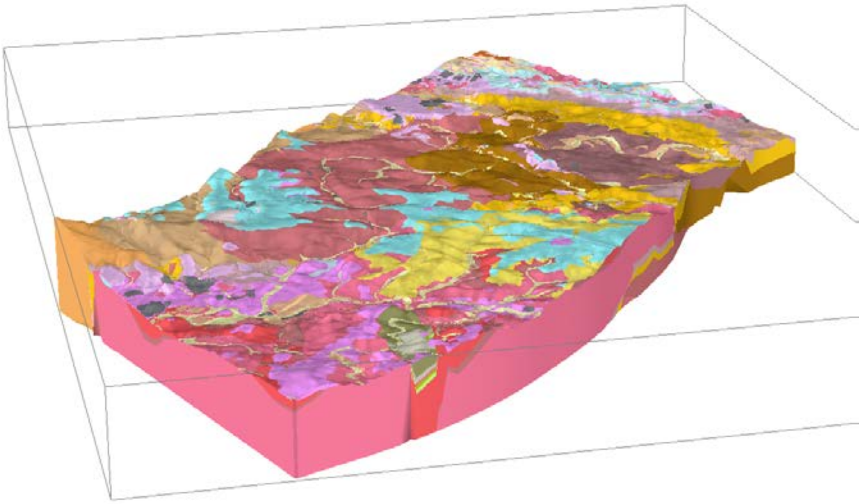
GSI3D Model metadata report for HS2 Area 6 (Cubbington to Hampton-in-Arden)

GEOLOGY AND REGIONAL GEOPHYSICS PROGRAMME

Open Report OR/15/044



BRITISH GEOLOGICAL SURVEY

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GSI3D Model metadata report for HS2 Area 6 (Cubbington to Hampton-in-Arden)

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Keywords

Report; GSI3D, High Speed 2; HS2.

National Grid Reference

NE corner 416305,280644
SE corner 439561,270841

Front cover

3D view of Area 6 model from north-west, 10x exaggeration

Bibliographical reference

WAKEFIELD, O J W, BARRON, A J M 2017. GSI3D Model metadata report for HS2 Area 6 (Cubbington to Hampton-in-Arden). *British Geological Survey Open Report*, OR/15/044. 25pp.

Keyworth, Nottingham British Geological Survey 2017

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Summary

This report describes the 3D geological model of HS2 (High Speed 2 rail link) Area 6, created by Oliver Wakefield with support from Steve Thorpe and Ricky Terrington. The model was created as part of a set of nine geological models that cover the proposed HS2 rail route from the end of the HS2 London model to Birmingham and the West Coast Main Line near Lichfield. The models were funded from the NERC/BGS Science Budget to promote BGS modelling and geological interpretation services to this important infrastructure project and to test methodologies and procedures for creating geological models by multiple compilers.

The report describes the model construction and purpose, with spatial limits and scale, sources of information, data processing, workflow, decisions, assumptions, rules and limitations, together with images of the model.

1 Modelled Volumes, Purpose and Scale

The model purpose was to model the bedrock, superficial and artificial ground following the proposed High Speed Rail link between London and Birmingham (HS2). This model area covers a 25 km section of the route, between Birmingham, Coventry and Warwick in the Warwickshire Coalfield (Figure 1). The model comprises the bedrock geology, superficial deposits and artificial ground of Area 6. This is one of an initial group of nine models along the planned route. The model is suitable for use at scales between 1:100 000 and 1:10 000 to a depth of 30 m below Ordnance Datum (OD).

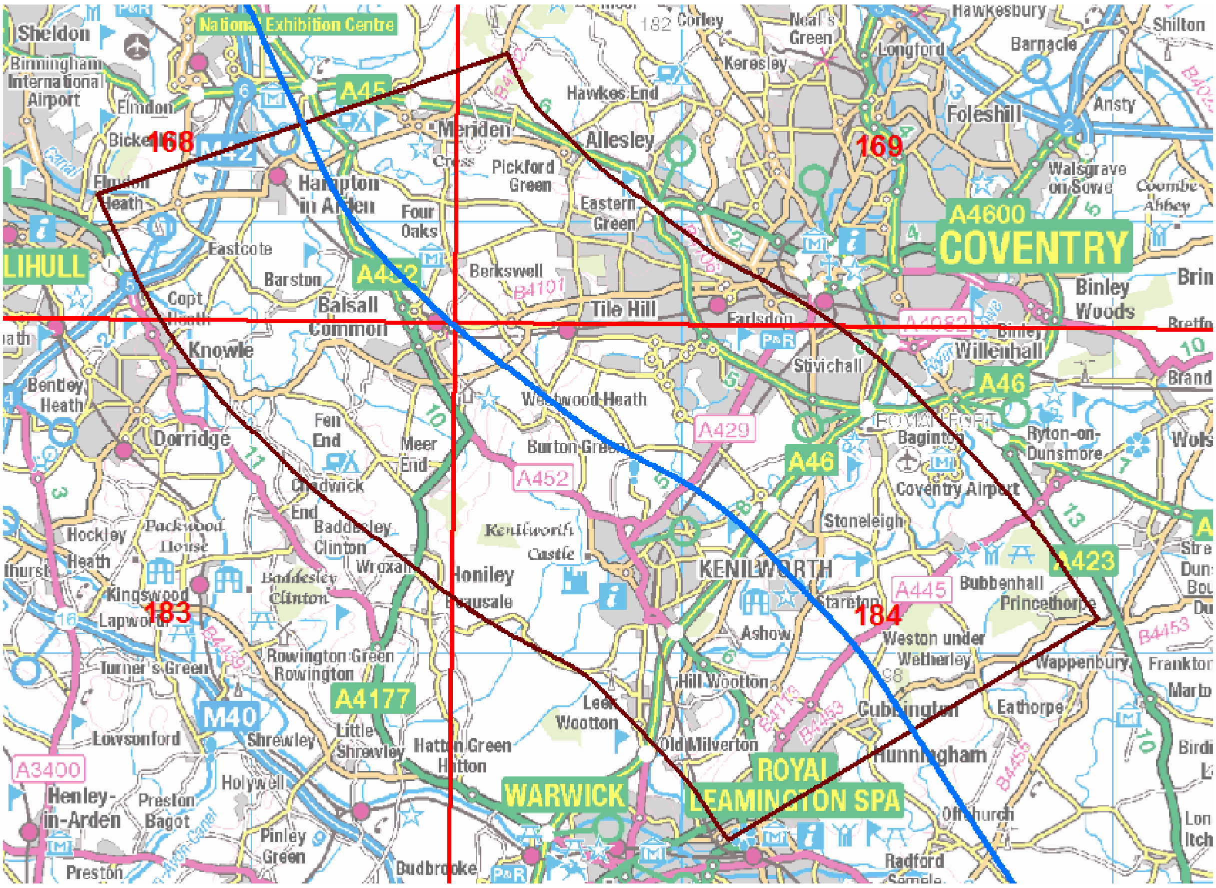

Figure 1 Location of the model area outlined in black, with the proposed HS2 route shown in blue. BGS 1:50,000 scale map sheet areas are shown in red.

2 Modelled Surfaces/Volumes

The modelled bedrock, superficial and artificial deposits are listed in Table 1 in the relative stratigraphic order used in the model. Brief descriptions of the geological units are given here, but more detail can be found in the BGS Lexicon of Named Rock Units. The level of detail and extent of the natural geology in the model may differ from that shown in other BGS datasets. Artificial ground was modelled according to the corresponding 1:50,000 scale geological maps. Table 1 should be used as the legend for viewing images of the model in this report

Table 1. List of geological units modelled

Name (LEX-RCS)	Lex Description	Lithology	Comment
WMGR-ARTDP	Worked and Made Ground	Artificial Deposits	
MGR-ARTDP	Made Ground	Artificial Deposits	
WGR-VOID	Worked Ground	Void	
ALV-XCZSV	Alluvium	Clay, silt, sand and gravel	
HEAD-XCZSV	Head	Clay, silt, sand and gravel	
PEAT-P	Peat	Peat	
RTD1-XSV	River Terrace Deposits 1	Sand and gravel	
RTD2-XSV	River Terrace Deposits 2	Sand and gravel	
RTD3-XSV	River Terrace Deposits 3	Sand and gravel	
RTD4-XSV	River Terrace Deposits 4	Sand and gravel	
TILMP1-DMTN	Till Mid Pleistocene	Diamicton	Added for outlier on GFDMP at Balsall Common
GFTMP-XSV	Glaciofluvial Terrace deposits Mid Pleistocene	Sand and gravel	In north only
GFDMP-XSV	Glaciofluvial deposits Mid Pleistocene	Sand and gravel	
DMG-XSV	Dunsmore Gravel Member, Wolston Glacigenic Formation	Sand and gravel	
GLLMP1-XCZ	Glaciolacustrine deposits Mid Pleistocene	Clay and silt	[UPPER UNIT ADDED BY ILC]
TILMP-DMTN	Till Mid Pleistocene	Diamicton	Includes much ODT
GFDMP0-XSV	Glaciofluvial deposits Mid Pleistocene	Sand and gravel	Unit beneath TILMP added by ILC, restricted to north of area
GLLMP-XCZ	Glaciolacustrine deposits Mid Pleistocene	Clay and silt	Very small outcrops only
ODT-DMTN	Oadby Member, Wolston Glacigenic Formation	Diamicton	Now restricted to small outcrops in extreme south of area. Remainder to TILMP
WOC1-XCZ	Wolston Clay Member, Wolston Glacigenic Formation	Clay and silt	Upper unit added by ILC, restricted to south-east of area
WOSG-XSV	Wolston Sand and Gravel	Sand and gravel	restricted to south of area, now Wigston Sand and Gravel Member, Wolston Glacigenic Formation
WOC-XCZ	Wolston Clay Member, Wolston Glacigenic Formation	Clay and silt	restricted to south of area
THT-DMTN	Thrussington Member, Wolston Glacigenic Formation	Diamicton	Now restricted to south of area. Remainder to TILMP
BGSG-XSV	Baginton Sand and Gravel Formation	Sand and gravel	Restricted to south of area, one outcrop to GDU
GDU-XCZS	Glacial deposits, undifferentiated	Clay, silt and sand	Includes indivisible BGSG, GLLMP and GFDMP beneath TILMP in west central part of Area 6 added by ILC
SASH-MDST	Saltford Shale Member	Mudstone	Only present in down-faulted block in NW
WCT-MDLM	Wilmcote Limestone Member	Mudstone and limestone, interbedded	Only present in down-faulted block in NW
CTM-MDST	Cotham Formation	Mudstone	Only present in down-faulted block in NW
WBY-SDST	Westbury Formation	Sandstone	Only present in down-faulted block in NW
BAN-MDST	Blue Anchor Formation	Mudstone	Only present in down-faulted block in NW
BCMU-MDST	Branscombe Mudstone Formation	Mudstone	See below
AS-SDSM	Arden Sandstone Formation	Sandstone, siltstone and mudstone	See below. *Important to note that in Area 6 this was originally modelled as AS-SISM, due to*

Name (LEX-RCS)	Lex Description	Lithology	Comment
			differences in lithology being mapped in Area 7. This was subsequently changed to AS-SDMS to match Area 7 (in Nov 2017).
SIM-MDST	Sidmouth Mudstone Formation	Mudstone	See below
TPSF-MDSA	Tarporley Siltstone Formation	Mudstone and sandstone, interbedded	See below
BMS-SDST	Bromsgrove Sandstone Formation	Sandstone	Modelled unit includes locally mapped lenticular mudstone beds
WRS-SDST	Wildmoor Sandstone Formation	Sandstone	Only present in faulted block in NE
AW-MDSD	Ashow Formation	Mudstone and sandstone	Modelled unit includes locally mapped lenticular sandstone beds
KHS-SDST	Kenilworth Sandstone Formation	Sandstone	Modelled unit includes locally mapped lenticular mudstone and conglomerate beds
TLM-ARSD	Tile Hill Mudstone Formation	Argillaceous rocks and [subequal/subordinate] sandstone, interbedded	Modelled unit includes locally mapped lenticular sandstone beds
ASY-ARSC	Allesley Member, Salop Formation	Argillaceous rocks and [subequal/subordinate] sandstone and conglomerate, interbedded	Modelled unit includes locally mapped lenticular sandstone beds
KRS-ARSC	Keresley Member, Salop Formation	Argillaceous rocks and [subequal/subordinate] sandstone and conglomerate, interbedded	Modelled unit includes extensively mapped sandstone beds

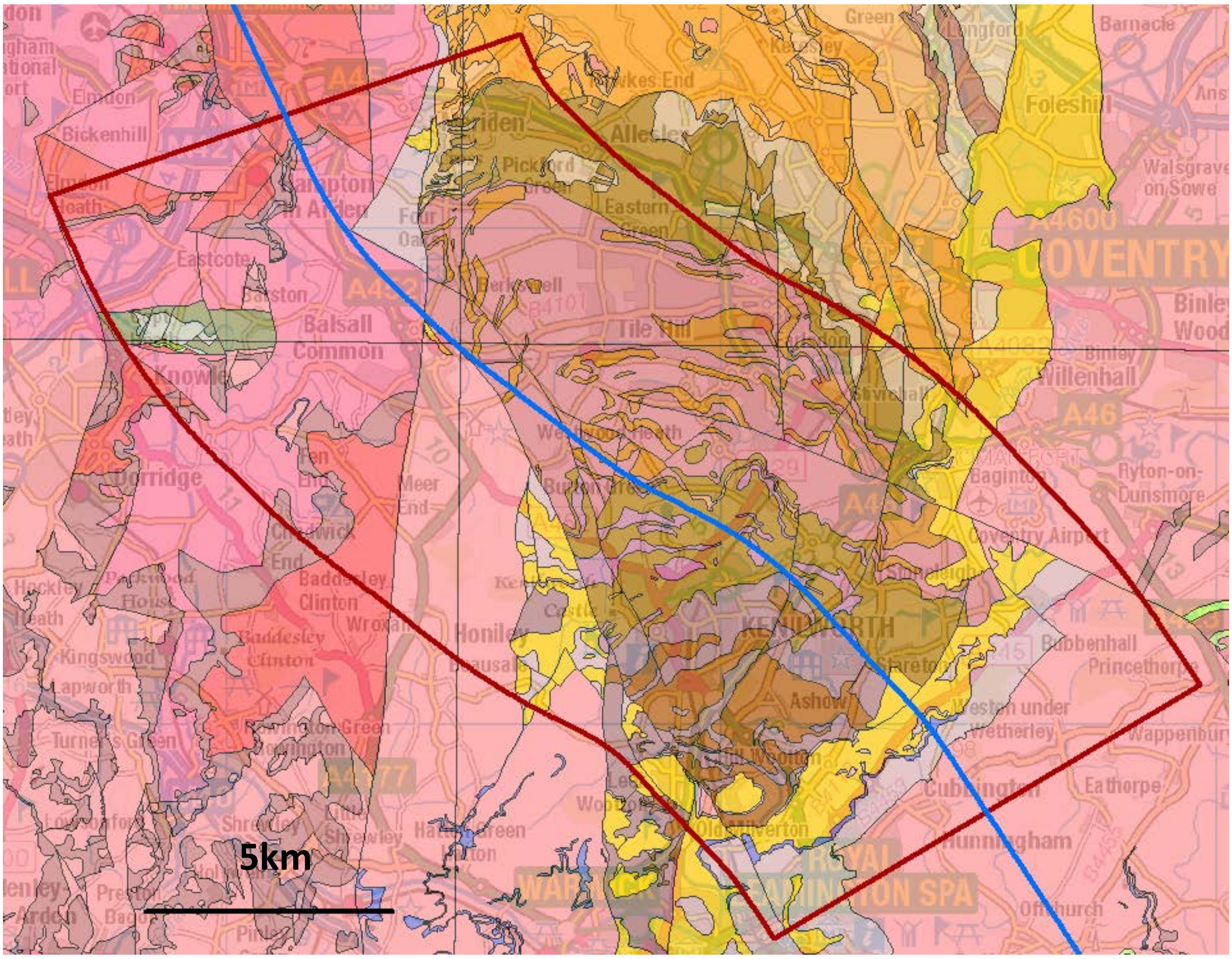

Figure 2 DiGMapGB-50 bedrock geology for HS2 Area 6. Proposed route shown in blue. Key to geology as Table 1.

The strata of the Warwickshire Coalfield (central portion of model area: Figure 2) at rockhead and at depth to -30 m OD in the model all belong to the upper Carboniferous to Permian Warwickshire Group. Mapping and borehole data has enabled these to be fully subdivided in this model into four formations: in descending order the Ashow, Kenilworth Sandstone, Tile Hill Mudstone and Salop formations, the last divided into the Allesley and Keresley members (Table 1). However, within all these units beds of subordinate lithologies are widely mapped, but they are not distinguished within the model because of their significant lenticularity, the lack of information in boreholes, and the considerable additional work modelling these would impose. It is also likely that they would compromise successful and reasonably fast calculation of the model. See also Section 8 (Model Limitations).

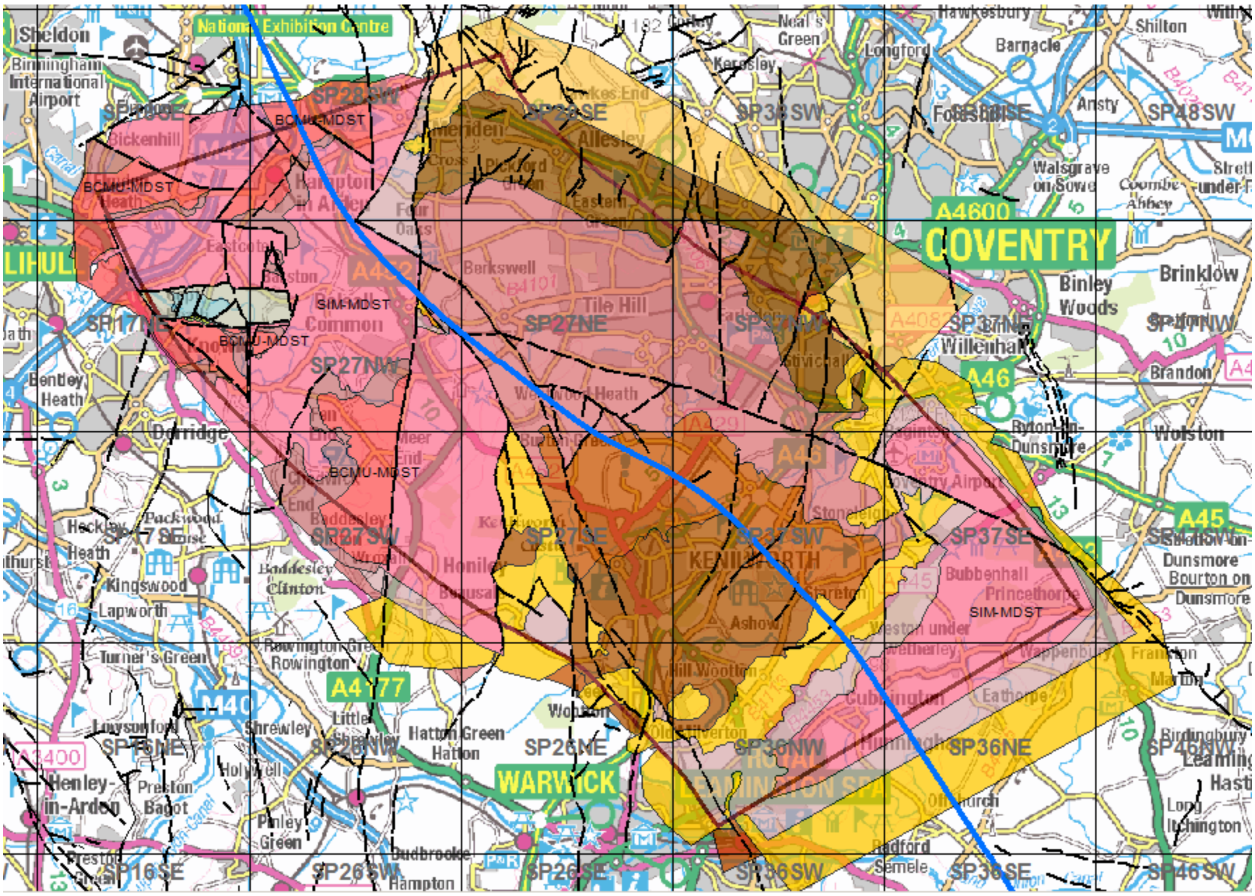

Figure 3. Bedrock envelope coverages with DiGMapGB-50 faults in Area 6 model. Proposed route shown in blue.

In the digital geological map data incorporated in the model (DiGMapGB-50; Figure 2) the Mercia Mudstone Group (MMG-MDST) was not subdivided, with the exception of the Arden Sandstone Formation (AS-SDSM), and locally thin siltstone beds or ‘skerries’ are not distinguished in the model. The presence of the Arden Sandstone where mapped at surface enables the distinction of the Branscombe Mudstone and Sidmouth Mudstone formations above and below, respectively. Inferred thicknesses of the constituent formations of the Mercia Mudstone Group, borehole data and field observations enabled the separation of the otherwise unmapped Tarporley Siltstone Formation at the base in the south-east of the model area (Figure 3). In addition, a fault-bounded outcrop of Bromsgrove Sandstone Formation in the north was reattributed as Tarporley Siltstone Formation. These changes were fed into the corporate 1:10 000 scale digital map data.

The area includes part of a highly complex Anglian glacigenic succession, which in places may be inadequately mapped for the purpose of constraining a 3D model (e.g. unclear superposition relationships, unlikely pinch-outs). Lenticular beds and repeated similar lithologies within this present further difficulties in modelling true/viable stratigraphical units. In addition, the correct identification of the Thrussington Member (THT) till and Oadby Member (ODT) till were doubtful in places and caused misfits. To address this, Oliver Wakefield reattributed some outcrops as Till, Mid Pleistocene (TILMP), although all Mid Pleistocene units are part of the Wolston Glacigenic Formation. After the model was submitted for technical check and QA, it was decided that in part of the area (west centre) it was necessary to combine the glaciofluvial (GFDMP-XSV) and glaciolacustrine (GLLMP-XCZ) deposits, plus a single outcrop of (dubious) Baginton Sand and Gravel Formation (BGSG-XSV), beneath the main till unit (TILMP) into one undifferentiated unit named Glacial deposits undifferentiated unit (GDU-XCZS, yellow in Figure 6 below) – see Section 7 (Model Limitations).

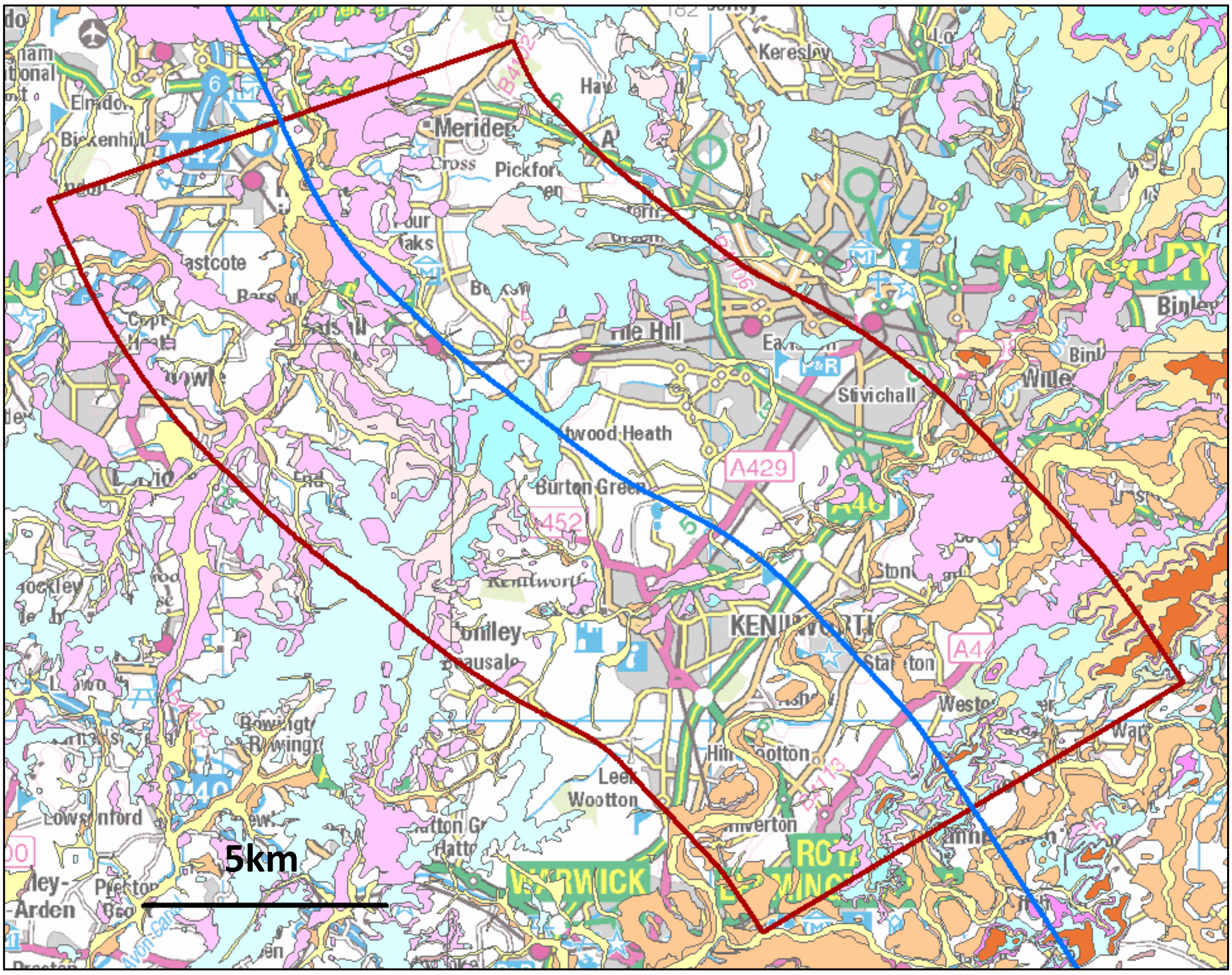

Figure 4. DiGMapGB-50 superficial deposits for HS2 Area 6. Legend as Table 1.

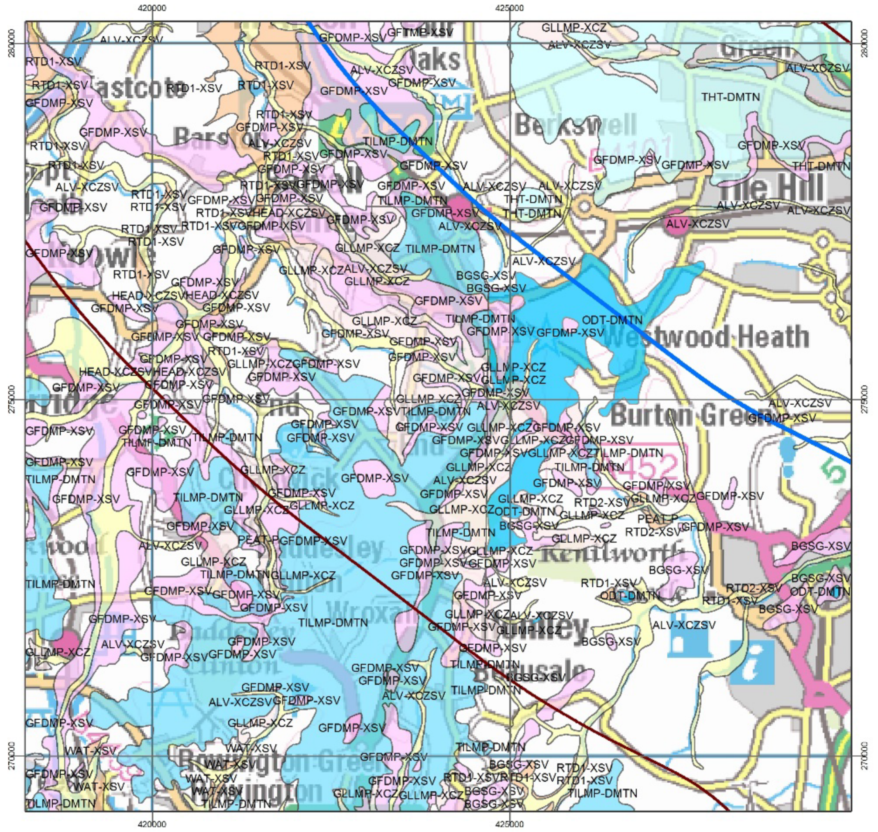

Figure 5. DiGMapGB-50 superficial deposits for west central area. Legend and LEX-RCS codes as Table 1.

Figure 6. Superficial deposits envelope coverages in west central part of Area 6 model. Legend and LEX-RCS codes as Table 1.

Sections were named according to a wider HS2 project convention, with six longitudinal sections running southeast to northwest named HS2_Area6_NWSE_X_OLIVERW as appropriate including one to coincide with the proposed HS2 route (HS2_Area6_NWSE_line_OLIVERW), and thirteen northeast to southwest 'rung' sections named HS2_Area6_SWNE_X_OLIVERW. Eighteen additional sections were constructed to help constrain faulted areas and where issues were encountered with the model calculation.

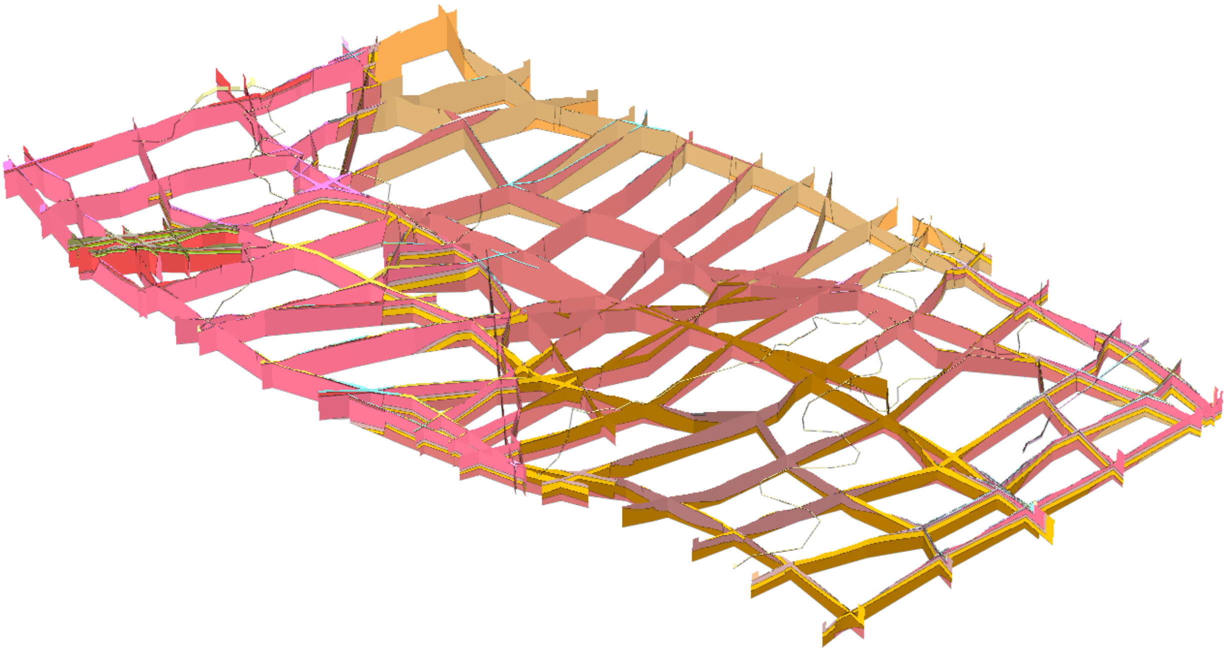

Figure 7. Complete cross-section set for Area 6 model – looking towards the north-east. Legend as Table 1. Vertical exaggeration x5.

3 Modelled Faults

All faults shown in the DiGMapGB-50 data that juxtapose modelled bedrock units at rockhead are inferred to displace them at depth were represented in the model. In addition, some faults were drawn that were not present in DiGMapGB-50, but are interpreted in the BGS Birmingham memoir (Powell et al., 2000) (Figure 8). These were modelled as steps in the geological surfaces rather than as a faulted bedrock model.

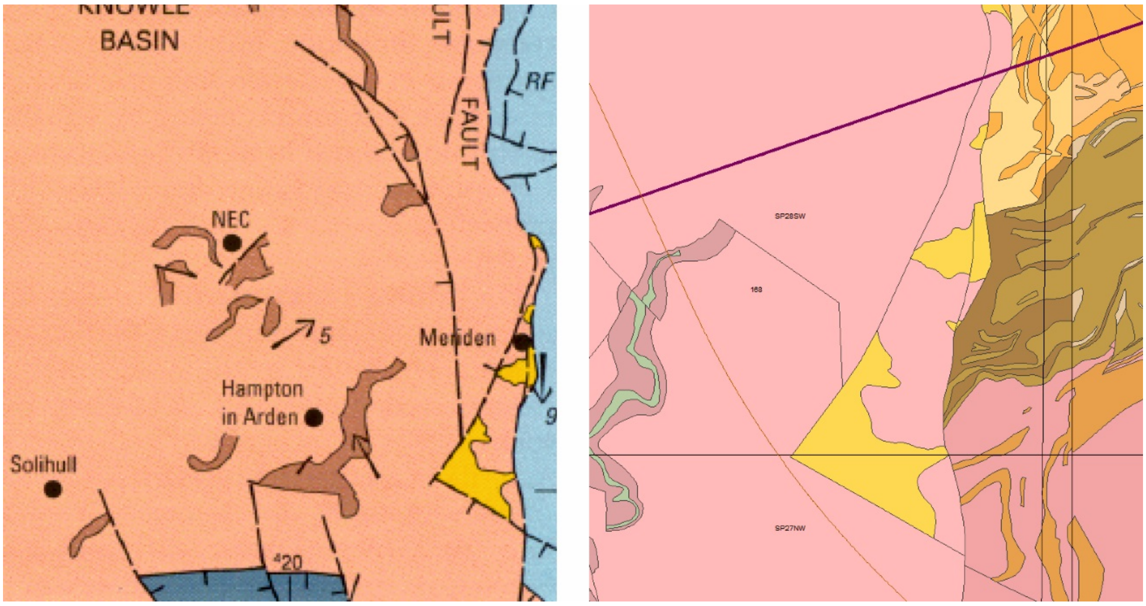

Figure 8 Comparison of part of fig. 1 of BGS Birmingham Memoir and DiGMapGB-50

The area also includes some larger faults that pass through the entire model broadly north-south. Additionally a relatively complex highly faulted area (southeast of Solihull) contains within it numerous larger and small compound faults and has the stratigraphically youngest rocks in the area.

4 Model Workflow

The standard GSI3D modelling workflow was followed for this project. GSI3D software utilises a range of data such as boreholes, digital terrain models (DTM) and geological linework to enable the geologist to construct a series of interlocking cross-sections. Borehole data is represented in GSI3D by two proprietary files: a borehole identification file (.bid), that contains ‘index’-level information including location and start-heights; a borehole log file (.blg), that contains the borehole interpretation. Constructing cross-sections is intuitive and flexible, combining borehole and outcrop data with the geologist’s experience to refine the interpretation.

Using both the information from the cross-sections and the distribution of each unit a calculation algorithm creates the triangulated surfaces for the top and base of each unit. In order to control the relative vertical ordering of the calculation, a generalised vertical section file (.gvs) is established. A proprietary legend file (.gleg) is created to control symbolisation of the cross-section and model. The modeller can view all the units in 3D and iteratively return to the cross-section to make amendments or add further cross-sections to refine the model. This process is a standard methodology within BGS for modelling Quaternary and simple bedrock horizons and is fully documented in Kessler *et al* (2009).

Ten additional helper sections (Figure 7) were created in specific problem areas. To aid the calculation of bedrock units in faulted areas, scattered data points were created for the geological units that intersect the base of the model. This was then manipulated in GSI3D so that it could be applied to the respective geological units. This process aided the calculation of the geological units to the basal model limit (-30 m O.D.).

5 Model Datasets

5.1 GVS AND GLEG FILES

The generalised vertical section (.gvs) and geological legend (.gleg) files were assembled using Notepad or Excel and iterated as the model expanded and new units were encountered. The GVS was based on DiGMapGB-50 data by identifying all those geological units that are within a 5km area of the HS2 route. However some units occur only in subcrop, so additional units in the GVS had to be appended as modelling progressed. The GLEG files were created using the standard BGS colours from DigMap-50. Overall GVS and GLEG files were created for the whole HS2 route, rather than for each individual model area. Thus the units used in this model are only a subset of those available in the overall HS2 GVS file.

5.2 GEOLOGICAL LINEWORK

Figure 2 and Figure 4 show the 1:50 000 scale mapped bedrock geology and superficial cover respectively. This, and the artificially modified ground data (Made Ground etc.), is generalised from the survey-scale 1:10 000 scale data. Lenticular beds were modelled by constructing projected boundaries to separate upper and lower units where a lenticular unit is absent, e.g. the Wolston Sand and Gravel Member within the Wolston Clay. Additional LEX-RCS codes were required (e.g. GLLMP1-XCZ, GFDMP0-XSV, WOC1-XCZ; Figure 5) in order to allow instances of the otherwise same superficial LEX-RCS code to be used at more than one stratigraphical level.

5.3 DIGITAL TERRAIN MODEL

The terrain model used in this model was the BGS Bald Earth 20 m DTM obtained from the BaldEarth model and trimmed to the project area (5 km buffer of the route shapefile). A NextMap DTM was also included, but not used for modelling.

5.4 BOREHOLE DATA

The distribution of borehole logs held in the BGS *Single Onshore Borehole Index* (SOBI) is generally concentrated in the central eastern section of the model (around southwest Coventry) and poor elsewhere (Figure 9). However, elsewhere some useful deeper boreholes are available, originally drilled for the Warwickshire Coalfield.

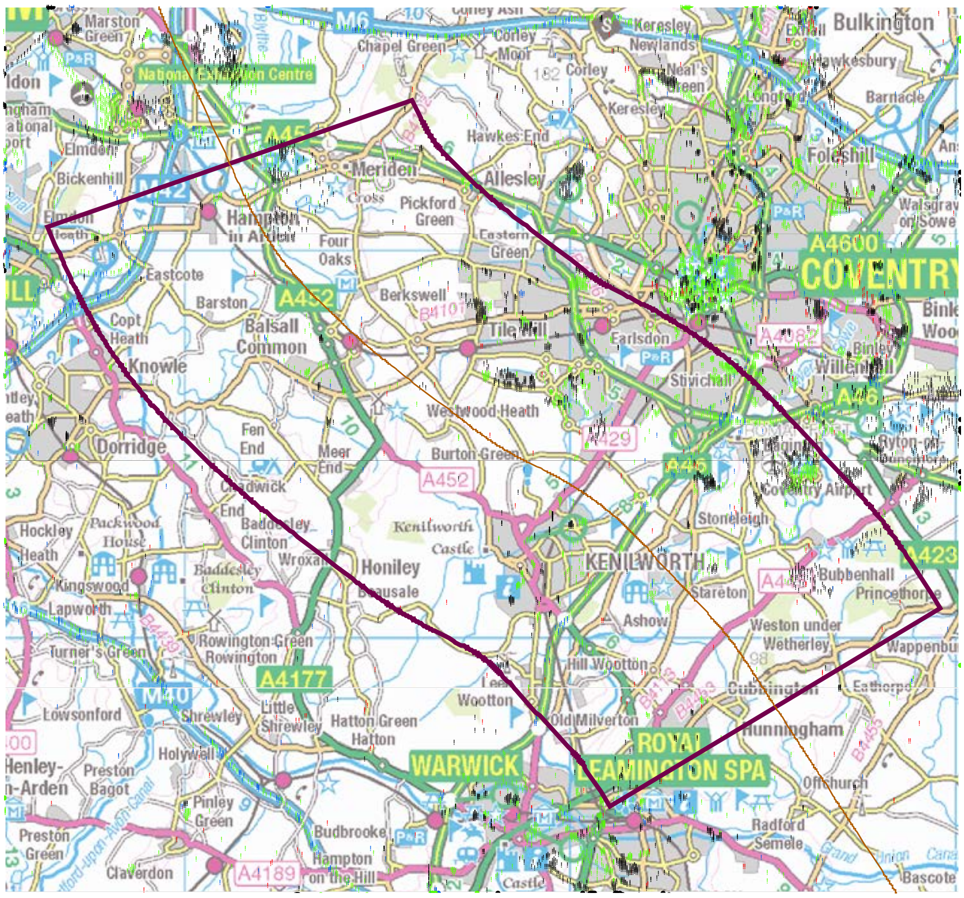

Figure 9 SOBI borehole distribution for HS2 Area 6. Boreholes are coloured according to their drilled depth. Green boreholes have drilled depths of 0-10 m, blue are 10-30 m and red are over 30 m. Black boreholes have unknown drilled depths.

A review of borehole records in the BGS *Single Onshore Borehole Index* (SOBI) in the model area was carried out and those that held sufficient geological information were selected for coding in the BGS *Borehole Geology* database (BoGe). After borehole coding was completed, the boreholes were extracted from the BGS *Single Onshore Borehole Index* (SOBI) database for use in the 3D modelling software using a set of queries. The borehole log file (.blg) needed to be deduplicated and a borehole filter tool was used to address this. A set of priorities were applied to borehole records that were coded by more than one project.

Some borehole records included now redundant stratigraphy, notably the use of the Keele Formation, now named Alveley Member (ALY), part of the Salop Formation (Waters et al., 2009), but in all cases, current stratigraphy was coded in the Borehole Geology database.

5.5 OTHER DATASETS

- Cross sections from BGS 1:50 000-scale maps

6 Model Development Log

During the course of the modelling, the modeller kept a running log of the development, changes and decisions made for their designated modelling areas (Figure 10). These records are kept as part of the model storage and metadata (QA) process and can be accessed as needed.

- Lias and Penarth Group formations around 418712, 277915 have abundant faulting around them. Have taken fault throw information from Redditch and Warwick Memoirs.
- Have sub-divided Mercia Mudstone Group
- Having difficulty resolving borehole SP36NW82 with mapped data at crop: http://bgsintranet/scripts/ida/boreholescan/dispBorehole.cfm?bgsID=321318
  Borehole data doesn't match map data. Borehole depicts MMG at 24 m below OD, while conversely the underlying BMS is shown at crop. Thickness of MMG group is also inconsistent with other adjacent boreholes and the MMG is the southern parts of the HS2 zone 6 model.

Figure 10. Example of model development log text

7 Model Assumptions, Geological Rules Used etc.

Superficial deposits with unknown thicknesses are modelled to ~3 m depth. Made and worked ground are only modelled where shown in the digital geological map data and their extent may therefore be significantly under-estimated in the model.

Fault displacements have been calculated where possible and modelled accordingly. Faults where the throw and angle are unknown are modelled with throws of 10 – 20 m, with throw directions inferred as ‘normal’ and modelled 60^{o} to the horizontal.

8 Model Limitations

8.1 MODEL SPECIFIC LIMITATIONS

The model honours the corresponding published BGS 1:50 000 scale maps as closely as possible, with the exception of errors caused by the resolution of the DTM (Figure 11) and the issues highlighted below.

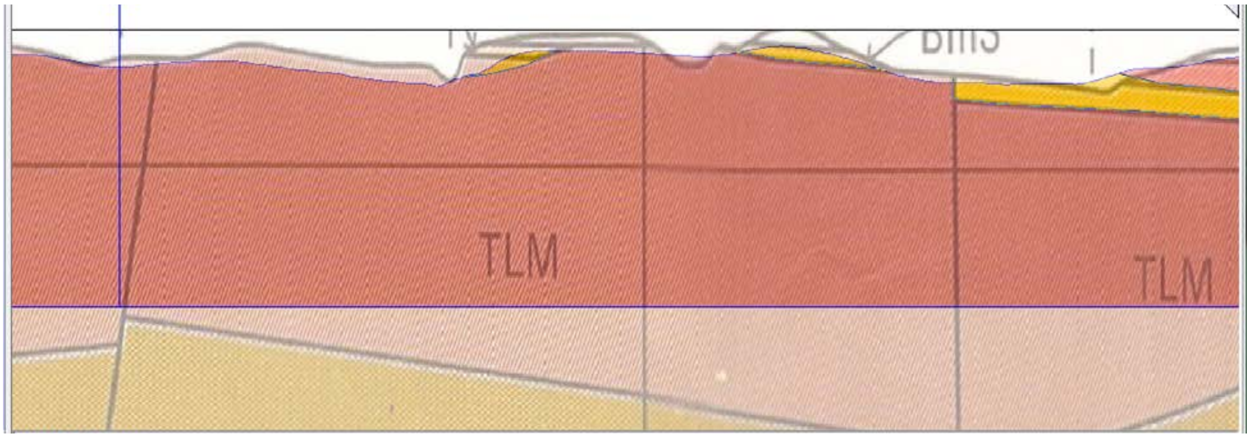

Figure 11. Comparison of published cross-section and DTM resolution

Significant assumptions on the throw of the various faults have been made. Where possible, fault throws have been calculated, but even where this is done the amount of throw along the lateral extent of the fault is uncertain. The orientation and angle of movement on the faults may also be uncertain. Assumptions have been made that all faults are ‘normal’ and dip at ~60^{o} to horizontal.

As stated above, geological mapping and borehole data have enabled the Warwickshire Group to be fully subdivided in this model into four formations in descending order: the Ashow, Kenilworth Sandstone, Tile Hill Mudstone and Salop formations, the last divided into the Allesley and Keresley members (Table 1). However, within all these units beds of subordinate lithologies are widely mapped, but are not distinguished within the model because of their significant lenticularity, the lack of information in boreholes, and the considerable additional modelling work these would impose. This is contrary to Area 5 where the Warwickshire Group has been modelled due to lack of information.

Minor thin siltstone beds or 'skerries' within the Mercia Mudstone Group (MMG) formations are not modelled, nor are the mudstone units in the Arden Sandstone Formation. Additionally, the lithological variation mapped in DiGMap50k has not been retained between the Area 7 model and the Area 6 model and both areas are modelled as AS-SDSM.

As stated in Section 2, the area includes part of a highly complex Anglian glacigenic succession, which is in places inadequately mapped (e.g. unclear superposition relationships, unlikely pinch-outs). Lenticular beds and repeated similar lithologies within this, present further difficulties in modelling true/viable stratigraphical units. In addition, the correct identification of the Thrussington Member (THT) till and Oadby Member (ODT) till was doubtful in places and caused misfits so some outcrops as Till, Mid Pleistocene (TILMP) were reattributed (although all Mid Pleistocene units are part of the Wolston Glacigenic Formation). A decision was taken that in part of the area (west centre) it was necessary to conflate the glaciofluvial (GFDMP-XSV) and glaciolacustrine (GLLMP-XCZ) deposits, plus a single outcrop of (dubious) Baginton Sand and Gravel (BGSG-XSV), beneath the main till unit (TILMP) into one Glacial deposits, undifferentiated unit (GDU-XCZS, yellow in Figure 6).

Information from borehole SP37SE773 in section HS2_Area6_NWSE_3 has been interpreted as unreliable. Specifically the recorded detail in the borehole record is not sufficient to adequately differentiate between the Bromsgrove Sandstone (BMS) and the formations of the Mercia Mudstone Group with a significant level of confidence. As such, more reliable information gleaned from nearby boreholes has been used to interpret the geology in this part of the section.

8.2 GENERAL MODELLING LIMITATIONS

- Geological interpretations are made according to the prevailing understanding of the geology at the time. The quality of such interpretations may be affected by the availability of new data, by subsequent advances in geological knowledge, improved methods of interpretation, improved databases and modelling software, and better access to sampling locations. Therefore, geological modelling is an empirical approach.

- It is important to note that this 3D geological model represents an individual interpretation of a subset of the available data; other interpretations may be valid. The full complexity of the geology may not be represented by the model due to the spatial distribution of the data at the time of model construction and other limitations including those set out elsewhere in this report.

- Best endeavours (detailed quality checking procedures) are employed to minimise data entry errors but given the diversity and volume of data used, it is anticipated that occasional erroneous entries will still be present (e.g. boreholes locations, elevations etc.) Any raw data considered when building geological models may have been transcribed from analogue to digital format. Such processes are subjected to quality control to ensure reliability; however undetected errors may exist. Borehole locations are obtained from borehole records or site plans.

- Borehole start heights are obtained from the original records, Ordnance Survey mapping or a digital terrain model. Where borehole start heights look unreasonable, they are checked and amended if necessary in the index file. In some cases, the borehole start height may be different from the ground surface, if for example, the ground surface has been raised or lowered since the borehole was drilled, or if the borehole was not originally drilled at the ground surface.

- Borehole coding (including observations and interpretations) was captured in a corporate database before the commencement of modelling and any lithostratigraphic interpretations may have been re-interpreted in the context of other evidence during cross-section drawing and modelling, resulting in occasional mismatches between BGS databases and modelled interpretations.

- Digital elevation models (DEMs) are sourced externally by BGS and are used to cap geological models. DEMs may have been processed to remove surface features including vegetation and buildings. However, some surface features or artefacts may remain, particularly those associated with hillside forests. The digital terrain model may be sub-sampled to reduce its resolution and file size; therefore, some topographical detail may be lost.

- Geological units of any formal rank may be modelled. Lithostratigraphical (sedimentary/metasedimentary) units are typically modelled at Group, Formation or Member level, but Supergroup, Subgroup or Bed may be used. Where appropriate, generic (e.g. alluvium – ALV), composite (e.g. West Walton Formation and Ampthill Clay Formation, undifferentiated – WWAC) or exceptionally informal units may also be used in the model, for example where no equivalent is shown on the surface geological map. Formal lithodemic igneous units may be named Intrusions or Dykes or may take the name of their parent (Pluton or Swarm/Centre or Cluster/Subsuite/Suite), or if mixed units Complex may be used. Highly deformed terranes may use a combined scheme with additional rank terms. Artificially Modified Ground units (e.g. Made Ground (undivided) – MGR, Landscaped Ground (undivided) – LSGR) are currently regarded as informal.

- The geological map linework in the model files may be modified during the modelling process to remove detail or modify the interpretation where new data is available. Hence, in some cases, faults or geological units that are shown in the BGS approved digital geological map data (DiGMapGB) may not appear in the geological model or vice versa. Modelled units may be coloured differently to the equivalent units in the published geological maps.

9 Supplementary Work

Supplementary work on the model was conducted and the following section details additional changes to the model.

All fieldwork was undertaken 17-18/7/14. Office work on revised linework completed 1/8/14.

The Arden Sandstone Formation (AS) was previously mapped as discontinuous in places. More recent work (e.g. Warrington *et al.*, 1980) has shown that it is a continuous unit across much of the UK. Fieldwork was undertaken to correct this, together with office work looking at boreholes and the topography to extend parts of the outcrop beneath superficial deposits. This includes the area between HS2 areas 6 and 7 (Figure 12).

Some of the deep boreholes have not distinguished the Tarporley Siltstone Formation but it is inferred to be present everywhere at the base of the Mercia Mudstone Group in this region (Warrington et al., 1980). Along the margin between Areas 5 and 6, Tarporley Siltstone Formation has been added with limited fieldwork and, in places, is constructed, based partly on an approximate thickness (Figure 13).

Problems were noted around the join between Area 6 and Area 7 where five outcrops of Bromsgrove Sandstone Formation had been mapped in two fault blocks but overlain by the Mercia Mudstone Group with no Tarporley Siltstone Formation delineated. This necessitated fieldwork to map in the Tarporley Siltstone. The whole area within the fault block was re-mapped as Tarporley Siltstone, apart from the middle one of the four outcrops of Bromsgrove Sandstone, on the south side of the village of Meriden, which was retained (compare Figure 2 and Figure 3). The outcrop of Bromsgrove Sandstone to the north east of Balsall Common has been changed to Tarporley Siltstone on the evidence of boreholes and a measured section in a railway cutting.

Within Area 6 the Tilehill Mudstone Formation is inferred to be present at depth in the Knowle Basin (western third of model area) beneath the Bromsgrove Sandstone Formation, in part based on cross-section on BGS Sheet 183 – Redditch. It is inferred to extend north in the fault block as drawn in cross-section Area6_NESW_Filler_14.

January – March 2015

New and amended linework on sheet 184 (Warwick) was compiled for adding to DiGMap 10 and 50. This includes the addition of Tarporley Siltstone Formation outcrop to the map face, amendments to the outcrop of the Arden Sandstone Formation (Figure 12) and superficial deposits, and some new faulting. This new linework was used to modify the geological model.

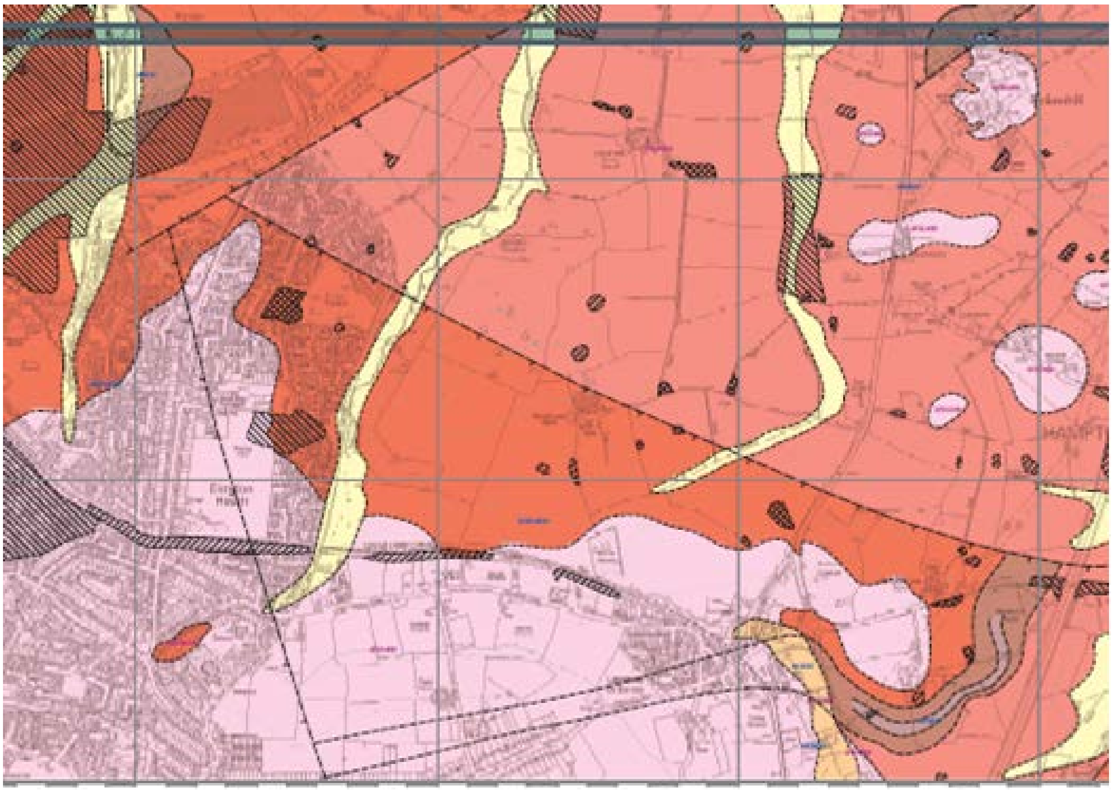

Figure 12. DiGMapGB-10 in north-west of Area 6 (SP18SE), with extended Arden Sandstone subcrop and additional fault

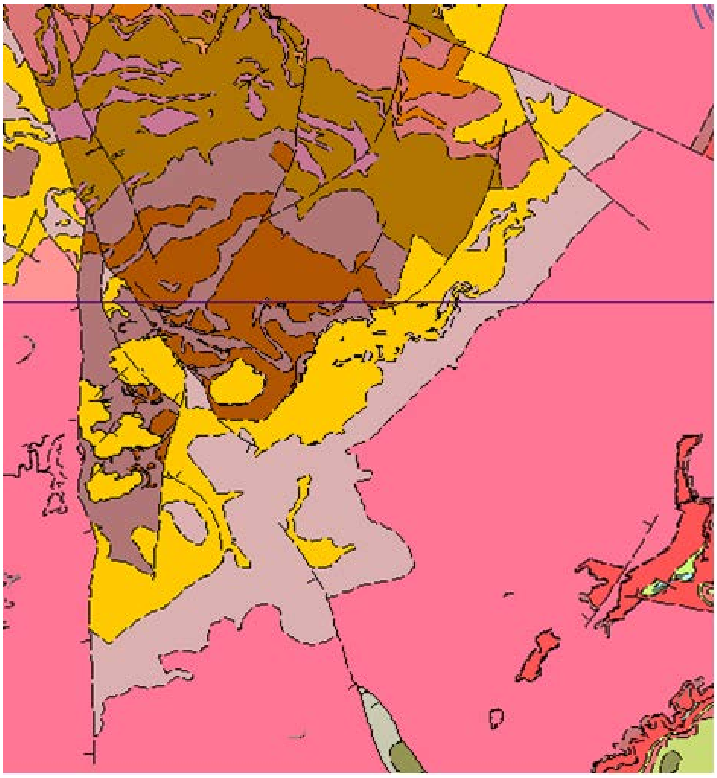

Figure 13. Example of constructed top of Tarporley Siltstone Formation (grey)

10 Model QA

In order for a geological model to be approved for publication or delivery to a client a series of QA checks is carried out. This includes visual examination of the modelled cross-sections to ensure that they match each other at cross-section intersections and fit the borehole and geological map data used. The model calculation is checked to ensure that all units calculate to their full extent within the area of interest and the modelled geological surfaces are checked for artefacts such as spikes and thickness anomalies. The naming convention of the modelled geological units is checked to ensure that recognised entries in the BGS Lexicon of Named Rock Units (http://www.bgs.ac.uk/lexicon/home.html) and the BGS Rock Classification Scheme (http://www.bgs.ac.uk/bgsrcs/) are used as far as possible.

Any issues found in the QA checking process are recorded and addressed before delivery/publication of the model.

11 Model Images

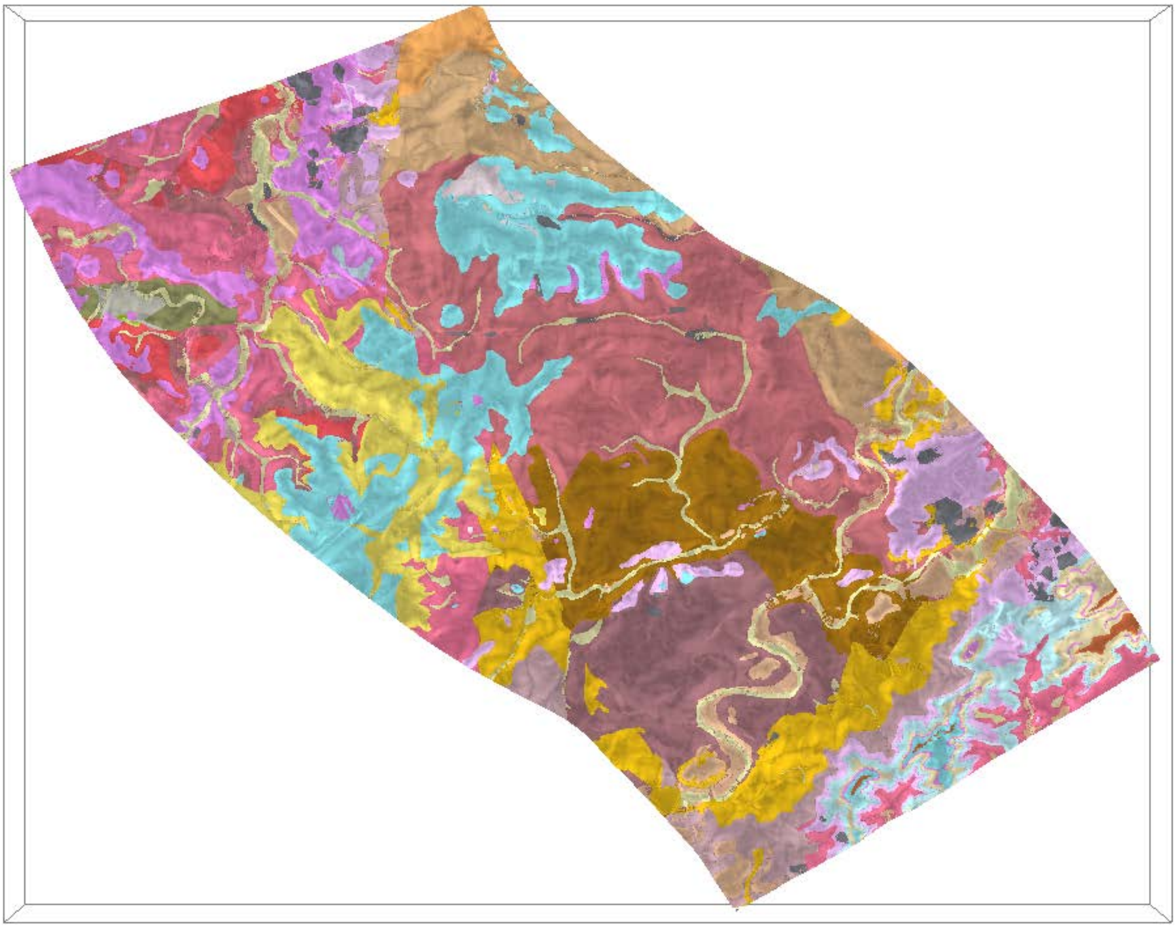

Figure 14. View of the 3D model from above, all units shown. Legend as per Table 1.

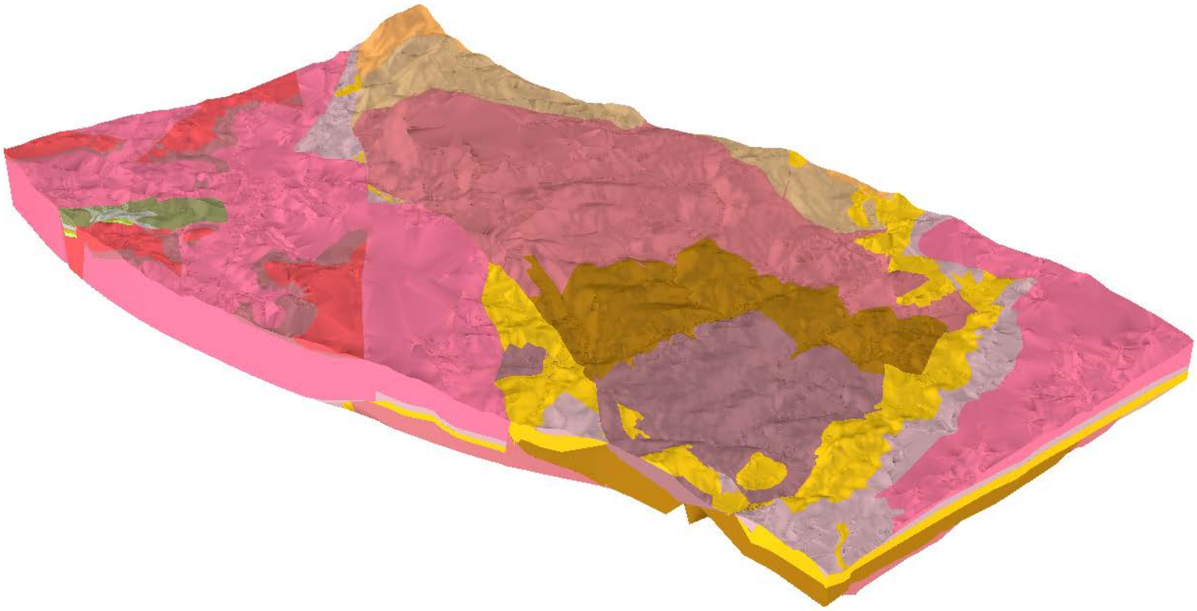

Figure 15. View of the Area 6 3D model bedrock from south. Legend as per Table 1 (10x exaggeration)

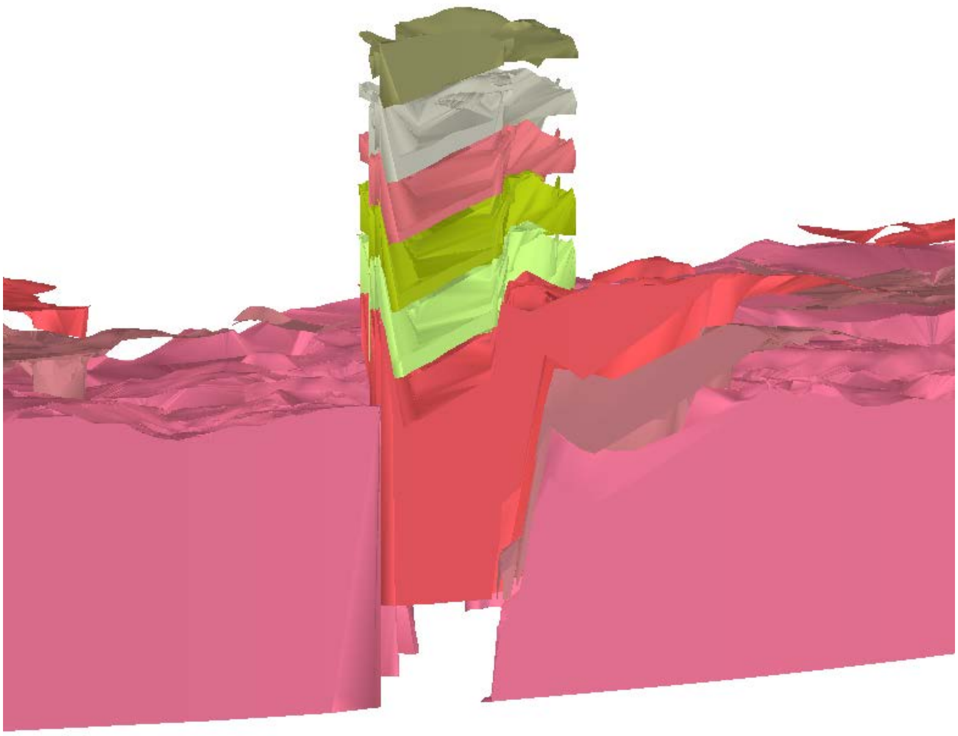

Figure 16. 3D 'exploded' view of graben in north-west of Area 6. Legend as per Table 1 (10x exaggeration)

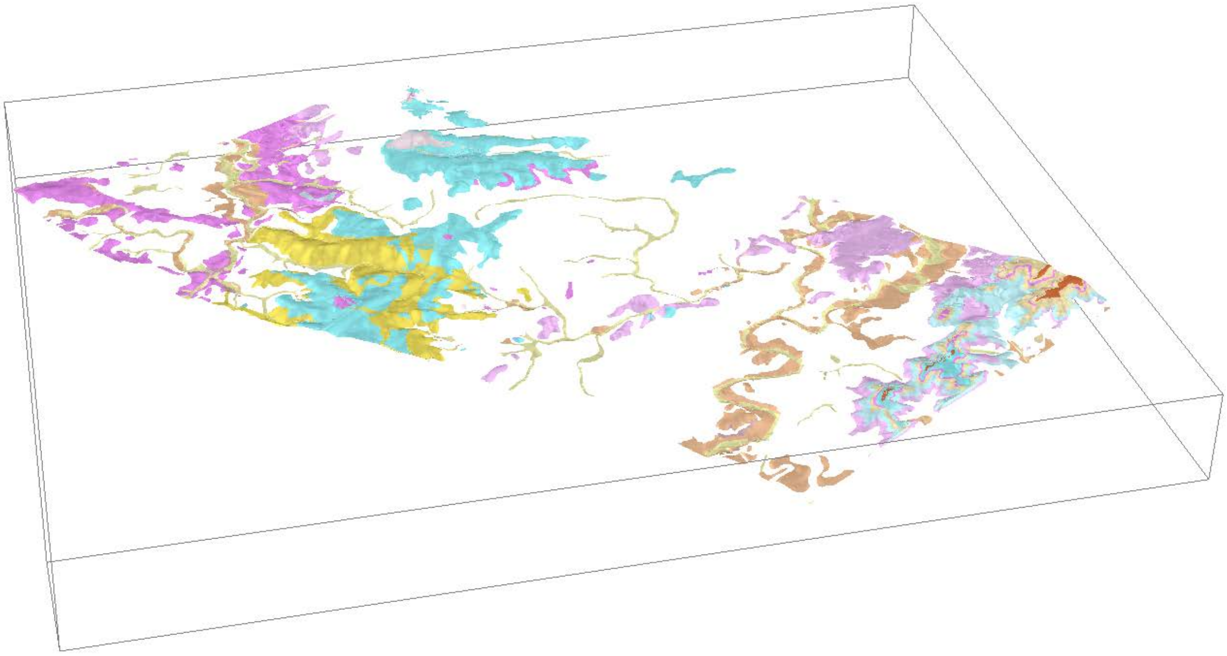

Figure 17. 3D view of the natural superficial deposits of Area 6 model, looking towards the north-east. Legend as per Table 1. (10x exaggeration)

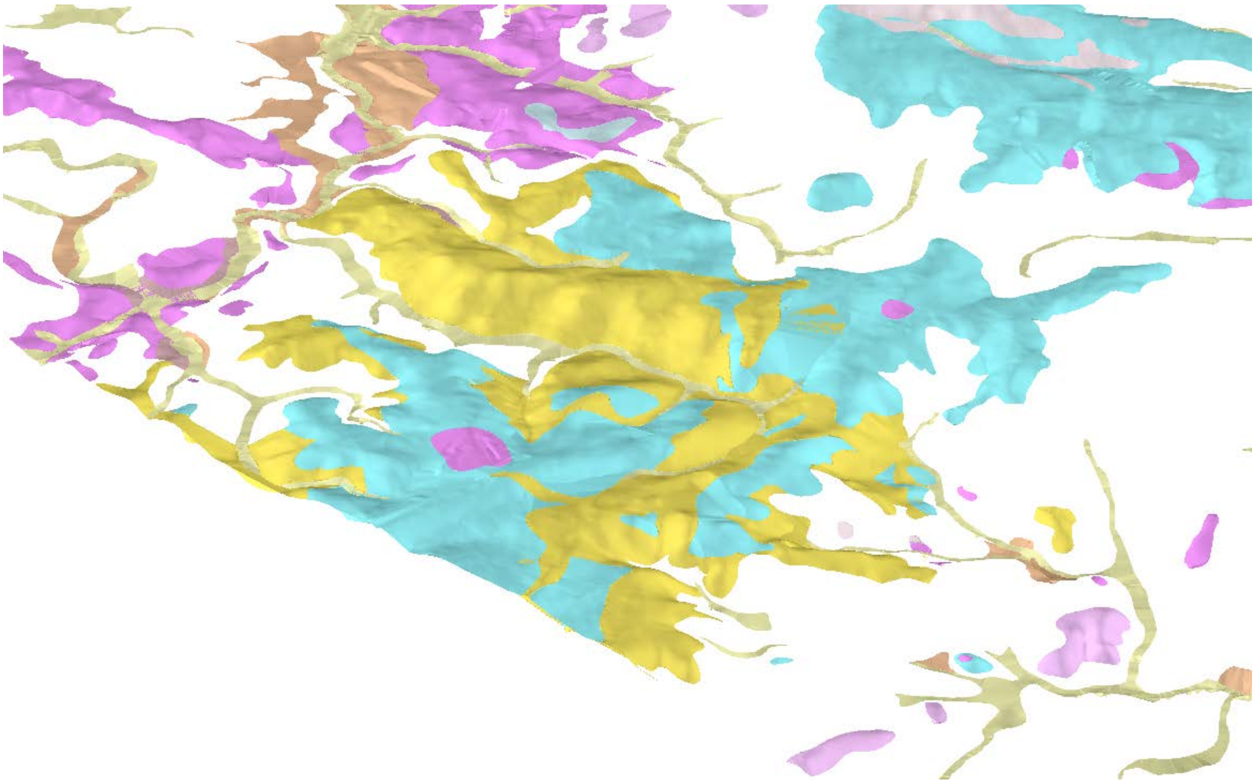

Figure 18. Close-up of superficial deposits in west central part of Area 6 showing GDU (yellow). Legend as per Table 1 (10x exaggeration)

12 References

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: http://geolib.bgs.ac.uk.

Bridge, D M, Carney, J N, Lawley, R S, and Rushton, A W A. 1998. Geology of the country around Coventry and Nuneaton. *Memoir of the British Geological Survey*, Sheet 169 (England and Wales).

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