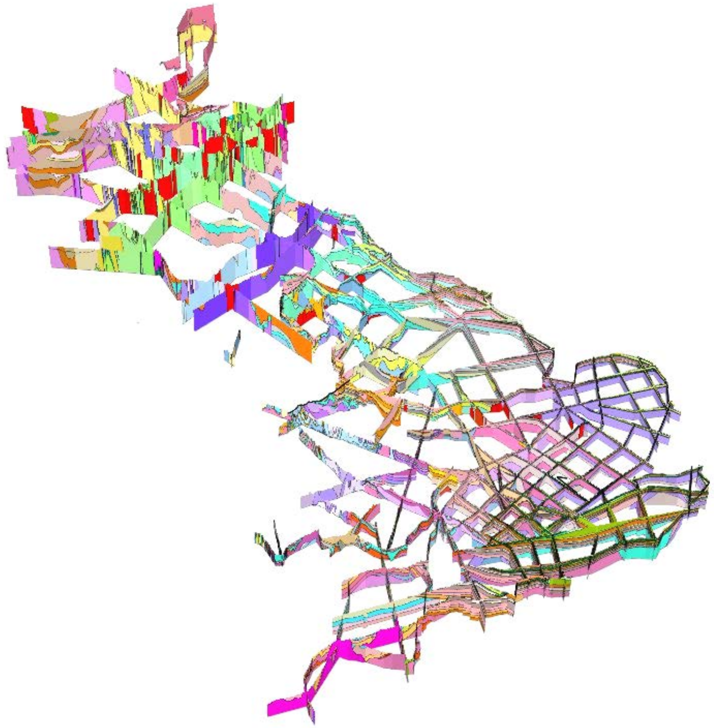
British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Applied geoscience for our changing Earth

Building the National Geological Model



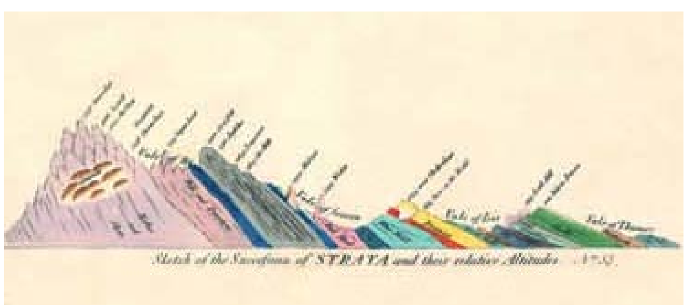
Steve Mathers

EUREGEO, Bologna 13 June 2012

Evolution of the Geological Map

The mission has remained constant

1815

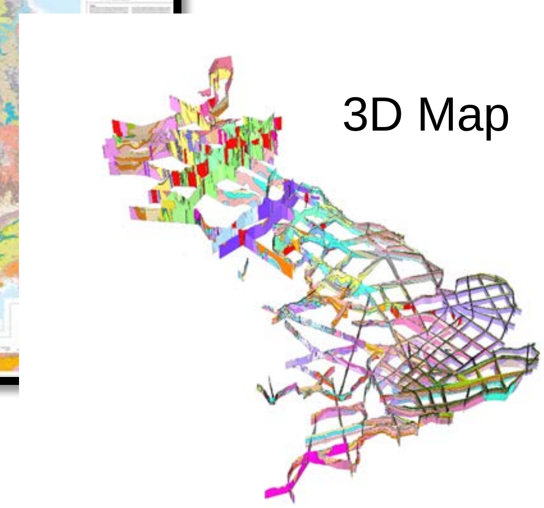


1874

1939

2007

Big change



3D Map

2012

Main Tools for the job

GOCAD Framework models especially basin scale

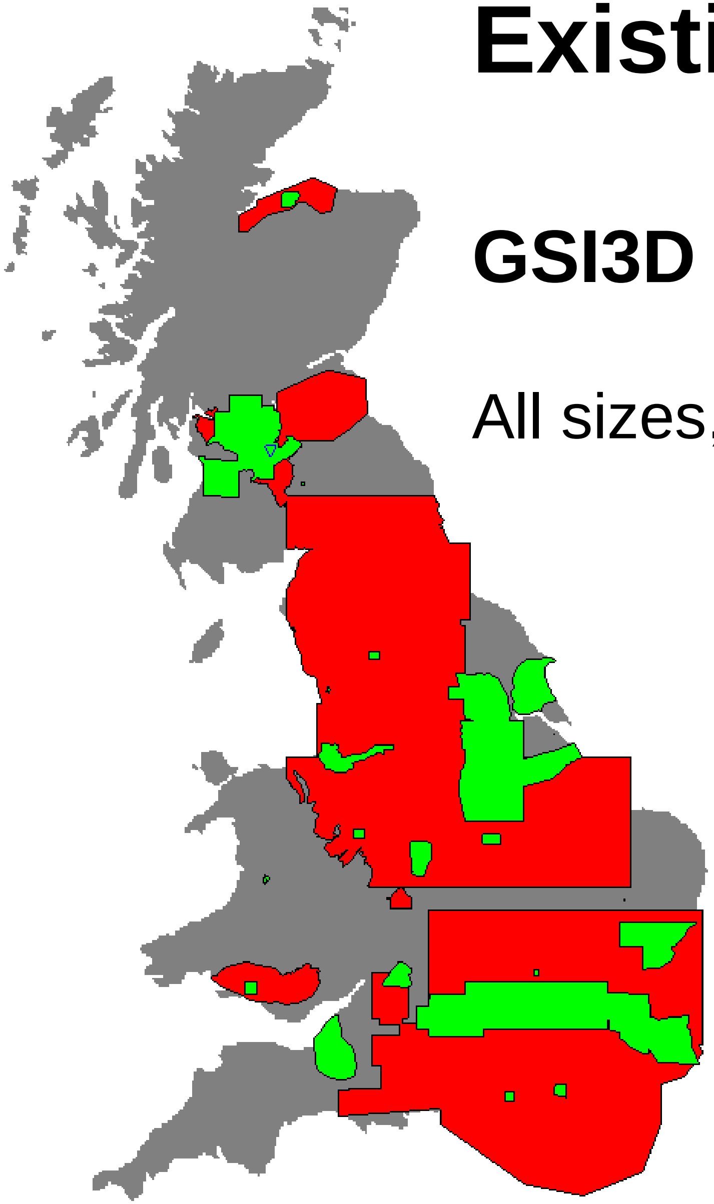
GSI3D Framework models especially Quaternary & Anthropocene

Petrel Stochastics, Flow,

Isatis Statistics

Geovisionary Fly through and visualisation

GIS Data conditioning



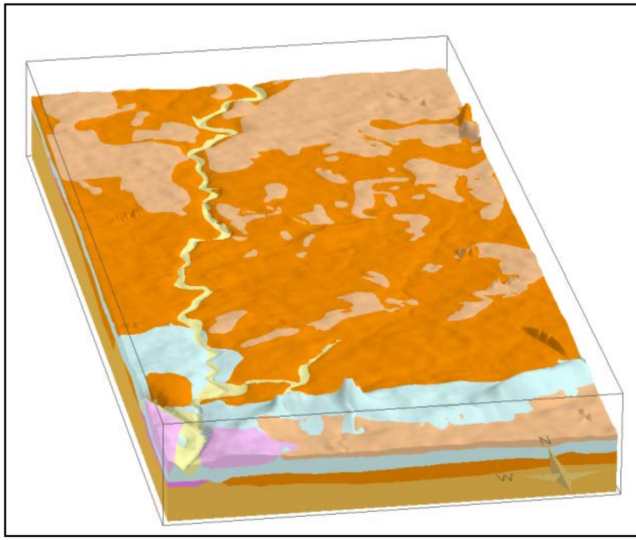
Existing framework models

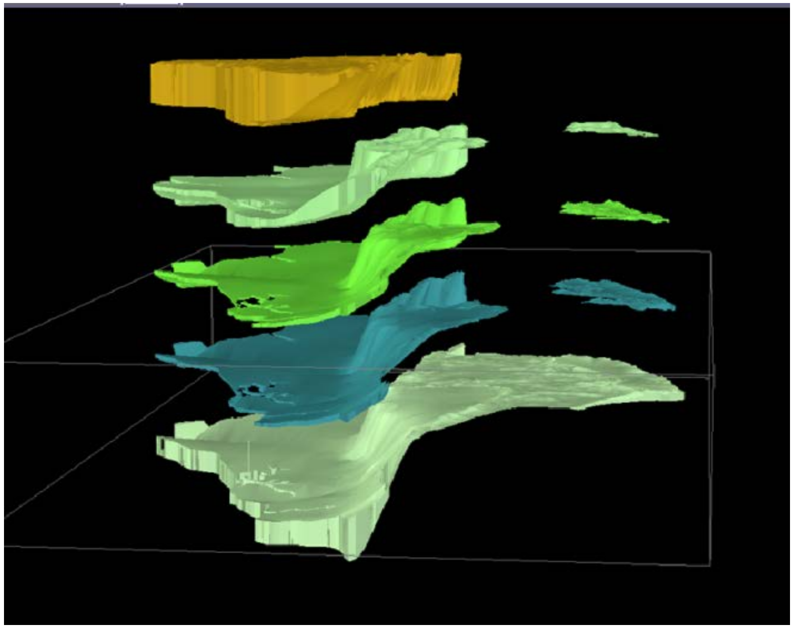
GSI3D & GoCAD

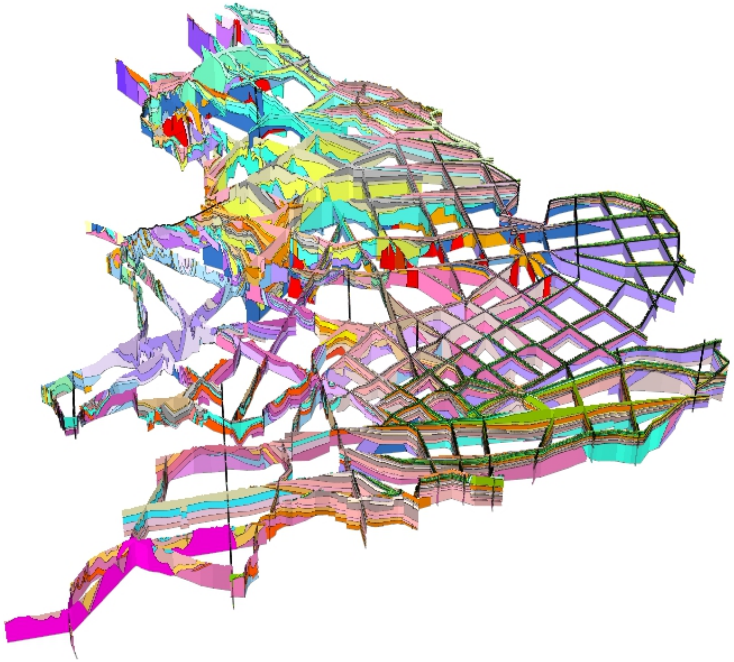
All sizes, shapes, depths and drivers

The models

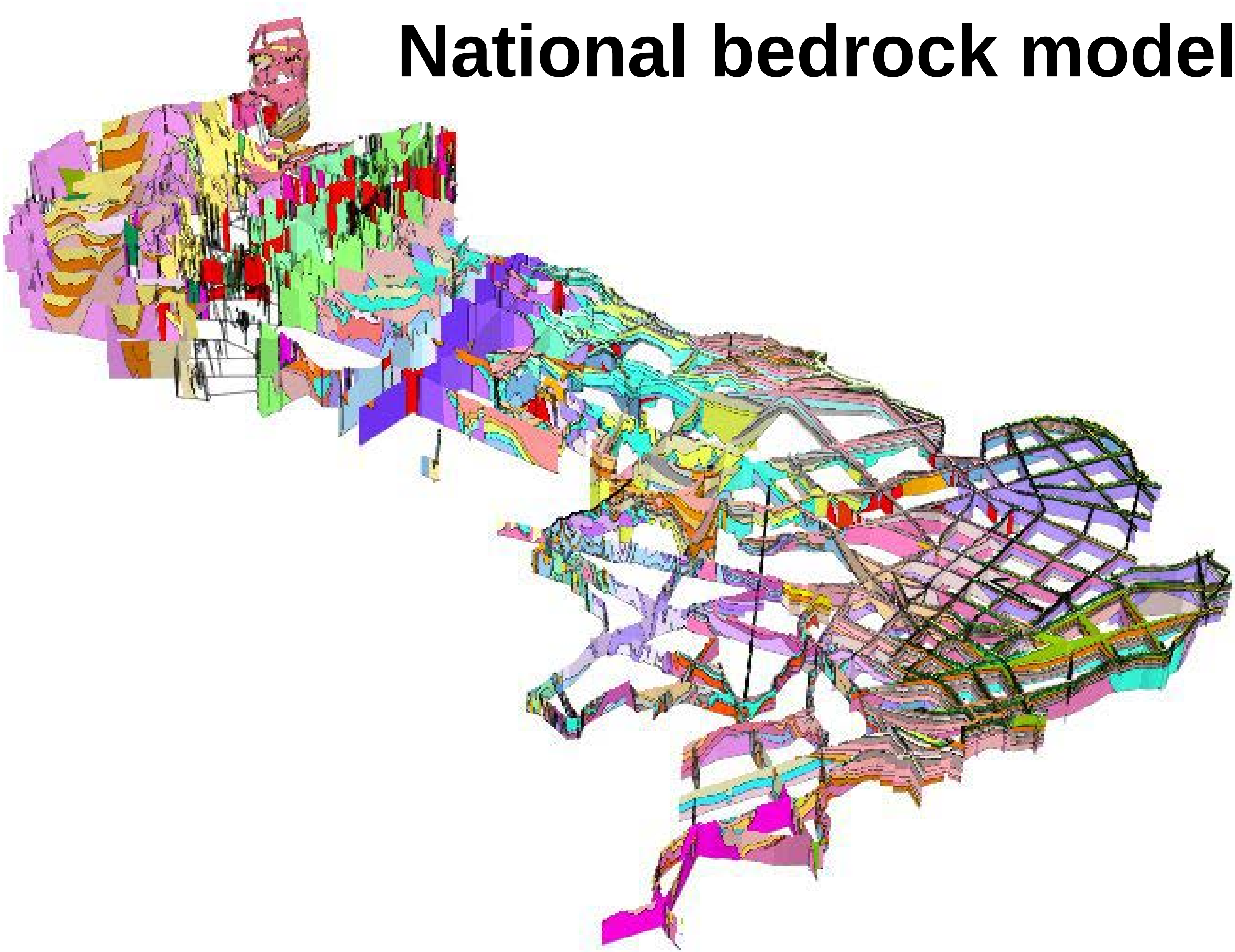
- National bedrock
- National crustal
- National Quaternary & Anthropocene
- Educational
- Collaborative
- Commercial



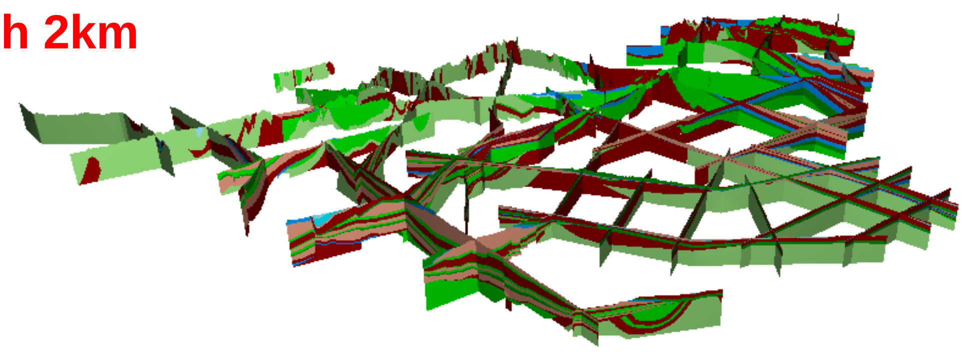




National bedrock model

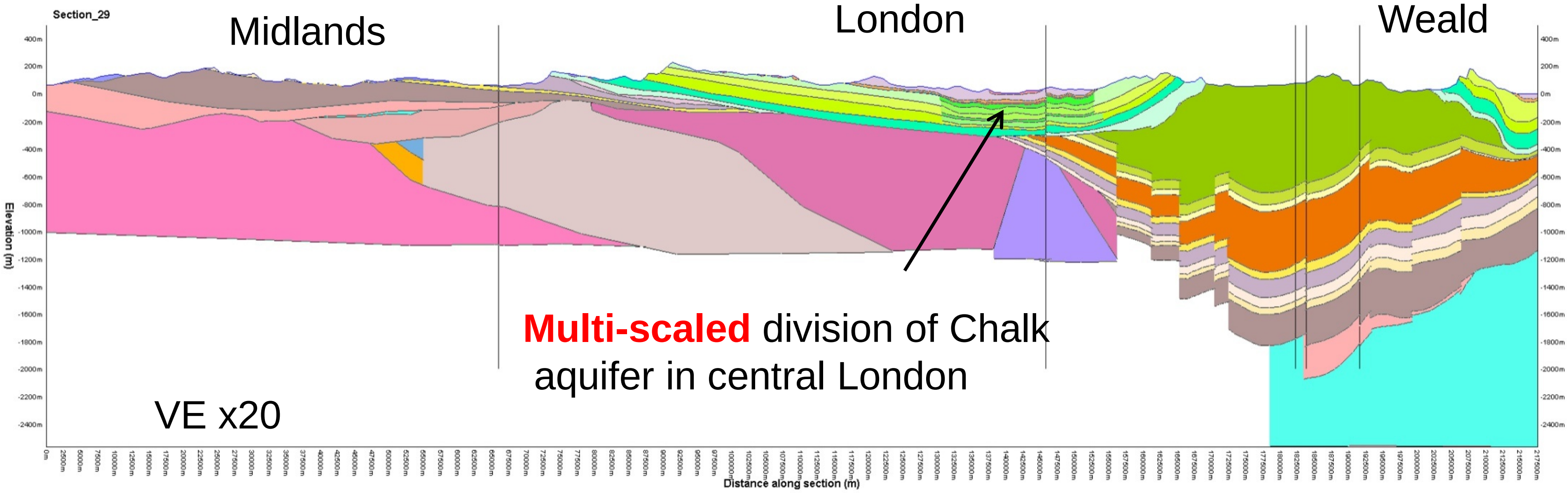


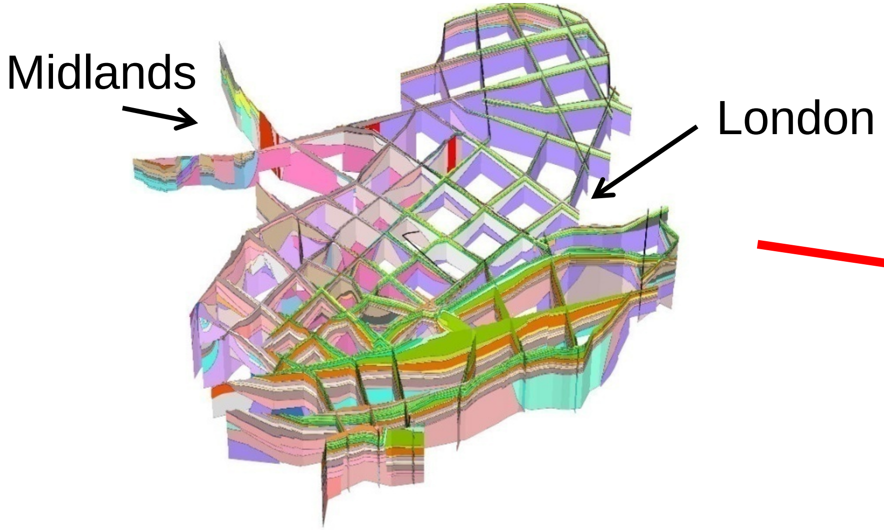
- These 125 sections are intelligent, **utilising c. 20 existing models, 100’s of existing sections contour and isopach maps**
- Measure 21,365 linear km’s, to the Brisbane IGC and back
- Based loosely on the 625K maps & schema 341 units,
- 14 geologists plus 3 data managers
- Use for national and regional assessments for Groundwater, Radwaste storage, Shale gas
- Geoscience Education (intended free downloads)
- Built using GSI3D average **depth 2km**



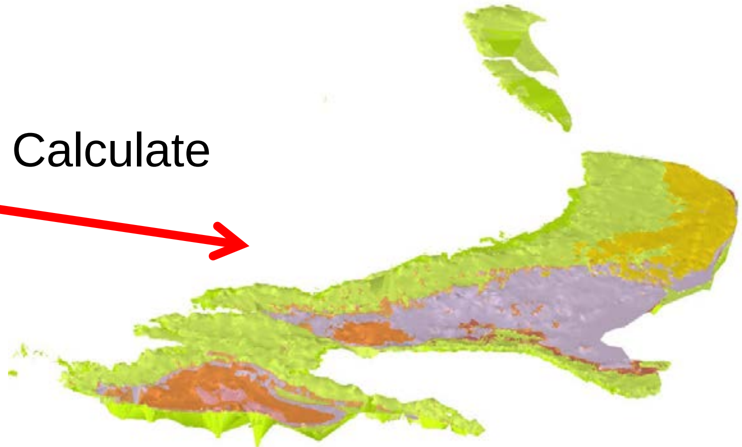
Parameterized (e.g. aquifer type)

Regional context



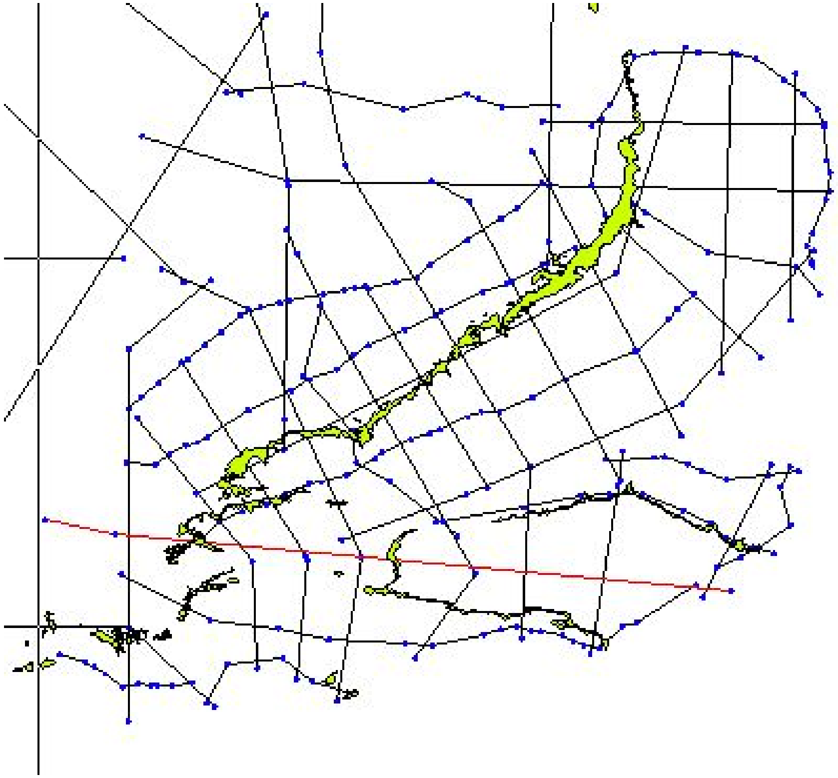


Calculate

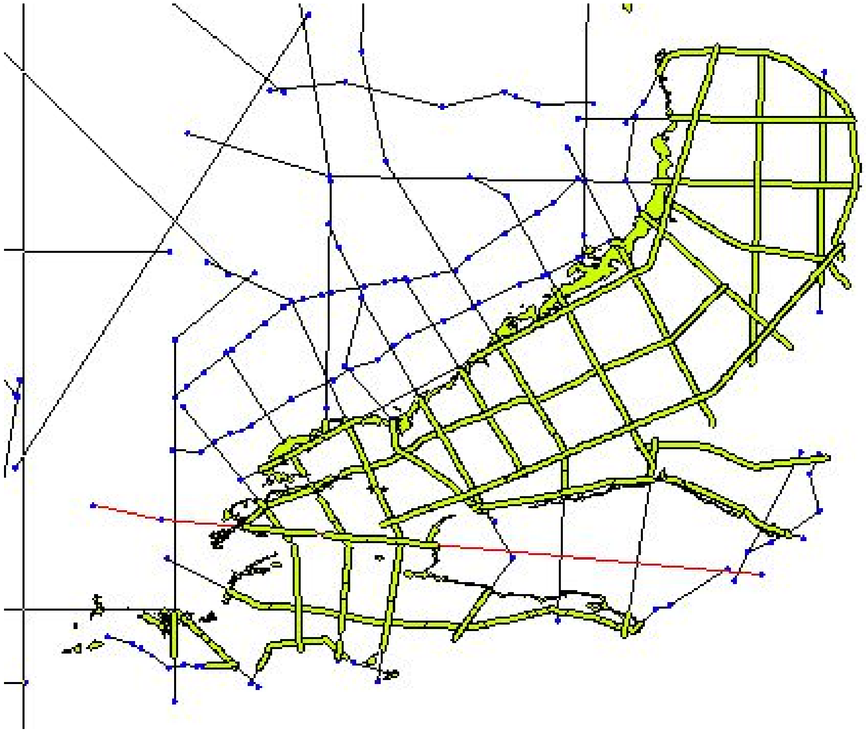


3D Volumes

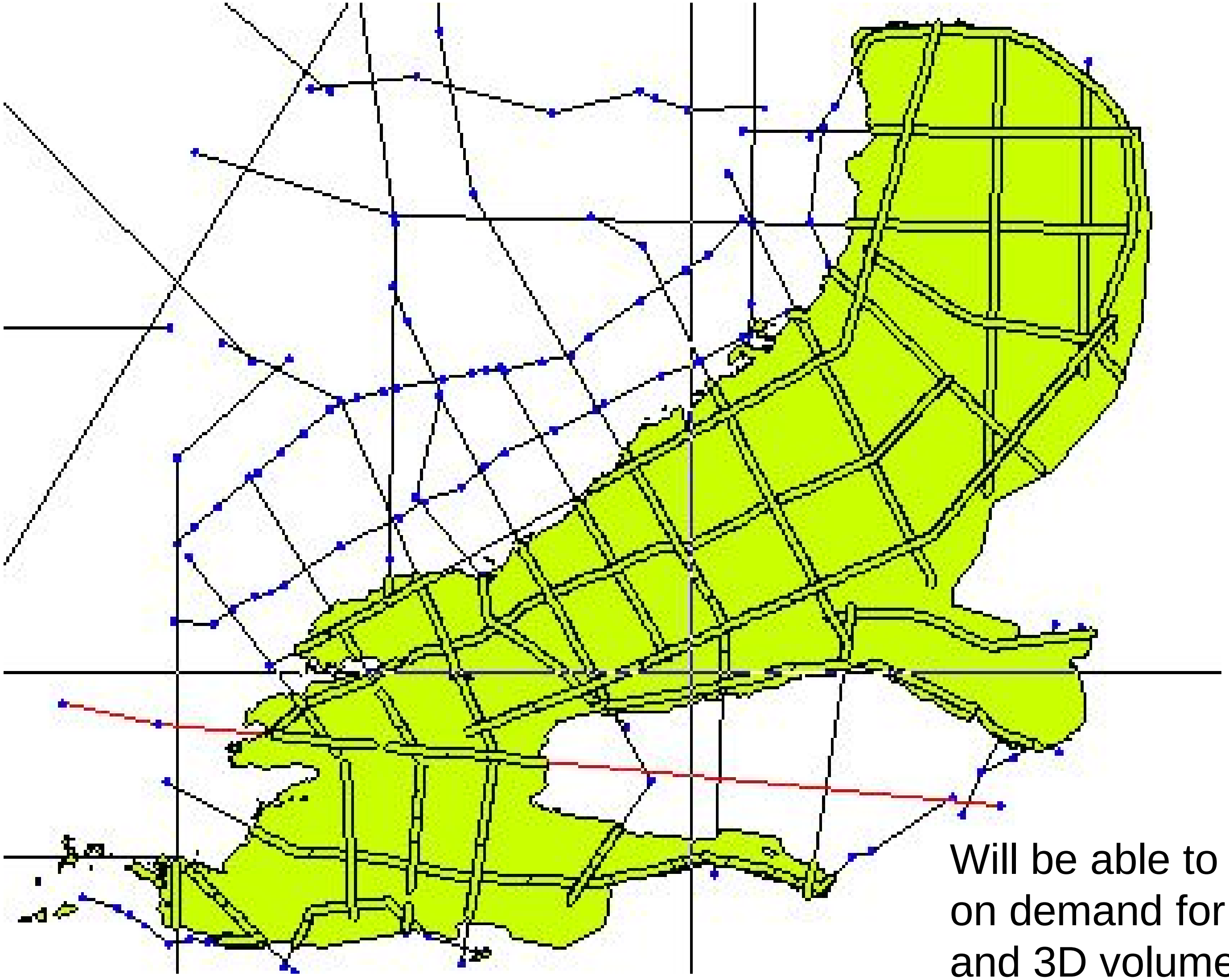
And we can do some neat things



Outcrop Grey Chalk
From shp file attribute table

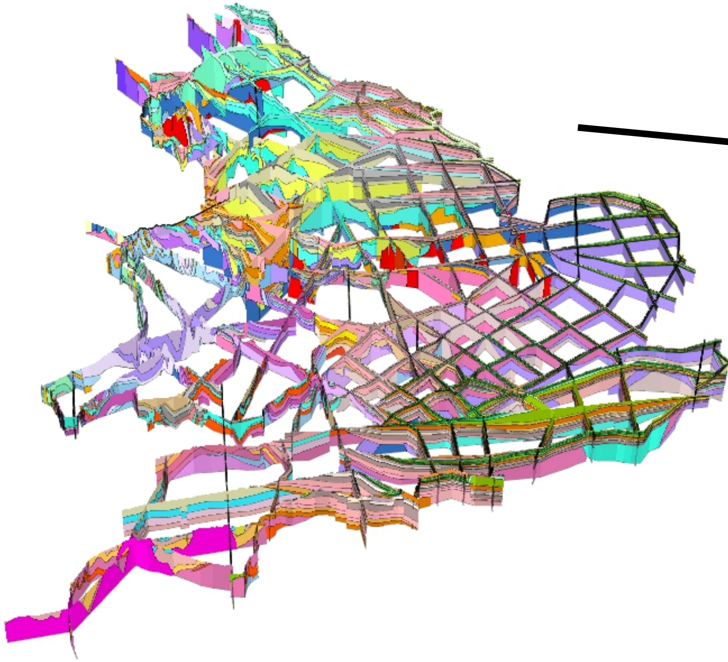


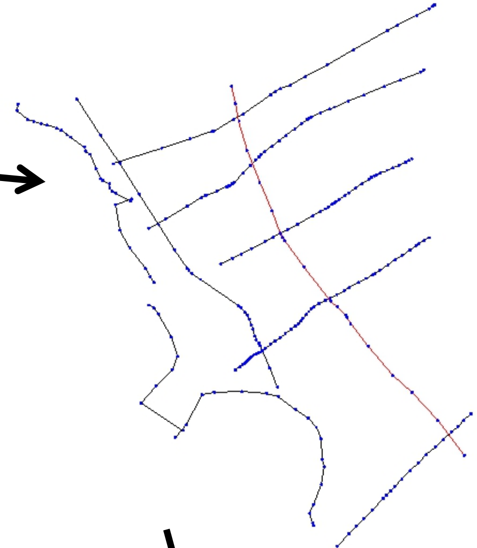
Distribution in sections
(defines subcrop)



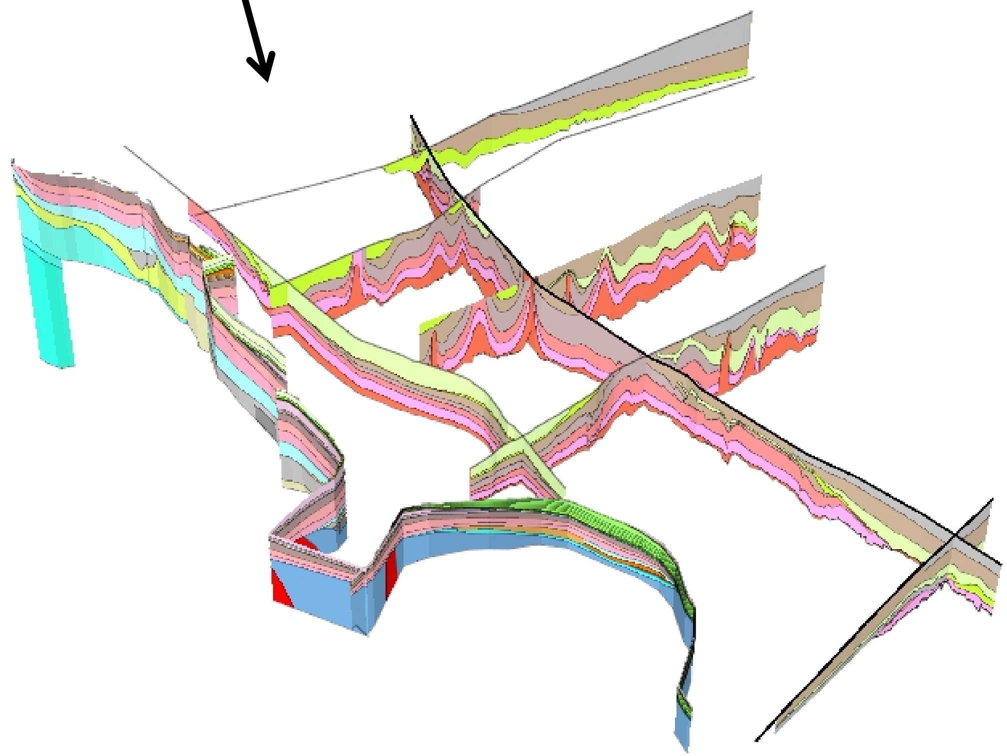
Will be able to supply these on demand for many units and 3D volumes for simpler bedrock

Outcrop and subcrop combined = **envelope** (unit distribution)
Current **EA Shale gas study** will use these





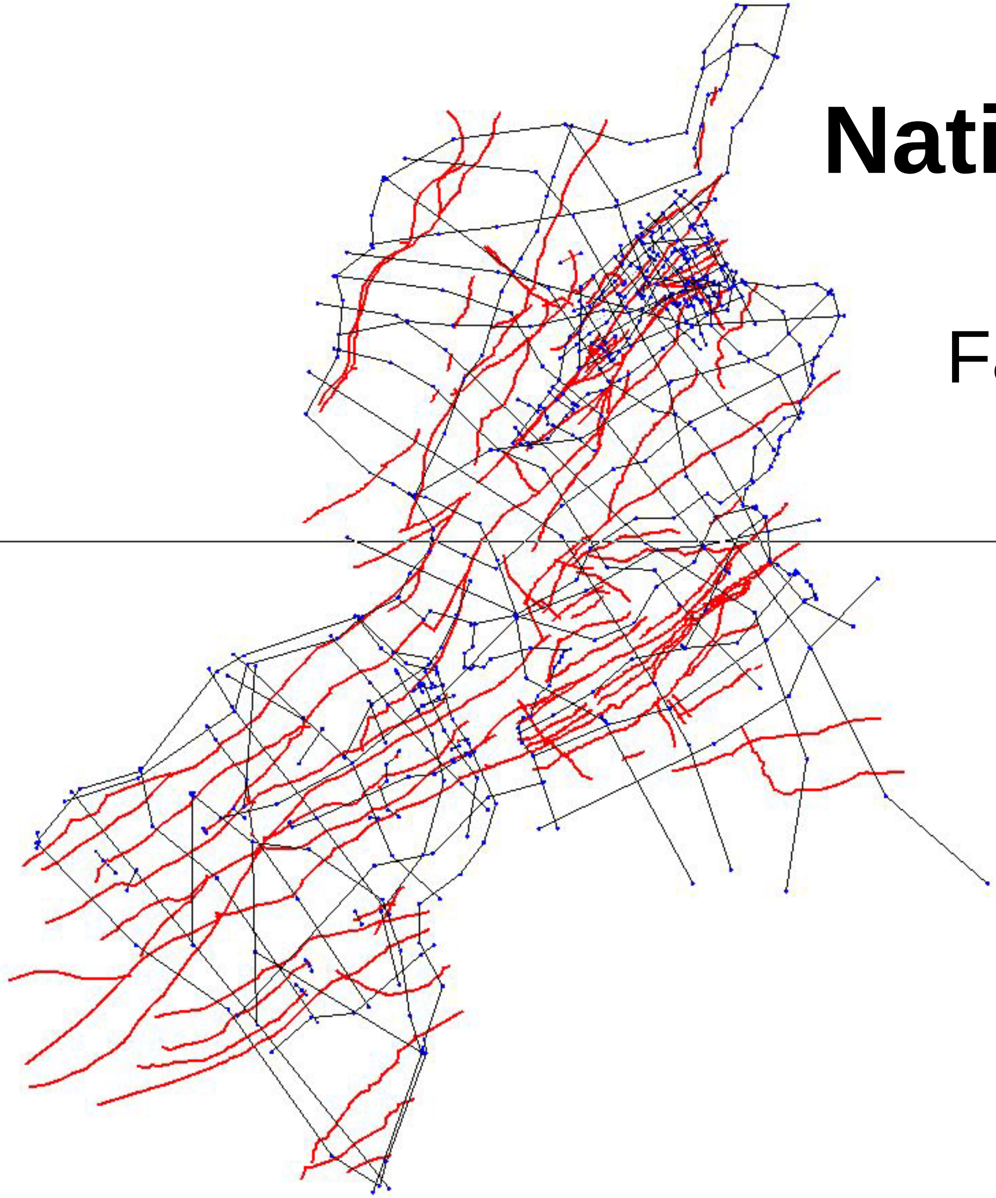
Moving offshore

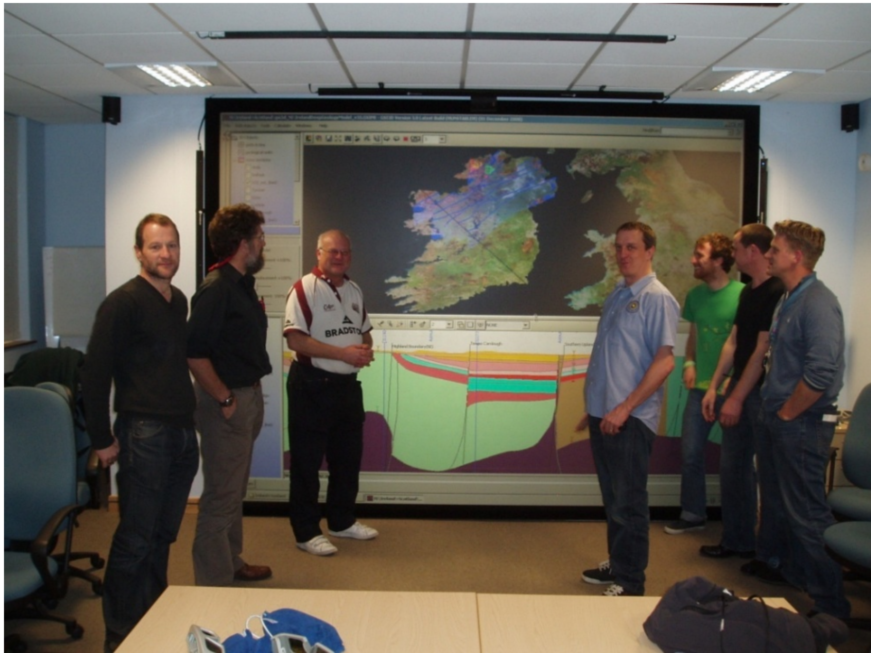


Getting our toes wet

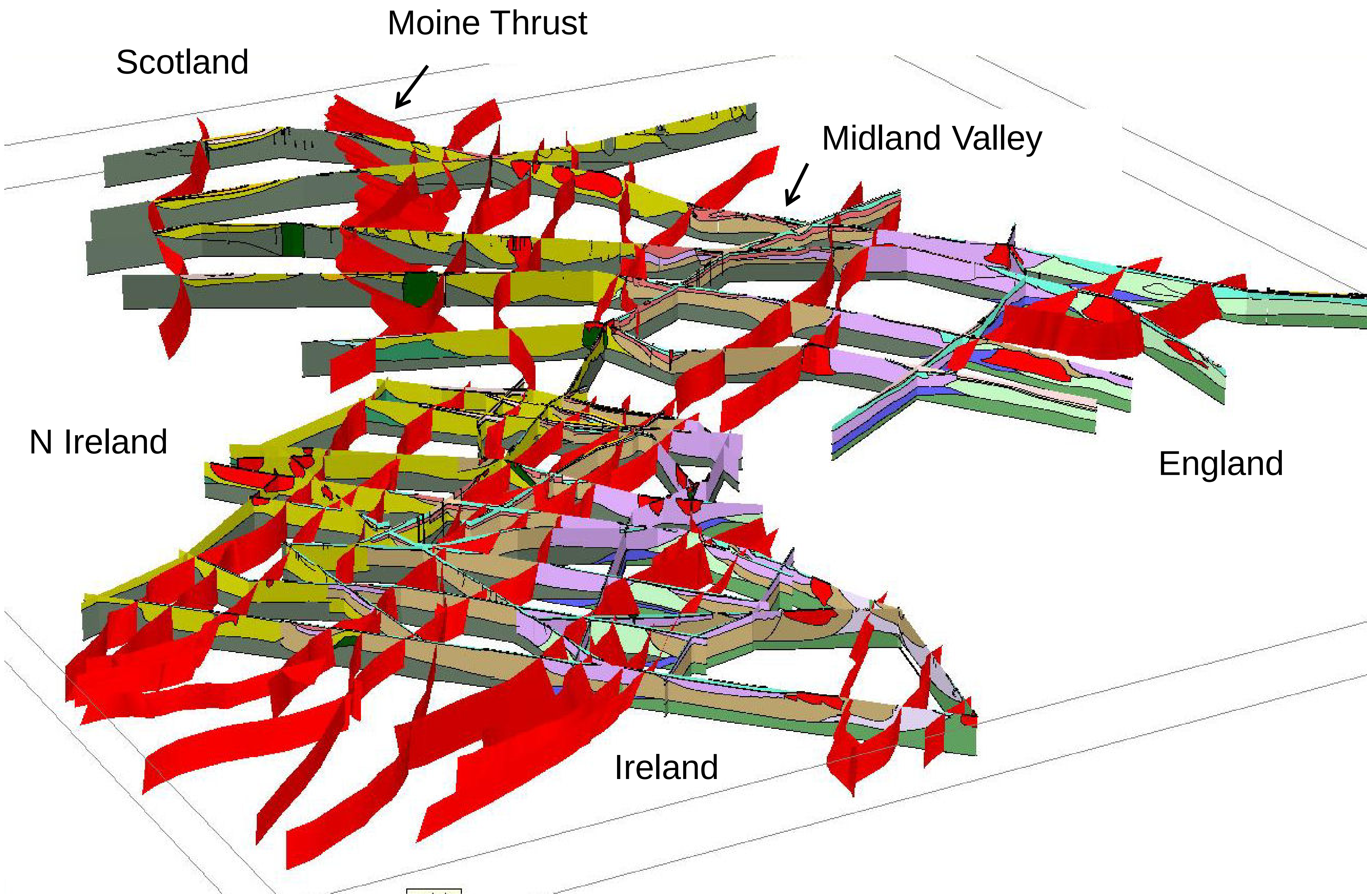
National crustal model

Faults and sections

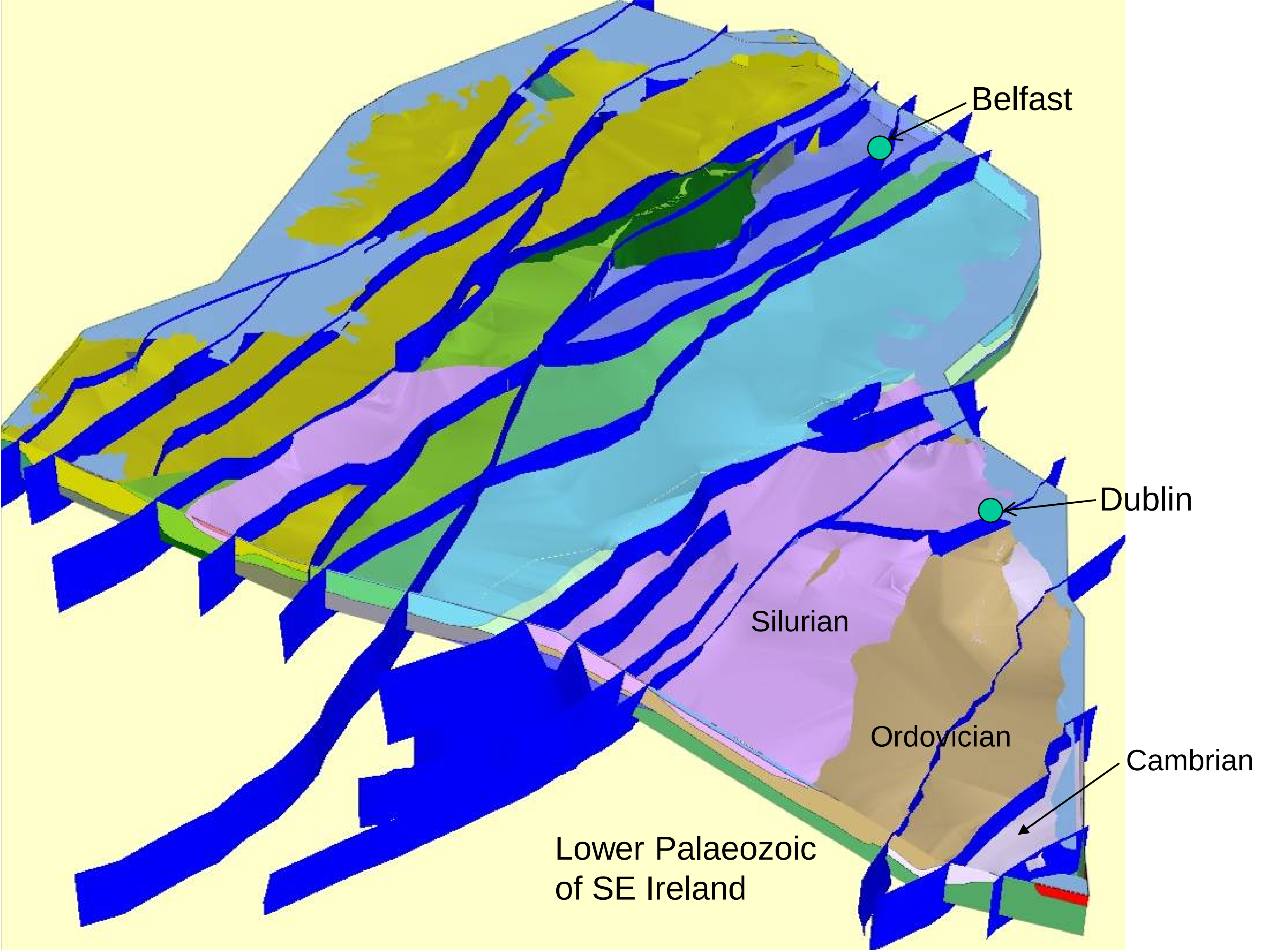




BGS-GSNI-GSI

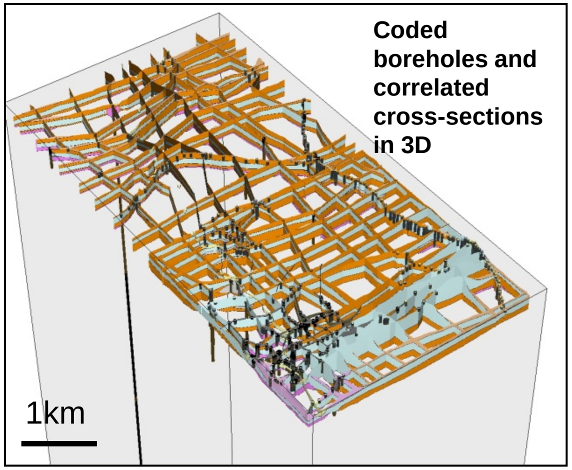


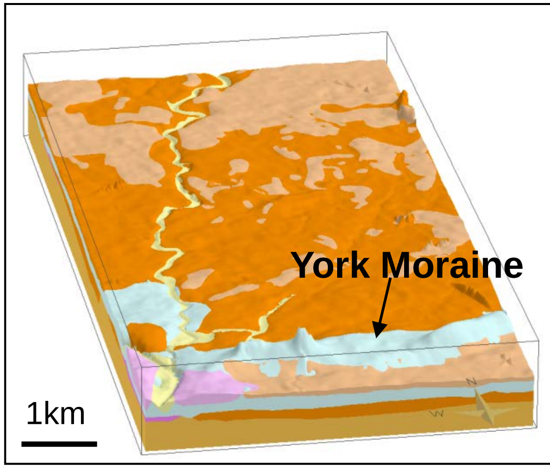
Note structural continuity of terranes along the Caledonian trend. Sections **15km deep**

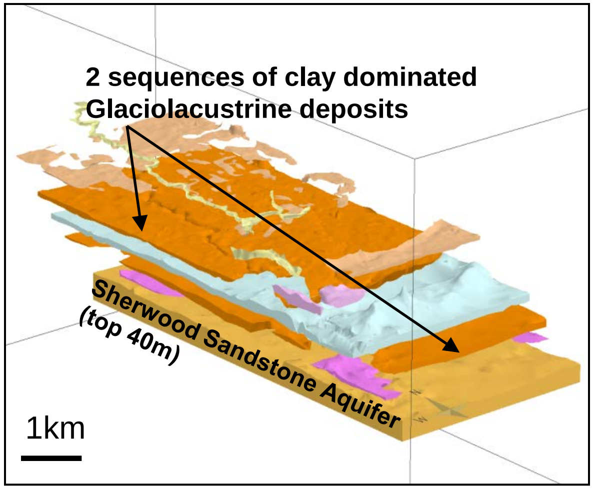

Belfast
Dublin
Silurian
Ordovician
Cambrian
Lower Palaeozoic
of SE Ireland

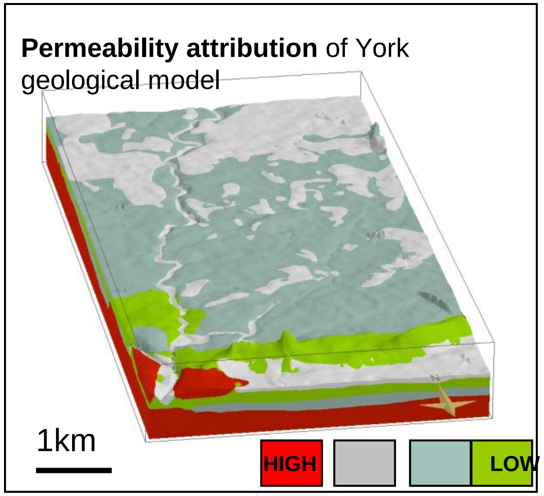
National 3D Quaternary & Anthropocene

- Unified 3D geological models of natural and artificial Quaternary deposits and landforms
- To develop the 3D modelling methodologies for natural and artificial Quaternary deposits
- To build a common Quaternary 3D lithostratigraphic framework through model integration and ‘arterial’ cross-section construction along major infrastructure routes

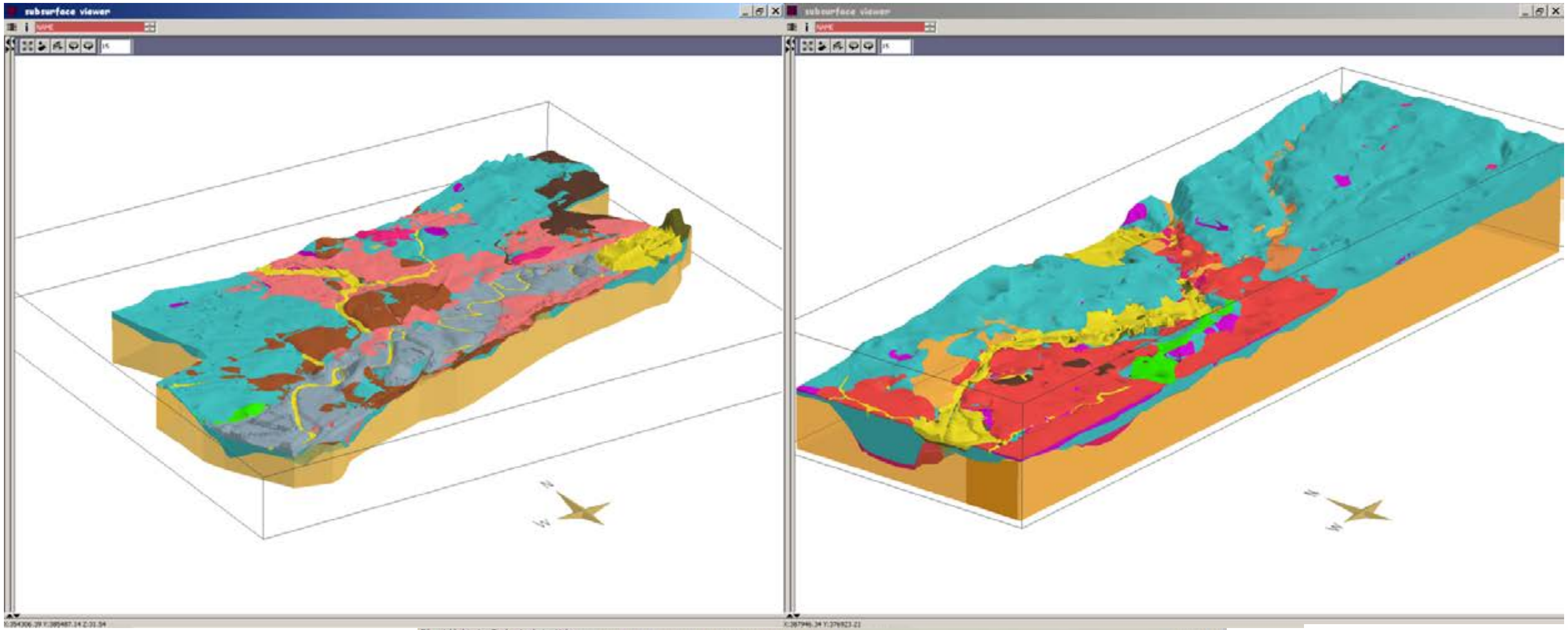


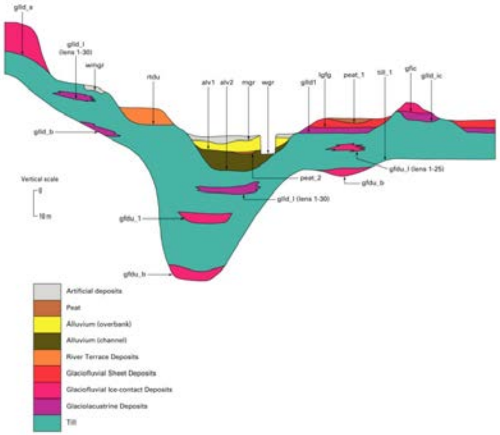


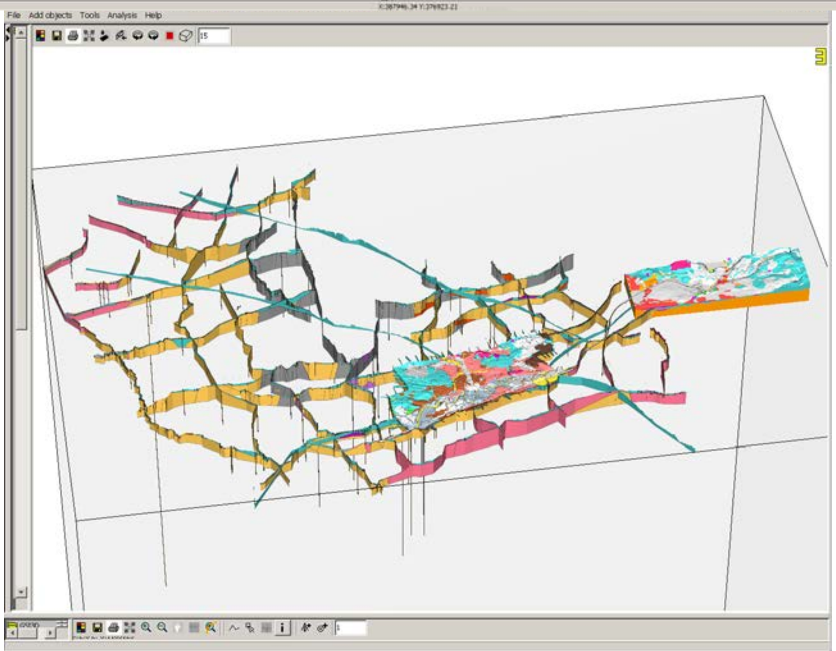


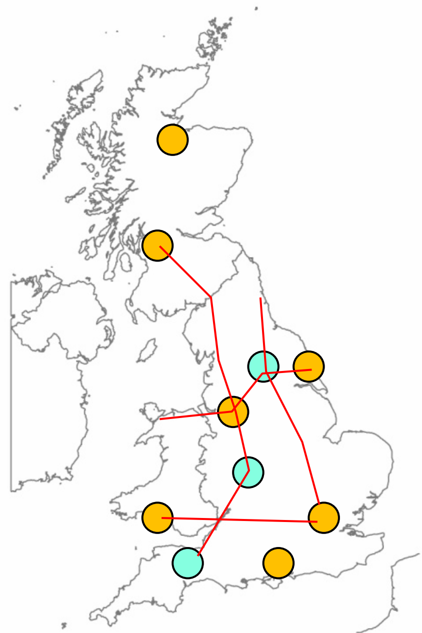


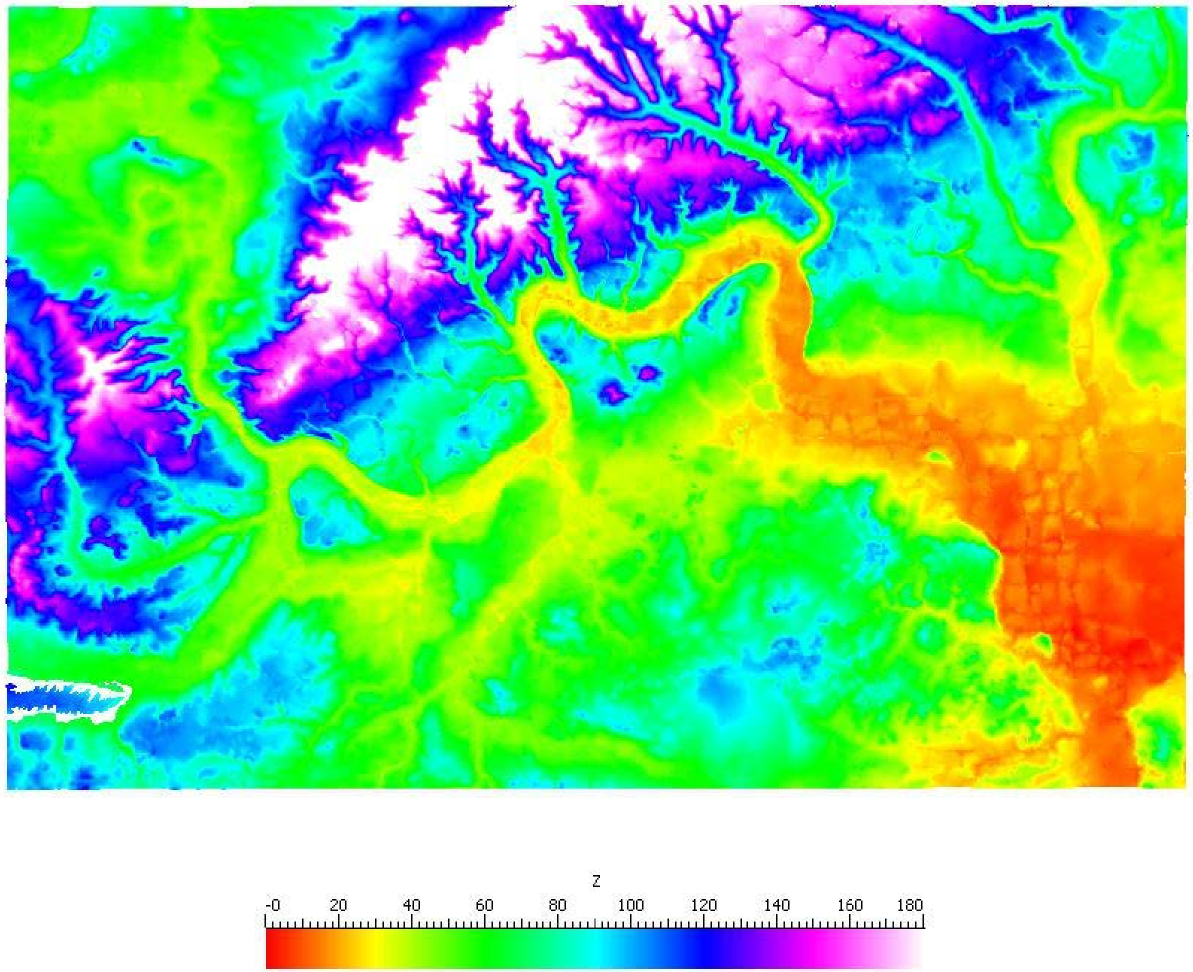
Model integration across domains







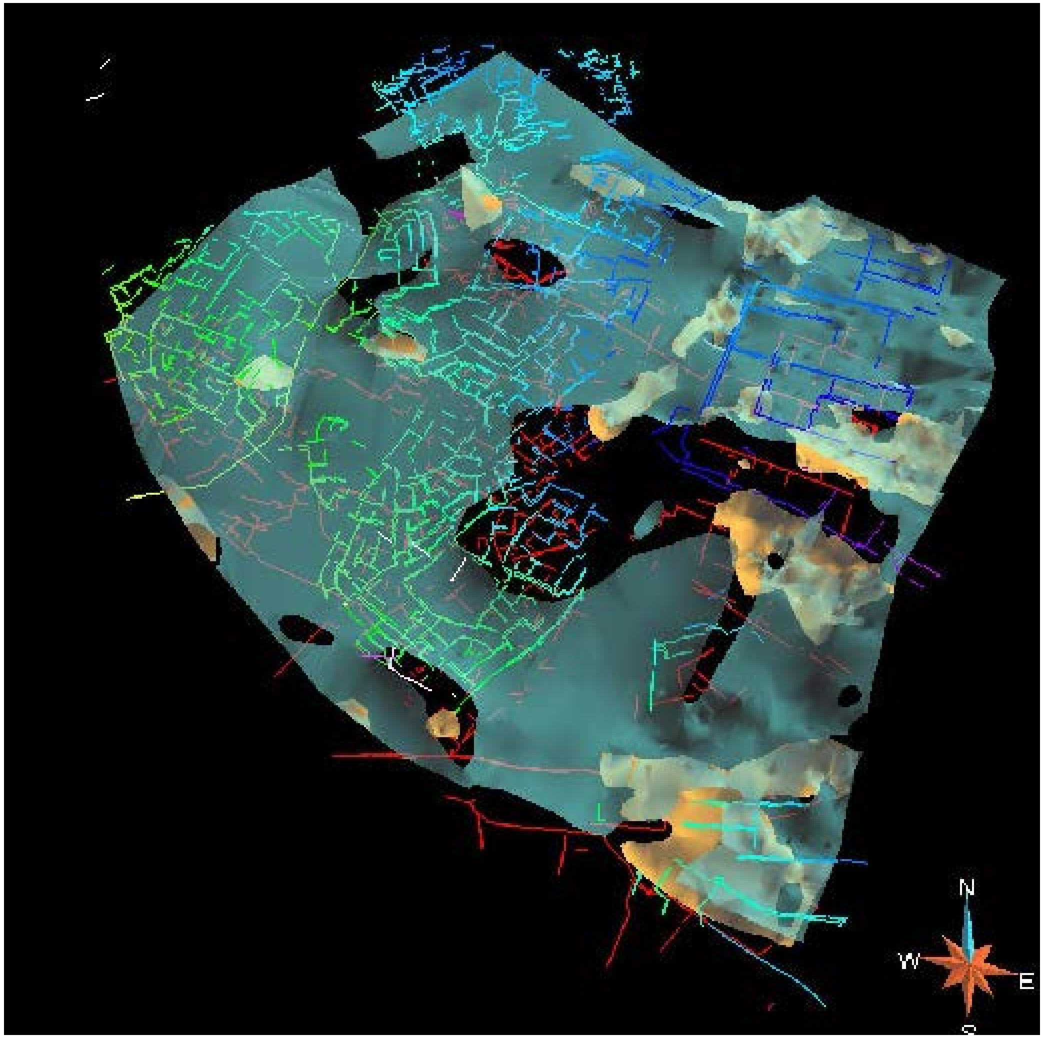




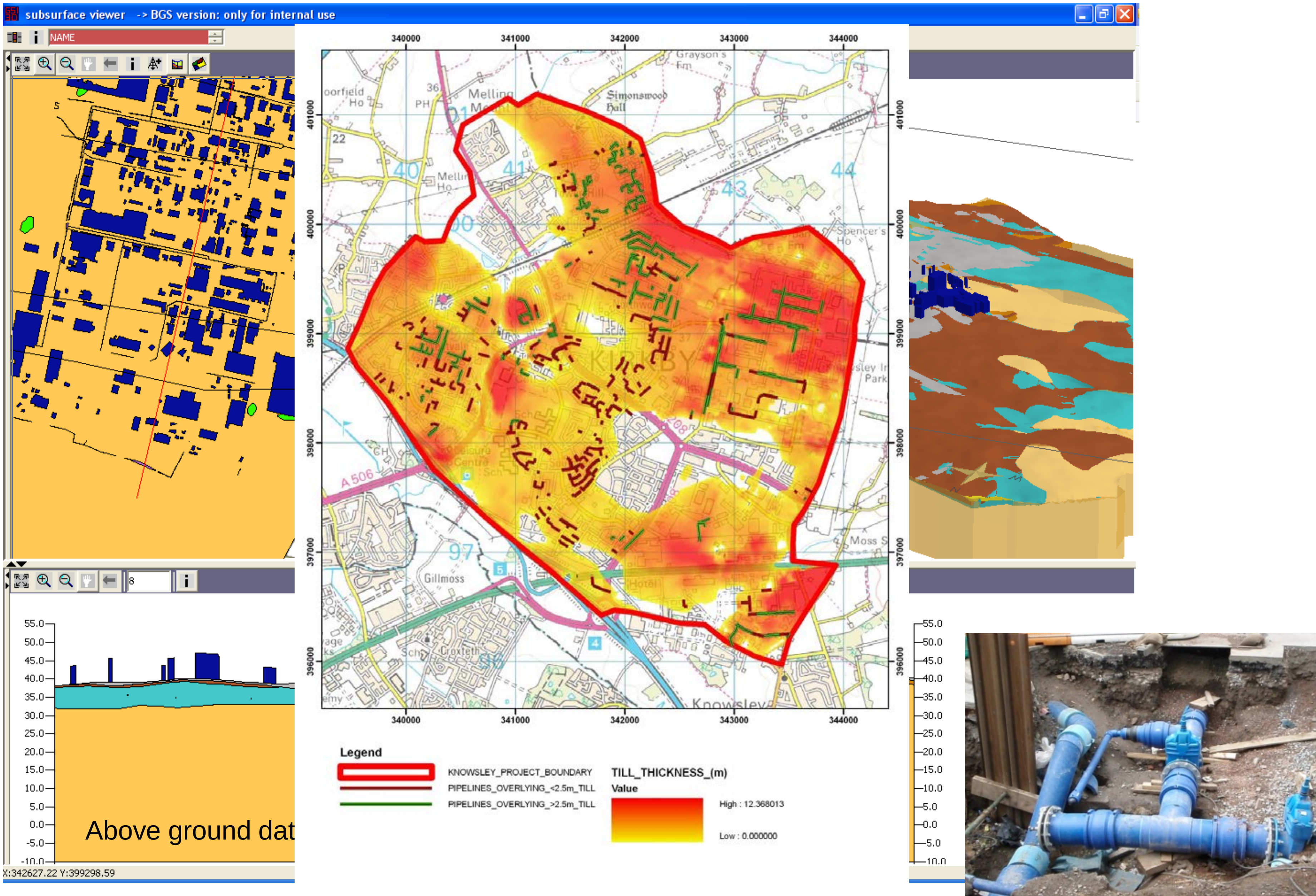
Base Quaternary surface

Buried Infrastructure

- Industrial park in North-West England
- Understand relationship between subsurface infrastructure (drain pipes) and geology
- Provide customer-focussed decision support tools
- 3D modelling to address real world problems

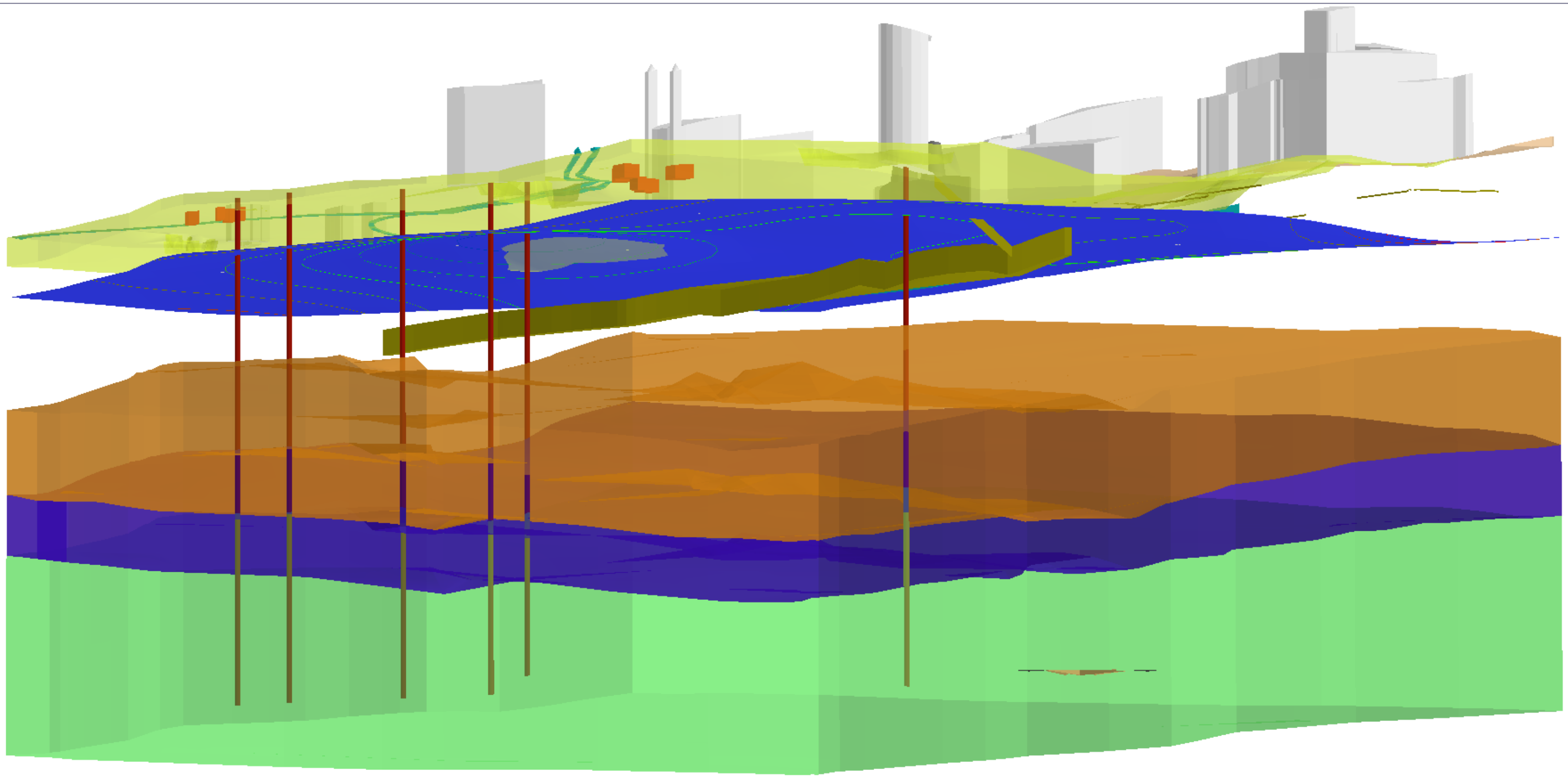


Urban Geology – integration of infrastructure



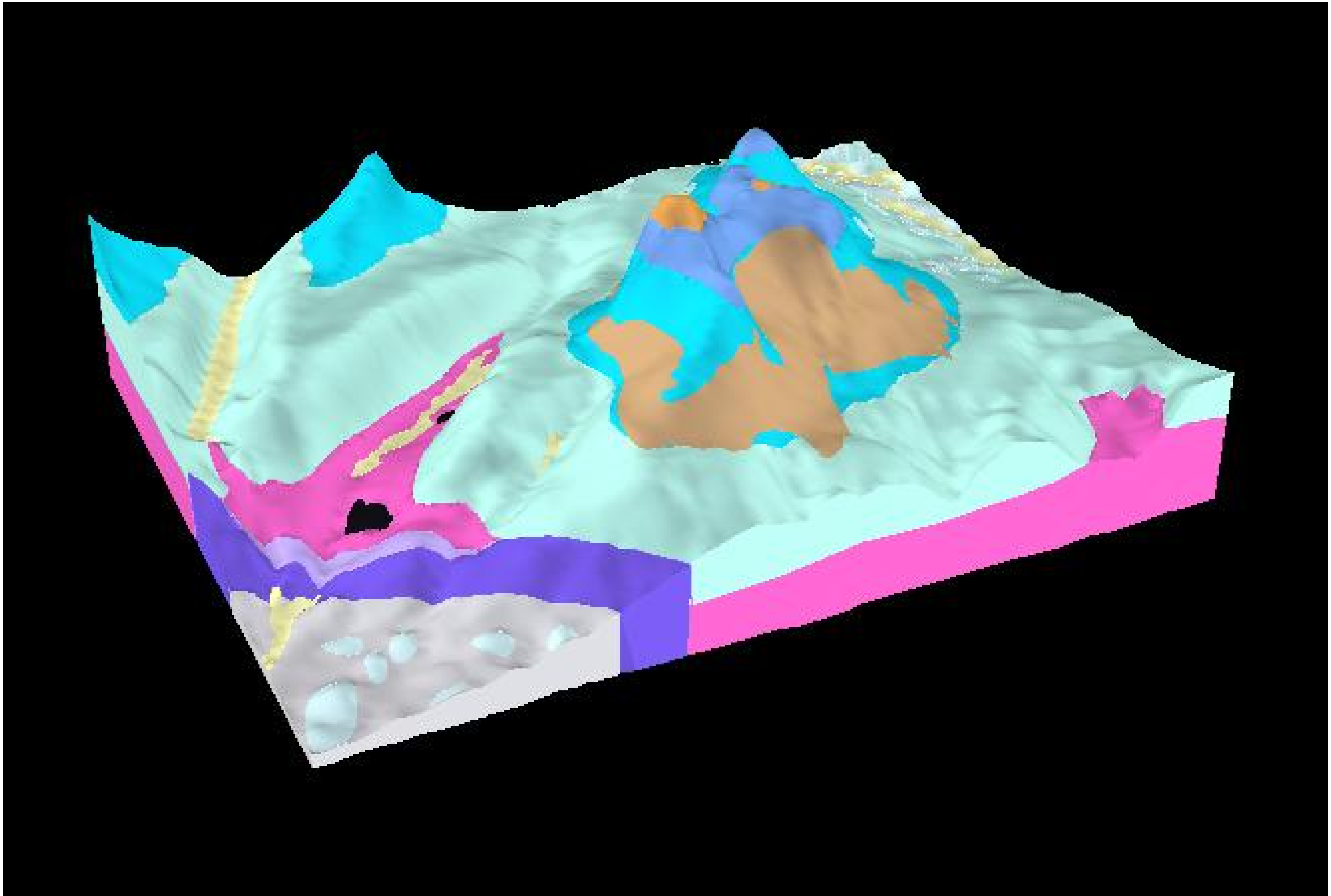
Future?

Subsurface information system



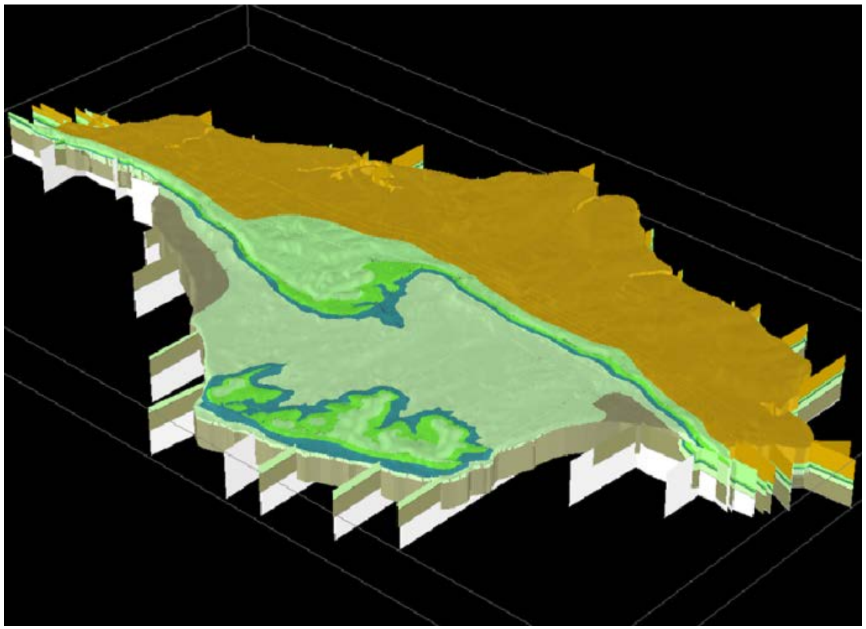
Will the subsurface under major cities become regulated?

Educational models

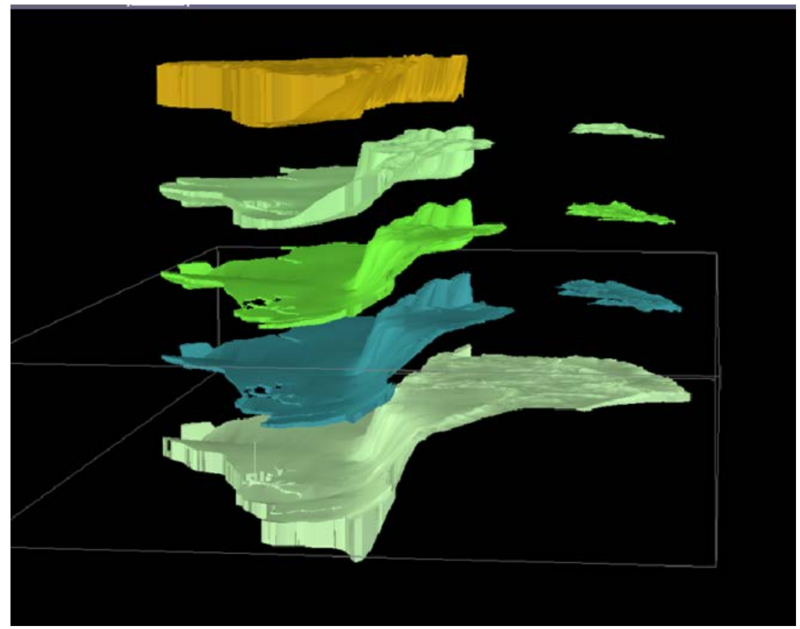


Educational models

Isle of Wight



Model units and grid of autogenerated sections

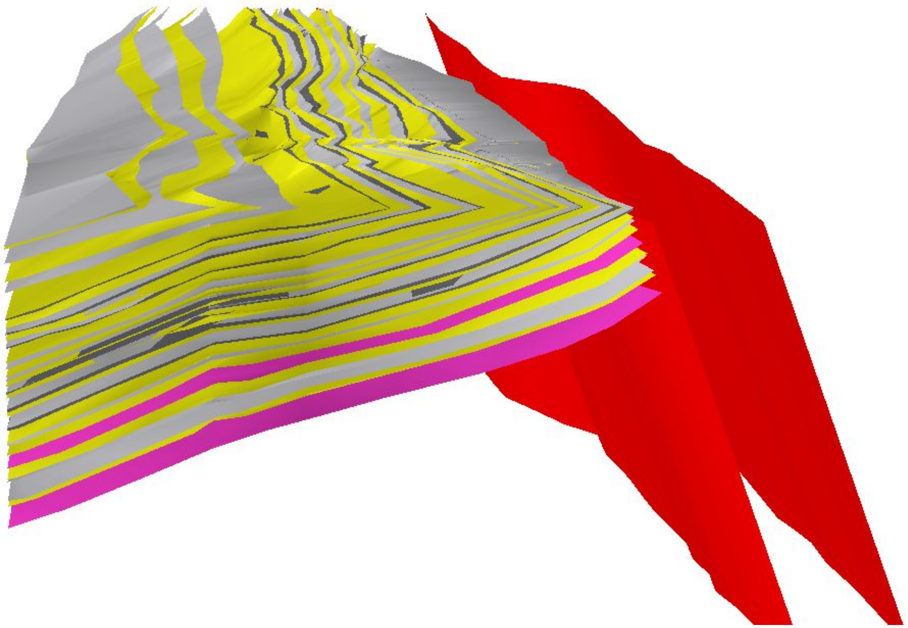


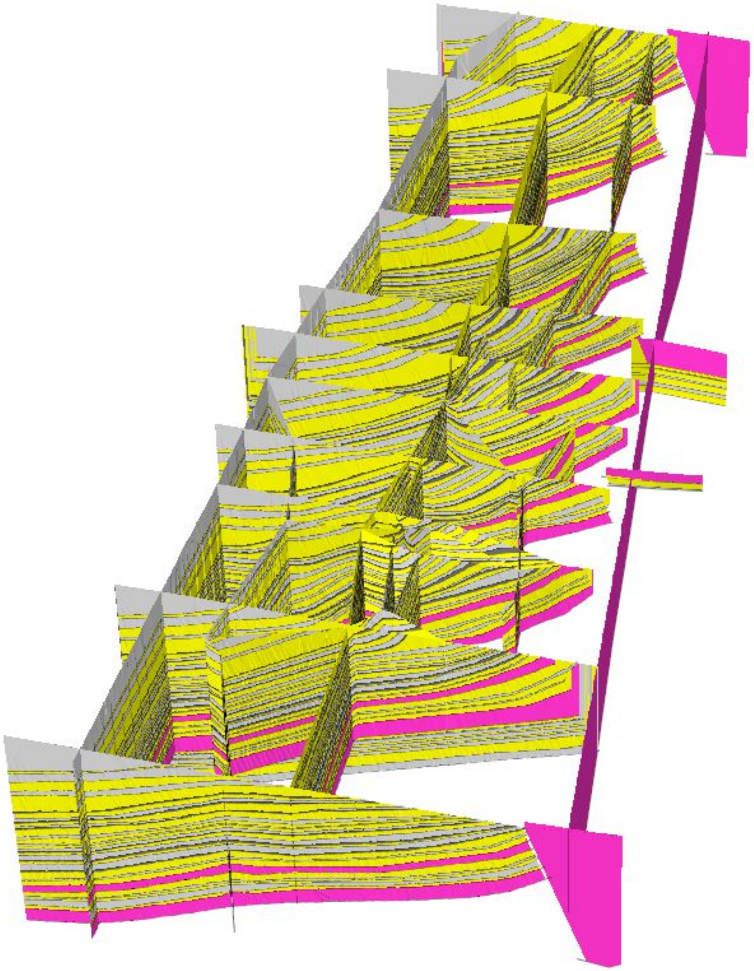
Exploded layers

Free downloads from BGS website with educational packages

Collaborative Model

USGS New Jersey

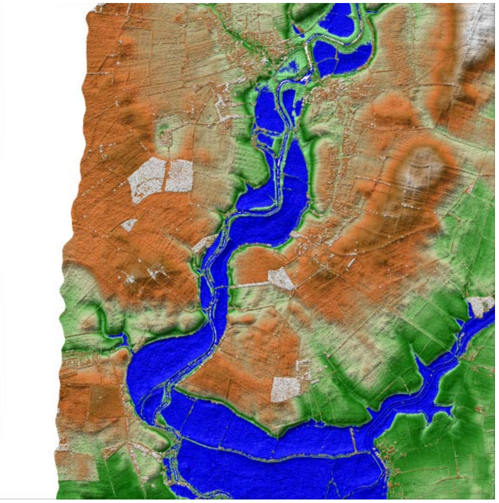


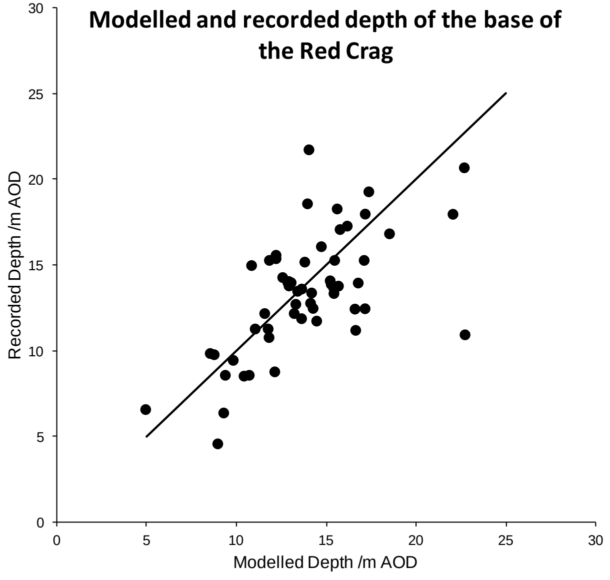


Microstratigraphy, autodensification
Will soon add chemical downhole data
for pollution plume and new logs

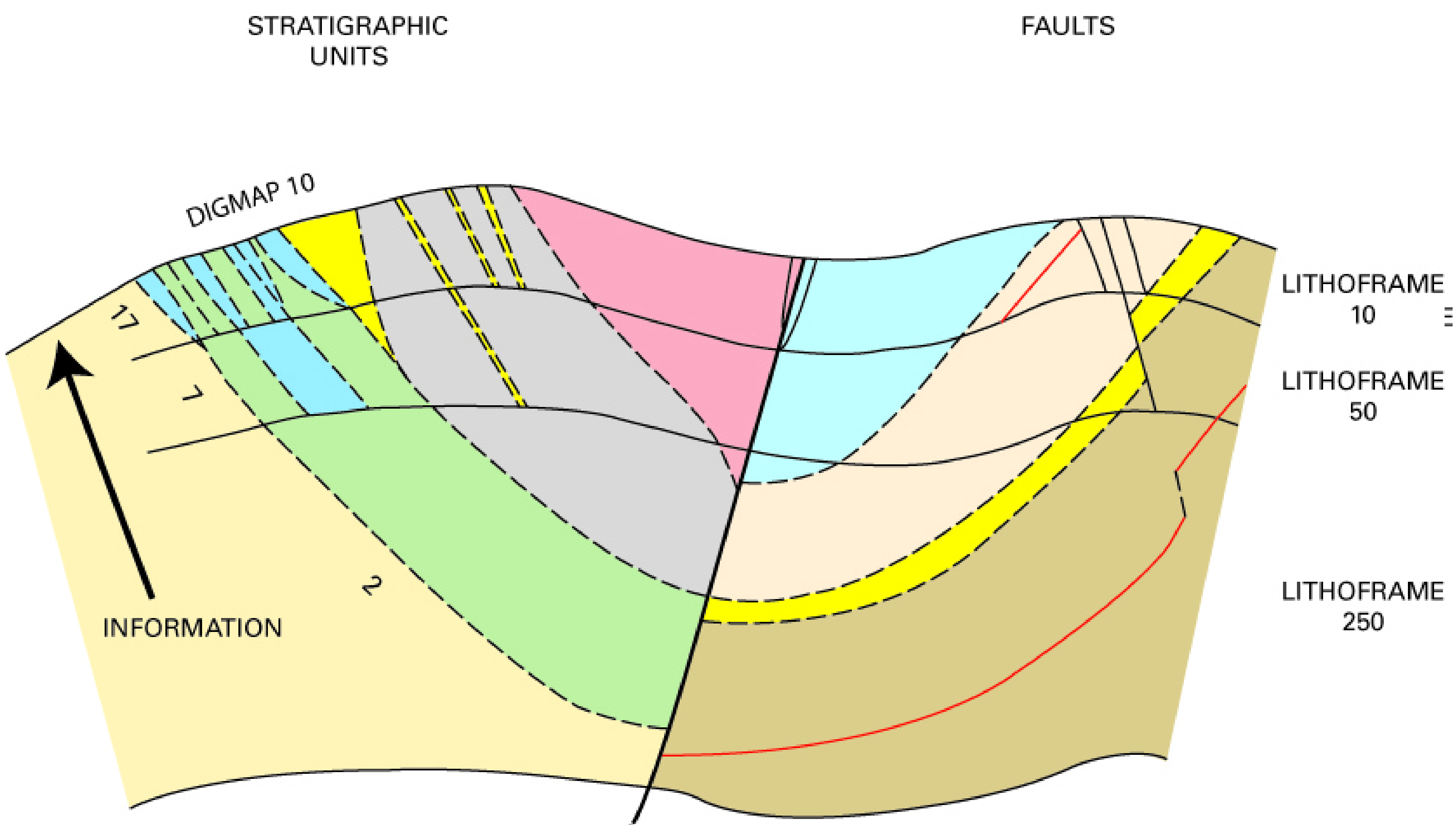
Generic issues and resources

- Model integration **multiscalar**
- DTM's
- 3D National library
- Model metadata & QA
- Uncertainty studies
- Property models, voxels and stochastics
- Model delivery
- Corporate workflow



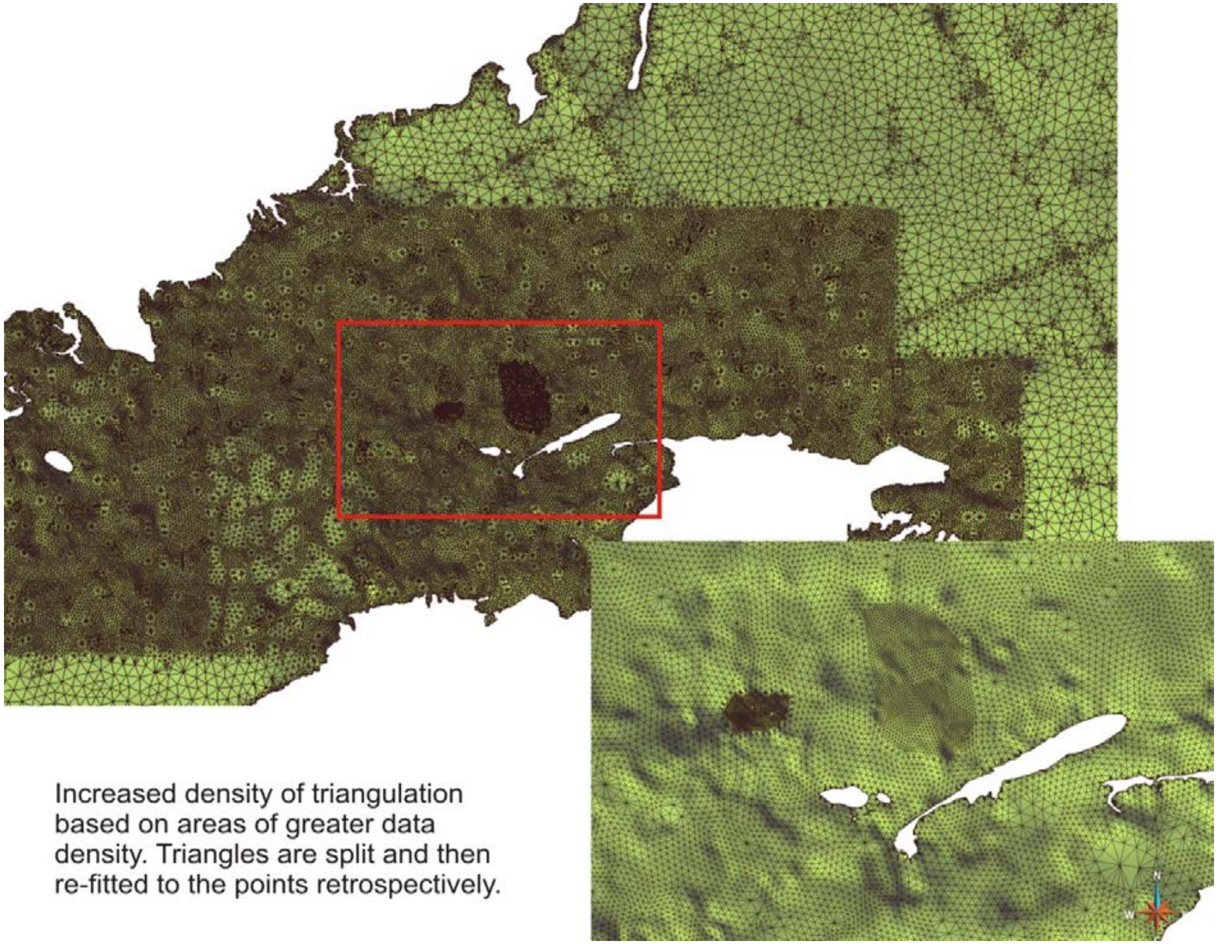


Nesting stratigraphies, compromises will be necessary



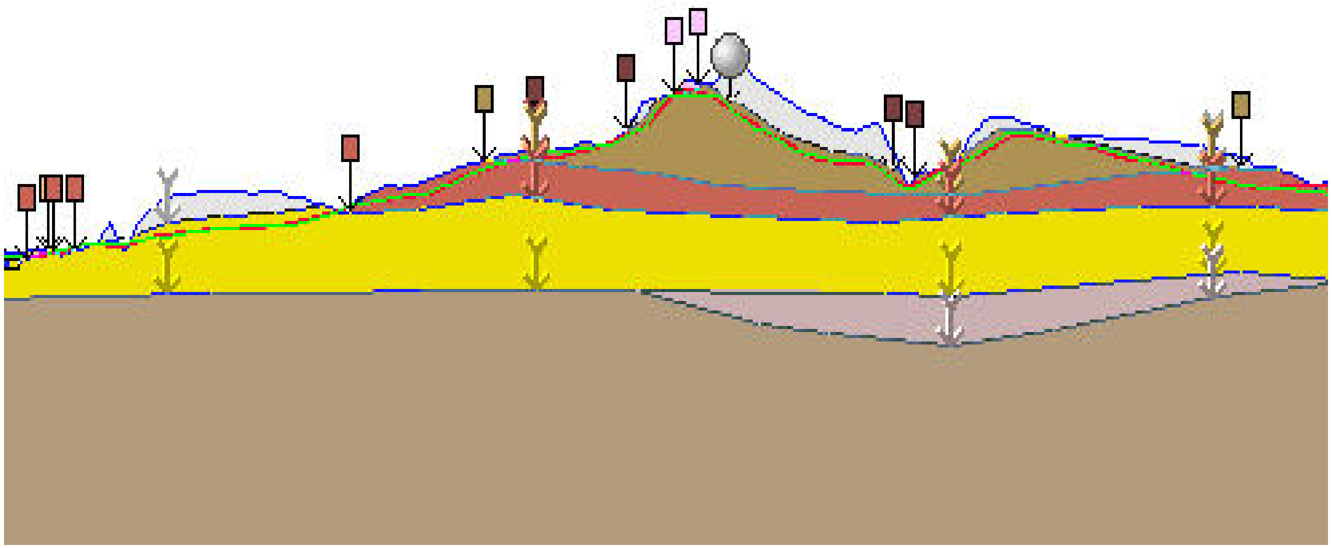
Easiest to do for Stratified rocks – stratigraphers permitting

GOCAD generated variable mesh



Increased density of triangulation based on areas of greater data density. Triangles are split and then re-fitted to the points retrospectively.

The Search for the holy grail
Bald Earth dtm and Multi-patches

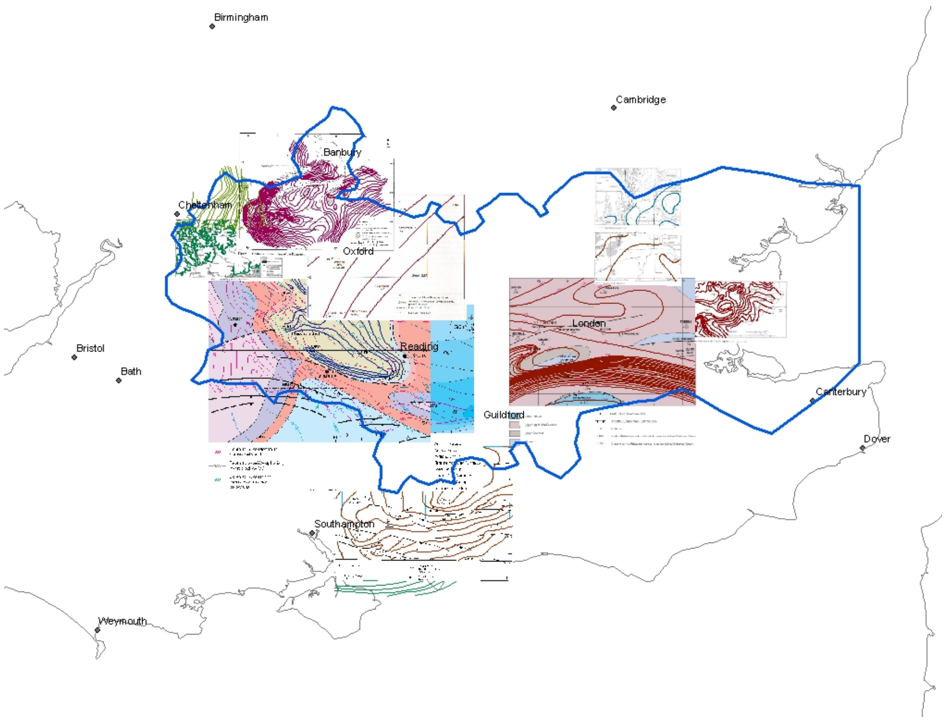


Blue = NextMap with woods included
Green = OS Panorama
RED = Merged BGS Bald Earth Model

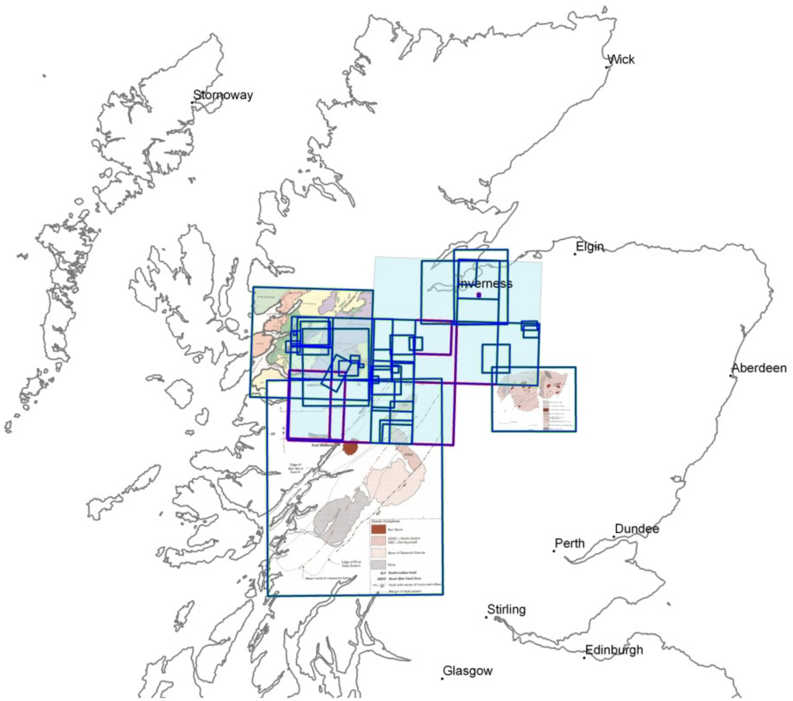
Aspiration a perfect bald earth model but present reality horses for courses

Resources - National 3D Library

Like Elsevier's Geofacets

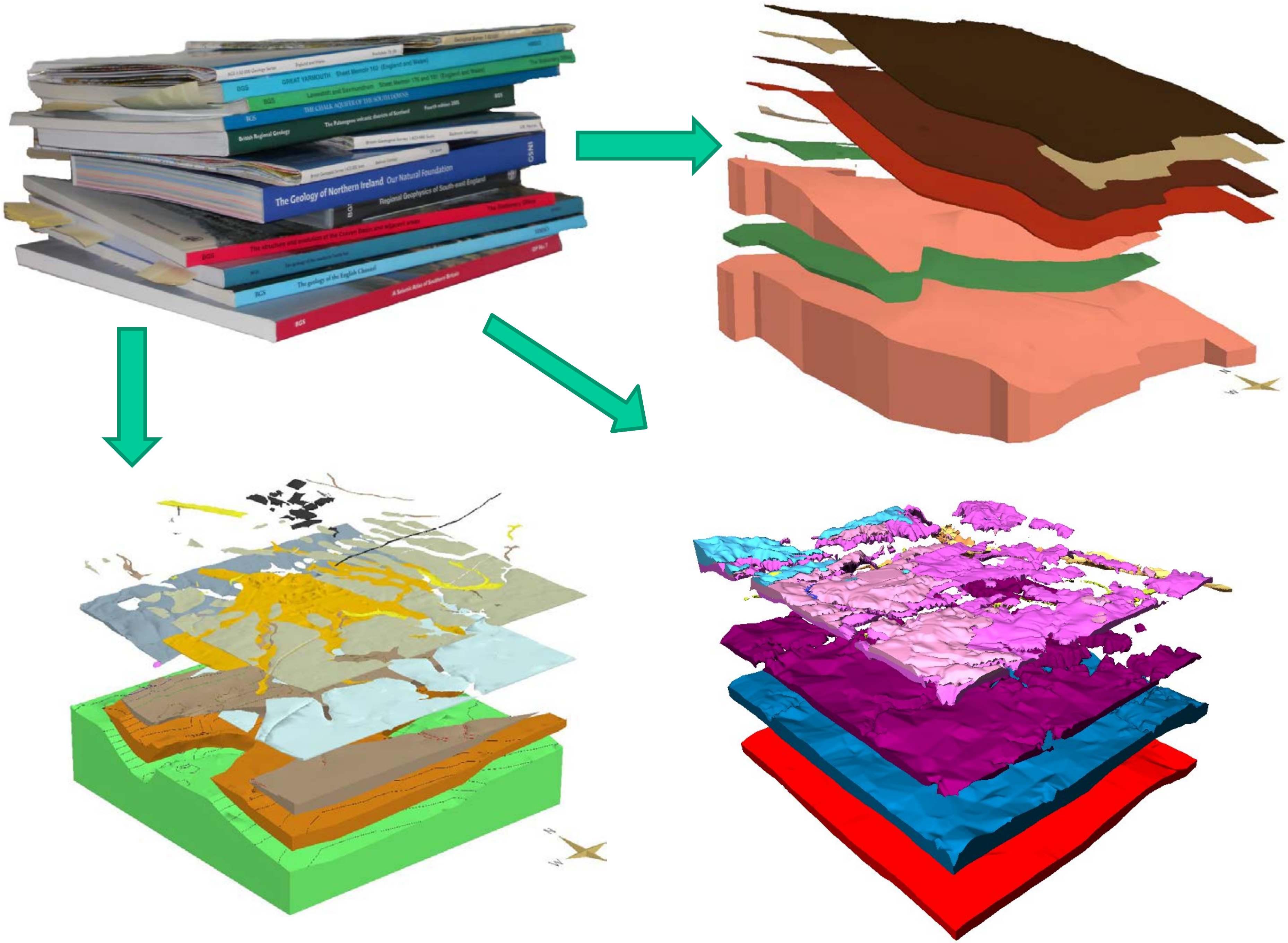


Thames Catchment



Great Glen Corridor

Mining the literature



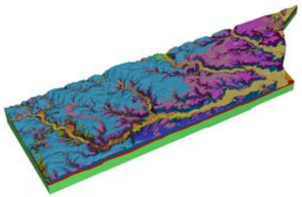
GREAT YARMOUTH Sheet Memoir 162 (England and Wales)
THE CHALK AQUIFER OF THE SOUTH DOWNS
British Regional Geology
The Palaeogene volcanic districts of Scotland
Fourth edition 2005
The Geology of Northern Ireland Our Natural Foundation
GSNI
Regional Geophysics of South-east England
The geology of the English Channel
A Seismic Atlas of Southern Britain
BGS
N
W

Model metadata report

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Model summary report for the Ipswich-Sudbury model

Geology and Landscapes Programme
Internal Report XX/00/00



BRITISH GEOLOGICAL SURVEY

WHATEVER PROGRAMME
INTERNAL REPORT XX/00/00

Model summary report for the Ipswich-Sudbury model.

S. Mathers

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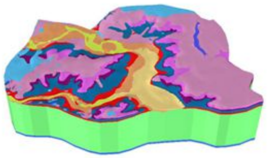
Keywords
Report, keywords.

National Grid Reference
SW corner 580000 230000
NE corner 646000 250000

Front cover& frontispiece
Cover picture the calculated block model of the Ipswich-Sudbury area.. Frontispiece cookie cut model of the Ipswich urban area.

Bibliographical reference
MATHERS, S.J.2012. Model summary report for the Ipswich-Sudbury model. *British Geological Survey Internal Report*, XX/00/00. Xpp.

Maps and diagrams in this book use topography based on Ordnance Survey mapping.



Keyworth, Nottingham British Geological Survey 2012

Summary Metadata & Model Approval Form

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

This form will comprise an important part of the model metadata. On completion it should be forwarded to the TL NGM with all the other model files and documentation for incorporation into the National Geological Model.

Model name	
Model file name including version	
Link to model folder	
Link to model internal report	
Lead modeller (name or code)	
Model resolution	
Scale of use	
Grid (BNG to be onshore default and should be used in future where possible)	
Datum used (OD Newlyn to be onshore default wherever possible)	
DEM - Capping surface	
Cell size used for calculation (in metres)	
Geology (select all that apply)	Bedrock ☐ Artificial ☐ Superficial ☐ Mass Movement ☐
Extent	BOTTOM LEFT COORDINATE X Y; TOP RIGHT COORDINATE X Y
Depth range (in metres from highest surface point)	
Purpose	
Intended Output (select all that apply)	TINs-Grids ☐ Viewer Model ☐ Images on web ☐ 3D PDF ☐ Groundhog ☐ Report ☐ Other (please specify)
Software(s) used including version	
Other Models fitted to, superseded or included	
IPR status	
Confidentiality status	

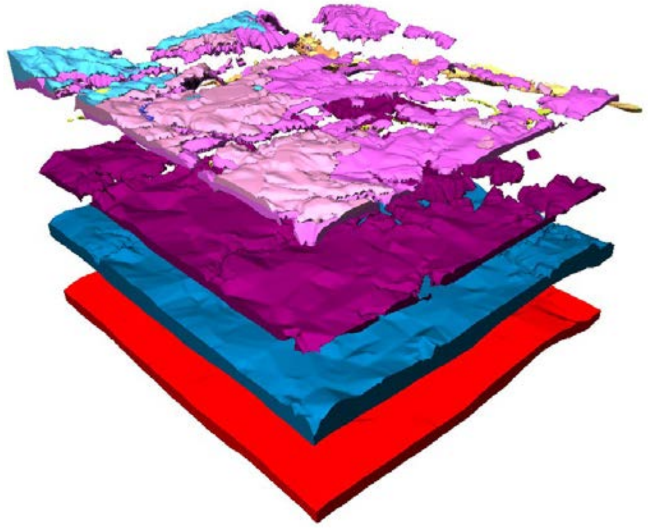
Dated signatures required:

1. Lead Modeller
2. Project Leader (responsible for final checking of model)
3. IPR Manager (as required)
4. Team Leader/Chief Geologist
5. HOS (for high profile or sensitive models when referred by the TL NGM)

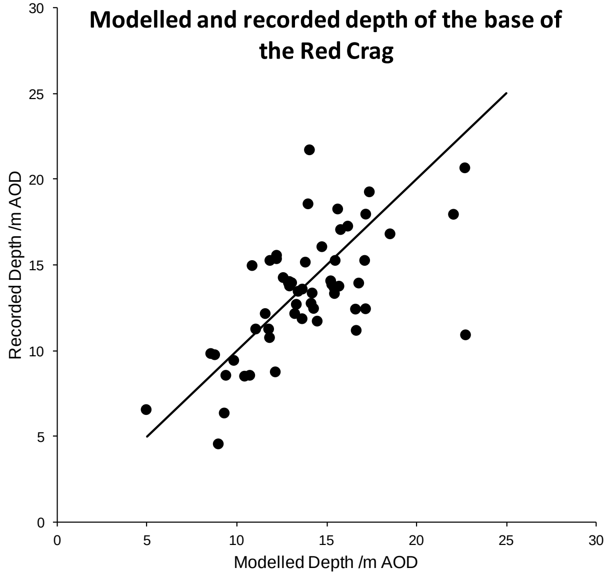
Model published

Uncertainty studies

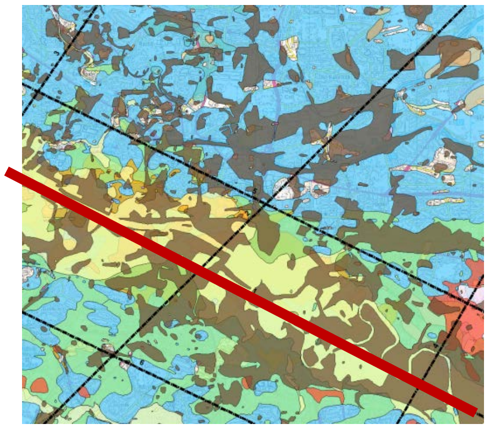
$$y_{\mathrm{b}}(\mathbf{x}) - y_{\mathrm{m},i}(\mathbf{x}) \;=\; \mu_{\mathcal{B}} + a_i(\mathbf{x}) + \varepsilon_i(\mathbf{x})$$



- Five modellers modelled six formations in the TM24 map sheet, each using a unique subset of the available boreholes from which a test set has been withheld.
- Each model can be compared with its test boreholes, to provide an overall data set on discrepancies between the model prediction and the corresponding observations.
- Analysis of these data enable us to quantify the overall model error, and the contributions made to it by variation between modellers and how model uncertainty varies with factors such as depth and distance to boreholes.

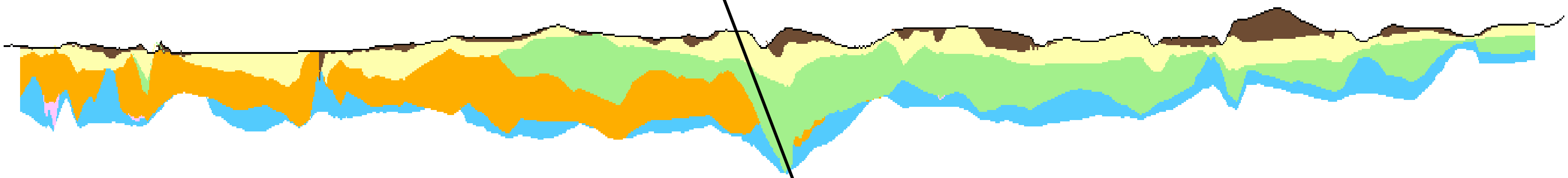


Comparing deterministic & stochastic

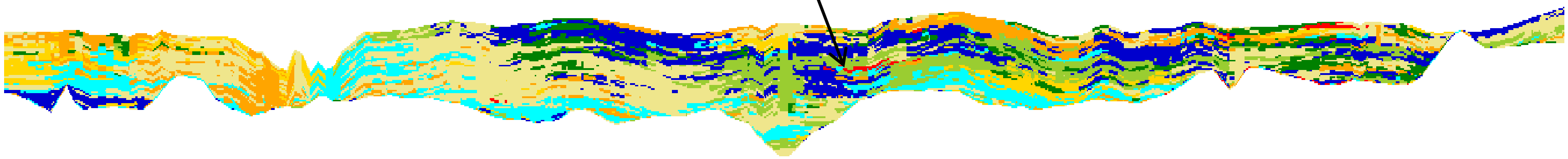


Captures greater lithological variability than the stratigraphy

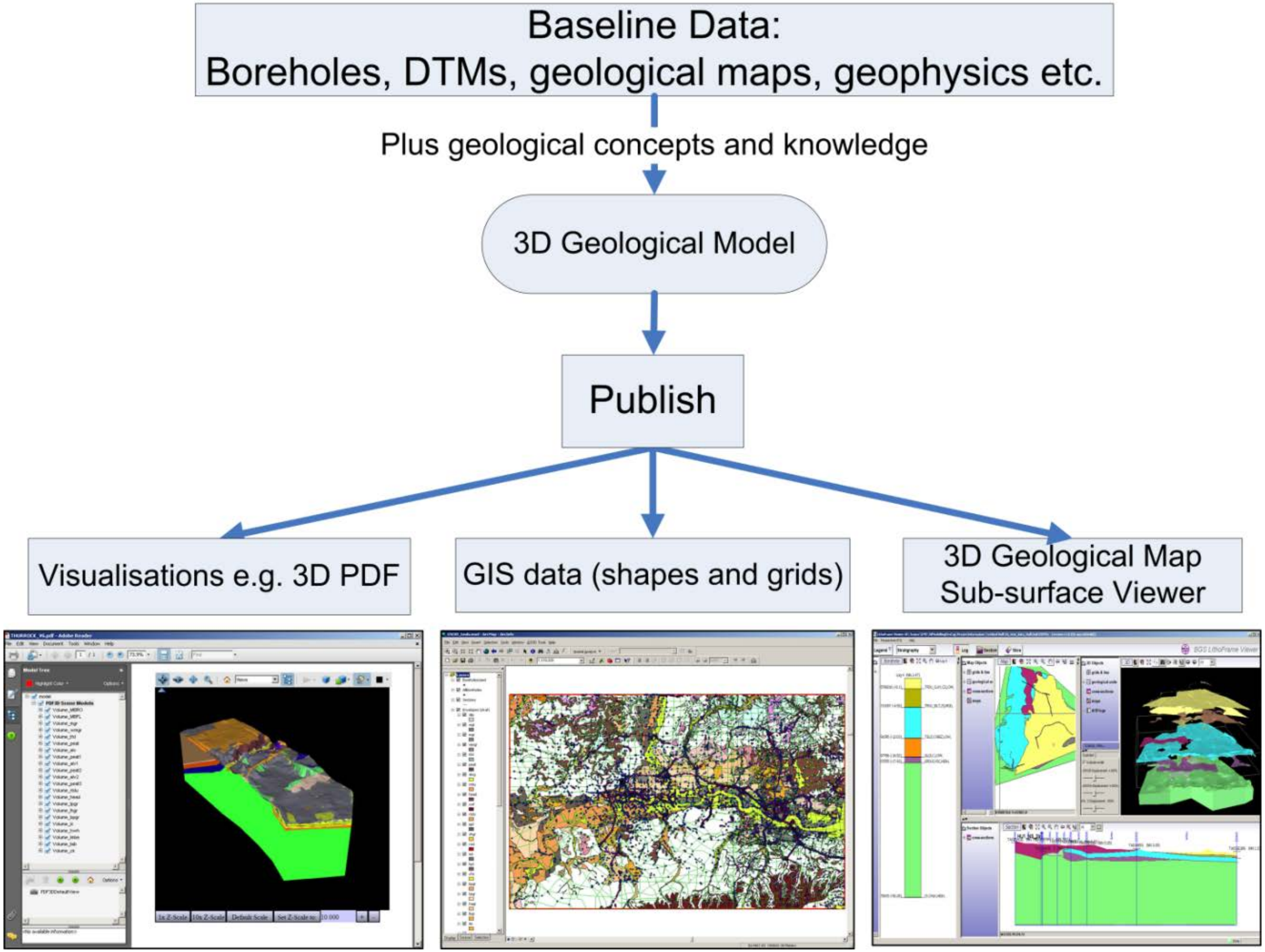
Deterministic



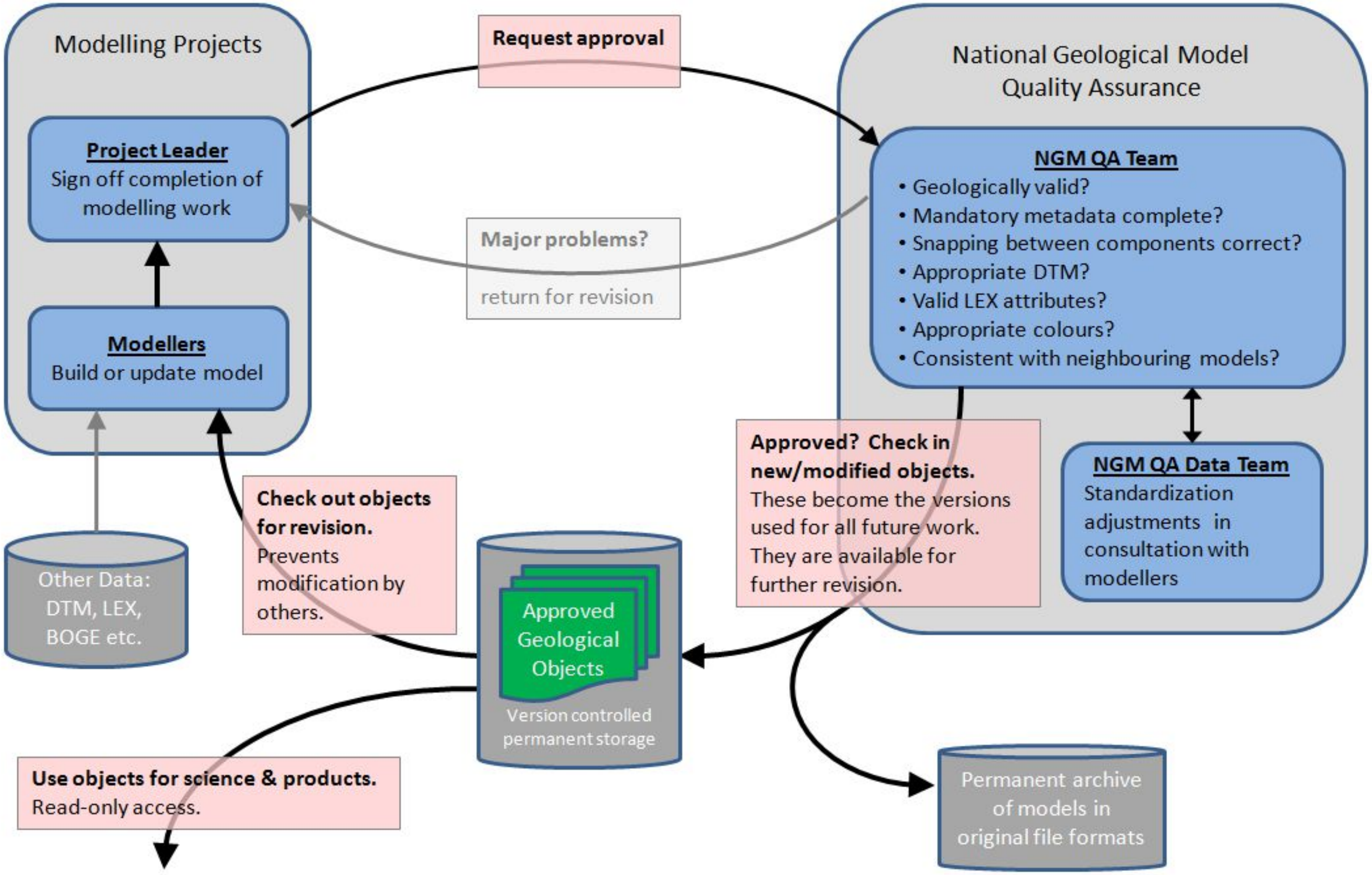
Stochastic

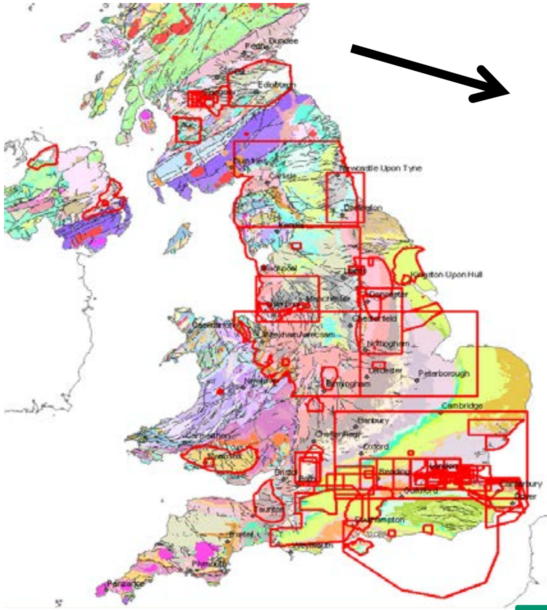


Model Delivery



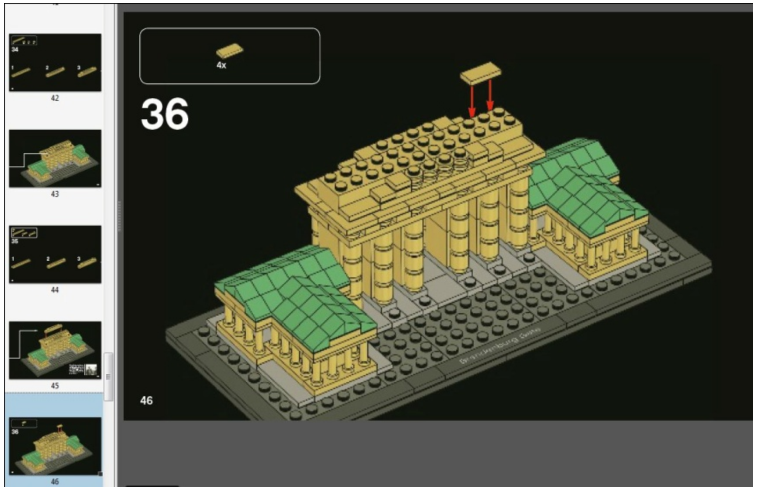
Model build & storage workflow





Existing models

Jumble of Lego bricks



Assembly instructions & QA

The National Geological Model

Frozen models

Objects Datastore

New generation models

Grazie!

Danke!

Gracias!

Thanks!