OR/19/032 Geology

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Site location

The Glasgow Geothermal Energy Research Field Site is located on the western side of the Central Coalfield of the Midland Valley of Scotland. It is located within glacial and post-glacial Quaternary superficial deposits overlain by a variable thickness of artificial (made) ground. These deposits rest on approximately 300 m of Scottish Coal Measures Group bedrock. Underlying this are the older Carboniferous strata of the Clackmannan and Strathclyde groups, which are hundreds of metres thick. The prior industrial land use has left a legacy of abandoned, flooded mine workings and a variety of artificial ground forming the current land surface.

Quaternary geology

A complex succession of Quaternary superficial deposits covers the research area, including widespread glacial till and marine, lacustrine and fluvio-glacial deposits, overlain by fluvial deposits, recent alluvium and anthropogenic (man-made) deposits.

The Quaternary deposits are of variable thickness, up to 30 m. The upper surface of bedrock is incised, with thicker accumulations of superficial deposits infilling a broadly NW–SE trending channel following the modern day River Clyde. There is widespread made, filled and landscaped ground relating to a variety of prior industrial land use, in some places this is 10–15 m thick. Table 1 summarises the sequence.

Table 1 Summary of superficial deposits and artificial ground sequence in the Clyde Gateway area.

Code	Equivalent description on 1:10 000 scale published map
Water	Unattributed polygons
Made Ground	Made Ground, Made Ground and Worked Ground, Infilled Ground
Peat	Peat — blanket or basin peat, Flandrian
Law Sand and Gravel Member	Alluvium — modern river floodplains — located along the upper reaches and tributaries to the River Clyde, Flandrian. Also includes some Alluvial Fan Deposits, Flandrian and some River Terrace Deposits, Flandrian.
Gourock Sand Member	Marine Deposits — located along the lower reaches of the River Clyde, Flandrian and Alluvium — modern river floodplains — along the upper reaches of the River Clyde, Flandrian
Killearn Sand and Gravel Member	Generally Raised Marine Deposits, Devensian, Raised Marine Deltaic Deposits, Devensian or Raised Marine Intertidal and Subtidal Deposits, Devensian
Paisley Clay Member	Generally Raised Marine Deposits, Devensian or Raised Marine Intertidal and Subtidal Deposits, Devensian
Bridgeton Sand Member	Largely concealed beneath younger deposits, where present, exposures usually represented as Raised Marine Deposits, Devensian

Ross Sand Member	Glaciolacustrine Deposits, Devensian Glaciolacustrine Deltaic Deposits, Devensian or Glaciofluvial Deposits, Devensian
Ross Sand Member (silt, sand)	Largely concealed beneath younger deposits, identified at depth from borehole data, rare exposures represented as Glaciolacustrine Deposits, Devensian or Glaciolacustrine Deltaic Deposits, Devensian
Broomhouse Sand and Gravel Formation (sand and gravel)	Largely concealed beneath younger deposits, where present, exposures usually represented as Glaciofluvial Deposits, Devensian, but also as Glaciofluvial Ice-Contact Deposits, Devensian
Broomhouse Sand and Gravel Formation (sand)	Not recorded on the maps in the Clyde Gateway area (concealed beneath younger deposits), identified at depth from borehole data
Wilderness Till Formation	Till — Devensian
Cadder Sand and Gravel Formation	Generally concealed beneath younger deposits, identified at depth from borehole data, rare exposures represented as Glaciofluvial Deposits, Devensian

The precise relationships between the Quaternary deposits are complex, varying laterally and vertically across short distances (Figure 4), making extrapolation difficult in areas where borehole data are sparse or absent. For that reason, both interpretative and stochastic modelling has been undertaken.

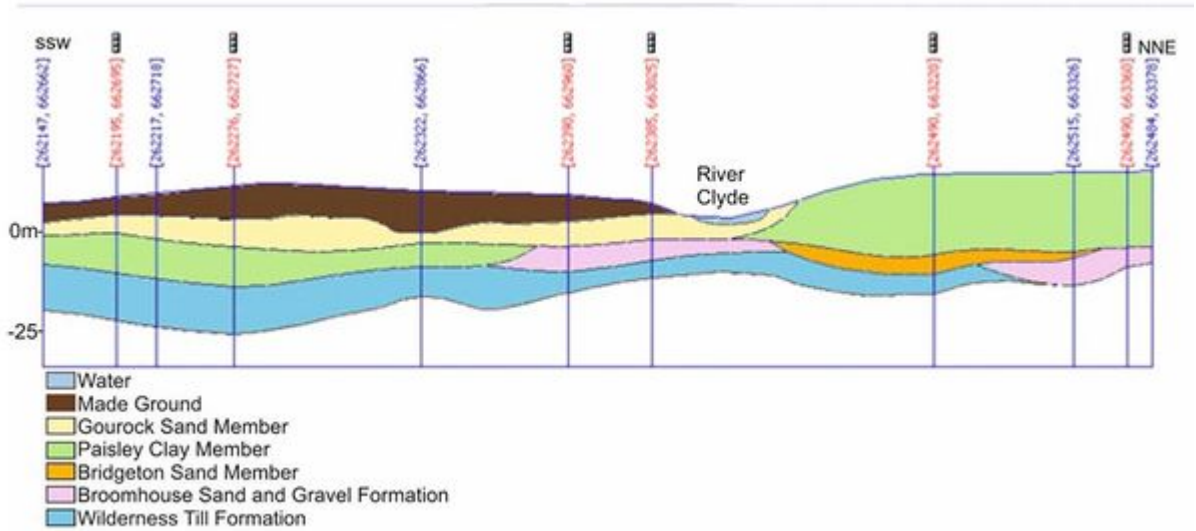

Figure 4 Example SSW–NNE cross-section of superficial deposits in the vicinity of the research site. Vertical exaggeration x 3. Borehole constraint points shown in red. Ground surface derived from NEXTMap Britain elevation data from Intermap Technologies.

Further information is available from Kearsey et al. (2015)[1], Monaghan et al. (2013)[2], Monaghan et al. (2017)[3], Arkley (2018)[4].

Bedrock geology

Geological maps and borehole data are available to view on the BGS GeoIndex Onshore. Data from mine abandonment plans includes extent, depth, working type, faults etc. for the stack of seven worked coal seams. The mine workings date from 1810–1934 with total extraction and stoop and room workings shown. It is expected that total extraction areas collapsed within a few years of mining to form a waste, and that the mines will be flooded.

Bedrock strata that will be accessed by the facility are the Scottish Upper, Middle and Lower Coal Measures formations of the Westphalian Scottish Coal Measures Group (e.g. Table 2; Figure 5).

These lithologically variable sedimentary rocks are well documented by borehole records and correlated using coal seams and marine bands.

Analysis of borehole, mine abandonment plan, map and legacy 2D seismic data to the north- east of the Clyde Gateway shows gently folded synclinal structures dissected by faults on a range of orientations (Figure 6). To the southeast of the study area the NW–SE trending Dechmont Fault is a major basin-bounding structure. E–W trending structures such as the Rutherglen, Shettleston and Great Dyke faults dissect the succession with smaller NNE to N trending structures.

Table 2 Approximate predicted depths to mined coals and stratigraphic boundaries at one of the proposed borehole locations (GGERFS01).

Approximate predicted depth relative to OD, metres, Location 01	**Stratigraphy**
-34	Glasgow Upper Coal (workings)
-66	Glasgow Ell Coal (workings)
-72	Glasgow Main Coal (workings)
-91	Humph Coal (workings)
-100	Glasgow Splint Coal (workings)
-104	Virgin Coal
-123	Airdrie Blackband Coal
-161	Airdrie Virtuewell
-167	Kiltongue Coal (workings)
-177	Base Coal Measures Group

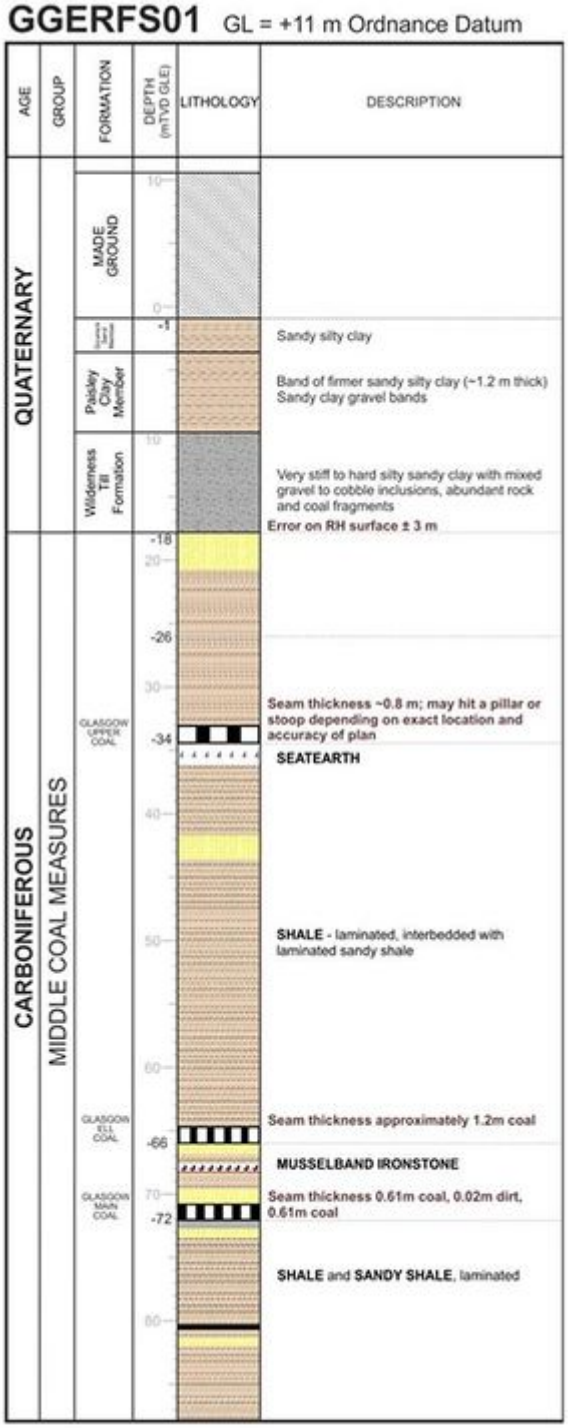

Figure 5 Borehole prognosis for site 01 based on surrounding borehole records, mine abandonment plans and BGS 3D modelling (2018 model version). Yellow indicates sandstone, black and white fill indicates mined coal seams.

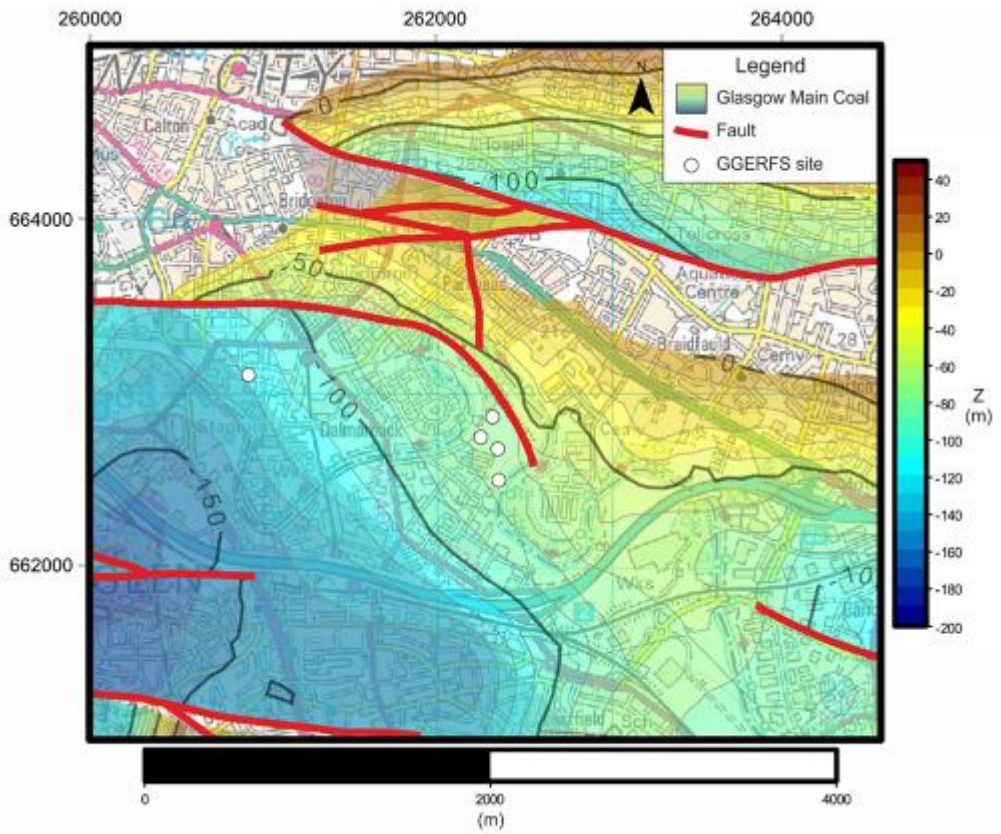

Figure 6 Contoured depth grid (m relative to Ordnance Datum) for the base of Glasgow Main Coal, horizon exported from the geological model as described in Burkin & Kearsey (2018)[5]. Contains Ordnance Survey data © Crown copyright and database rights. All rights reserved [2019] Ordnance Survey [100021290 EUL].

Further information available from: BGS (2007)[6], Monaghan et al. (2013), Monaghan et al. (2017)[3], Burkin and Kearsey (2018)[5].

Geological models

BGS has updated 3-dimensional geological framework models of the superficial and bedrock geology (see also Figure 3, 6), integrating a wide range of available data and knowledge. These models are currently progressing through a quality control system and will be released shortly. They will be continually updated as new data emerges during borehole drilling. Stochastic models of the superficial deposits also exist (e.g. Kearsey et al., 2015[1]). The geological framework models form the basis for mine, hydrogeological and thermal models.

References

1. ↑ [1.0] [1.1] KEARSEY, T, WILLIAMS, J, FINLAYSON, A, WILLIAMSON, P, DOBBS, M, MARCHANT, B, KINGDON, A, and CAMPBELL, S.D. 2015. Testing the application and limitation of stochastic simulations to predict the lithology of glacial and fluvial deposits in Central Glasgow, UK. *Engineering Geology*, 187. 98–112. 10.1016/j.enggeo.2014.12.017.
2. ↑ MONAGHAN, A A, ARKLEY, S L B, WHITBREAD, K, and MCCORMAC, M. 2013. Clyde superficial deposits and bedrock models released to the ASK Network 2014: a guide for users Version 3. *British Geological Survey Open Report, OR/14/013*. 35pp. http://nora.nerc.ac.uk/id/eprint/505554/

3. ↑ [3.0] [3.1] MONAGHAN, A A, Ó DOCHARTAIGH, B, FORDYCE, F, LOVELESS, S, ENTWISLE, D, QUINN, M, SMITH, K, ELLEN, R, ARKLEY, S, KEARSEY, T, CAMPBELL, SDG, FELLGETT, M, and MOSCA, I. 2017. UKGEOS — Glasgow Geothermal Energy Research Field Site (GGERFS): Initial summary of the geological platform. *British Geological Survey Open Report, OR/17/006*. 205pp. http://nora.nerc.ac.uk/id/eprint/518636/
4. ↑ ARKLEY, S. 2018. Model Metadata Report for the Glasgow Geothermal Energy Research Field Site Superficial Deposits Model. *British Geological Survey Open Report, OR/18/064*. 54pp.
5. ↑ [5.0] [5.1] BURKIN, J, and KEARSEY, T. 2018. Model metadata report for the GGERFS initial bedrock model *BGS Open Report OR/18/053*. http://nora.nerc.ac.uk/id/eprint/522737
6. ↑ BRITISH GEOLOGICAL SURVEY, 2007. 1:10 000 scale superficial deposits map of NS66SW.

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