TELLUS Conference

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A National Geoscience Framework for the 21st century

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NATURAL ENVIRONMENT RESEARCH COUNCIL

In the beginning

- First maps linked to industrialisation & science
- BGS established in 1835 to provide a 'geological baseline' for the industrial revolution
  - Raw materials for industry & development (coal, iron ore, limestone, construction materials)
  - Knowledge of geology for canal, railway & tunnel construction

William Smith's 1815 geological map that "Changed the World"

Griffith's map of Ireland (1855)

John MacCulloch's map of Scotland (3rd edition 1840)

Continuous improvement

1835 - present

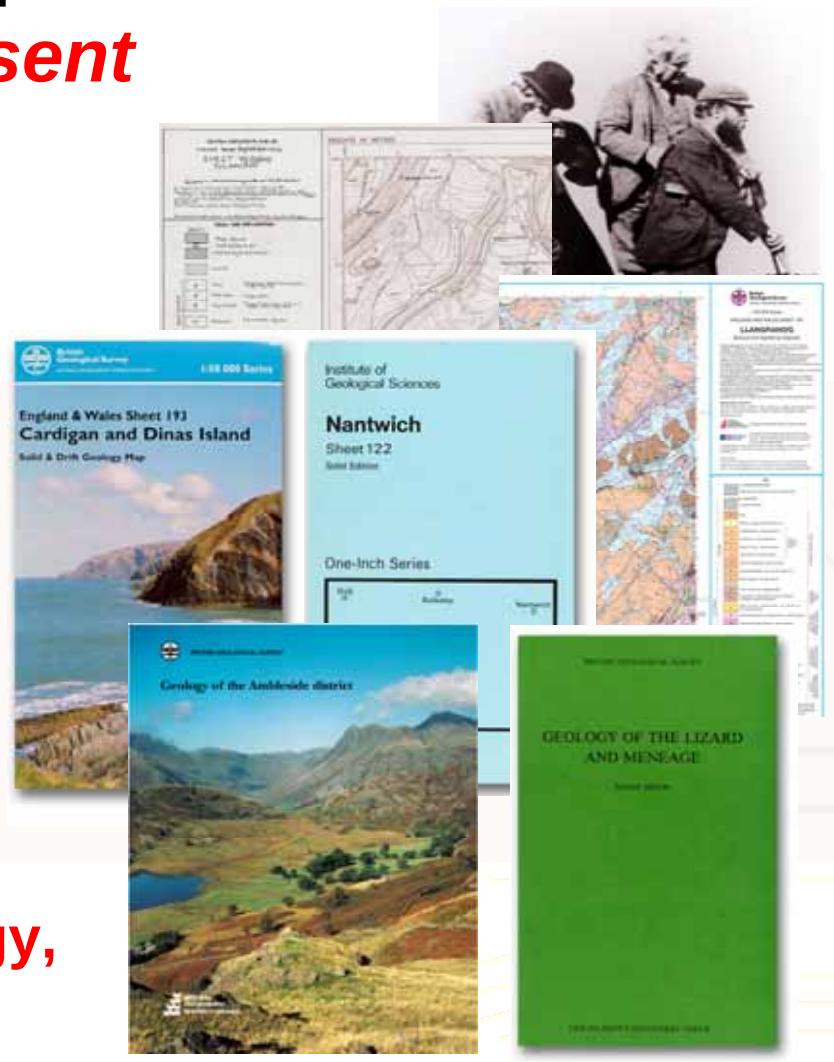
Primary geological survey at 6 inch (10k) scale

Detailed mapping of important resource areas (e.g. coal fields)

Systematic map coverage at 1 inch (50k)

Detailed descriptions of geology & resources (Memoirs)

First class understanding of geology, rock properties and resources



New ‘layers’ of information

Mid 20th century onwards

1st generation airborne geophysics
Magnetic only, analogue recording, 2km line spacing, 305m elevation

Regional gravity surveys
1 observation per 1-2 sq km

1st regional geochemical surveys
Stream sediments, 20 elements, mineral focused

Continental shelf
Offshore seismic, regional grav/mag, seabed geology

Improved framework for resource exploration & tectonics

Analogue to digital – *late 20th century*

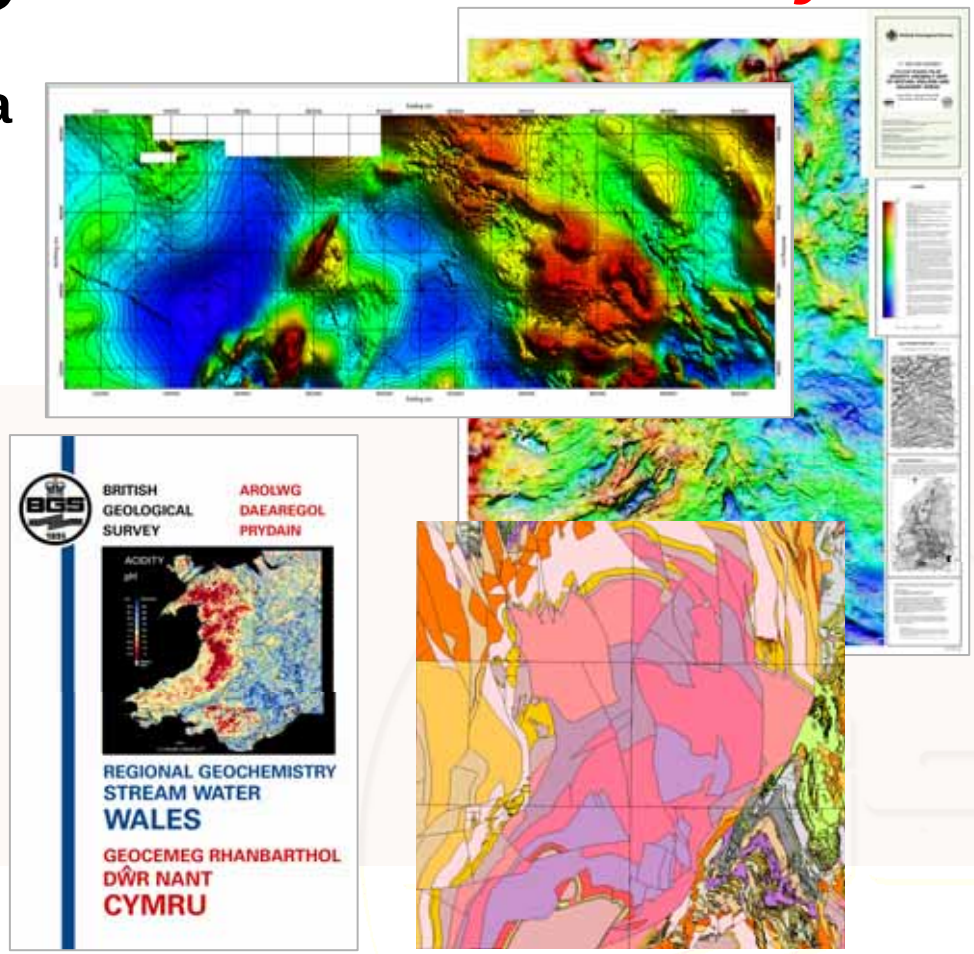
Digitise analogue geophysical data
Digital maps, data and models

New generation of high resolution airborne geophysical surveys
HiRES-1 (mag & radiometric only)

Enhanced geochemical surveys
Sediments/water/soil, 50 elements, environment focus, digital data

Digitised 2D geology
Start digitising legacy data

Continental shelf
Commercial 3D seismic available



‘Geoscience Framework’ to meet needs of late 20th century

A changing world

Pressures on land & resources continue to grow

P… groundwater resources, n… biodiversity

Develop… with minimal impact on en…

Need renewable and …hon energy

EU & national environment… …tion & directives (water, soils, habit…

Environmental impact assessments & regional strategies

Identify and tackle current and legacy pollution – brown field development

Living with climate change

Meeting the challenges

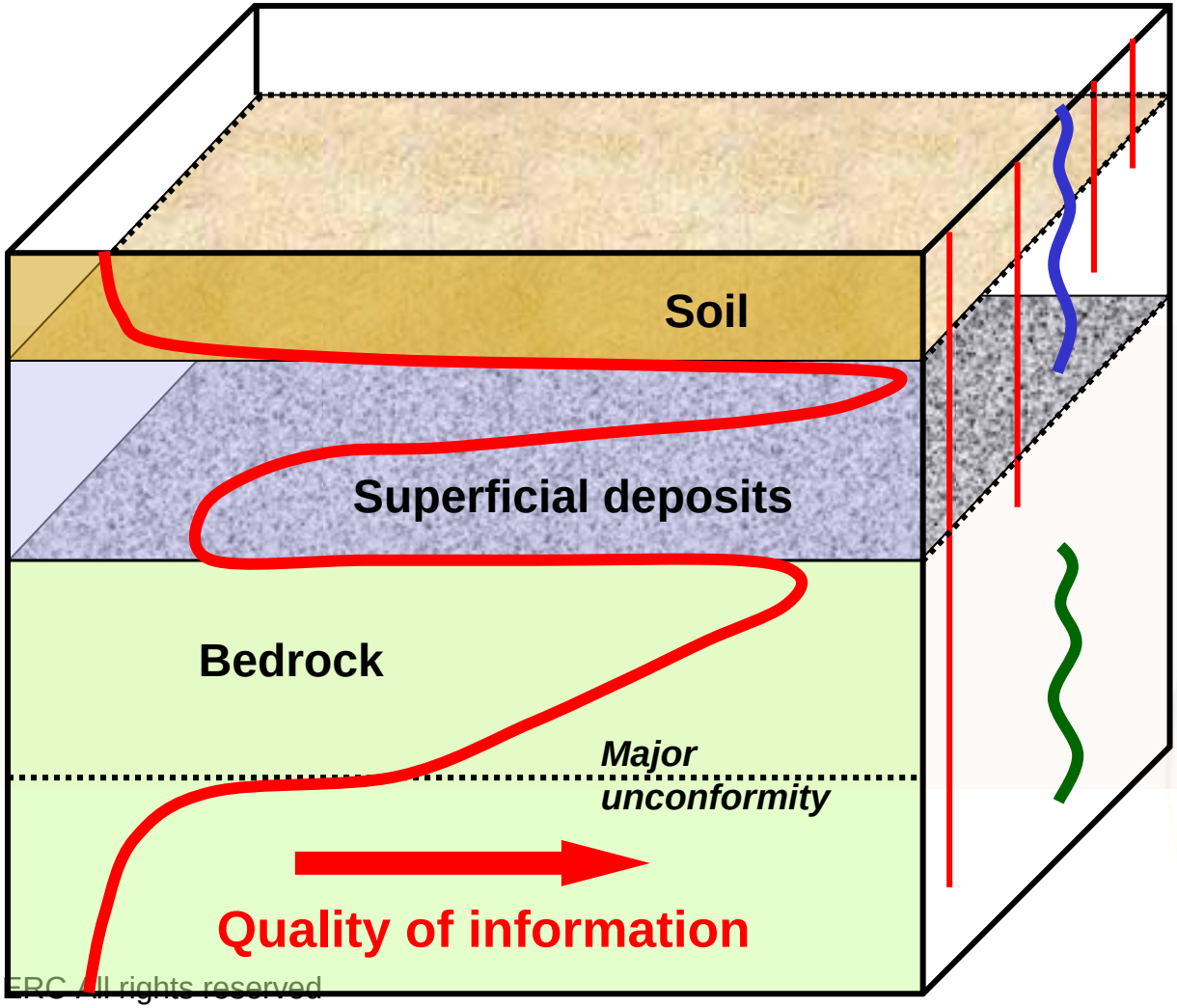
- **Time-dependent (4D) natural & human-induced processes operate within a 3D structural framework.**
- **Every challenge requires more detailed knowledge of**
  - **3D geological structure (digital 3D models as well as maps)**
  - **Geological & environmental properties of the surface & subsurface**
- **Especially in the shallow 'zone of human influence'**

A very 'lived-in' environment

60 million people & 300 years exploitation of shallow subsurface

Shallow subsurface preserves a record of climate change and human environmental impact

The digital information gap



2D Superficial geology

Incomplete geochemistry

Boreholes

2D Bedrock geology

Local shallow geophysics

Deep regional geophysics (grav/mag) & seismic (in major baisns)

~~Digital 3D geology~~

~~Properties of the shallow subsurface~~

What's needed?

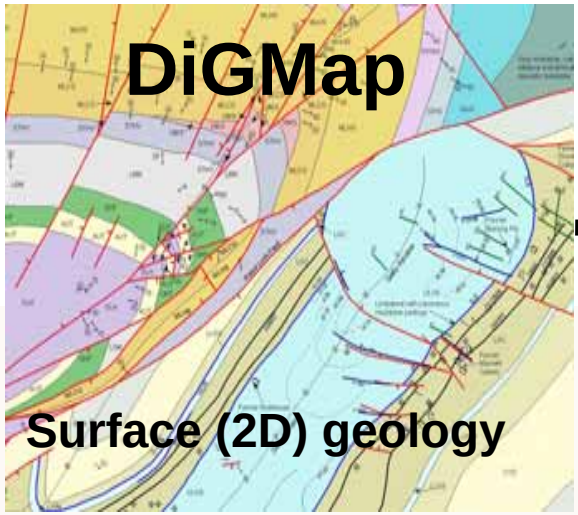
- **A 'next generation' Geoscience Framework to underpin**
  - **Sustainable management of the environment**
  - **Responsible economic development**
  - **Compliance with regulations and directives**
  - **Research into natural & human-induced processes (Earth system)**

Part of the wider 'Spatial Data Architecture'

A geoscience framework for the 21st century

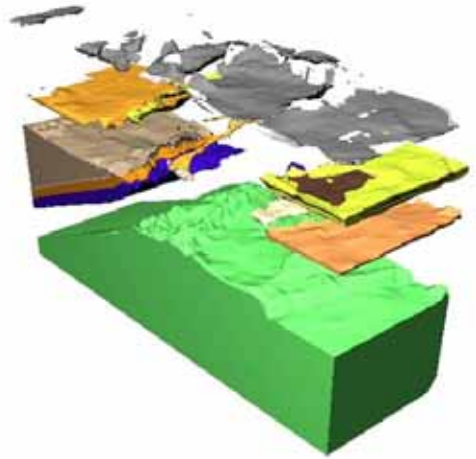
- 3D geology – standardised lithostratigrapic framework
- Fully digital workflow
  - Field Map Model Delivery
- Geological & environmental properties of the 3D Earth
  - Physical & engineering properties of rocks
  - Natural & anthropogenic chemicals in the environment
  - High resolution geophysical imaging of the shallow subsurface
- National coverage to a consistent standard

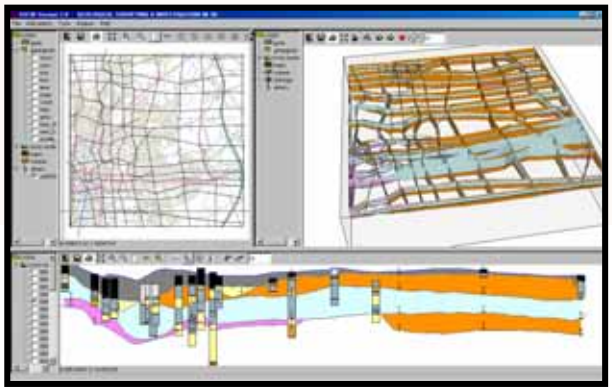
Geological Framework - *2D to 3D*

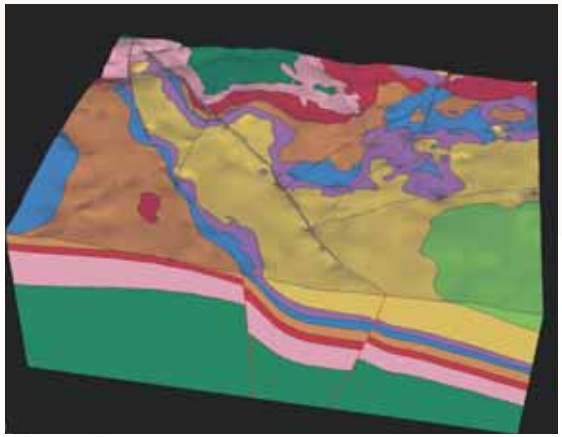


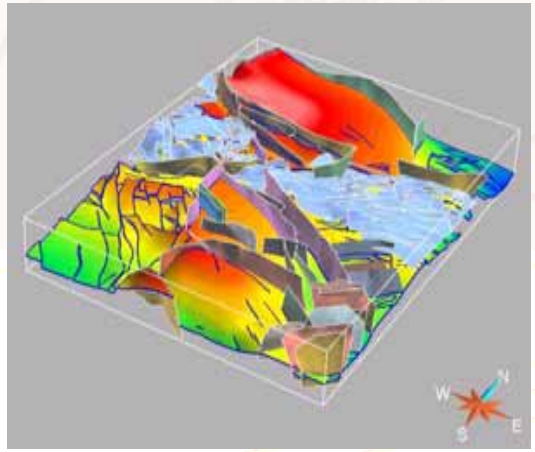
LithoFrame

Attributed 3D models at 10k, 50k, 250k & 1M







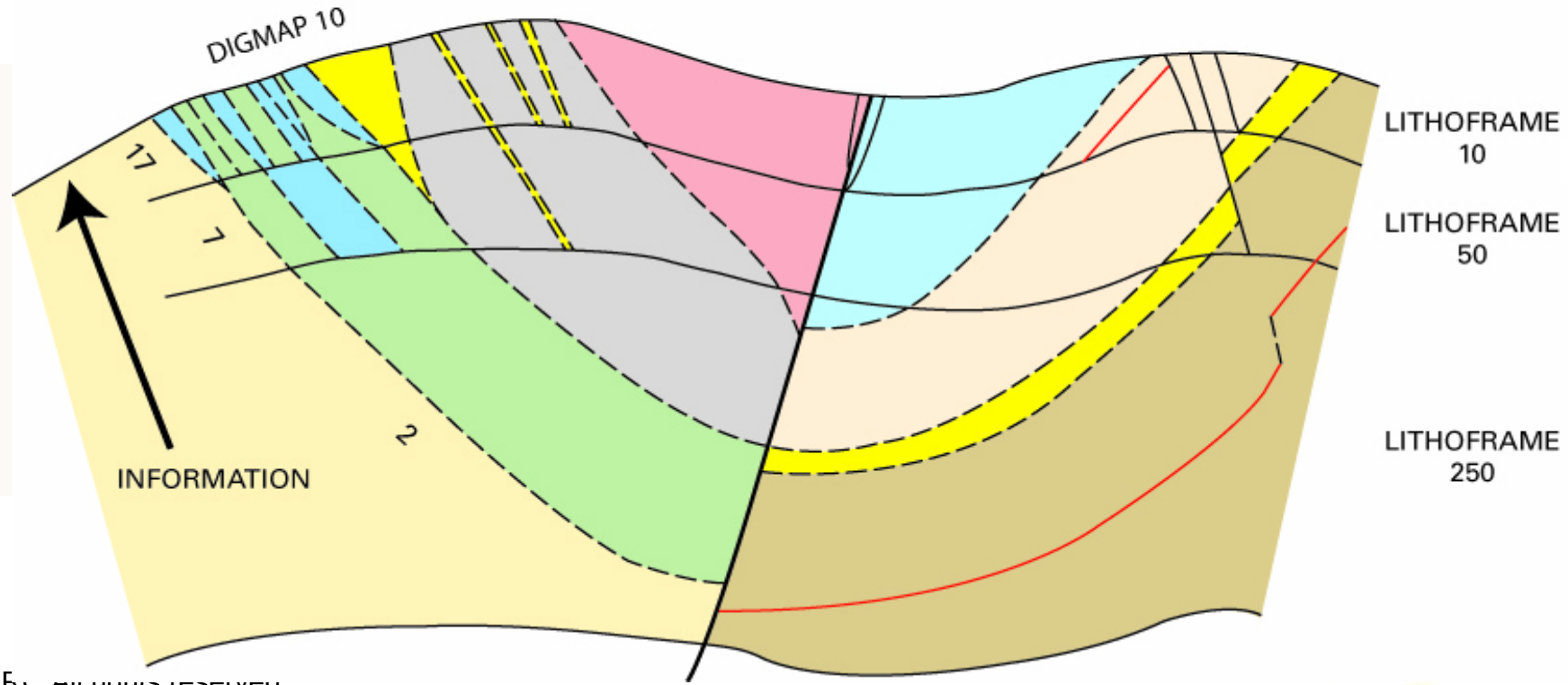


Different resolutions for different applications

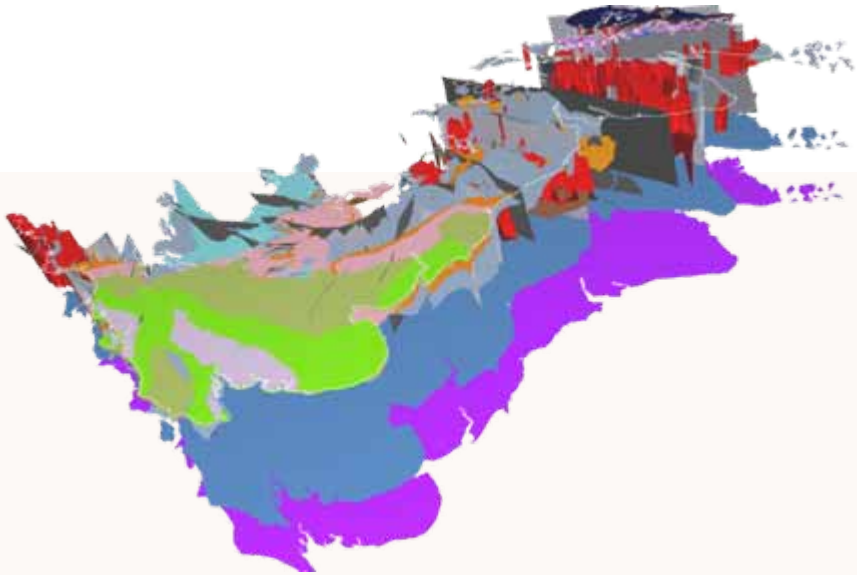
STRATIGRAPHIC UNITS

FAULTS

LithoFrame10 – depth 100-200m – Beds & superficial deposits



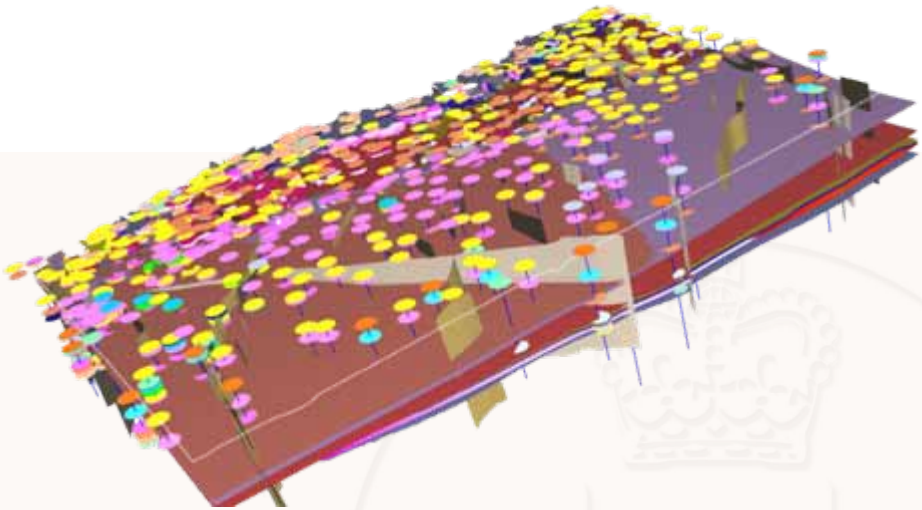
National Model



Major geological units and faults

Regional Model

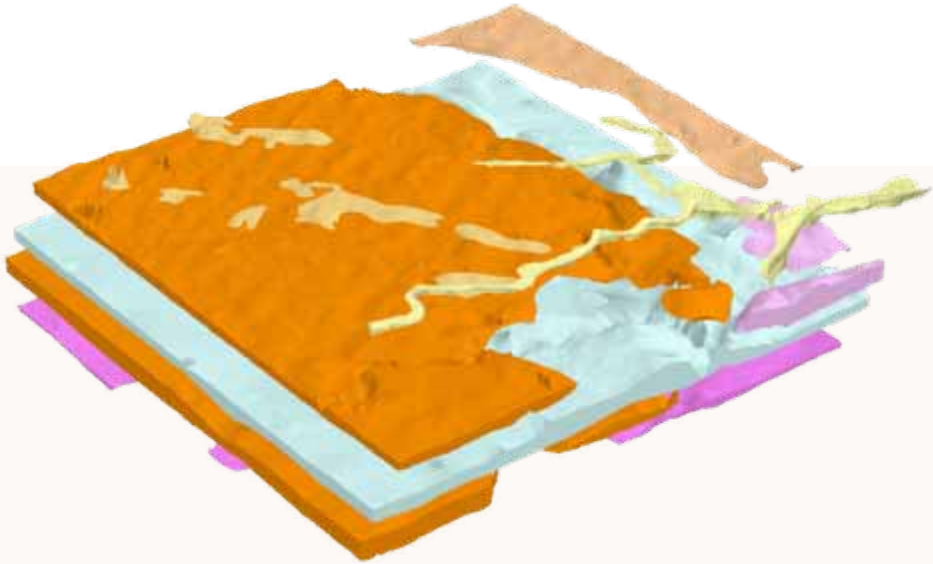
Eastern England



Permo-Triassic aquifer model for the Environment Agency

Detailed Model

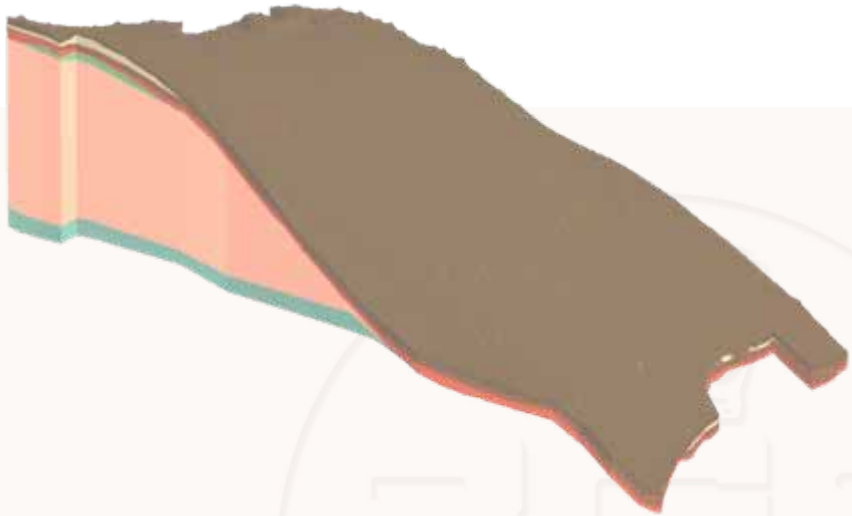
City of York



Urban planning & archaeology

Site Specific Model

Southwell, Nottinghamshire



Soil & weathering systems

A geoscience framework for the 21st century

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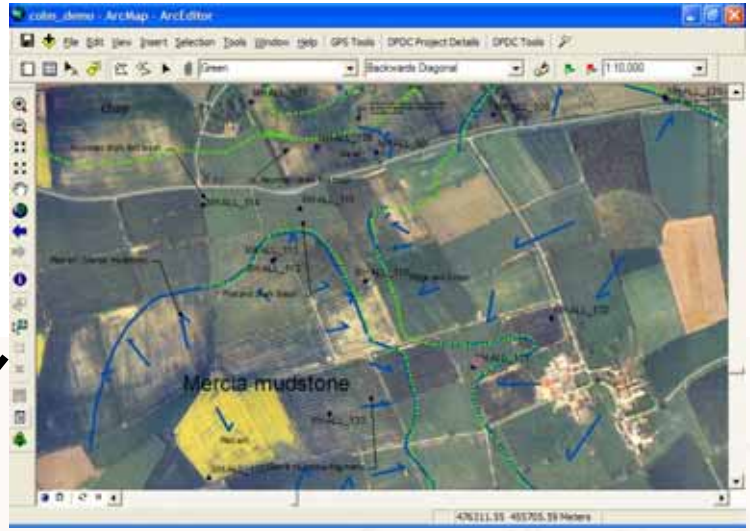
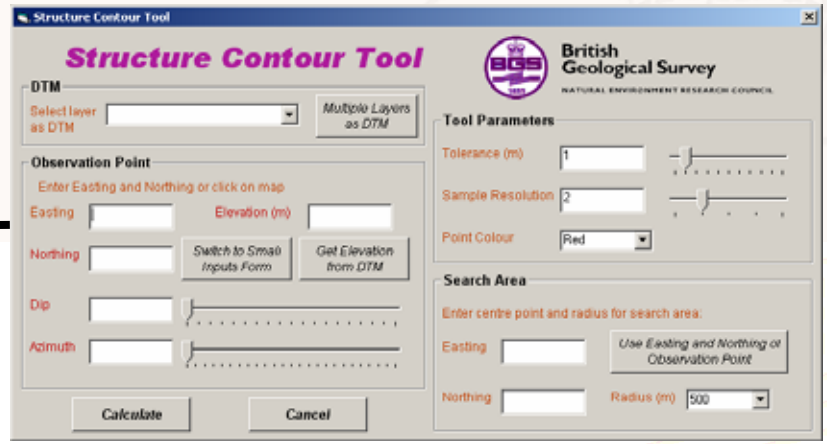
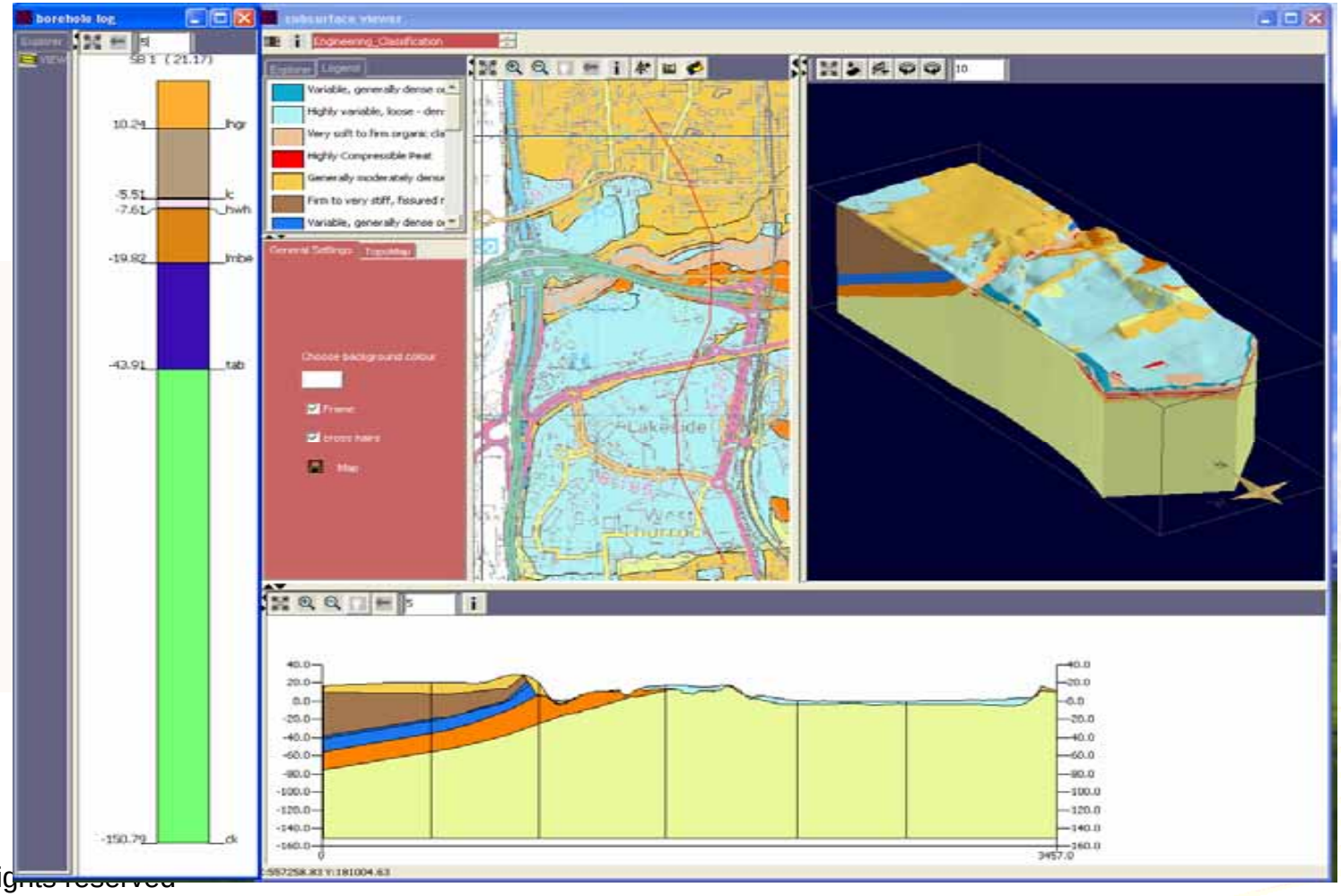
Digital field mapping - *Culture change*





Delivering the '3D Geological Map'

Subsurface viewer – released 2005



Immersive 3D systems

GeoVisionary

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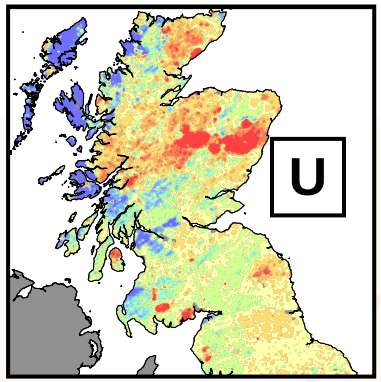
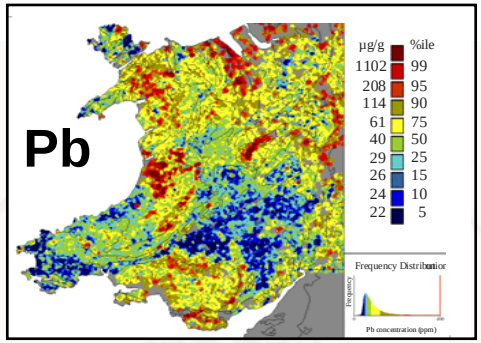
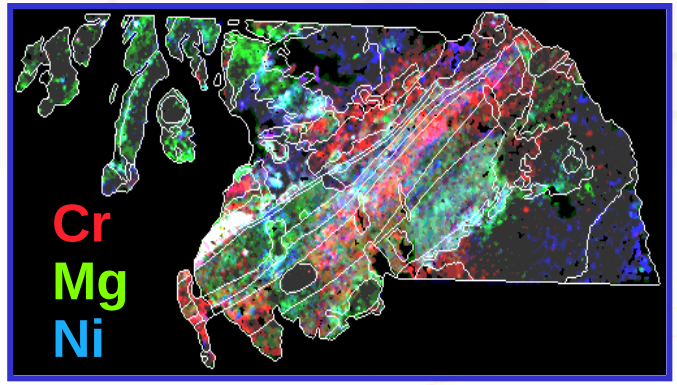
Natural & anthropogenic chemicals in the environment

High resolution regional coverage
Stream sediment, stream water & soils
1 sample per 2 km². ~50 elements

- Natural geochemical variations
- Impact of human activity
  - Urbanisation, industry & agriculture
- Key data resource for
  - Managing the environment
  - Planning & development
  - Mineral exploration
  - Agriculture: trace element effects on crop health and yields
  - Rivers: trace elements & pollutants harmful to aquatic life and plants
  - Human & animal health, epidemiology
  - Geology & research



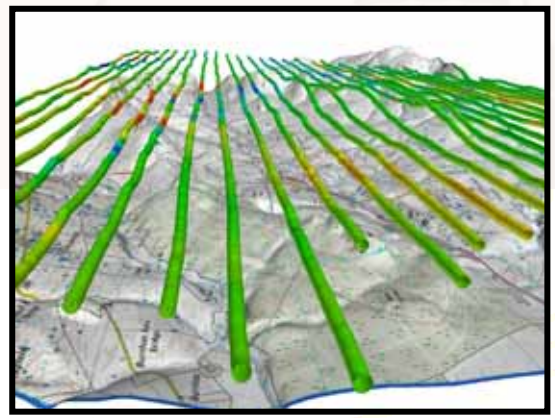




High resolution geophysical imaging of the shallow subsurface

- **Radiometric sensors**
  - measure near-surface natural (geological) & man-made radioactivity
- **Electro-magnetic (EM) sensors**
  - measure electrical conductivity of the shallow subsurface (to around 100m)
- **Magnetic sensors**
  - measure changes in the Earth's magnetic field related to sub-surface structure (variations in rock magnetism)

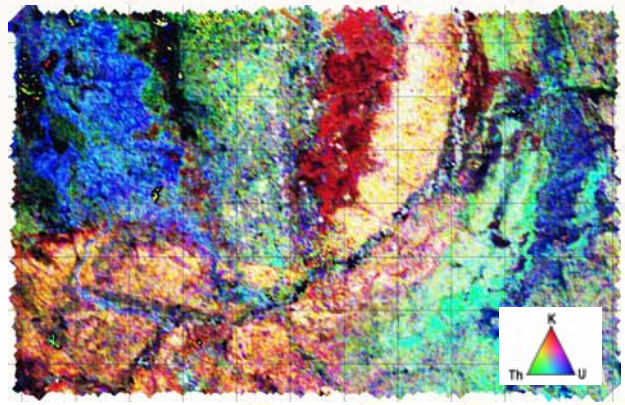
High resolution airborne surveys
200m line spacing. 56m elevation
Thee complementary data sets



Radiometric data

Natural & man-made radioactivity

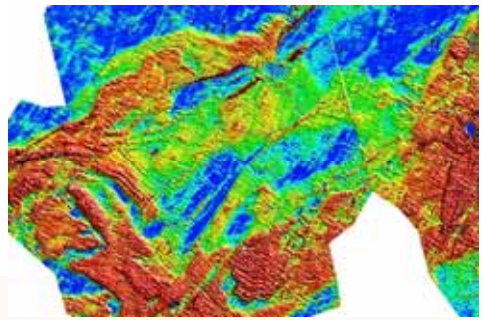
- **Baseline levels of natural radioactivity**
  - background for future contamination & epidemiological studies
  - mapping near surface geology, soils & peat
- **Distribution of ^{137}Cs (Cesium)**
  - e.g. Chernobyl fallout
- **Radioactive industrial waste**
- **Areas prone to high levels of radon**
- **Data for mineral exploration**



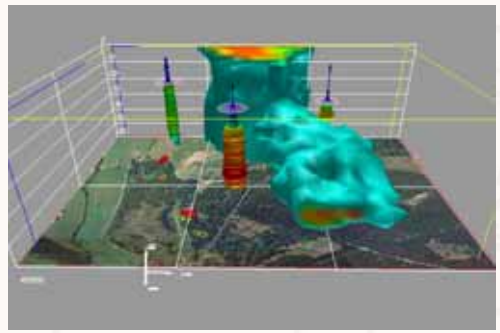
Electro-magnetic (EM) data

Near-surface electrical conductivity

- **High electrical conductivity (in top 100m) relating to leakage from**
  - **land-fills, waste dumps & mine waste tips**
  - **industrial pollution**



- **Metalliferous mineral deposits**
- **Ground conductivity**
  - **e.g. to site masts and electrical infrastructure**

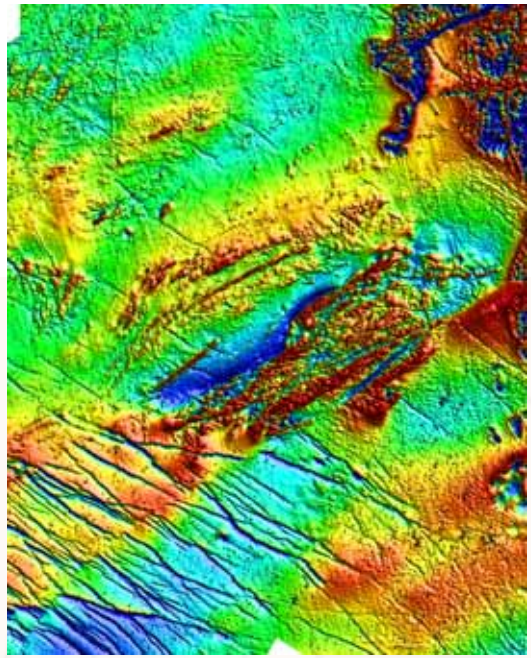


- **Concealed geological structure**

Airborne magnetic data

Variations in rock magnetic properties

- **Concealed geology (shallow & deep)**
  - Especially in volcanic & metamorphic terrains (e.g. Scotland & N Ireland)
  - But also in 'non-magnetic' sedimentary basins in all parts of the UK
- **Structural controls on mineralisation**
  - Targets for follow-up exploration
- **Environmental applications**
  - Structural controls on groundwater movement
  - Identification of 'lost' and illegal land-fills containing metal waste



Modern high resolution data provide much greater definition of concealed structure

Existing data - ***2km line spacing dating from 1950s & 60s***

Role of geochemical & geophysical data sets in managing the environment

- Defining natural & human-induced conditions in the near surface
- Provide multiple integrated data sets for
  - Defining environmental & geological baselines
  - Identifying sources of natural and anthropogenic contamination
  - Understanding movement of pollutants through the subsurface

- Powerful evidence base to underpin
  - Monitoring and protecting the environment (e.g. groundwater, habitats, biodiversity, human & animal health)
  - Managing sustainable development of land & natural resources
  - Developing environmental strategies and remediation plans
  - Compliance with environmental legislation
  - Targeting site investigations

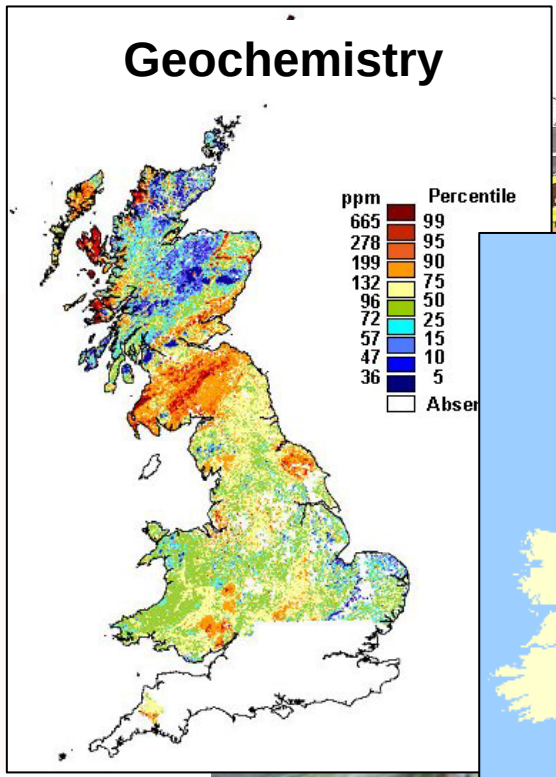
SOURCE

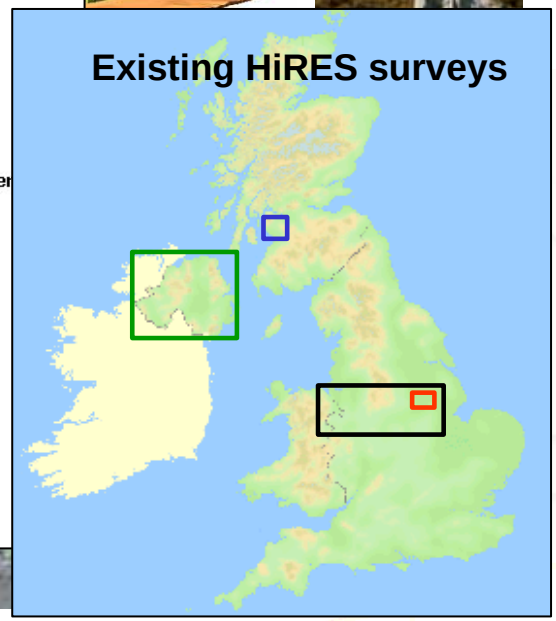
PATHWAY

RECEPTOR

Progress towards the 'next generation' Geoscience Framework at BGS

- Complete 'baseline' 2D geological coverage
- Fully implement digital field data capture digital workflow
- Increasingly deliver 3D geology as standard product
- New 3D visualisation
- Move to 'issue-driven' responsive revision of 2D/3D geology





Similar approach offshore

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

www.bgs.ac.uk

TELLUS

'Understanding Underground'

Two new and comprehensive surveys of Northern Ireland

Low-level airborne geophysical survey

Geochemical surveys of soils & streams

Tellus launched in 2004
Surveys completed 2006

Department of Enterprise, Trade and Investment
www.detini.gov.uk

Geological Survey of Northern Ireland

TELLUS

Goals

UNDERSTAND and **CONTRIBUTE** to the sustainable development and management of our natural resources

MEASURE and **ASSESS** the environmental well-being of Northern Ireland, using modern mapping techniques

Department of Enterprise, Trade and Investment
www.detini.gov.uk

Geological Survey of Northern Ireland