

HiRes airborne geophysical survey of Anglesey: a key dataset for unravelling complex geology and establishing an environmental baseline

Applied geoscience for our
changing Earth

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INTRODUCTION

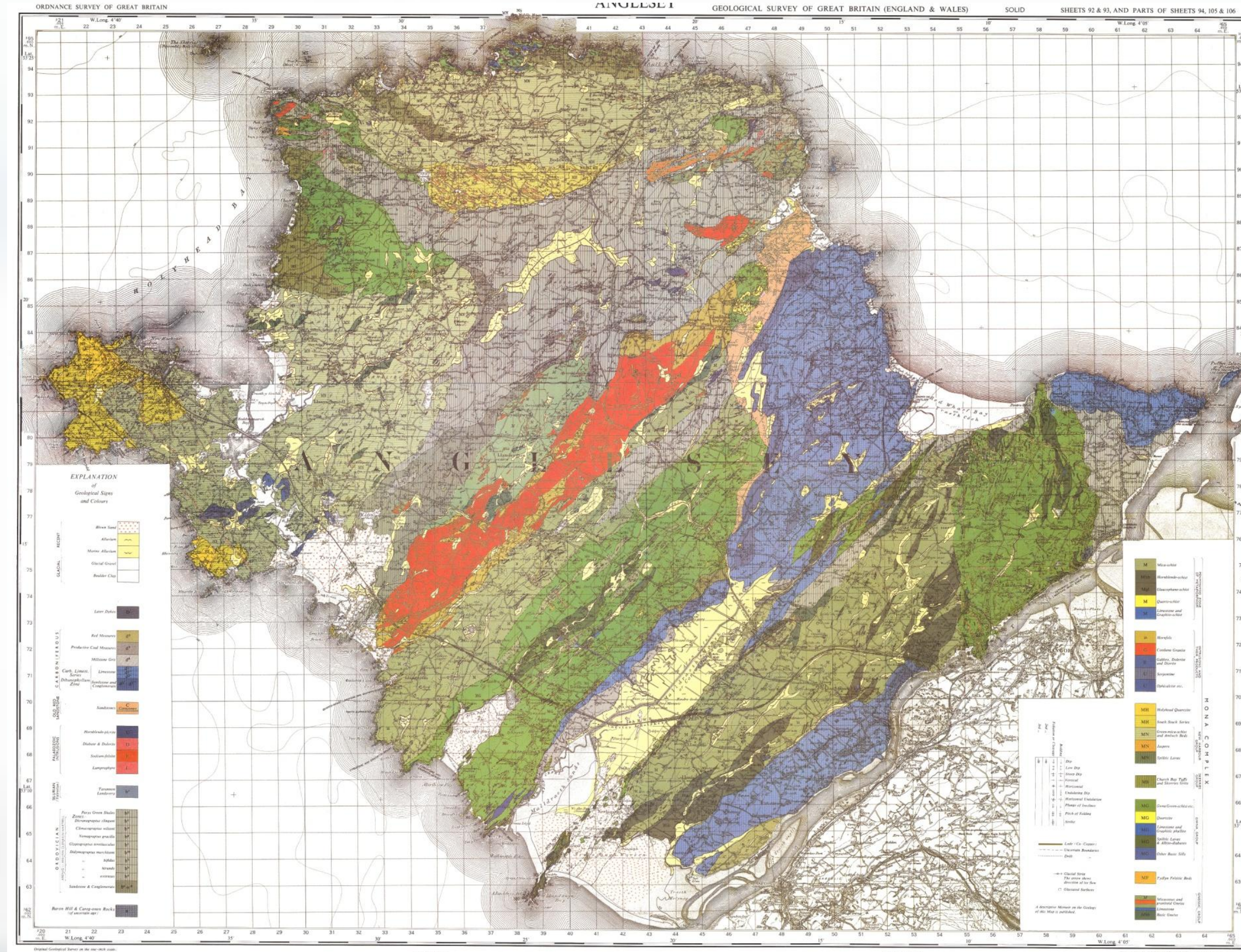


The island of Anglesey (Ynys Môn) lies off the northwest coast of Wales, separated from the mainland by the Menai Strait. Primary geological surveying was published in 1920. Because of the relative antiquity of this data, the island is currently undergoing re-mapping by the British Geological Survey (BGS). The new survey is motivated by a unique and complex set of social and economic drivers, and planning constraints that make the provision of up to date baseline geological data an urgent priority.

Provision of new data is predicted to augment the rich history of scientific research undertaken on the island. The new survey will also underpin geological interpretation and coincides with Anglesey being awarded UNESCO European Geopark status. Together these are expected to contribute to tourism and inward investment to the island which has a relatively weak economy, largely based on agriculture, nuclear power generation and aluminium smelting. These drivers are balanced against demands of understanding and mitigating the environmental legacy of historic coal and copper mining as well as the need to support planning decisions motivated by ongoing development of a major international transport node at Holyhead with associated rail and road links. The new mapping exercise comprises targeted land-survey carried out at 1:10 000 scale and includes a high resolution airborne geophysical survey (HiRES) that forms the subject of this poster.

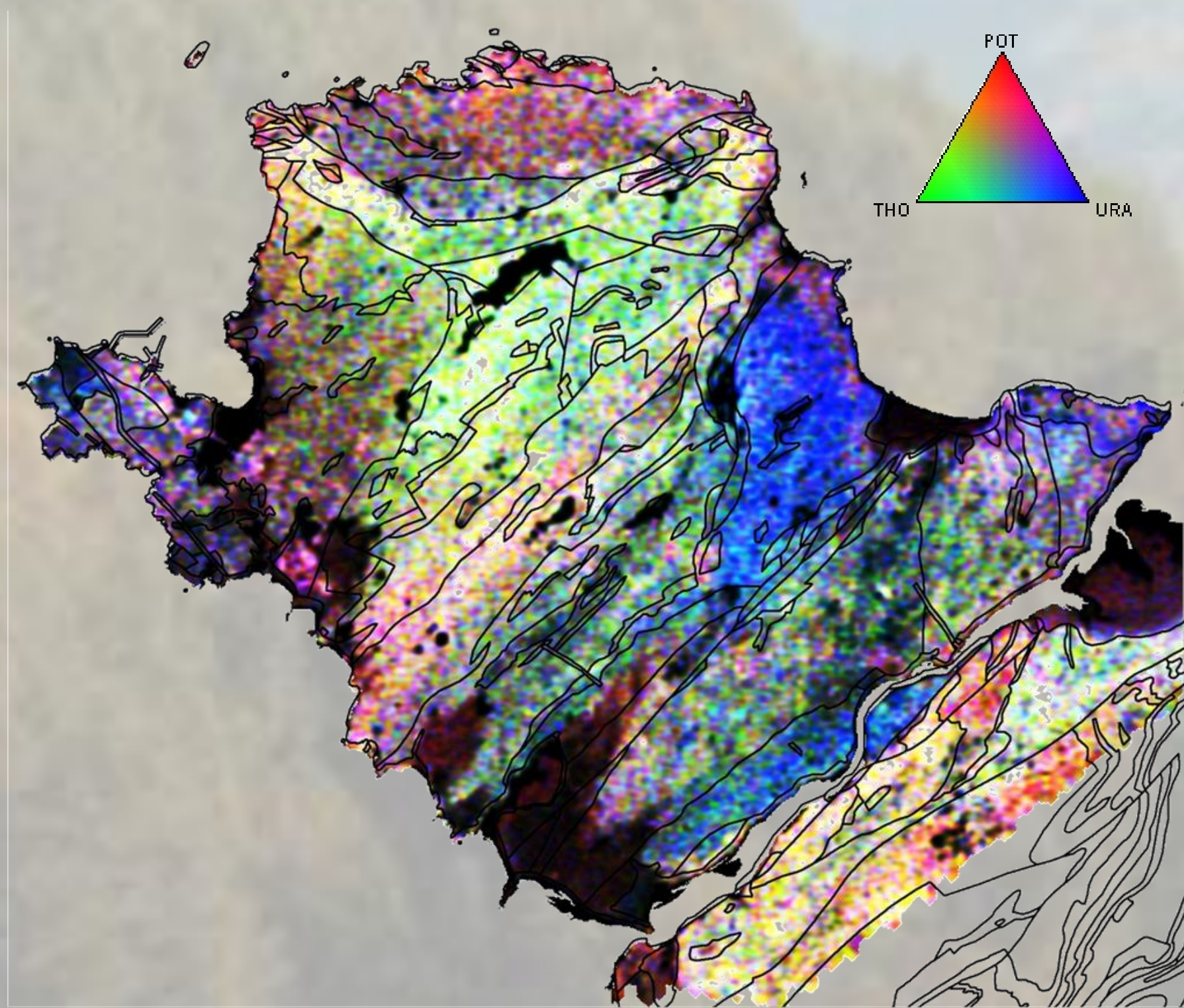
The survey employed a unique 'three-in-one' capability of magnetic, radiometric and electromagnetic measurements mounted on Twin-Otter aircraft. Some 6,300 line-km of data were acquired at a line-spacing of 200 m. As well as providing valuable insights into the distribution of concealed features and properties of both bedrock and superficial deposits, the new geophysical data along with existing geochemical data will define a baseline against which environmental change can be measured.

THE GEOLOGICAL MAP



Original 1:50 000 scale bedrock geological survey of Anglesey, published in 1920. The new geological survey will incorporate results of academic research over the last 90 years as well as tools unavailable to late 19th to early 20th Century geologists such as airborne and satellite surveys, readily available geochemistry, isotope geology and advanced biostratigraphic tools.

THE RADIOMETRIC DATA



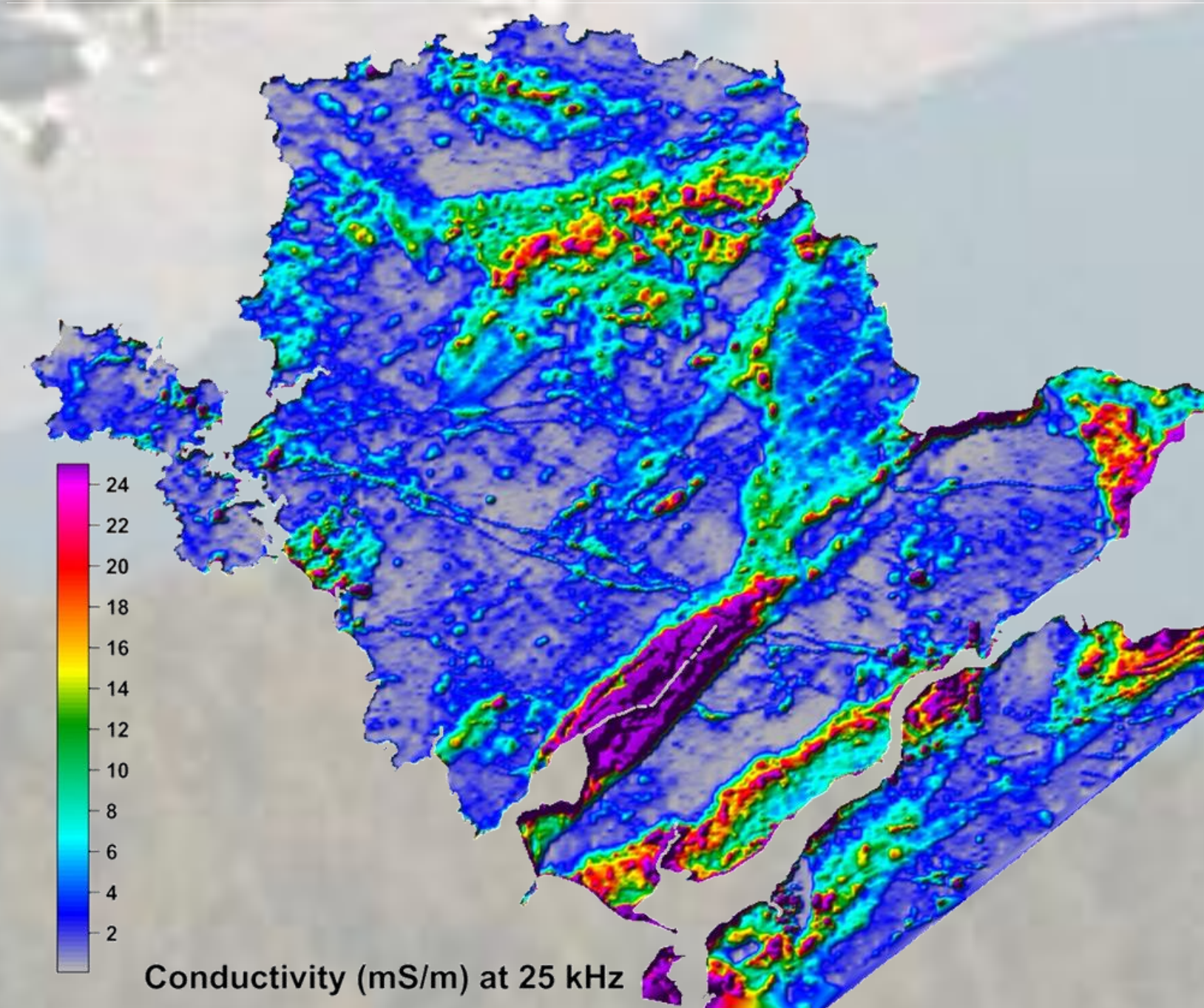
The radiometric data are typically used in studies of:

- Bedrock geology: compositional/lithological changes within mapped units
- Superficial geology and soil
- Overall gamma dose rate including Uranium as a source of Radon gas
- A baseline in order to assess future impacts (in the UK we have observed technological/industrial enhancements of natural radioactivity)
- Direct and indirect indications of mineralisation

The image shown is a Ternary radiometric image formed by a 3-way colour stretching of the individual contributions from Potassium (red), Uranium (blue) and Thorium (green).

Geological linework (1:250k) is used to demonstrate the main lithological associations. For example: Carboniferous limestones are particularly high in Uranium (blue) and are associated with a known level of radon risk; Ordovician mudstones have high Thorium (green) values.

THE ELECTROMAGNETIC DATA



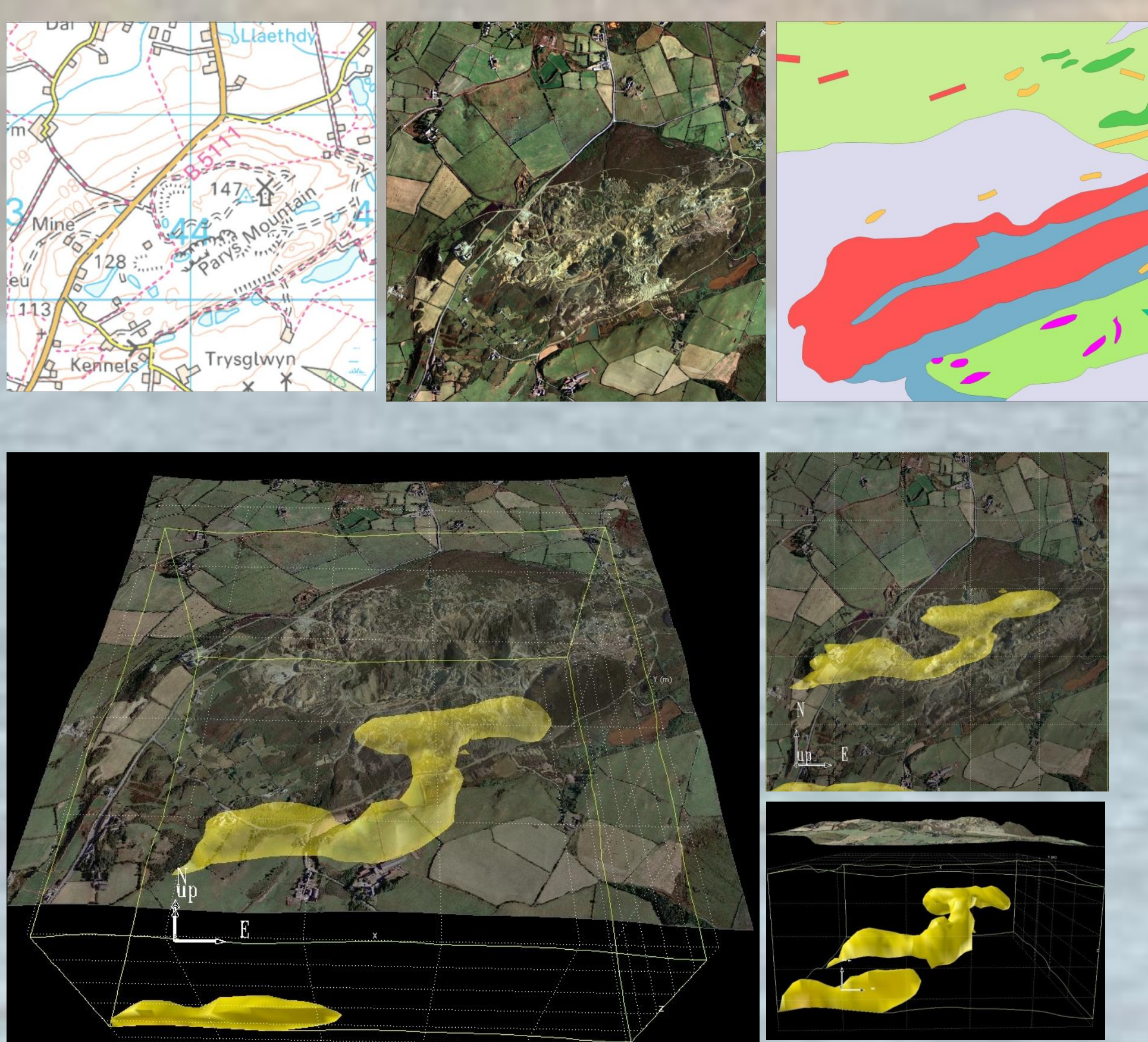
The EM data are converted to maps of electrical conductivity at each of the 4 measured frequencies. The 4 frequencies provide different depths of investigation. Our data is most sensitive to the conductivity distribution in the upper 100 m. The data provide information on:

- Bedrock/concealed geology: compositional/lithological changes within mapped units
- Superficial geology and soil
- Leakage from land-fills, waste dumps and industrial pollution
- Coastal saline intrusion
- A baseline in order to assess future impacts
- Direct and indirect indications of mineralisation

The image shown is the apparent conductivity at 25kHz (mS/m) which provides the shallowest depth of investigation. Many of the formations are highly resistive (<2 mS/m). The data are highly influenced by cultural influences (roads and concealed pipeline routes). A major conductive feature is contained within a fault bounded Carboniferous Coal Measures basin. This is assumed to be saline intrusion

THE ELECTROMAGNETIC DATA

A detailed 2 x 2 km study of Parys Mountain mine

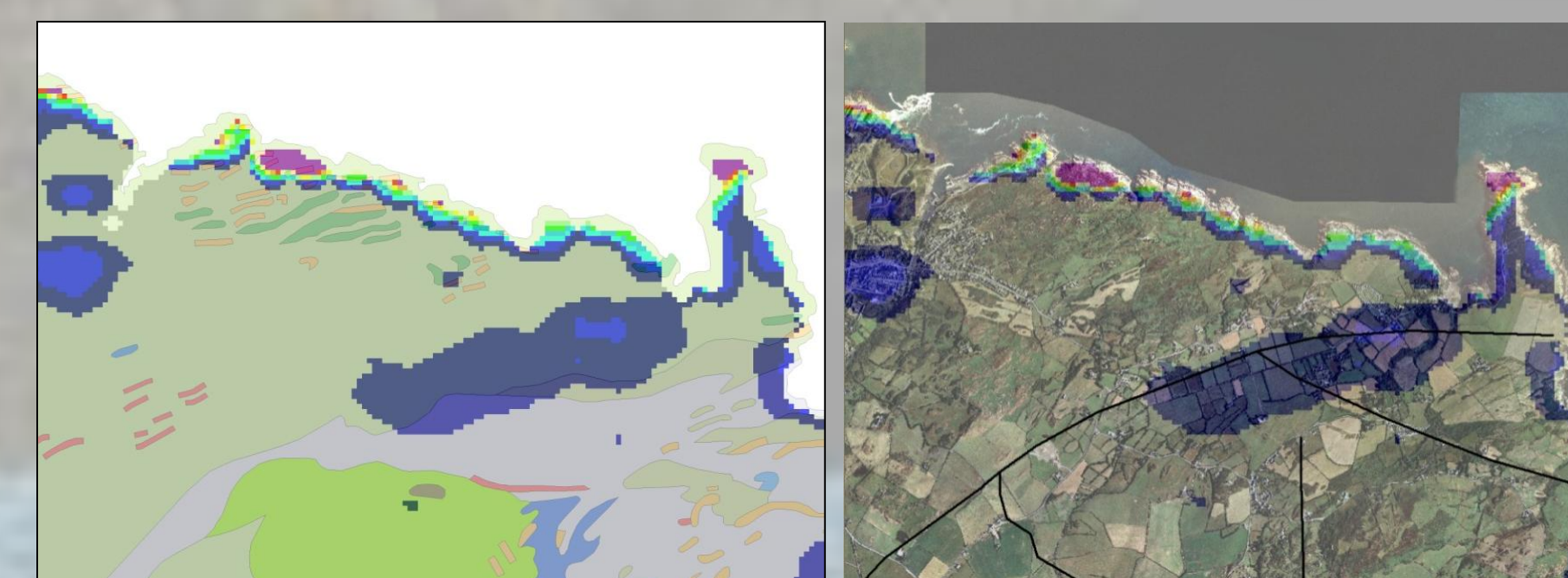


Parys Mountain is the site of historic copper mining dating back to the Bronze Age, reaching its peak in the late 18th to early 19th century. Mineralisation is associated with a rhyolitic body hosted by latest Ordovician sediments. A high level of soil contamination inhibits plant growth at the site and the presence of contaminated, acidic mine waters, partly derived from historic precipitation lagoons, presents a challenge to environmental management.

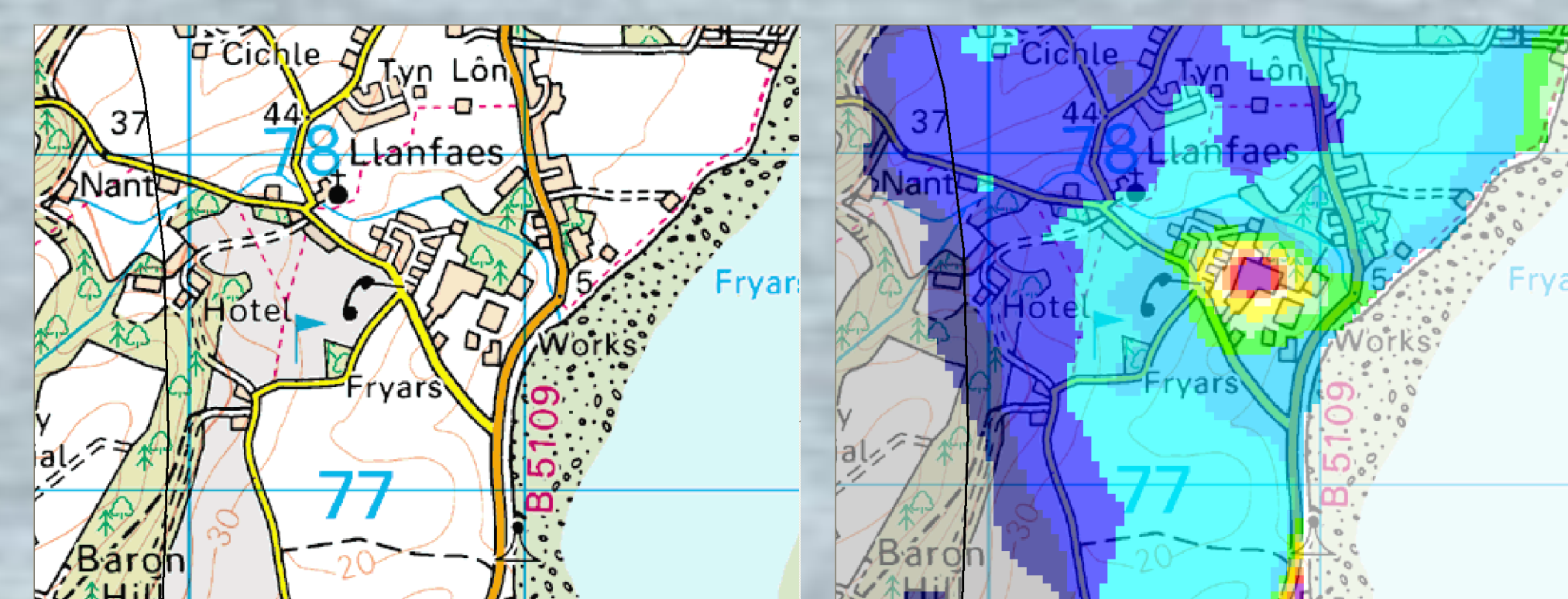
The 4 frequency EM data were used to construct a subsurface conductivity model. In order to display the information we isolate the most conductive zone (> 20 mS/m) and view this as a volume draped below the surface topography. The images show the 20 mS/m isosurface in yellow within a volume of 2 x 2 x 0.1 km. The feature observed displays an association with the zone of historical, shallow mining of Cu ore.

THE ELECTROMAGNETIC DATA

Local investigations of high conductivities

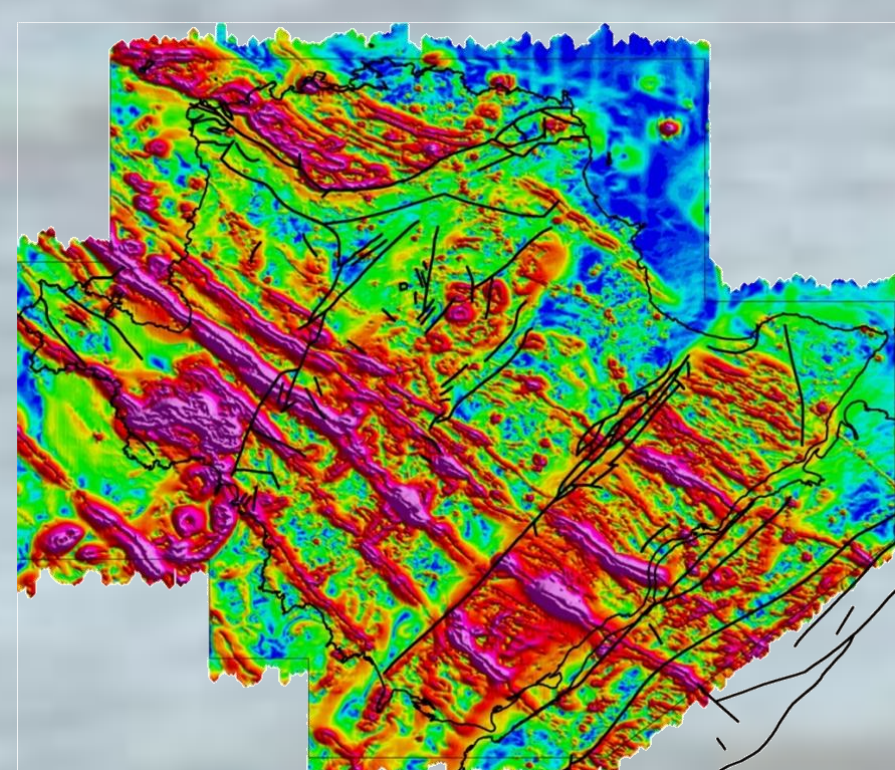


The images show the 12 kHz conductivity in contour form on 50k geology and an ortho-photograph. The width of the area shown is ~ 4 km. Localised conductive zones in this northern part of the CH fault/shear zone may indicate ridge features in the conductive basement

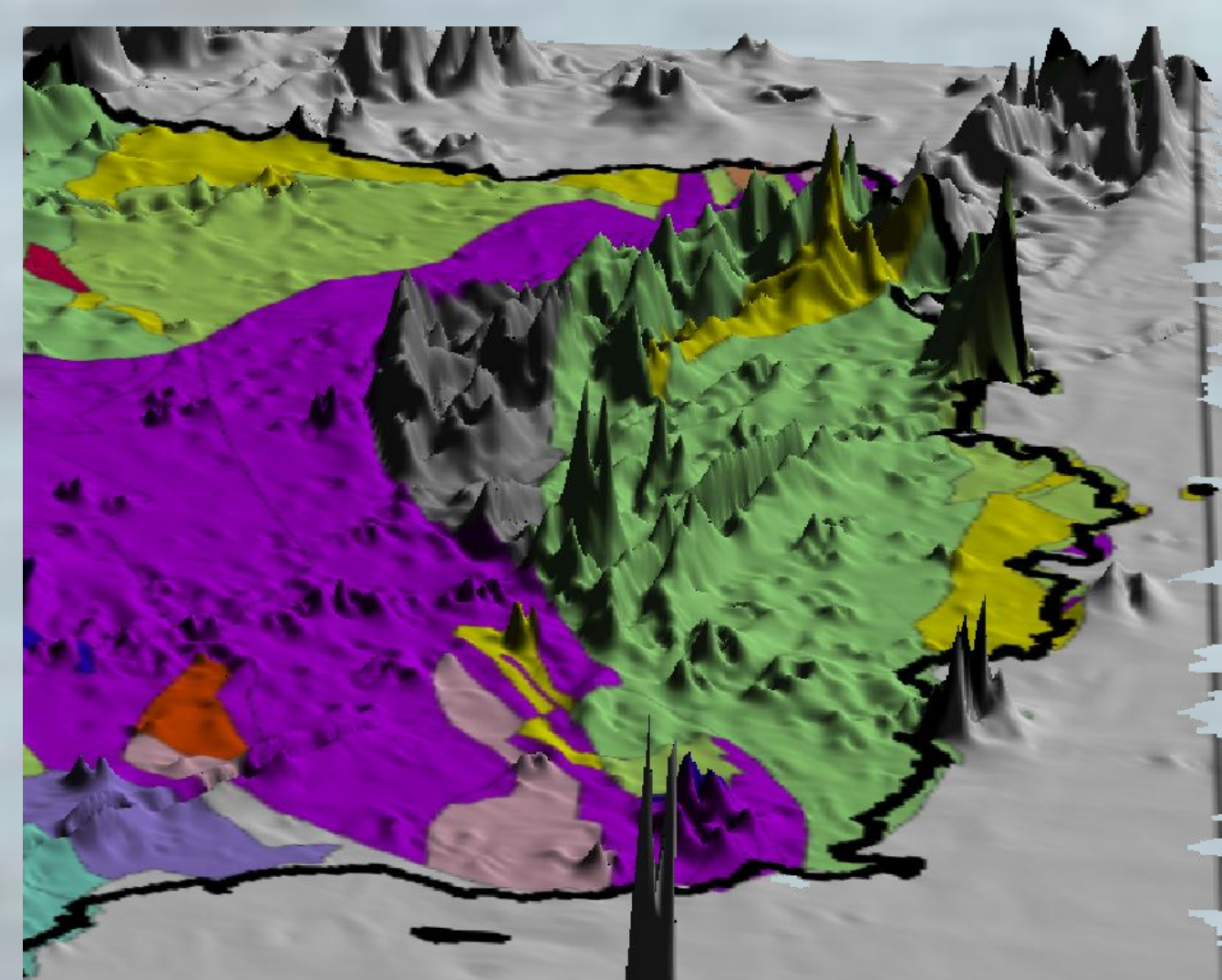
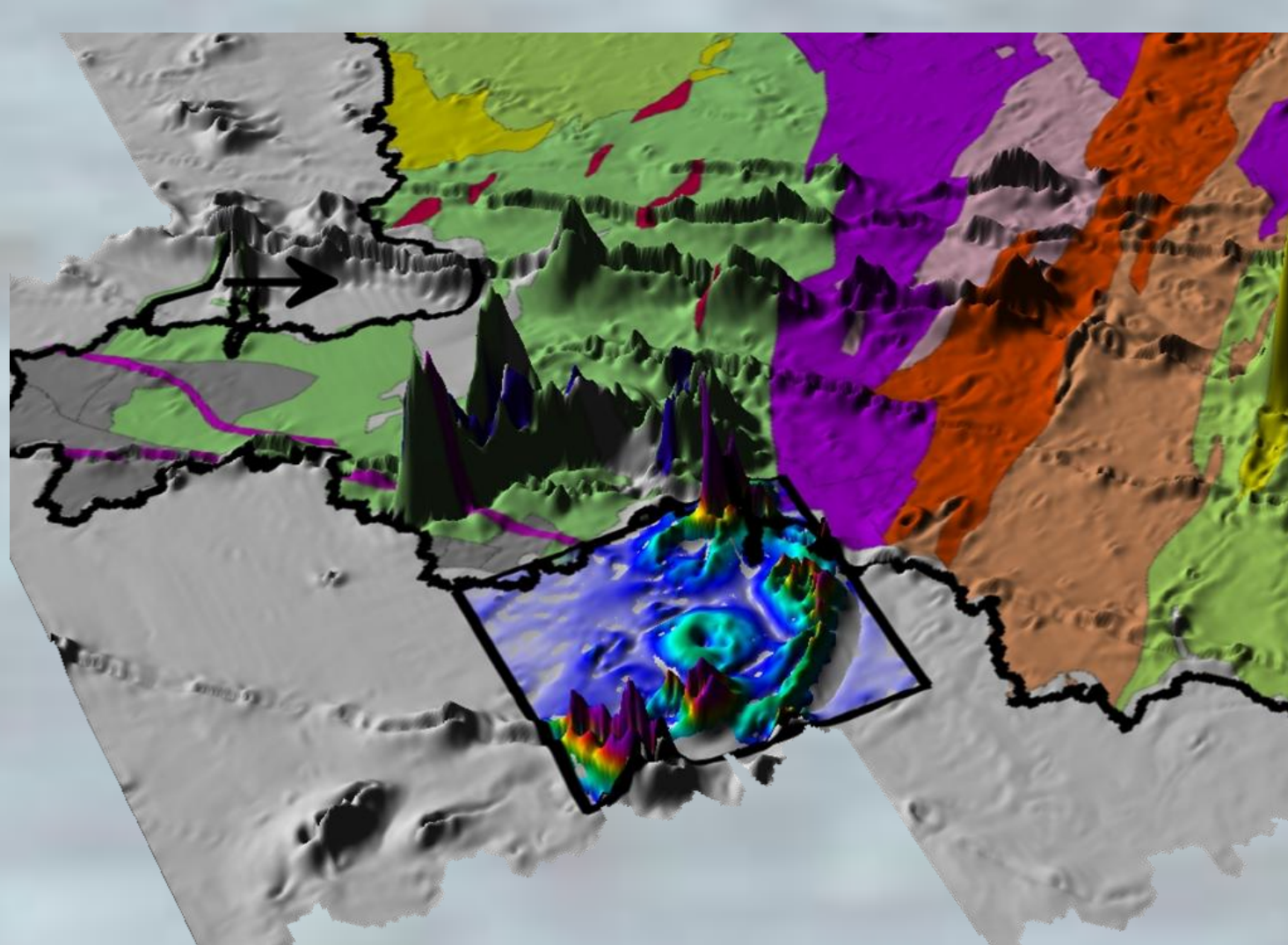


The conductivity data reveal quite localised zones of high conductivity. Here a small anomaly (in red) is associated with an industrial works near the coast. The grid interval is 1 km.

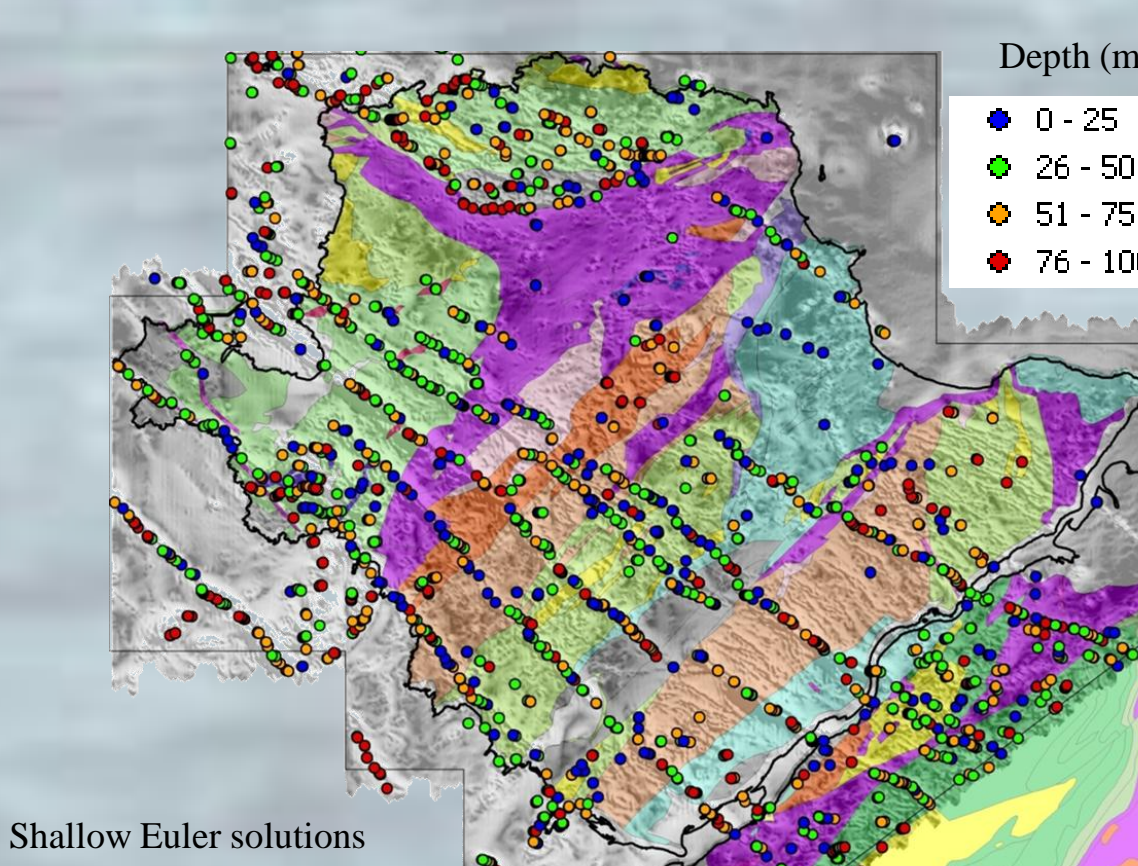
THE MAGNETIC DATA



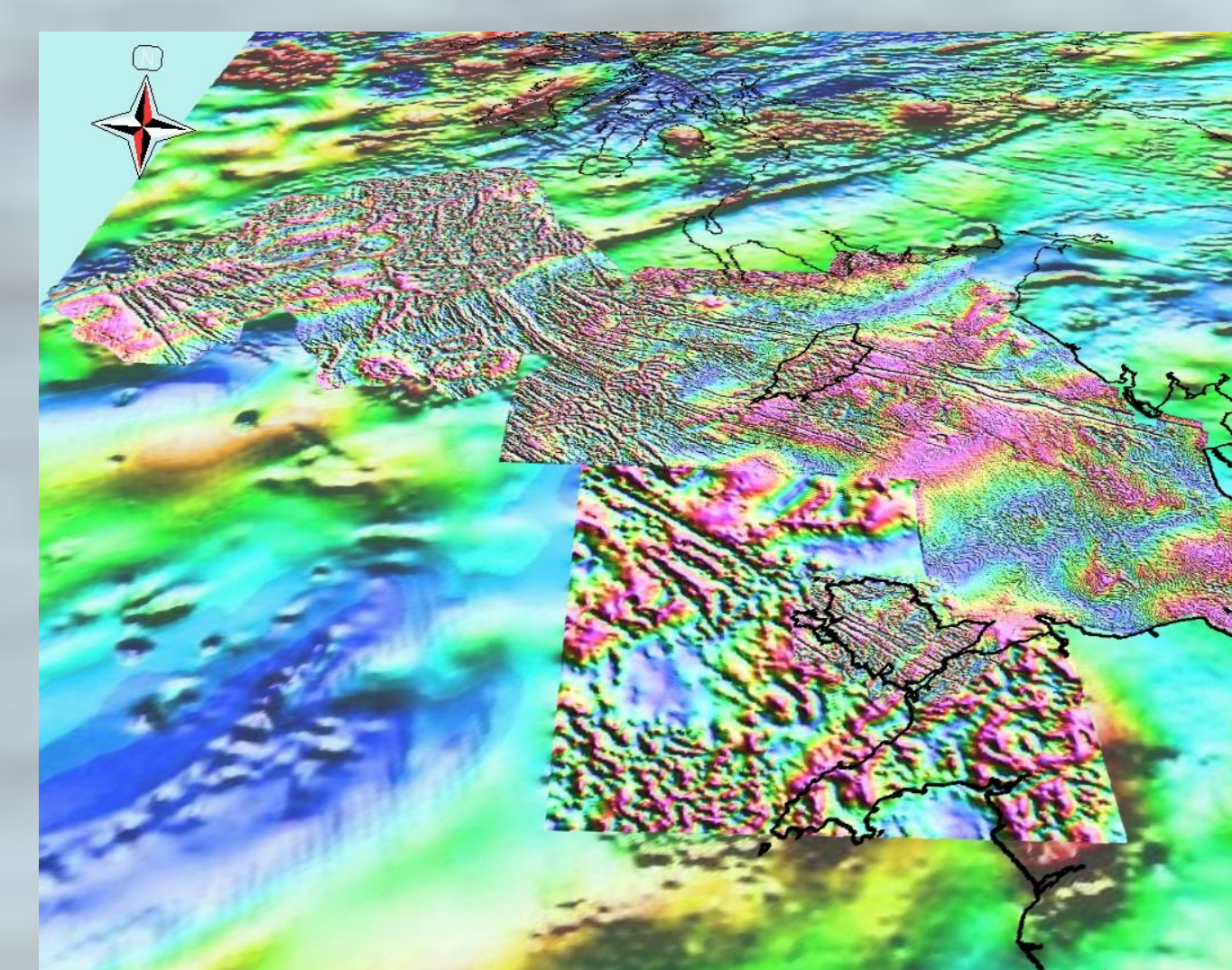
Airborne magnetic data are closely aligned with geological interpretations. The detail in the HiRES data should allow for resolution of magnetic structural features approaching the 1:10k scale. The magnetic data, when processed, reveals responses from a variety of structures, as shown here. The images show the processed magnetic data as a 3D surface.



THE MAGNETIC DATA



The magnetic response is, in part, dominated by the NW-SE trending Paleogene dyke swarm. The data can be processed to provide locations and depths of the structures using the gradients in the data, as shown.



The data obtained across Anglesey can be compiled alongside other existing airborne magnetic data sets. The compilation shown uses the magnetic tilt derivative from 4 data sets to reveal the prominence and extent of the largely concealed structures. Analysis of these data are currently allowing a reappraisal of the Alpine collisional tectonics and Icelandic mantle plume magmatism in the Palaeogene.