



**British  
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

Applied geoscience for our  
changing Earth

International Workshop on Groundwater Systems in Europe

# Application of 3D modelling to groundwater management in the UK

Rob Ward

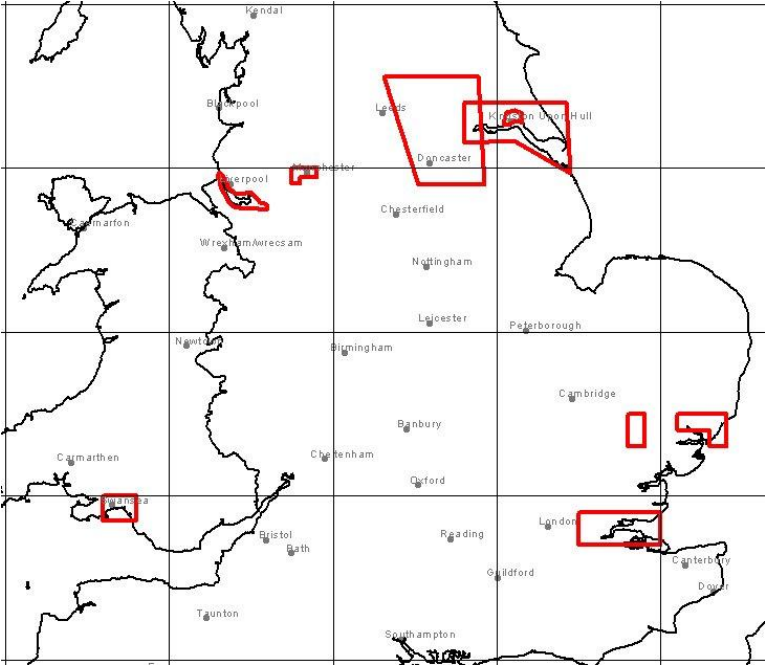
Director of Groundwater Science  
British Geological Survey

# Overview

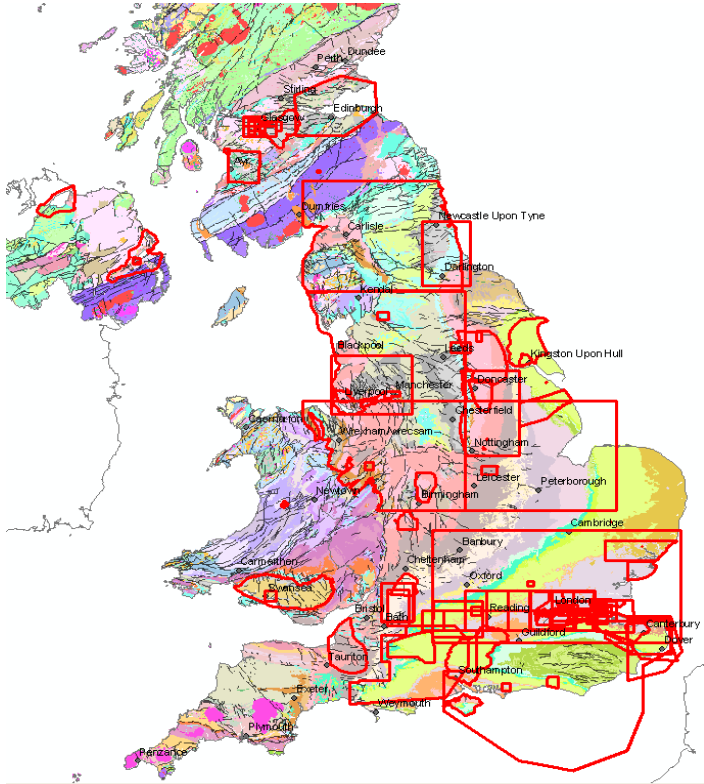
- 3D geological model development
- Hydrogeological attribution of 3D model
- Example applications of 3D modelling to decision making:
  - Integrated basin (water resource) management
  - Shale gas

# 3D Digital Geological Model development

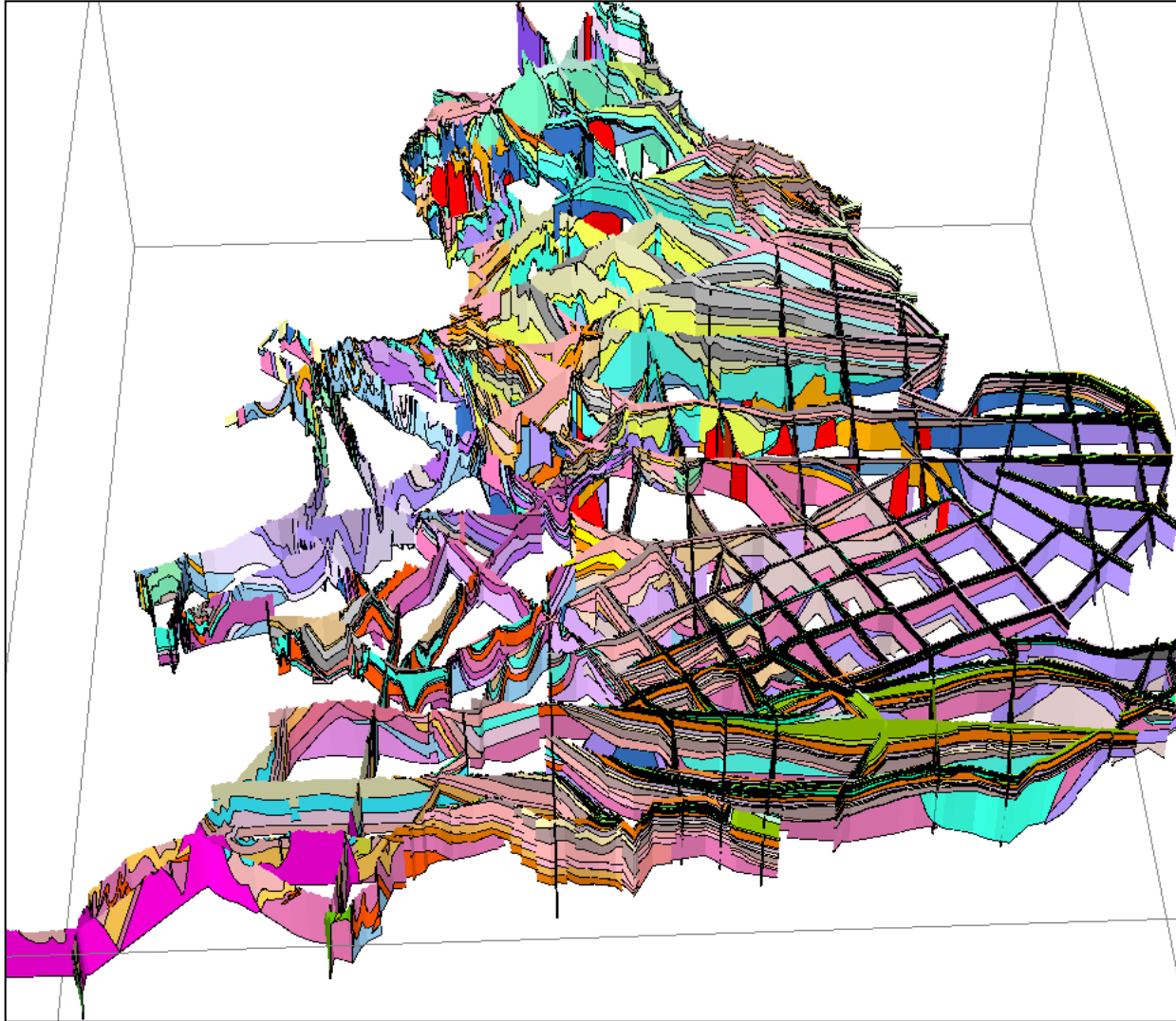
2004



2013

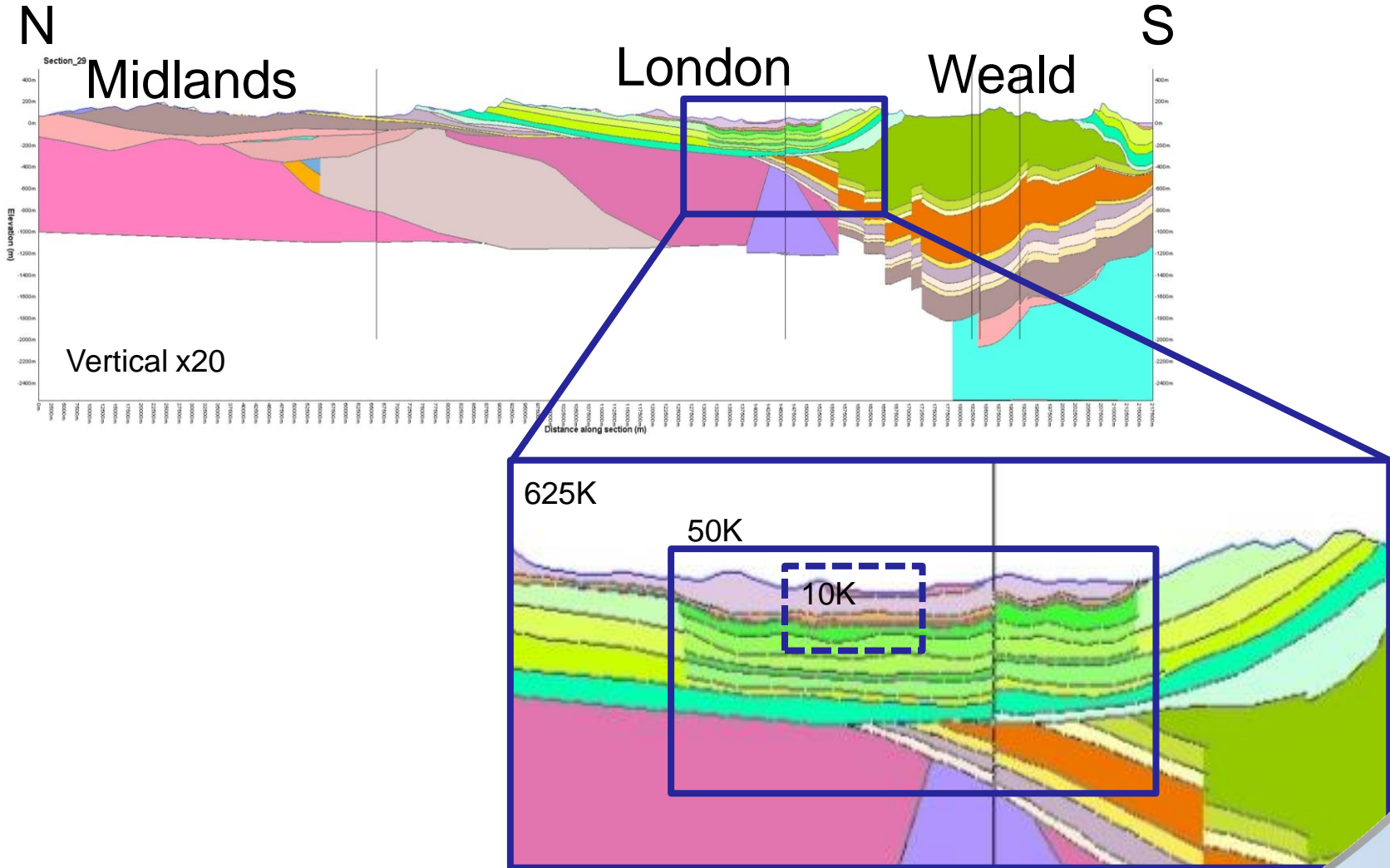


# National 3D Geological Model (GB3D)



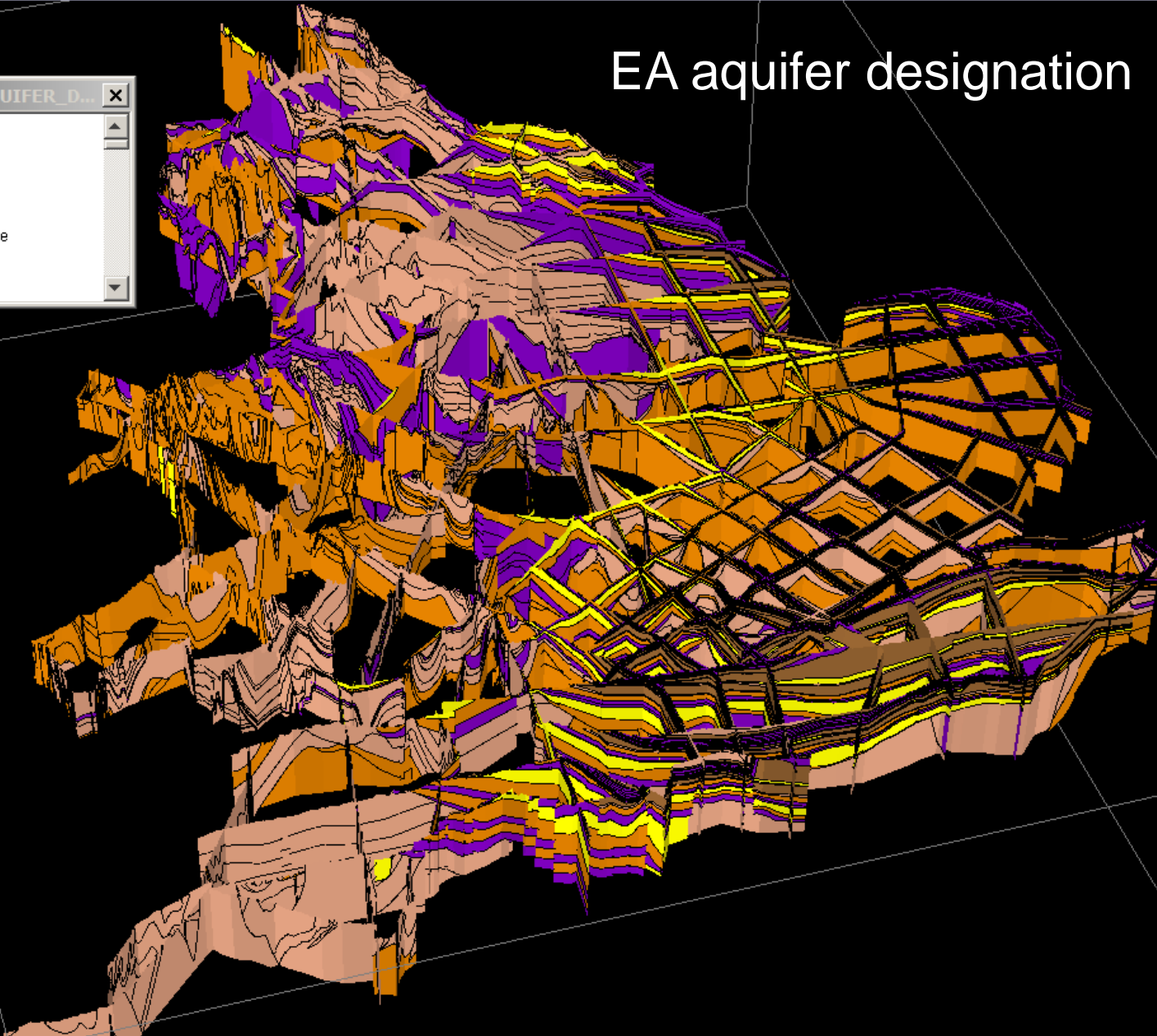
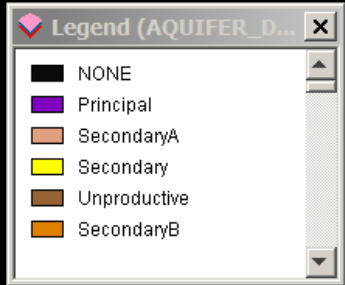
- 84 sections (England & Wales)
- ~12,000 km of section lines
- Sections down to ~5km
- Section spacing ~30km
- 227 rock units included in the model
- 625K scale platform

# Multi-scale 3D modelling

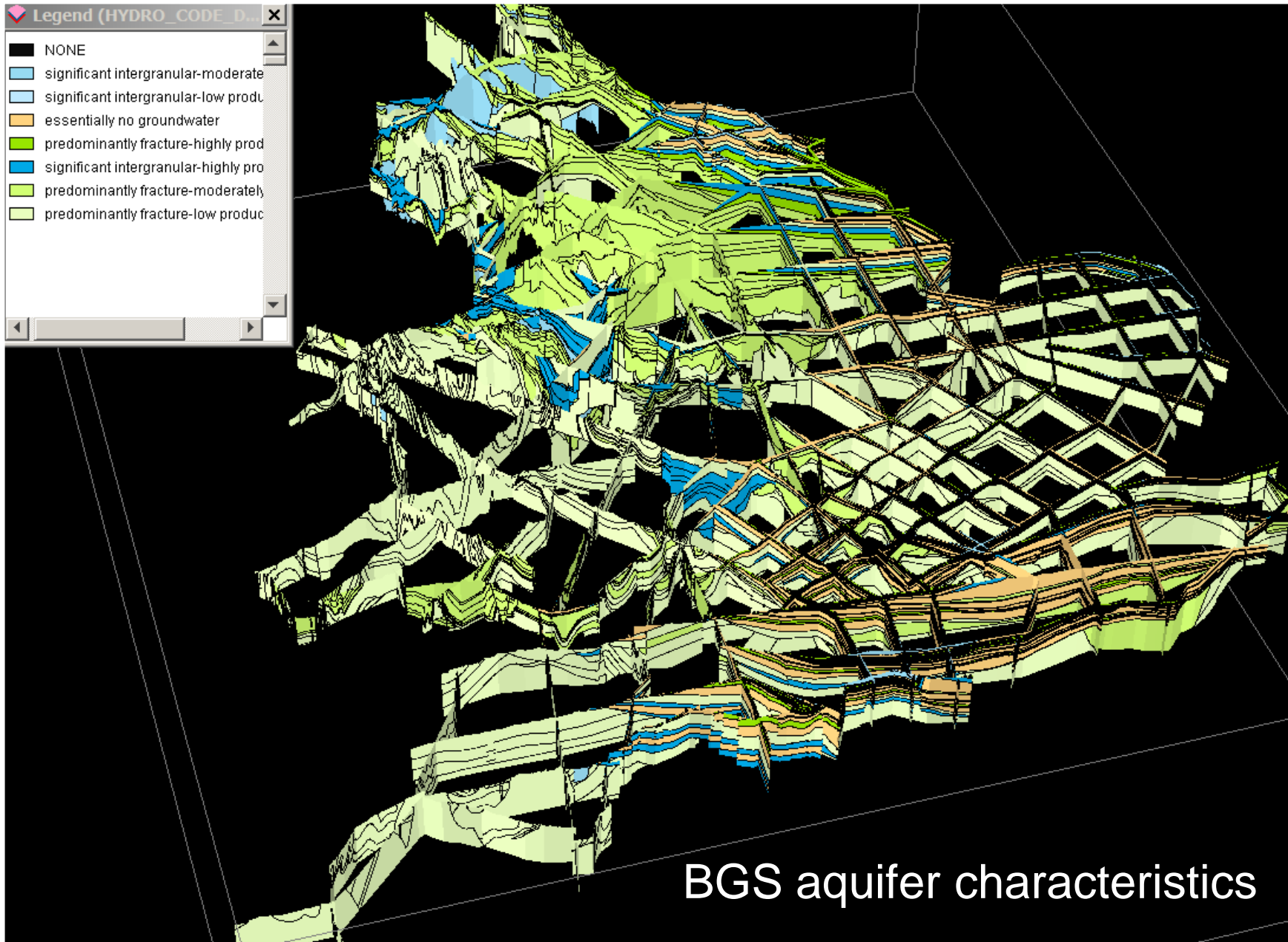


# Attribution of the geological model

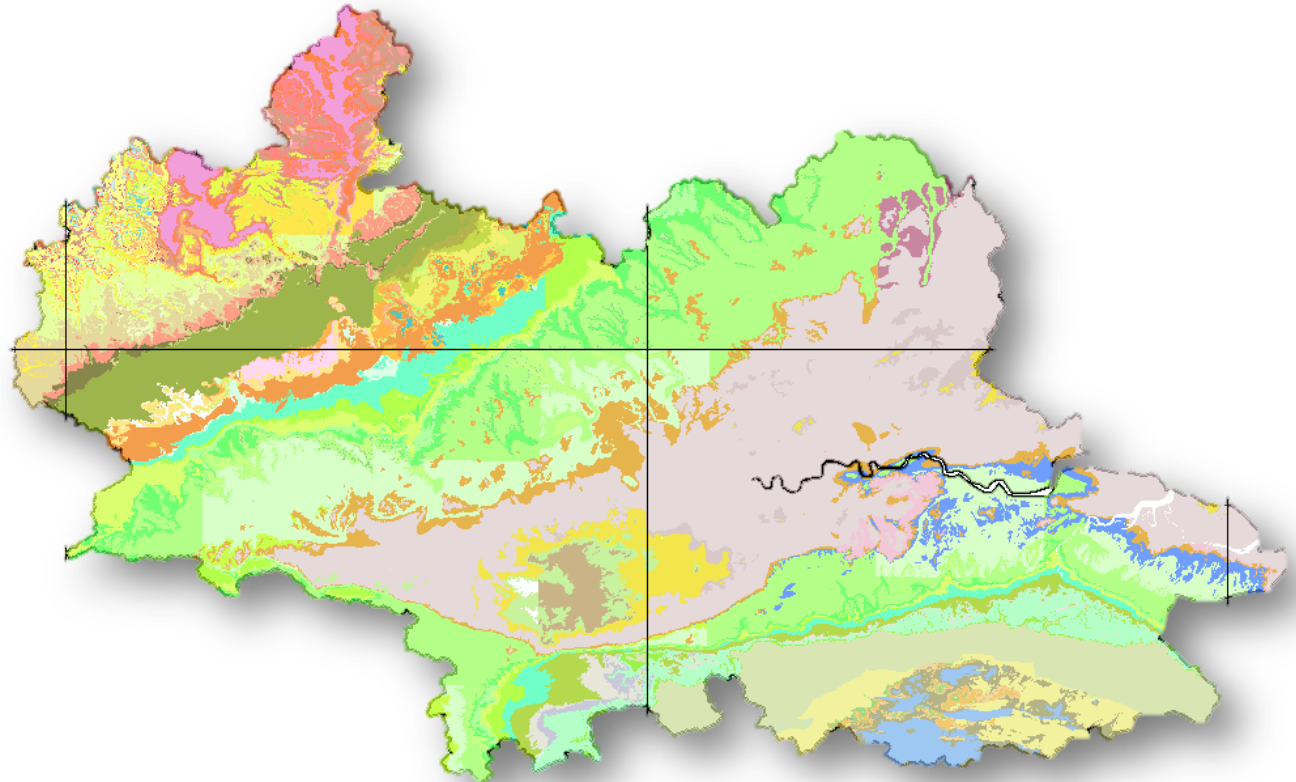
EA aquifer designation



# Attribution of the geological model



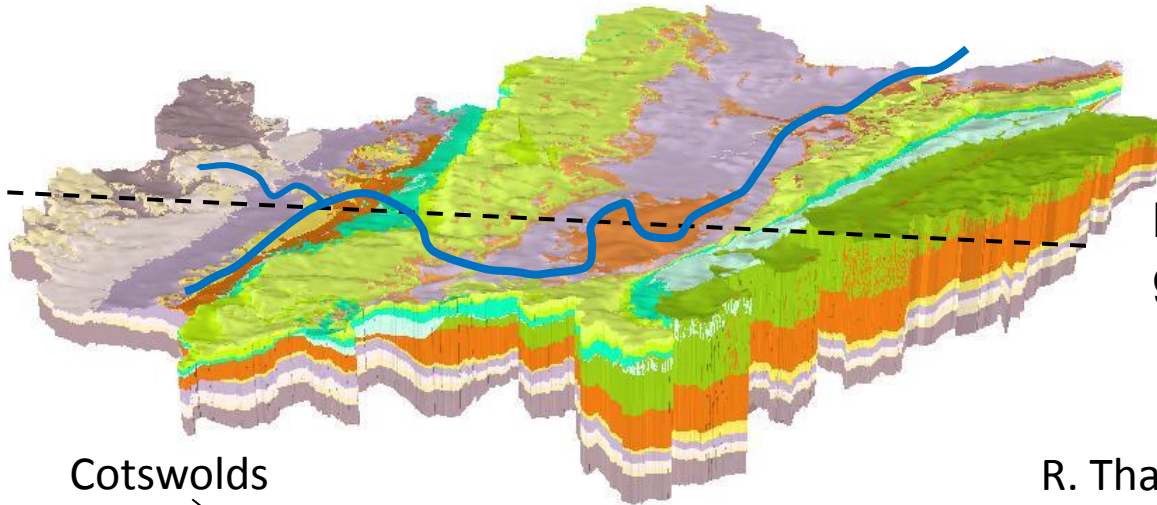
# Integrated science for a whole basin approach to water resource management



Geology mapped at 1:50,000 scale



# Thames Basin



**Mapped geology/  
geological model**

Cotswolds

R. Thames

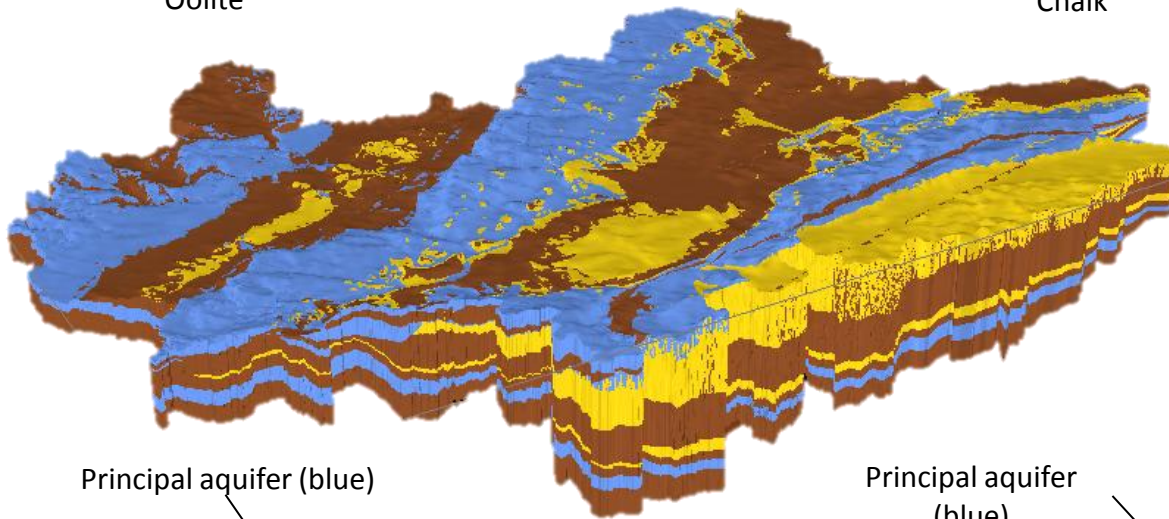
The Weald

Oolite

Chalk

Wealden Group

Oolite



**Aquifer designations/  
parameterised model**

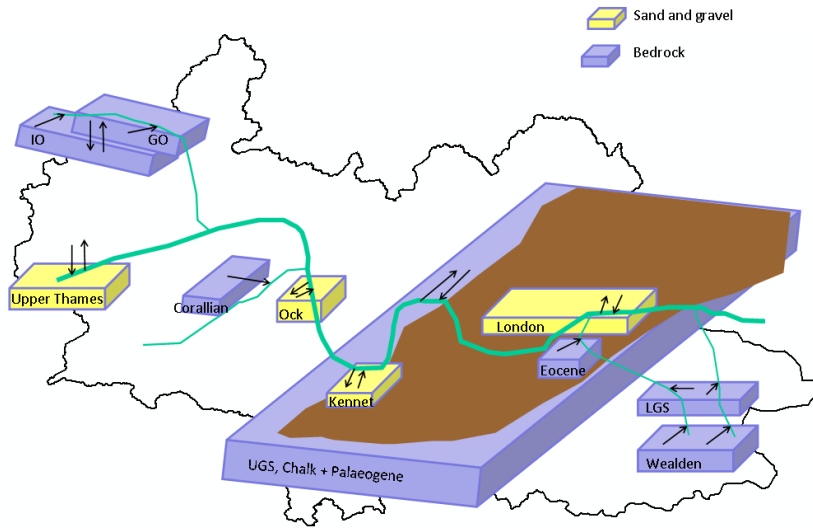
Principal aquifer (blue)

Principal aquifer  
(blue)

Secondary aquifer (yellow)

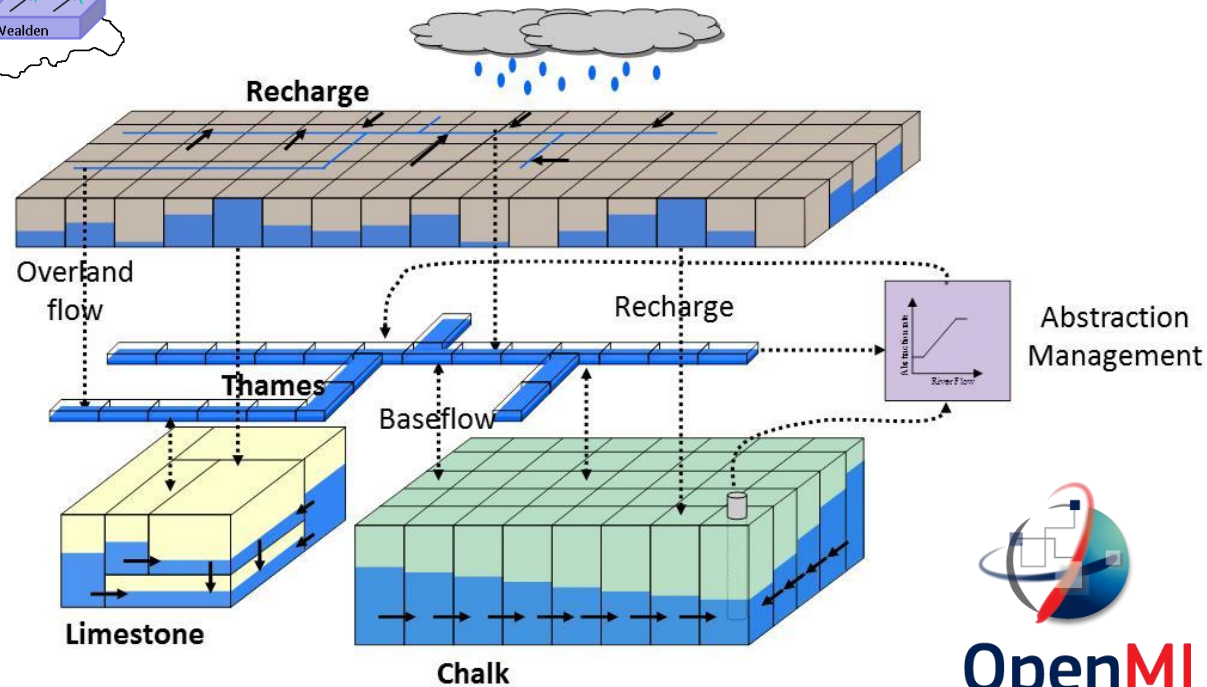
Unproductive/impermeable strata  
(brown)

# Linking multiple hydrological models

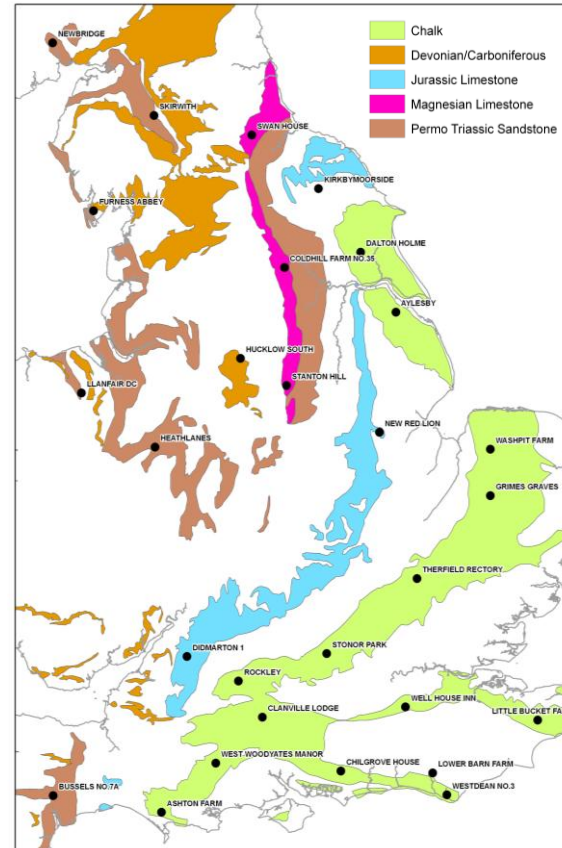
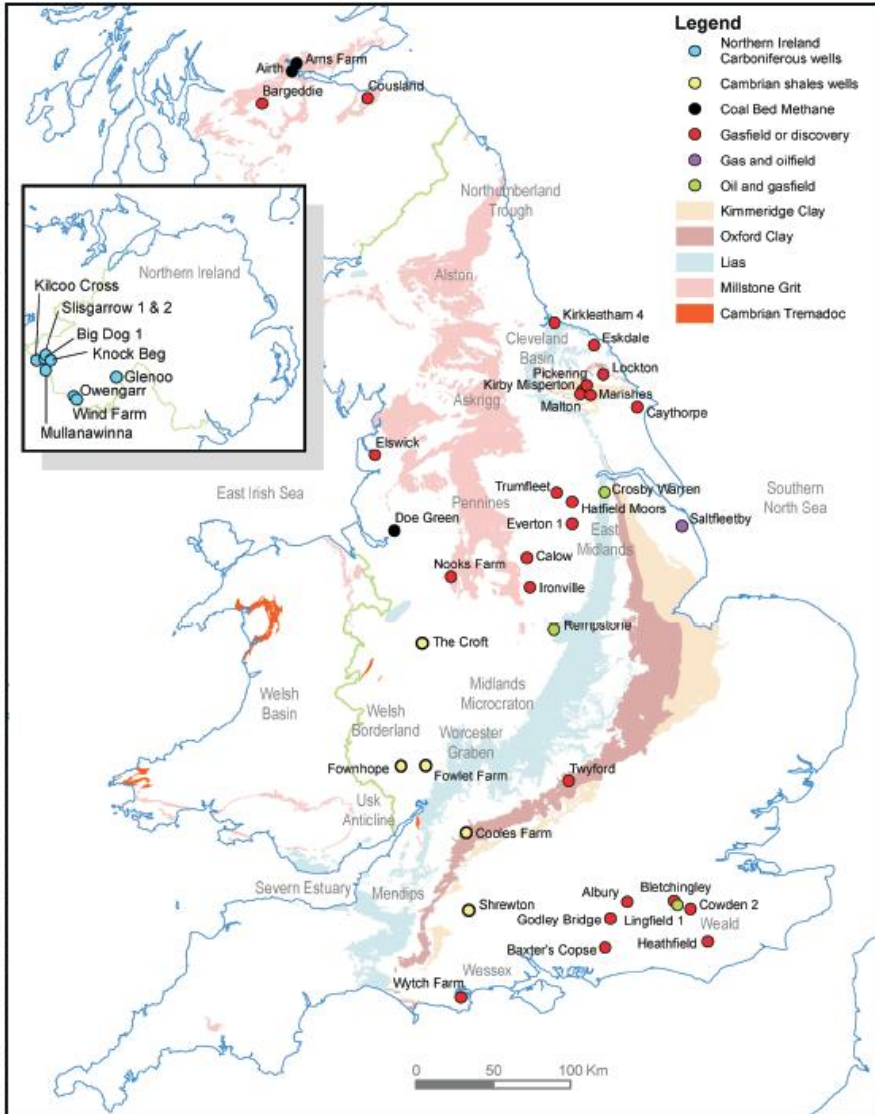


Modelling predictive scenarios of water resource management in the Thames basin.

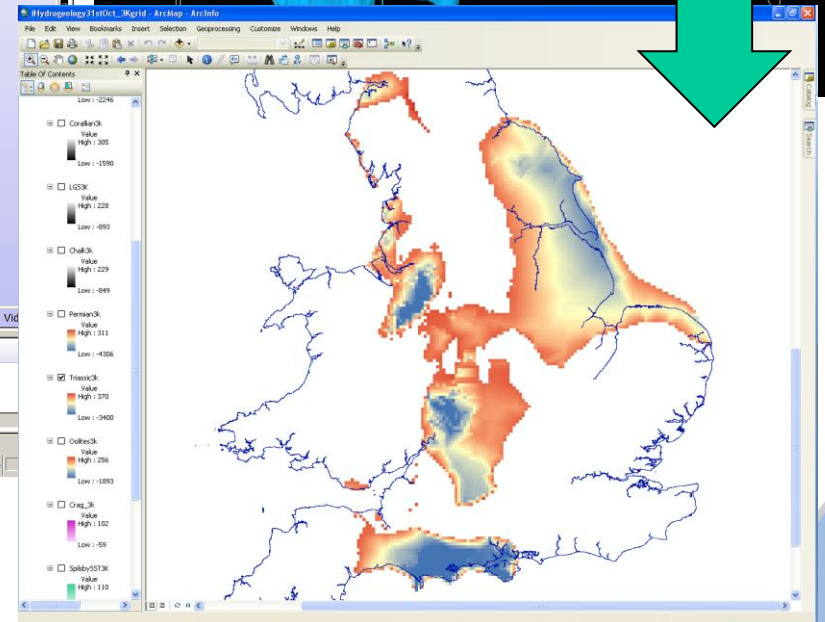
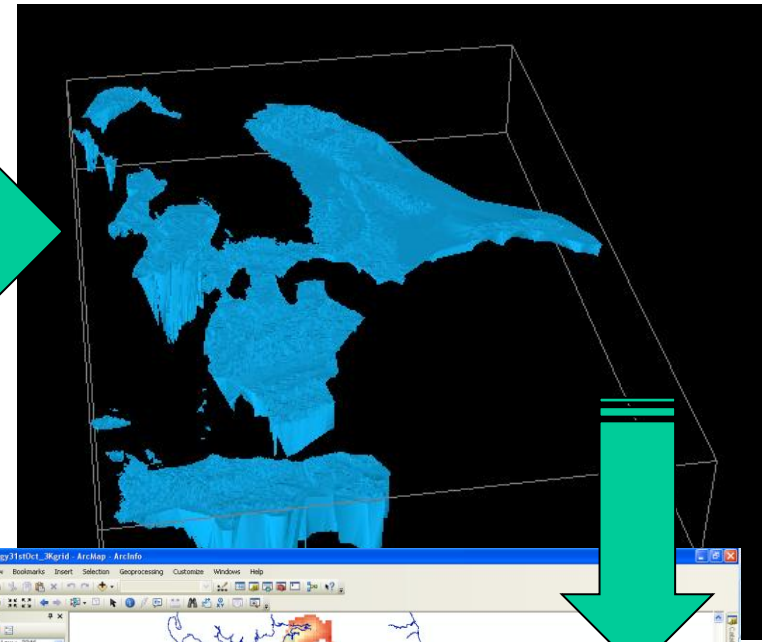
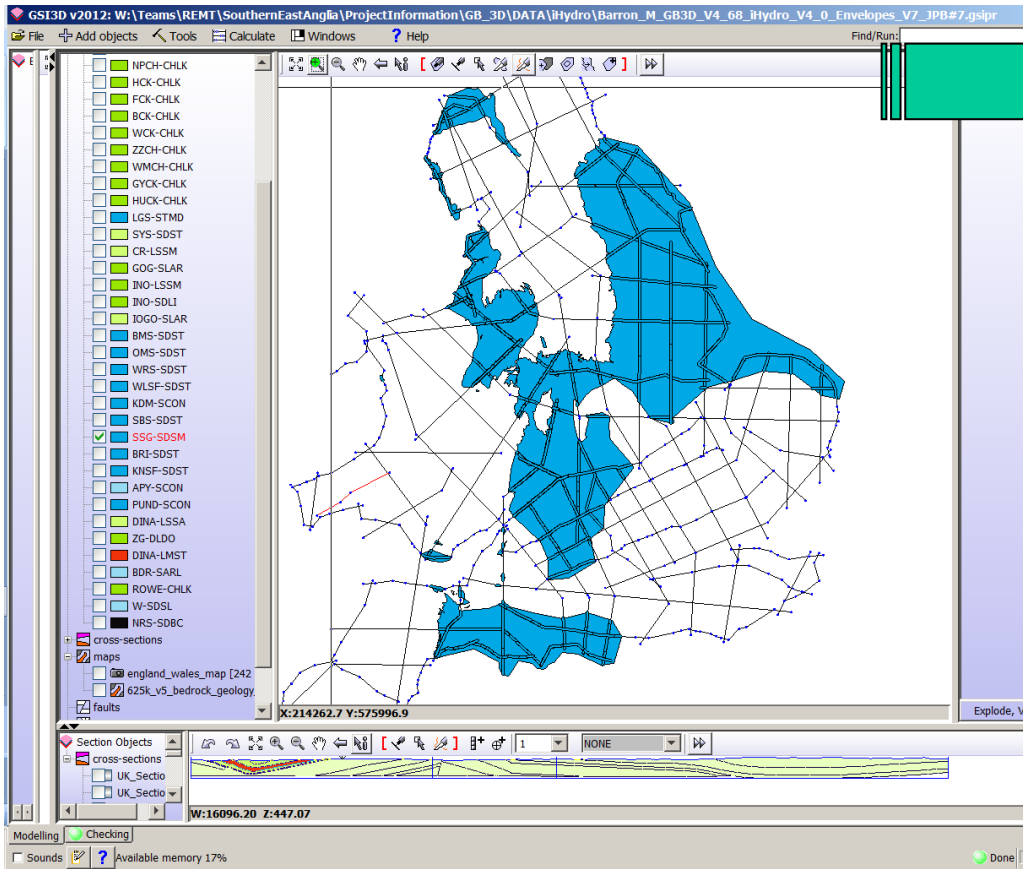
An integrated model incorporating both river and groundwater models is required to connect aquifers to the river system.



# Shale gas



# 'Full crop' and volume mapping

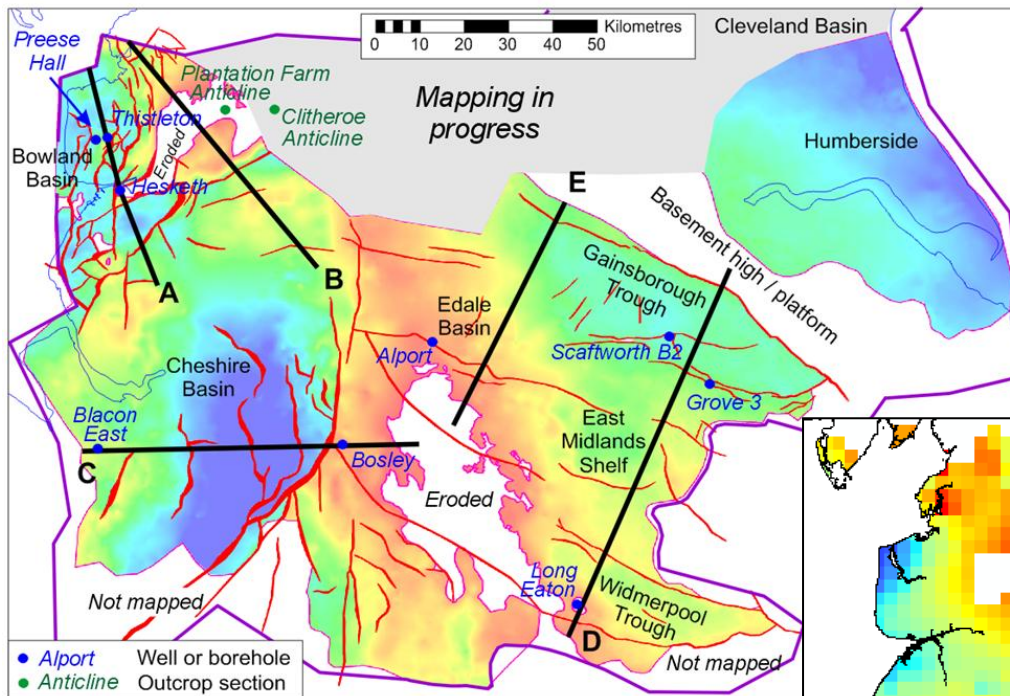


1. Full extent of geological units identified from fence diagram

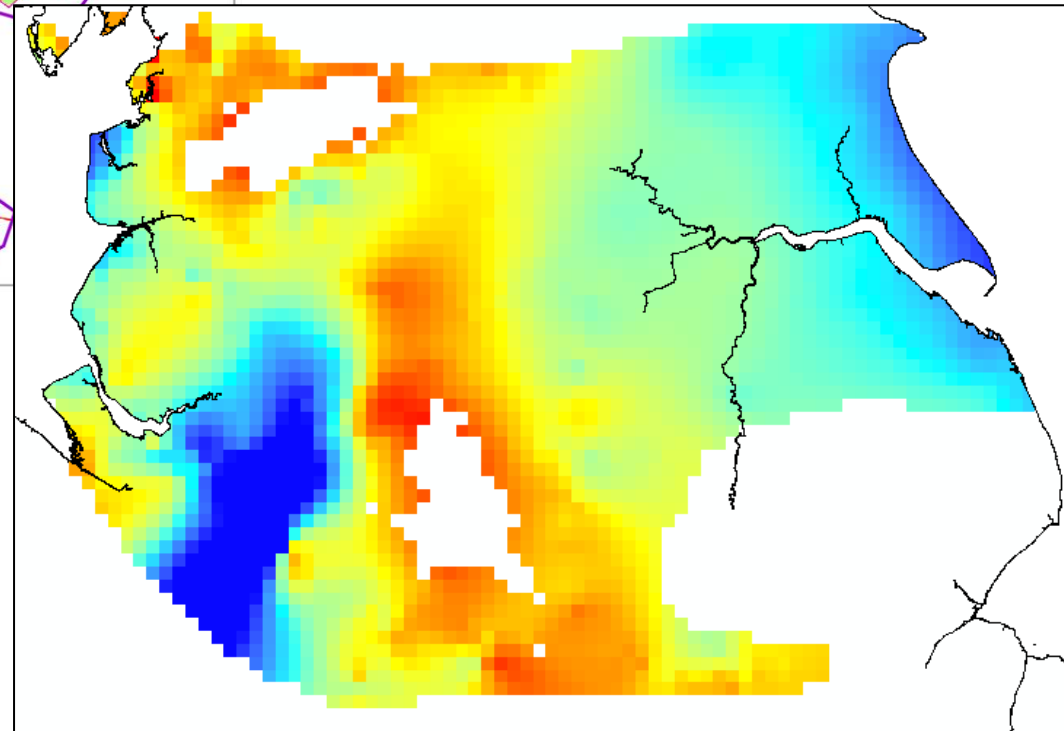
2. Surfaces interpolated between section lines (base aquifer surfaces, upper shale gas surfaces)

3. Mapped surfaces analysed in a GIS (depth maps and vertical separation maps)

# Top surface of 'Bowland shale'

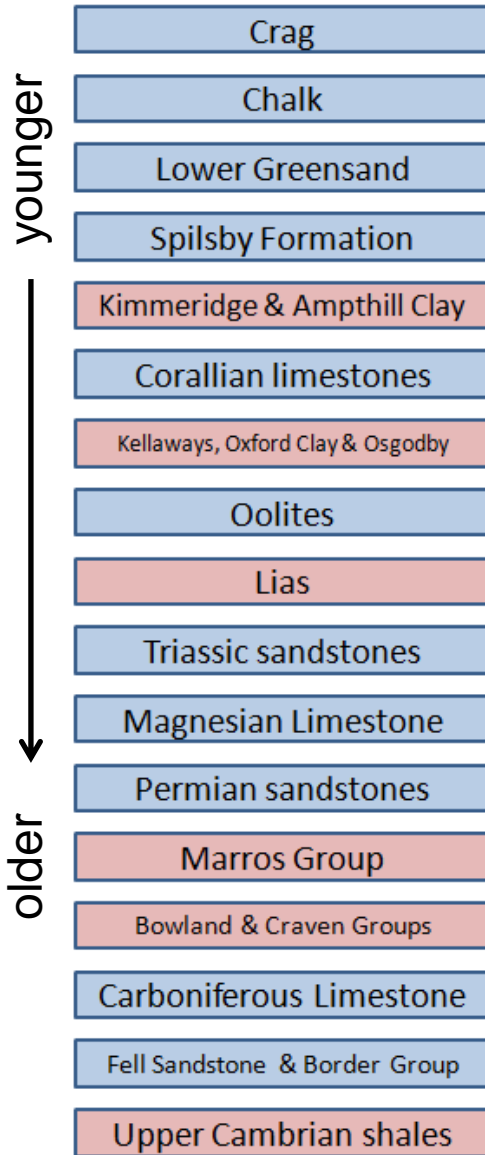


DECC Assessment of shale gas resources of Carboniferous (2012). Depth to top 'Bowland-Hodder' unit.

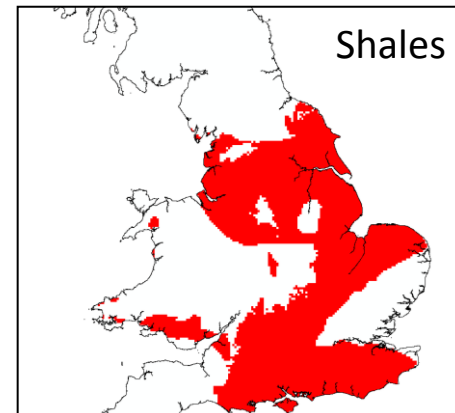
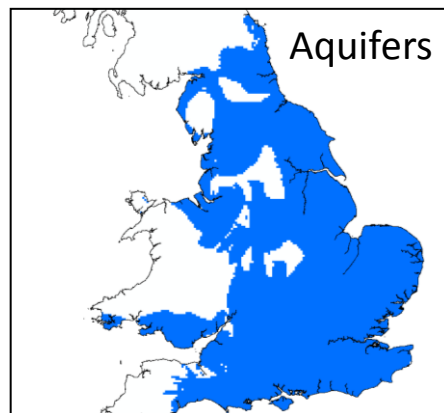


iHydrogeology GIS Depth to top Bowland & Craven shale unit at 3km by 3km resolution (no faults)

# Aquifer / shale gas stratigraphy



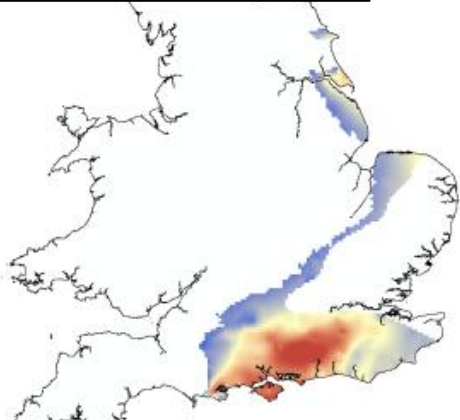
	Kimmeridge Clay	Oxford Clay	Lias	Marros	Bowland & Craven	Upper Cambrian
Crag						
Chalk						
Lower Greensand						
Spilsby sandstone						
Corallian						
Oolites						
Permo-Trias sandstones						
Magnesian Limestone						
Appleby Group						
Carb Limestone						
Fell Sst & Border Group						
	Principal aquifer overlies potential shale gas source rock					
	Potential shale gas source rock overlies Principal Aquifer(s)					
	No overlap between Principal Aquifer and potential shale gas source					



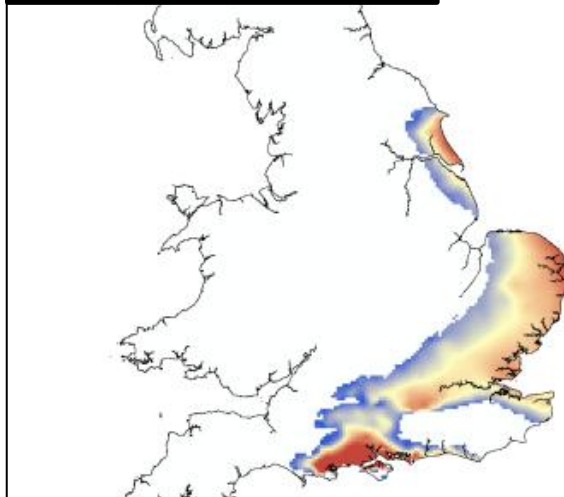
# Example separation maps

**Top shale gas surfaces**

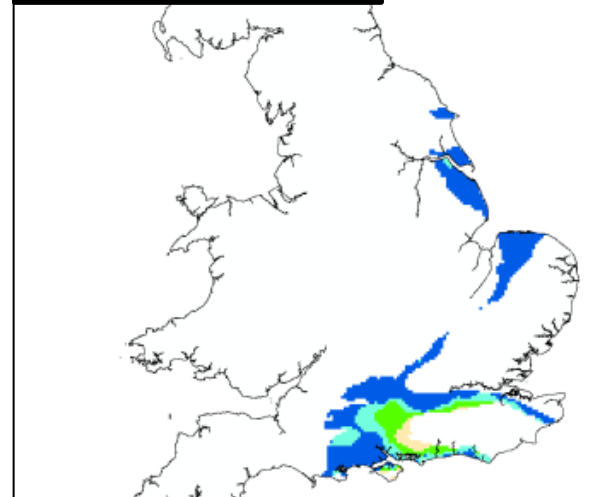
Kimmeridge Clay & Chalk



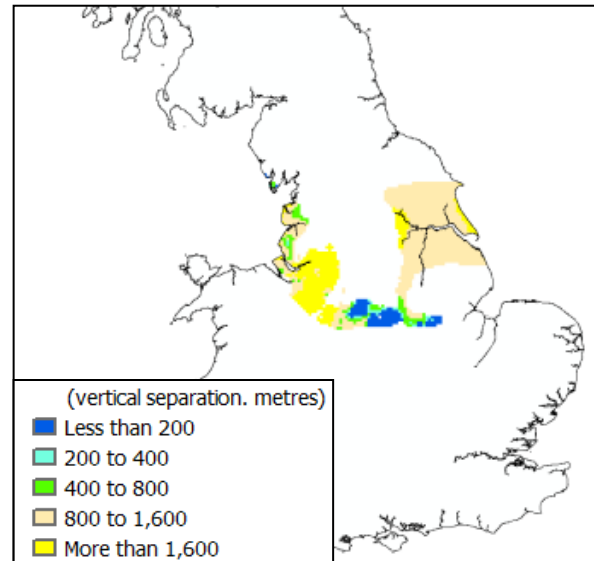
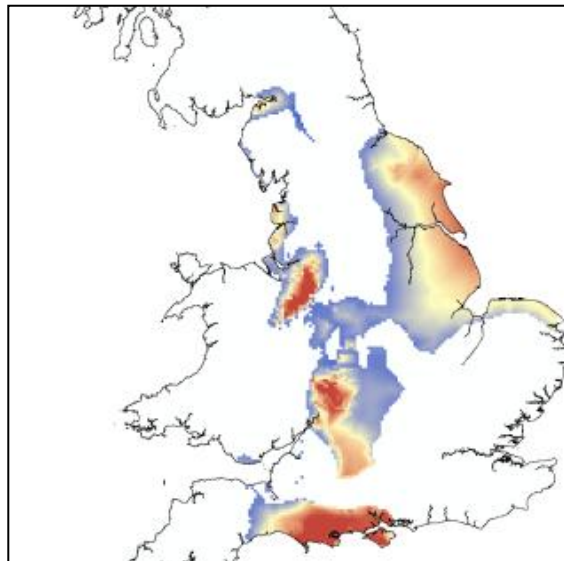
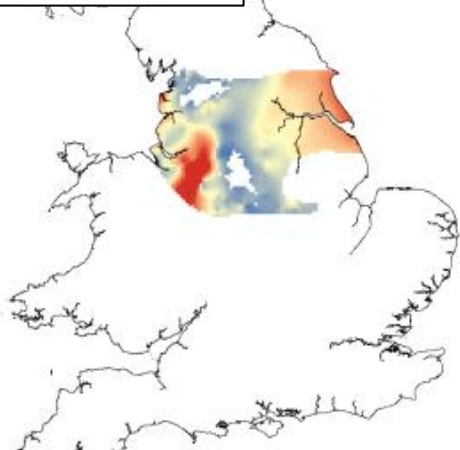
**Base aquifer surfaces**



**Overlapping areas**



**Bowland shale &  
Triassic sandstone**



# Thank you

