMATION (MRr)  
Thin-grained, brown, fine-grained, oolitic, fossiliferous (1-5 m)

DYPSAM FORMATION (Dys)  
Siltstone, grey, micaceous, topsoiliferous with beds of sandstone (4 m to 25 m)

CHARMOUTH MUDSTONE FORMATION (ChM)  
Mudstone, grey, with sporadic thin sandstones and sandstones (pinnacled, or all). Phosphate nodules (p) scattered locally (see also limestone nodules (ln) concentrated in certain beds) (1 to 150 m)

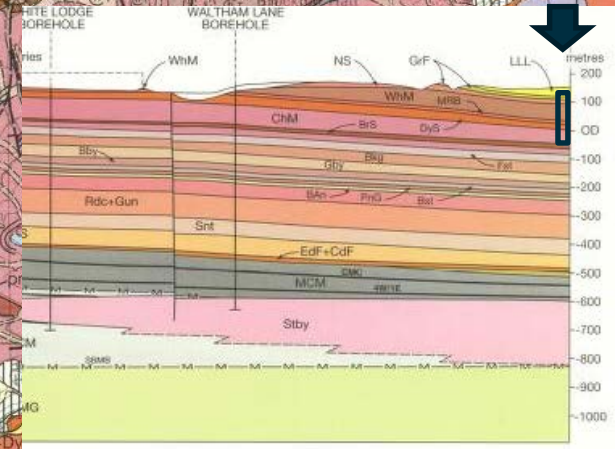
Drag overlay box to pan



At 1:50 000 scale map feature accuracy is >50m!

Also check 1:10 000 scale maps if available as more accurate and detailed!

If it looks structurally complicated ask a qualified geologist



Zoom in/out or use mouse wheel

<http://www.bgs.ac.uk/data/maps/>





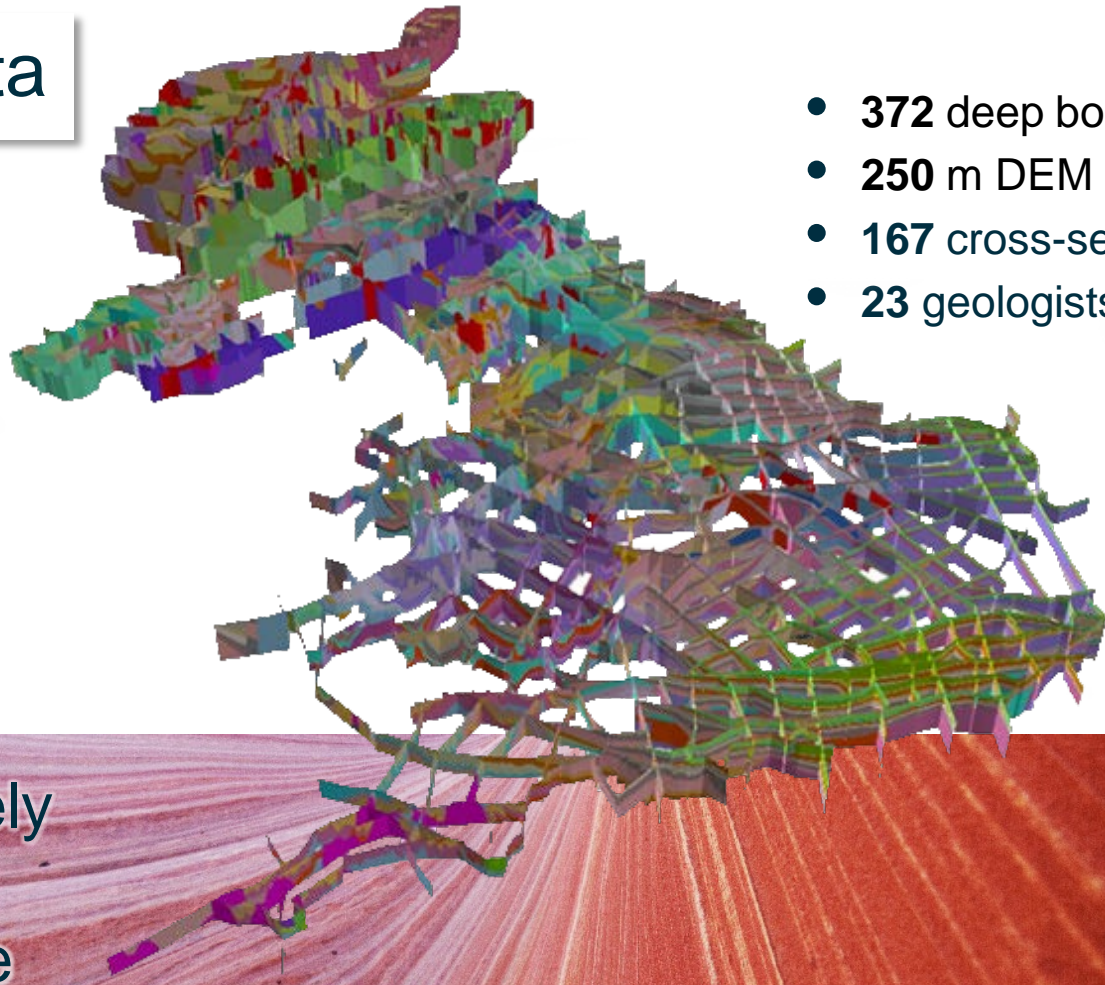
BGS – NOT JUST ABOUT MAP DATA

We work hard to make our  
data available in the 3<sup>rd</sup>  
dimension



# 3D Model Data

- **625 000** SCALE
- **20,000** LINE-KM
- **6000** M
- **445** UNITS

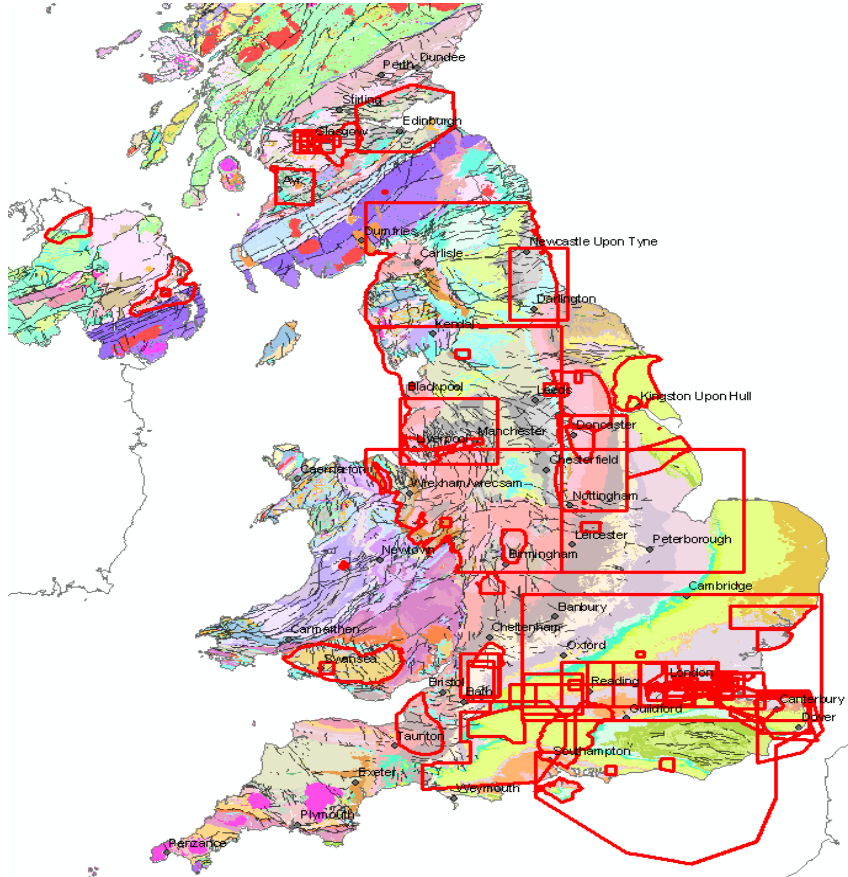


- **372** deep boreholes
- **250** m DEM
- **167** cross-sections
- **23** geologists

- UK3D is freely available via BGS website

<https://www.bgs.ac.uk/research/ukgeology/nationalGeologicalModel/GVModels.html>

# Model Approval & Licensing

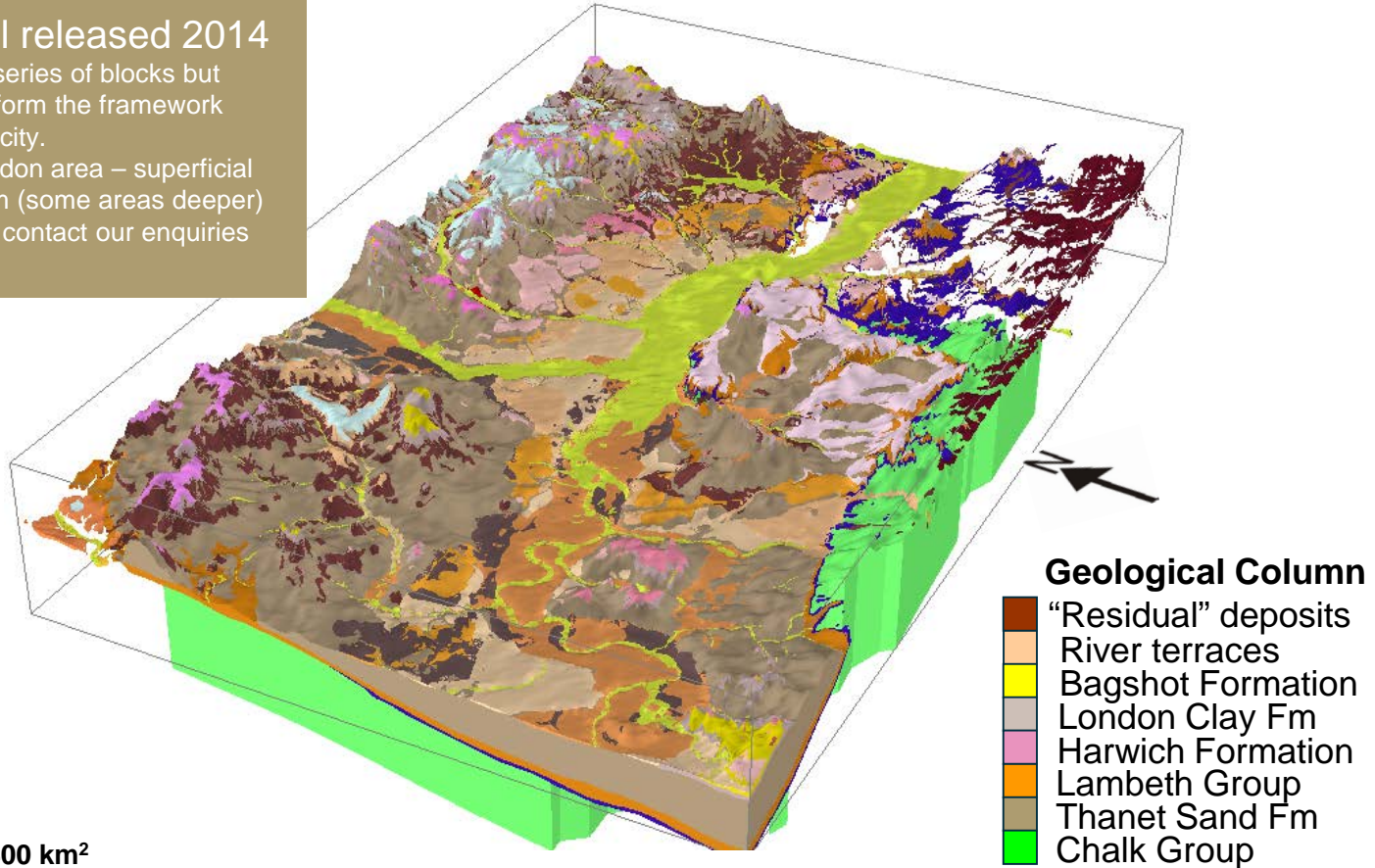


- In 2004 BGS began collating all 3D Model data
- QA processed
- Some models available for licensing
- Range of scales, purposes, geology
- This data will soon be available on the GeoIndex
- Plans to make some key 3D data interactive

# Catchment/Urban scale models

## London Model released 2014

Originally built as a series of blocks but stitched together to form the framework model of our capital city.  
Main geology of London area – superficial and bedrock to 150m (some areas deeper)  
Available to licence, contact our enquiries team



2400 km<sup>2</sup>



# Brownfield Applied Example

## Smaller site-scale modelling

In conjunction with United Utilities to provide assessment of sewer leakage risk under industrial park

Provides a scoring system for depth of pipe and geology surrounding the sewer to assess the risk to the aquifer.

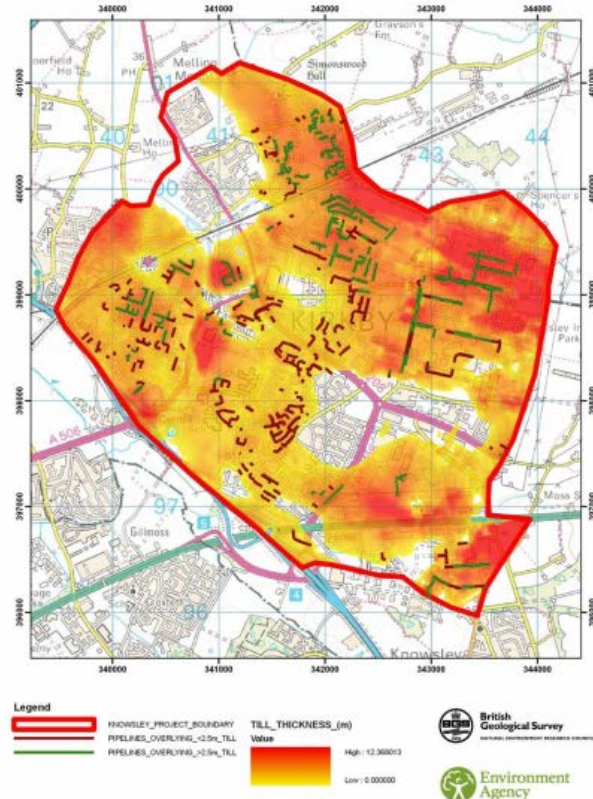
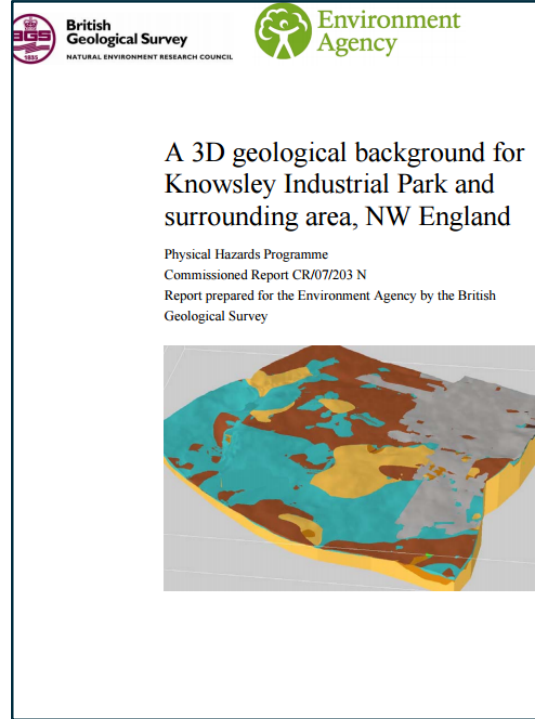
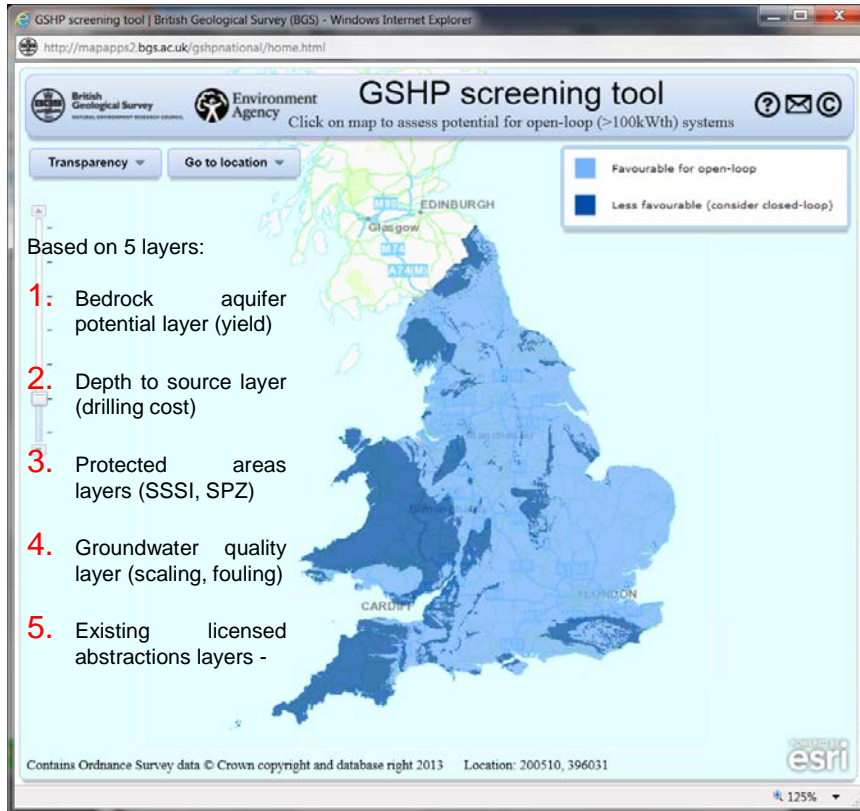


Figure 13 Pipeline segments that lie above or within Till compared to Till thickness. Pipeline thickness schematic only



# Open Loop Screening Tool (aimed at >100kW schemes)



- <https://www.bgs.ac.uk/research/energy/geothermal/gshp.html>
- 'Favourable' = Aquifers are present within 300m of surface with yields per borehole of at least  $1 \text{ L s}^{-1}$
- 1:250,000 scale (1:50,000 West Midlands)
- Initial screening assessment only (for larger >100kW heating capacity schemes)
- Actual projects require site-specific assessments of the underlying geology and expected yields, as available from BGS' GSHP GeoReports (<https://shop.bgs.ac.uk/georeports/>) and geological/hydro consultancies

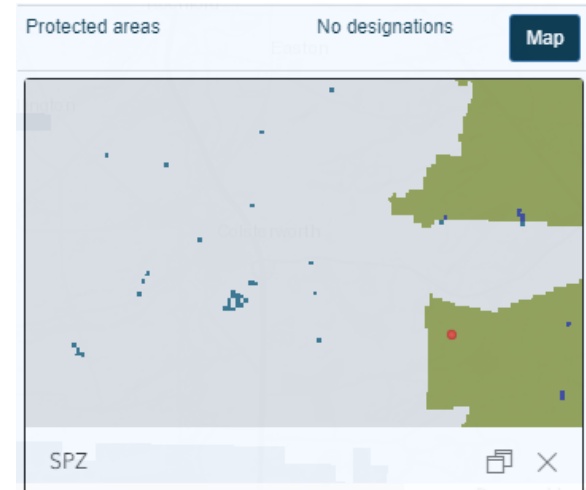
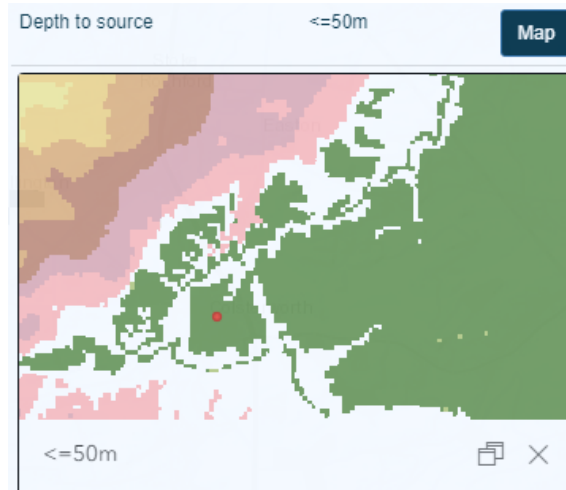
# Open Loop Screening Tool: Example

The screenshot displays the 'GSHP Screening Tool' interface. At the top left, the logos for BGS and Environment Agency are visible. The main map area shows a geographical region with various towns and villages labeled, including Langar, Kettlewell, Waltham on the Wolds, and Melton Mowbray. A blue-shaded area represents the screened region. On the left side, there is a zoom control and a transparency slider. On the right side, a sidebar titled 'GSHP data layers' lists several criteria and their results:

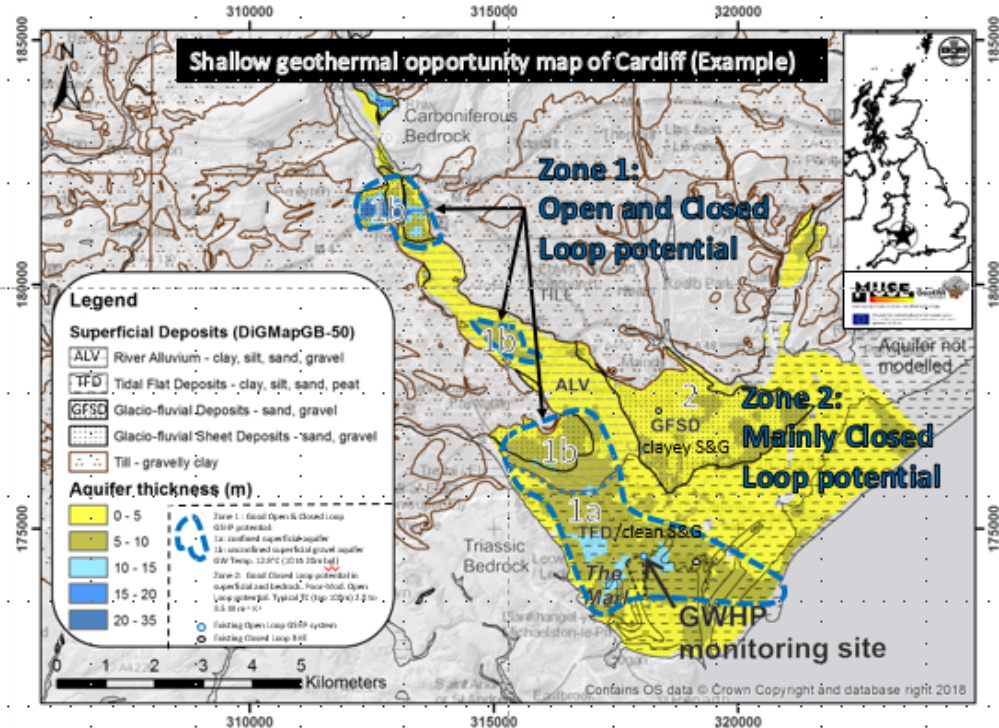
GSHP data layers	
GSHP viability screening layer	Favourable
Bedrock aquifer potential	Good aquifer (>6 l/s) at outcrop <a href="#">Map</a>
Depth to source	<=50m <a href="#">Map</a>
Protected areas	No designations <a href="#">Map</a>
Existing licensed abstraction (per day per licence)	none found
<b>Groundwater chemistry</b>	
Langelier saturation index	none found
Ryznar stability index	none found
Larson-Skold corrosive index	none found
Iron	none found

At the bottom of the sidebar, there is a button that says 'Please see help for details'. The bottom of the map area shows the text 'Esri UK, Esri, HERE, Garmin, USGS, NGA'.

# Open Loop Screening Tool: Sub layers



# Future? Closed & Open Loop Screening at City-Scale



- ‘Opportunities map’ aimed at energy-town planners, consultants
- Based on 3D geology models; translated for GSHP relevance
- 1:50 000 scale equivalent
- Typical range TC in top 100m
- Locate existing schemes (MCS)
- Map against heat demand
- Designs need to be informed by proper site investigations! (desk study & walkover, test drilling, TRT, pump tests, local experience)



# Groundhog Desktop

- Groundhog available to download from BGS website
- Comes shipped with connections to BGS open data
- Download AGS data
- Allows imports/exports to numerous popular formats
- Cross-section drawing provide tools for developing conceptual understanding

Map 1

Workspace | Library | Time | Help

Workspace

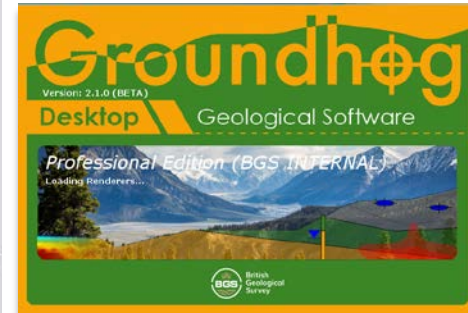
- Site / Project
- Models
- System Objects
- BGS Objects

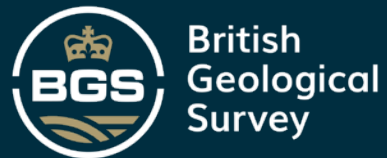
BGS internal-version specific objects

Identify Results

TERMS_OF_USE	©NERC, Open Government Licence
SHEET	EW142_MELTON_MOVBRAV
MIN_TIME_D	RIHAETIAN
BGSREF_FH	630
MAX_PERIOD	TRIASSIC
SETTING_D	lakes
SETTINGPLUS_D	Null
TYPE_D	sedimentary bedrock
LEX_RCS	BAN-MDST
LEX_RCS_D	BLUE ANCHOR FORMATION - MUDSTO...
MAX_TIME_D	WORLDW
FLUTHER_INFO	<a href="http://www.bgs.ac.uk/products/digitalmaps/">www.bgs.ac.uk/products/digitalmaps/...</a>
ENVIRONMENT_D	These sedimentary rocks are lacustrin...
NOM_BGS_VR	2000
@BGS_SoL_Bedrock OBJECTID	171253
BROAD_D	mudstone
LEX_RCS_I	12301299_BAN-MDST

X: 468282.43 Y: 333590.43 Z: [SK635E - SK6833] [1:50000.0] Use SHPT to preview objects





THANK YOU

Any questions?

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[sthorpe@bgs.ac.uk](mailto:sthorpe@bgs.ac.uk)

