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Geological Survey of Northern Ireland

TELLUS

Regional interpretation of new airborne geophysical imagery of Northern Ireland

Michael Young, Mark Cooper & Alex Donald

Geological Survey of Northern Ireland, Colby House, Stranmillis Court, Belfast BT9 5BF
E-mail: mike.young@detini.gov.uk

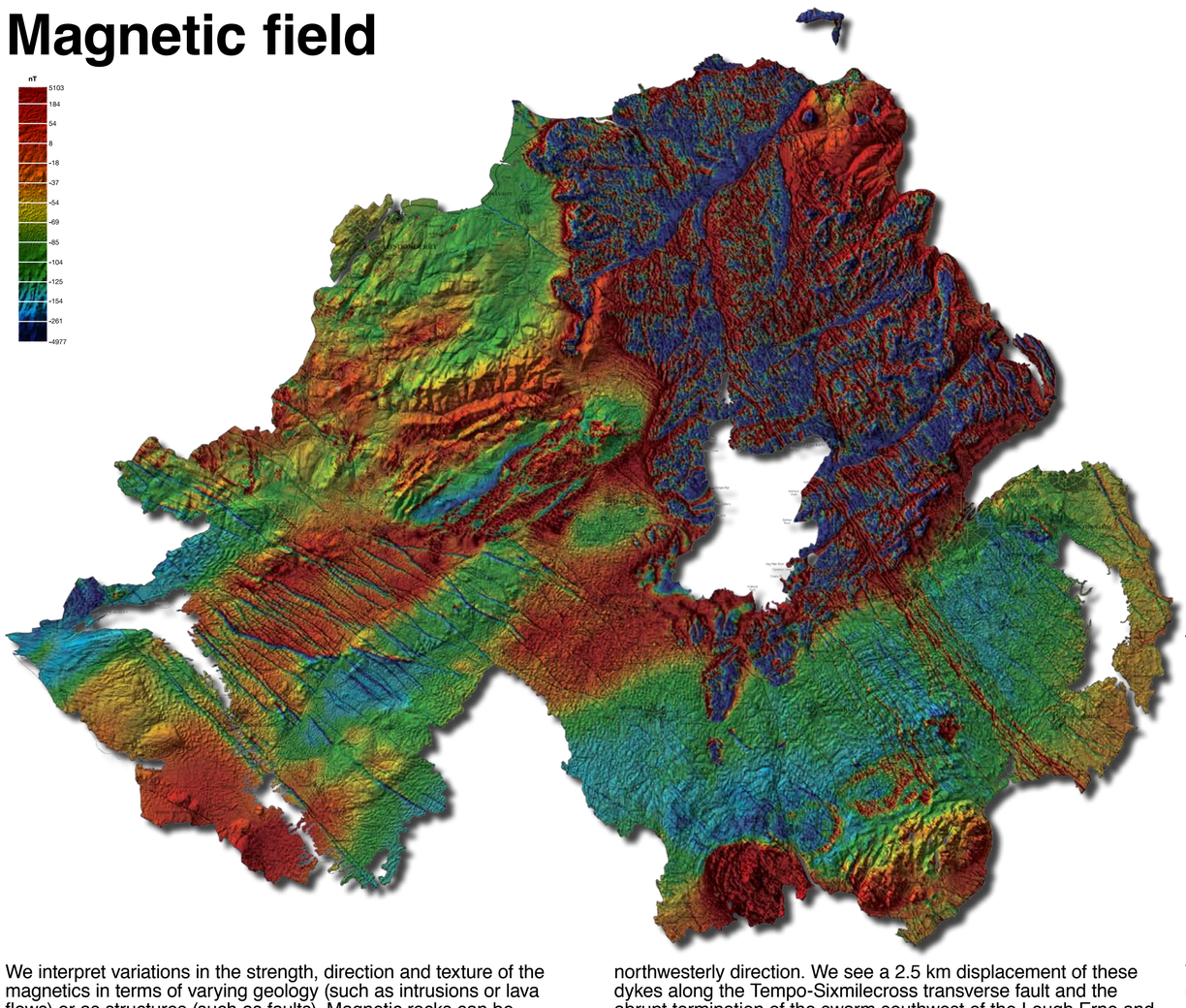
With contributions from: David Beamish, Baz Chacksfield, Chris van Dam, David Jones, Cathy Scheib and Adrian Walker

The main results of the Tellus airborne geophysical survey of Northern Ireland, flown in 2005/6, are digital datasets, maps and images of:

- **The Earth's magnetic field**
- **The apparent electrical conductivity of the near-surface**
- **The radioactivity of the soils and rocks at surface.**

We use these complementary parameters to distinguish and interpret geological structures and features of the Earth. In interpreting these data we compare them with other mapped data, particularly superficial and bedrock geology, geochemistry, soil-type, land-use and topography. Man-made structures and wastes may also be detected and mapped.

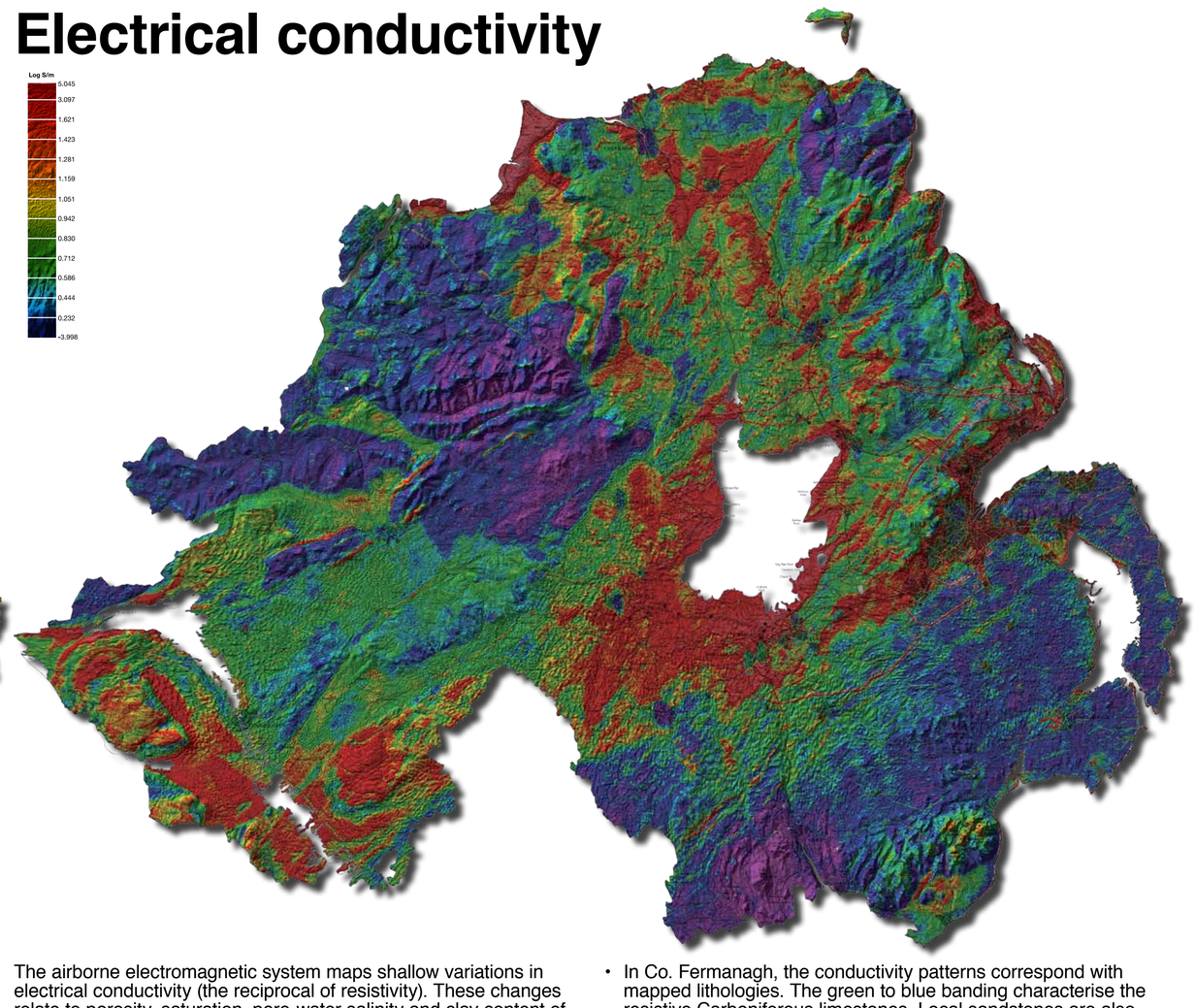
Magnetic field



We interpret variations in the strength, direction and texture of the magnetics in terms of varying geology (such as intrusions or lava flows) or as structures (such as faults). Magnetic rocks can be detected at depths of several km. Some of the prominent magnetic features we see are:

- Strong magnetic relief over the Antrim Basalts of northeast Northern Ireland. Lineaments indicate boundaries between lava flows, faults and major regional structures. Gold, platinum, nickel and chromium soil anomalies correlate with some features and indicate mineral potential.
- Prominent circular or elliptical anomalies over the Palaeogene intrusives of the Mourne Mountains Complex and Slieve Gullion Complex, and the Caledonian age Newry Igneous Complex. Structures and textures within these anomalies (visible at a large scale) characterise different age of intrusion or later cross-cutting intrusions. Gold mineralization is associated with these intrusives, which also have some potential as hot-rock geothermal sources.
- Prominent dyke swarms of various magnetisation direction and azimuth, indicating different ages of emplacement. In the west, these vertical sheet-like intrusive bodies vary in thickness between 5 to about 150 m, crossing Co. Fermanagh and Co. Tyrone in a northwesterly direction. We see a 2.5 km displacement of these dykes along the Tempo-Sixmilecross transverse fault and the abrupt termination of the swarm southwest of the Lough Erne and Enniskillen. Two separate groups of dykes occur in Co. Down and Co. Antrim. The older group is negatively magnetised like the Fermanagh dykes and does not transect the Upper Basalt Formation. The second group is positively magnetised and intrudes the Upper Basalt Formation. These dyke swarms are thinner than those in Co. Fermanagh.
- The Tyrone Igneous Complex. The complex is contemporaneous with and part of the same Ordovician island arc as mineral-rich areas of Newfoundland and New Brunswick.
- Anomalies in the Dalradian Supergroup in the northwest and the Lough Derg Inlier in the far west. The magnetic rocks here are magnetite-rich semi-basites, psammites and greenshists, rocks often associated with mineralisation.

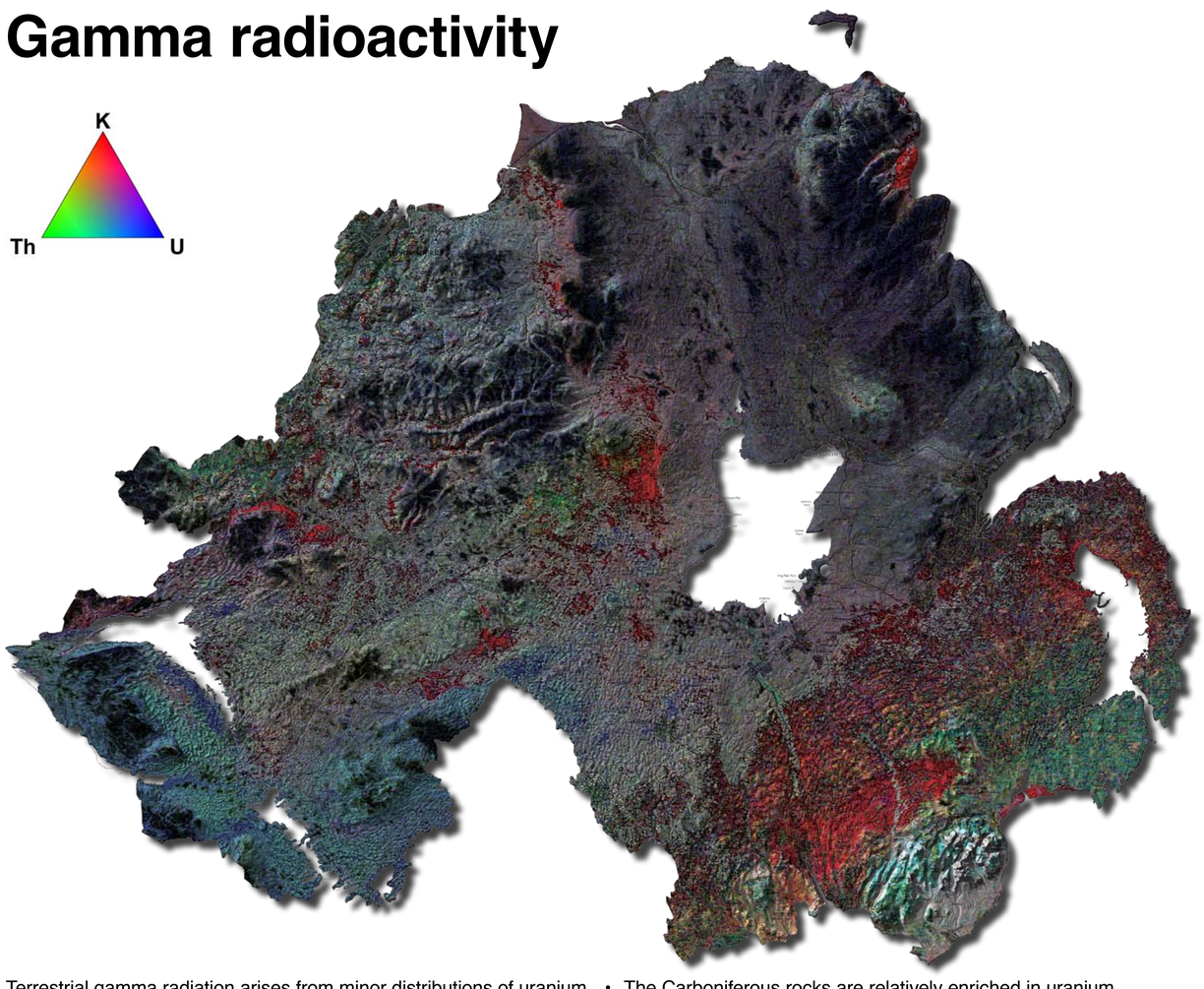
Electrical conductivity



The airborne electromagnetic system maps shallow variations in electrical conductivity (the reciprocal of resistivity). These changes relate to porosity, saturation, pore-water salinity and clay content of near surface rocks. We use conductivity as a tool for mapping the geology of the upper 30 m but anomalies may also be diagnostic of industrial pollution, landfill plumes or groundwater salinity. Features of the regional conductivity map include:

- Dalradian sammites and pelites, gneisses and most schists are resistive (purple to blue shades in the figure), typical of older, metamorphosed, harder rocks. Exceptions are possibly graphitic schists or shear zones along thrust faults.
- Thin lineaments, associated with a number of the main terrane bounding faults, are clearly mapped. Numerous linear conductors are associated with the gold mineralization in Co. Tyrone.
- Ordovician greywackes of the Longford-Down are generally resistive but bands of Moffat shales show clearly as linear conductors.
- The Slieve Gullion Complex is resistive, unlike the other local intrusive complexes. Parts of the Mourne Mountains are very conductive.
- In Co. Fermanagh, the conductivity patterns correspond with mapped lithologies. The green to blue banding characterise the resistive Carboniferous limestones. Local sandstones are also resistive but the shales relatively conductive (red). Some of the Co. Fermanagh dykes have a prominent conductivity signature.
- The Antrim basalts display unexpectedly high conductivity. This may reflect an open pore structure in lava flows near surface but may also indicate conductive overburden or acid peat.
- Seawater and tidal estuaries are conductive and appear as red to white colours. Seawater intrusion of coastal sediments occurs at Magilligan Strand (Lough Foyle) and extends perhaps into the Mercia Mudstone Group.
- Anthropogenic responses include major and minor powerlines and an interesting anomaly stretching southwest from the WWII torpedo testing station in Lough Neagh. No major industrial pollution plumes are recognised at the regional scale but numerous local anomalies of landfills and industrial sites are mapped at the fine scale.

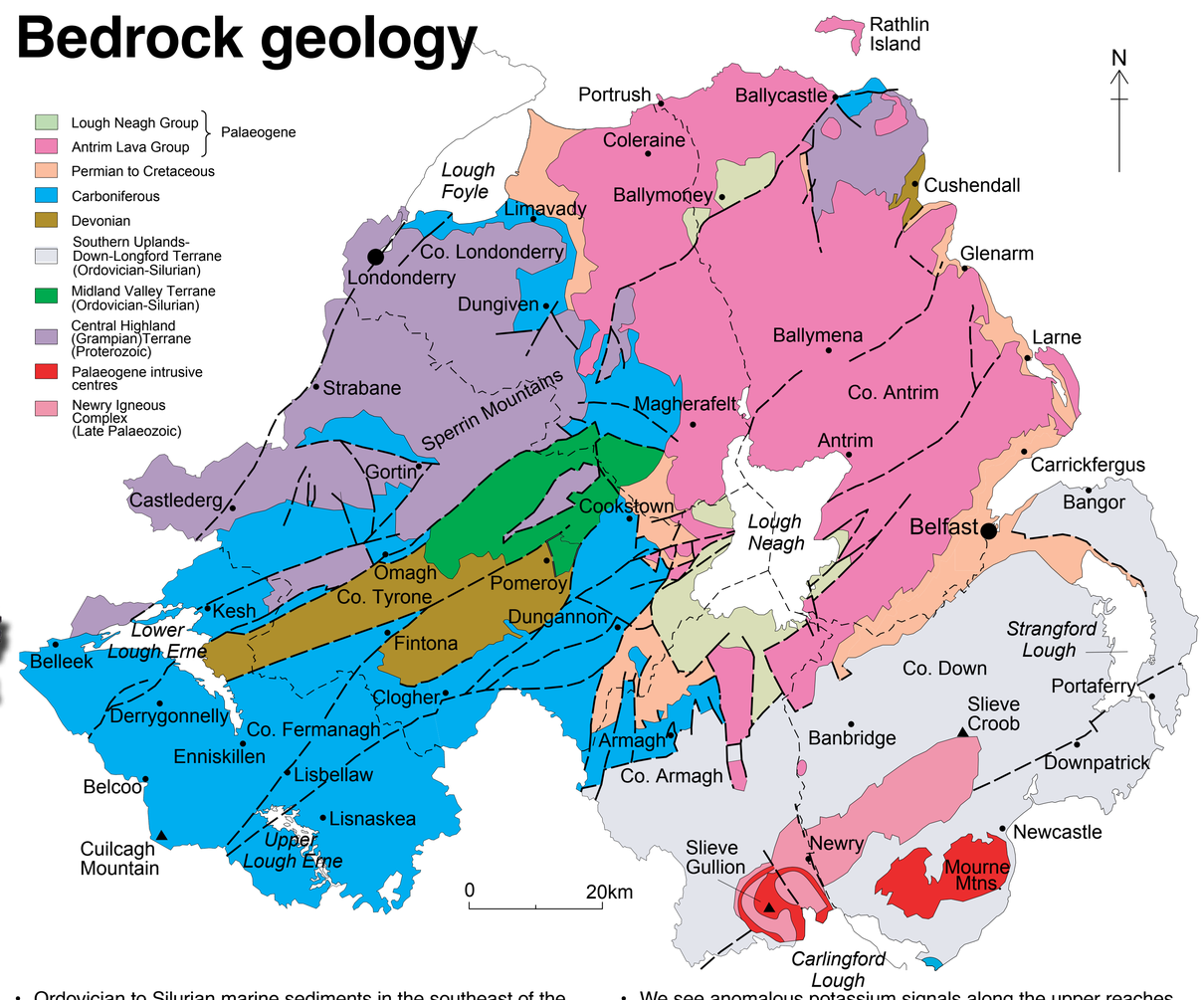
Gamma radioactivity



Terrestrial gamma radiation arises from minor distributions of uranium, thorium and potassium isotopes in the upper 30 cm of soil and rock. The relative variation of these isotopes is a useful auxiliary tool for mapping lithology. We can diagnose clay-rich soils by statistical analysis of the potassium-40 gamma emissions. The gamma-ray data are useful in refining statistical estimations of in-house radon risk, radon being an isotope in the uranium decay series. The ternary presentation colour-mixes the uranium, thorium and potassium signals, such that signals high in all three appear as a bright white, while signals deplete in all three appear black.

- The dark or black areas denote areas where natural radiation is largely or completely screened, often by lakes or by blanket peat bog. We use this effect for delineating and estimating the thickness of peat, in controlled conditions.
- The Carboniferous rocks are relatively enriched in uranium, probably in the black (marine) shale component. Glacial action may have spread detritus from shale outcrops.
- Some of the Permian to Triassic sediments appear relatively enriched in potassium.
- The felsites/granitites of the Mourne Mountains Complex and Slieve Gullion Complex are enriched in U, Th and K-40 isotopes. Prominent K-40 zones occur within the Slieve Gullion Complex.
- Prominent textures, particularly thorium, previously unmapped, occur in the Newry Igneous Complex.

Bedrock geology



- Ordovician to Silurian marine sediments in the southeast of the country are relatively enriched in all three elements. Here the Gala Group sediments are differentiated in two types, more potassium-rich in the north and more thorium-rich in the south.
- The Antrim Basalts, so prominent on the magnetic data, are characterised by very low levels of radioactivity, as we expect from basalts, but the signal may also be attenuated by peat. Prominent zonation is visible in the potassium channel.
- Data over build-up areas is probably more related to building and construction material used than to the underlying rock. Data is also noisy due to the greater survey height.
- We see anomalous potassium signals along the upper reaches of Strangford Lough, Dundrum Bay and on the mudflats of Greencastle Bay (Carlingford Lough) and the cause of this is not known. It may be related to the use of potash fertiliser. Quarries/landfill and the ash pile at Kilroot power station show prominent anomalies.