New mapping of natural and man-made radioactivity

Cathy Scheib and Dave Jones

Acknowledgements: **Tellus** and **JAC** teams; Don Appleton (BGS); Jon Miles & Martyn Green (HPA); Robert Lamour (EHSNI); David Sanderson & Alan Creswell (SUERC), Andrew Tyler, Stuart Bradley & Christopher Brodie (Stirling Uni ERL).

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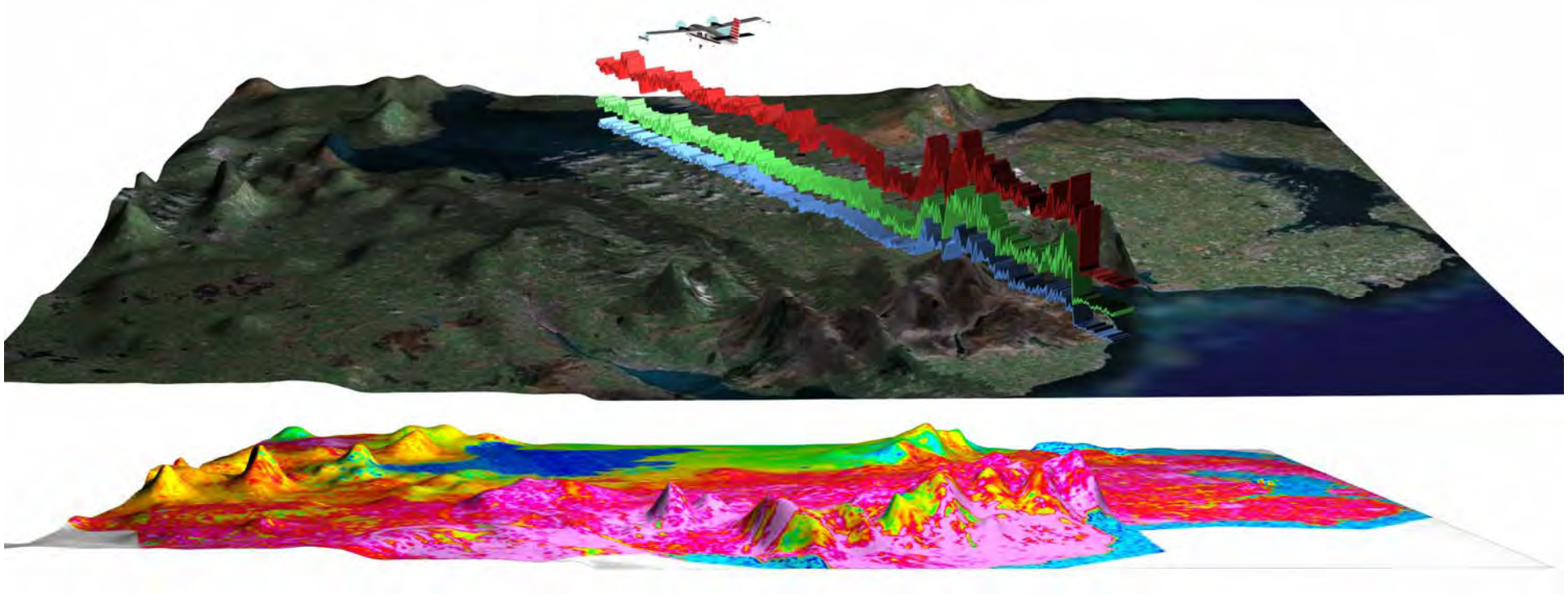
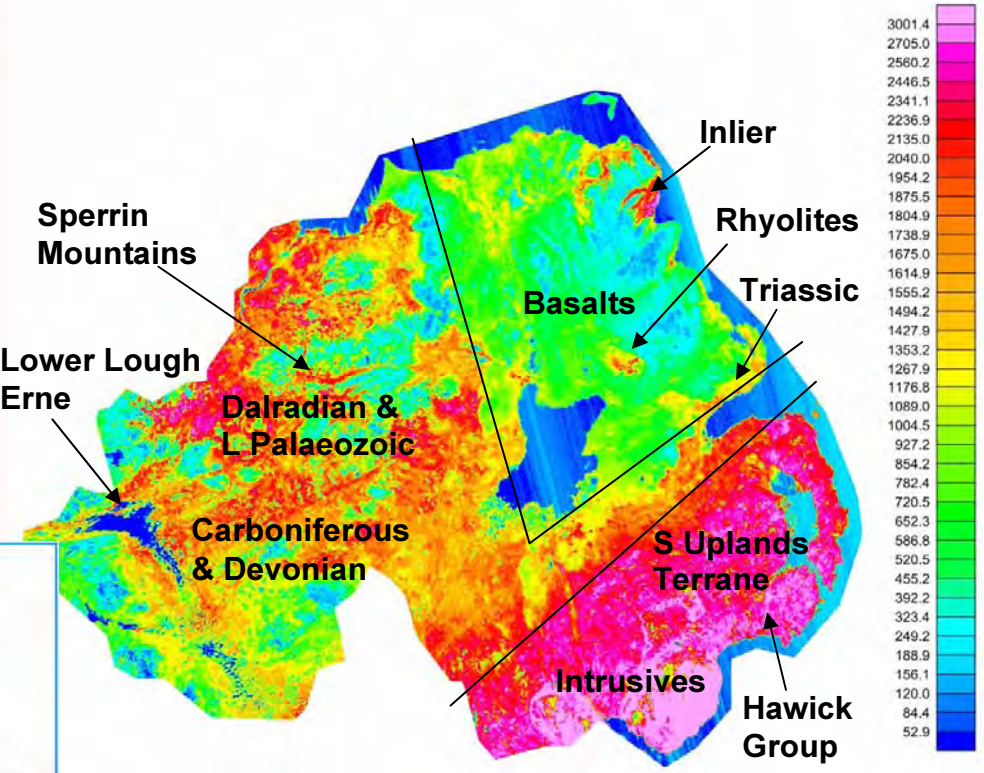
What does the radiometric data reflect, and *what can it be used for*?

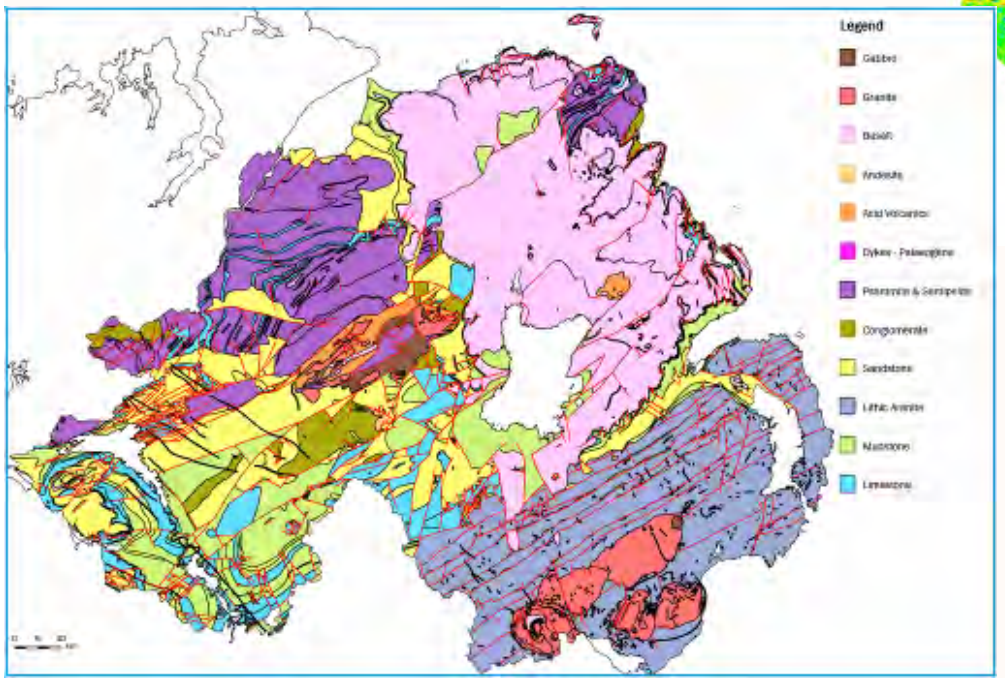
1. Bedrock geology (compositional changes within mapped units); *improved mapping/ understanding of zonation*
2. Superficial geology and soil; *improve maps, peat resources*
3. Enhancement in natural concentrations and inputs (^{137}Cs) due to man's activities; *environmental monitoring, diverse range of environmental studies*
4. Overall gamma dose rate; uranium source of radon; *health studies/ mitigation*
5. Snapshot; *baseline studies to assess future impacts*
6. Direct and indirect indications of mineralisation; *mineral exploration*



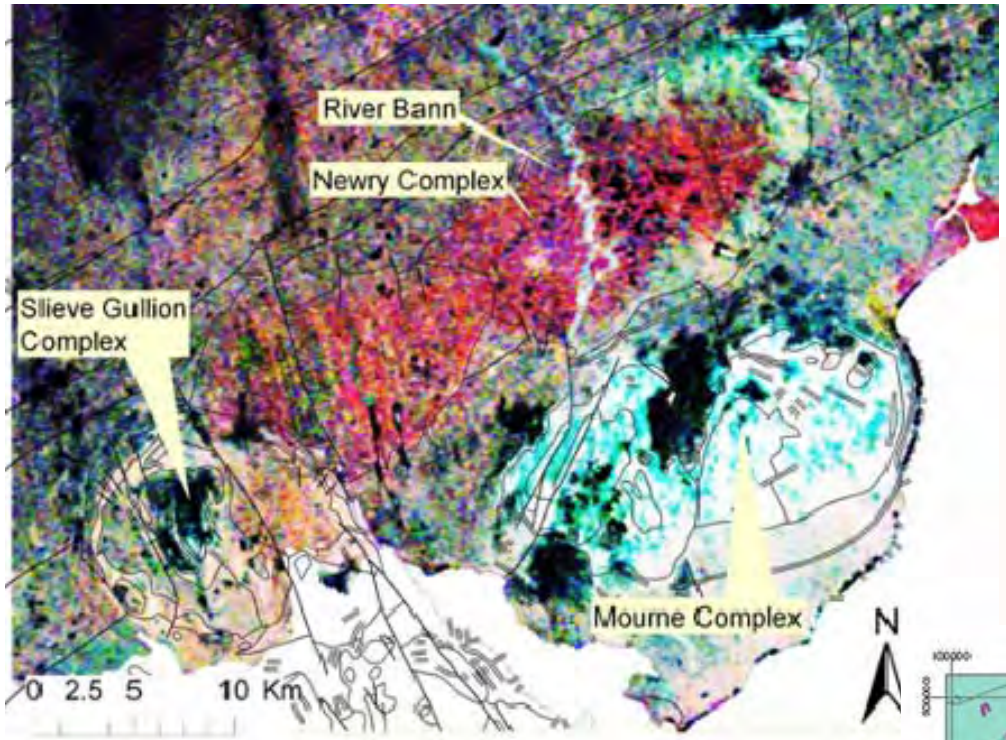
- K, eU, eTh and ^{137}Cs
- Single element maps, total count, ratio maps and ternary images.
- ‘Footprint’ at 56 m: approx 75 % from a width of about 150 m, extending to around 220 m along the flight line

Total Count & bedrock geology

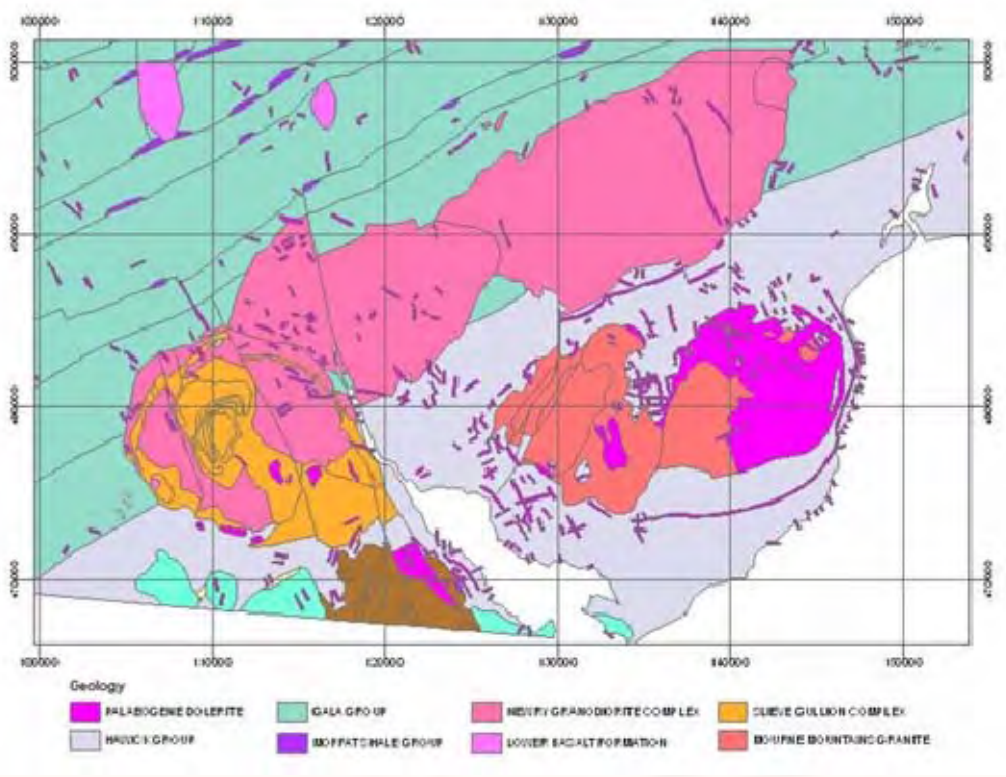




SE Northern Ireland: intrusives

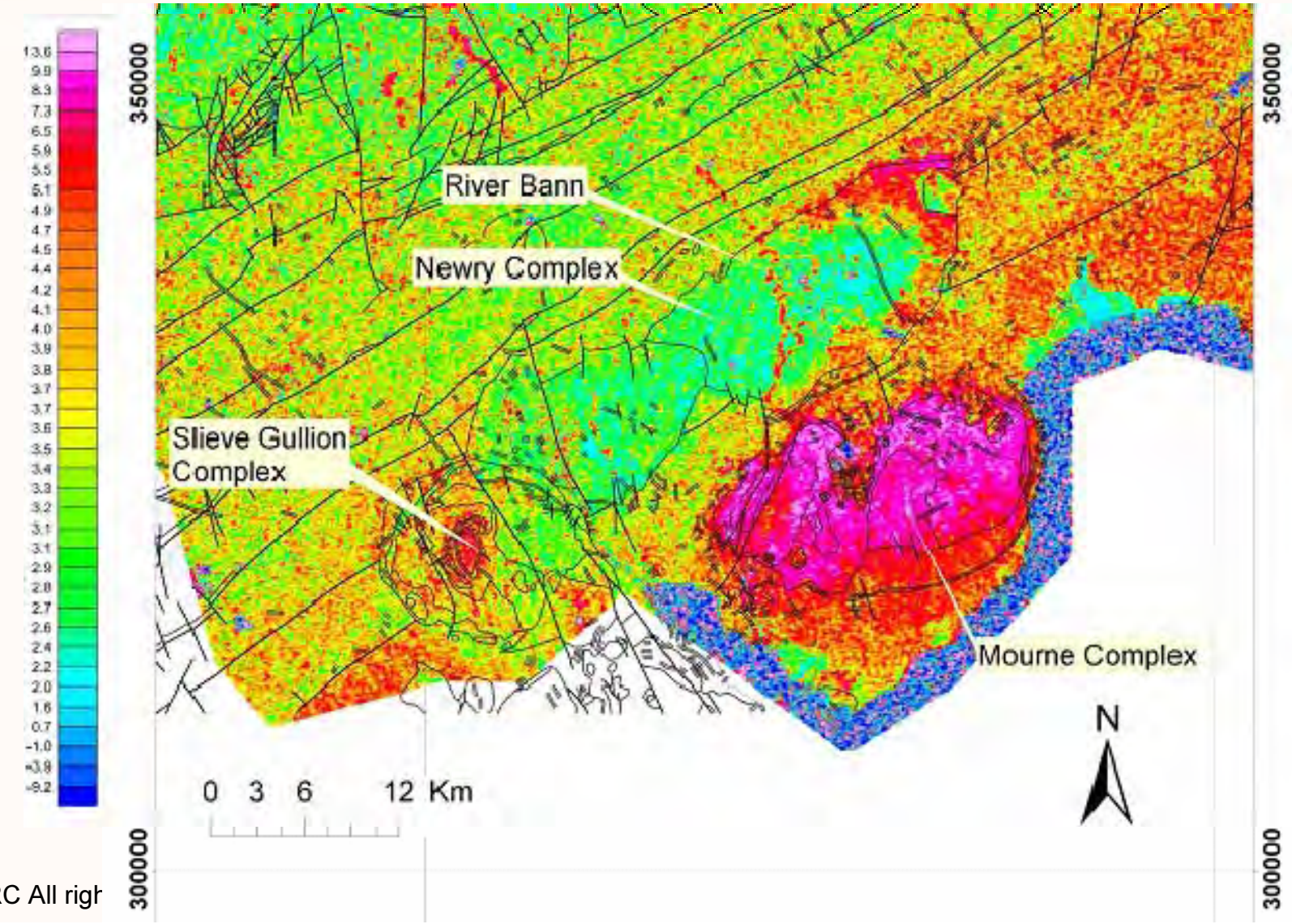


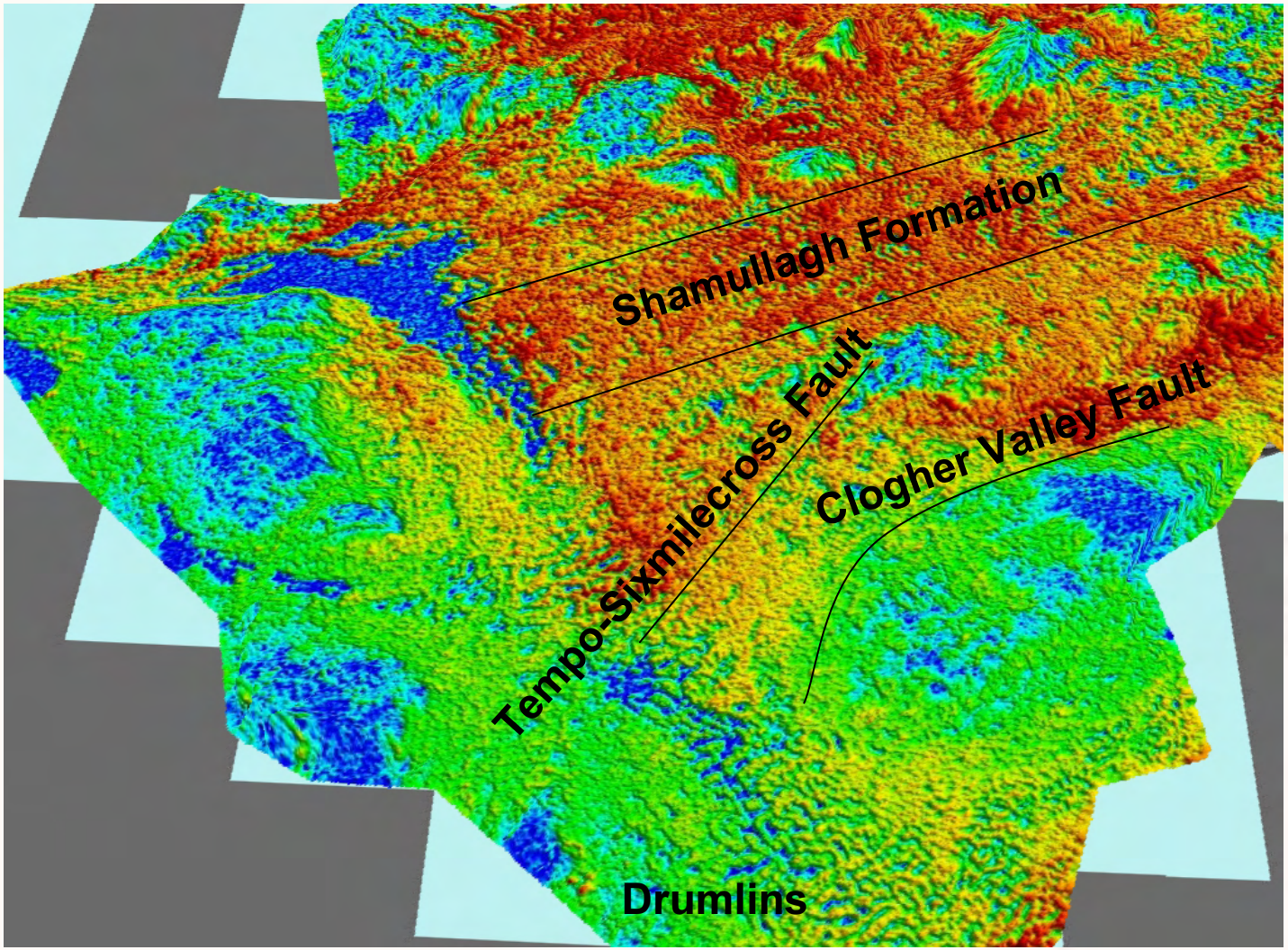
Ternary plot with solid geology lines

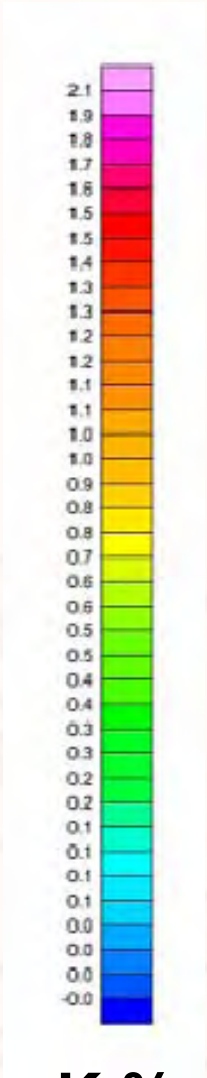


Simplified solid geology

SE Northern Ireland: Th/K ratio with solid geology lines

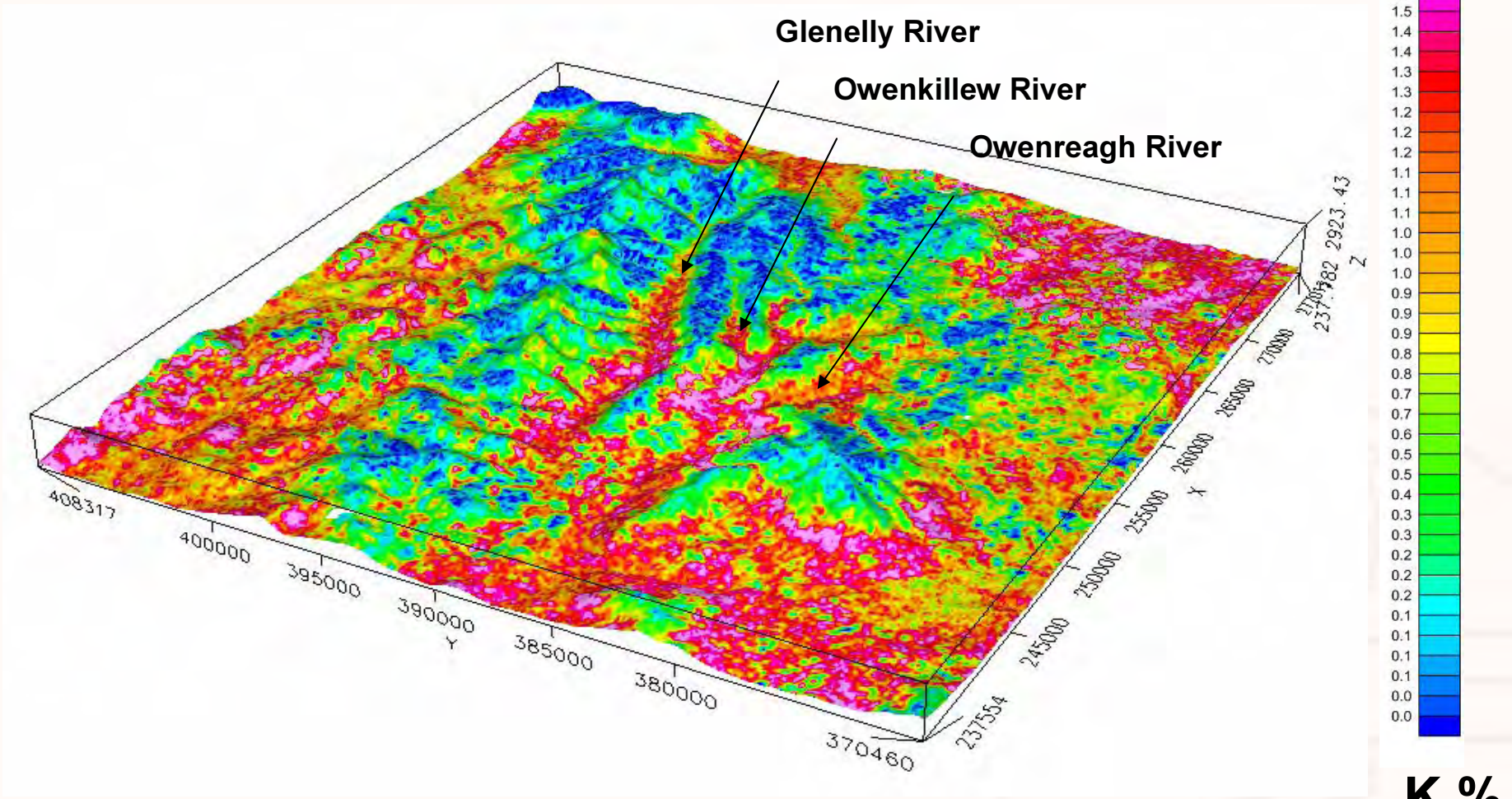






- Also apparent in magnetic data/ geochemistry

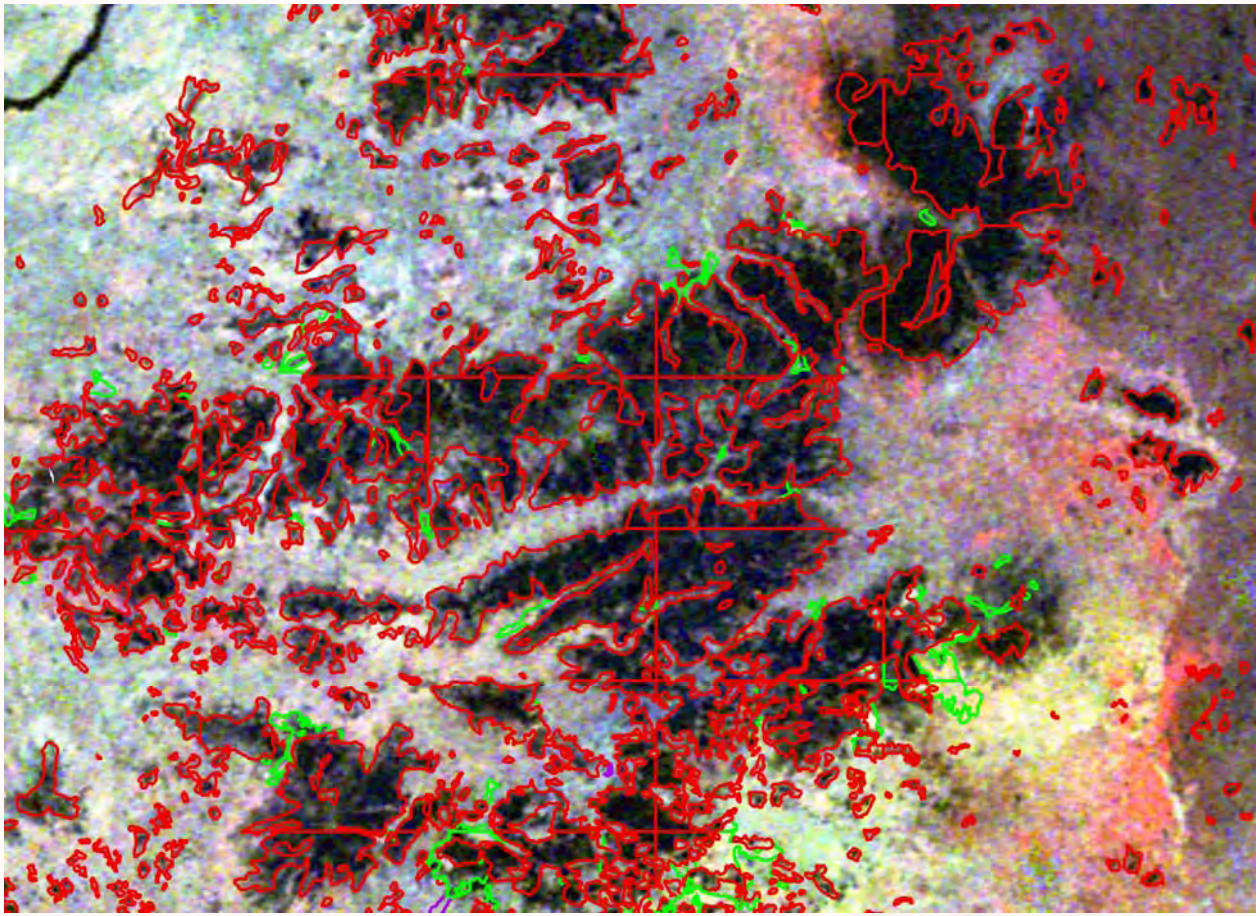
Superficial deposits



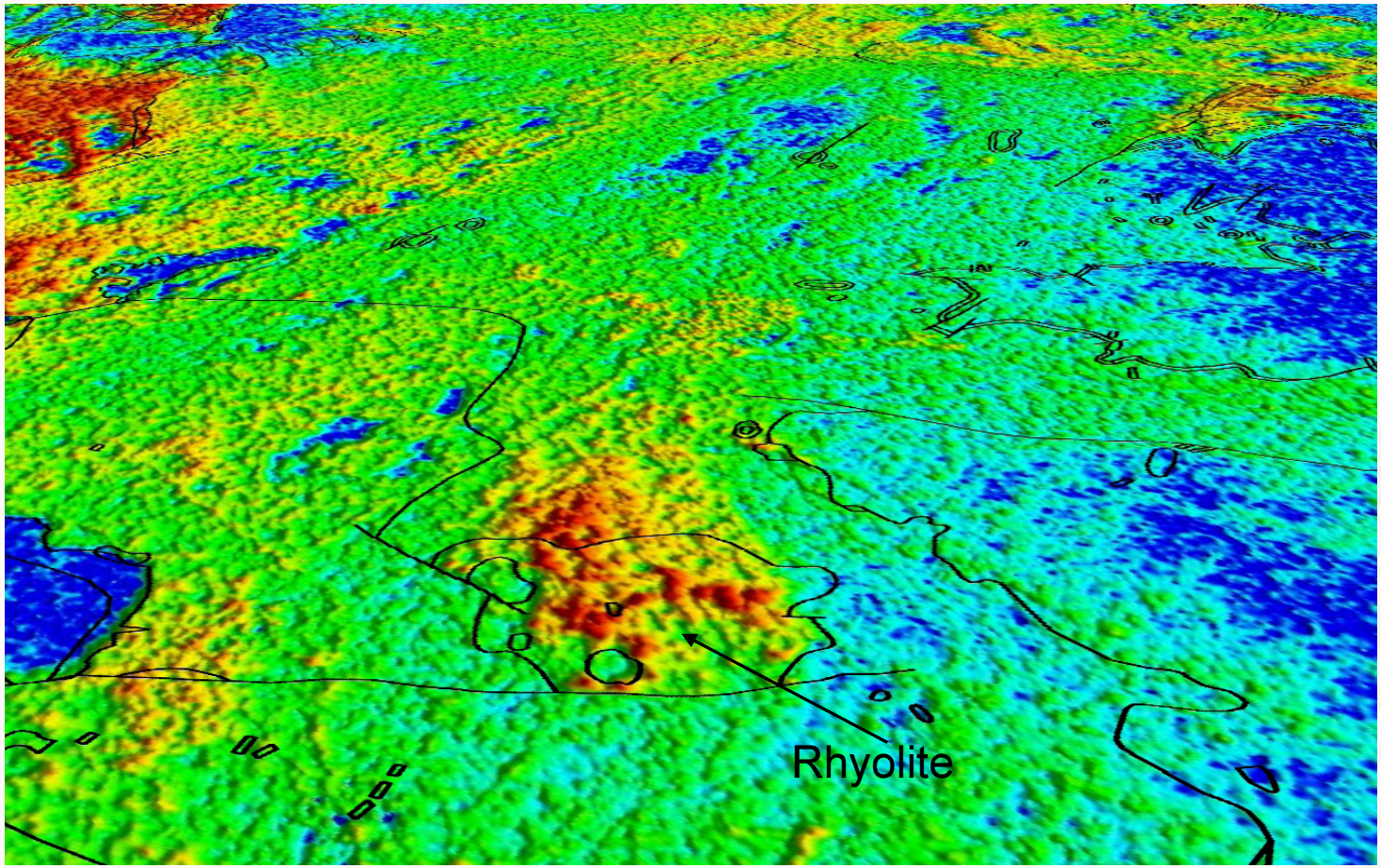
Sperrin Mountains: draped on topography, Looking NE

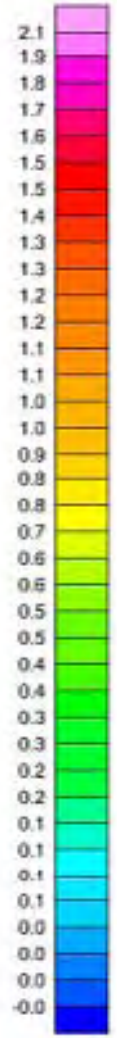
Peat cover

- Visible on radiometric images
- Generally good correspondence with mapped boundaries- but not in all locations
- Improved information on peat would be valuable for a range of end uses



Superficial deposits reflecting ice transport direction





K %

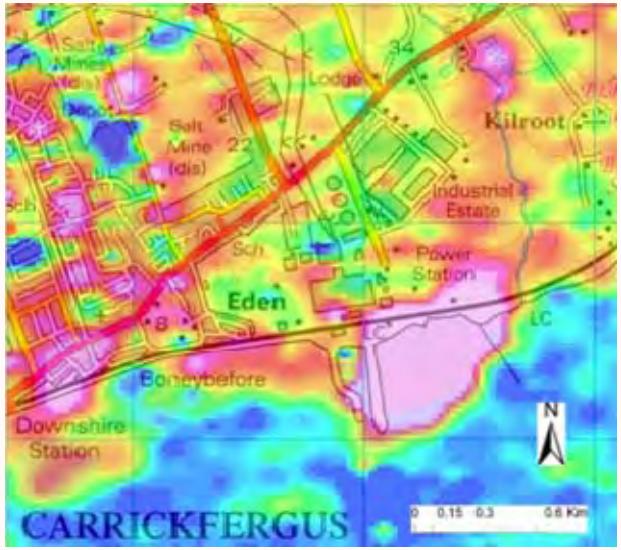
- Looking N over basalts with bedrock geology line-work

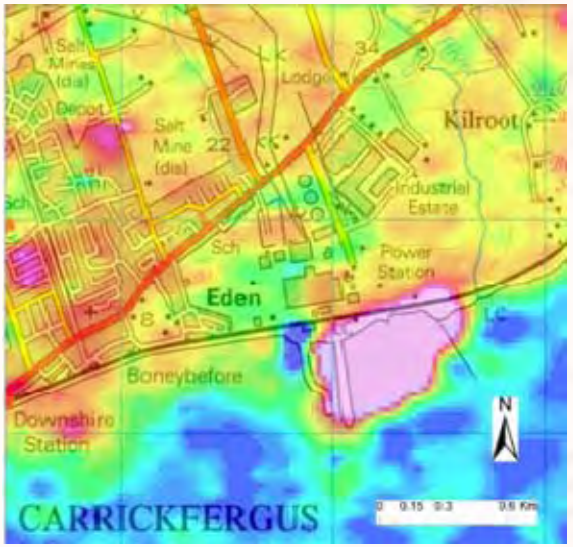
Technological enhancement of natural radioactivity

Total Count

K %

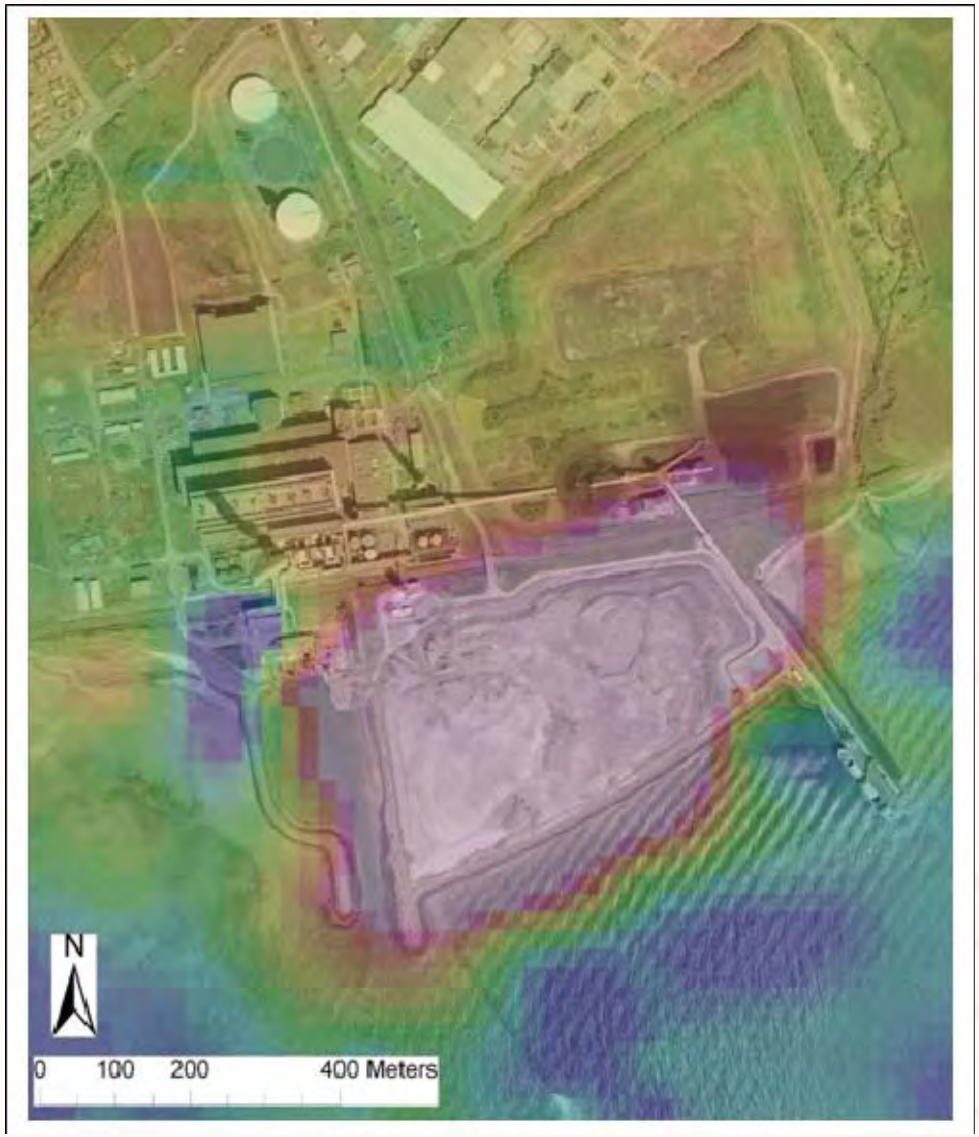
U ppm

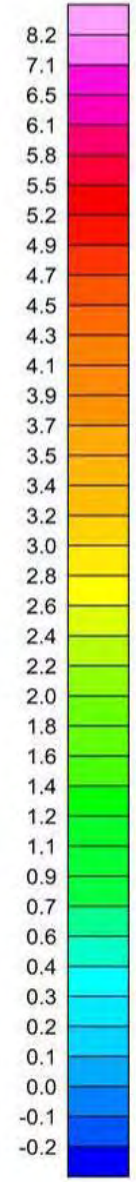




Th ppm

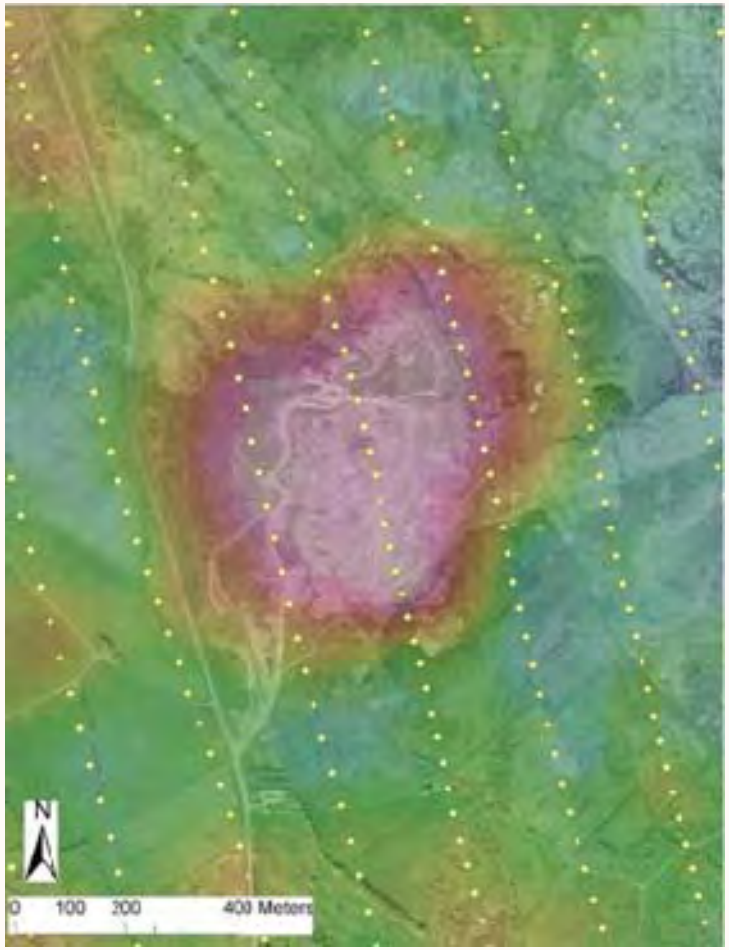
Carrickfergus power station: eTh on air photo

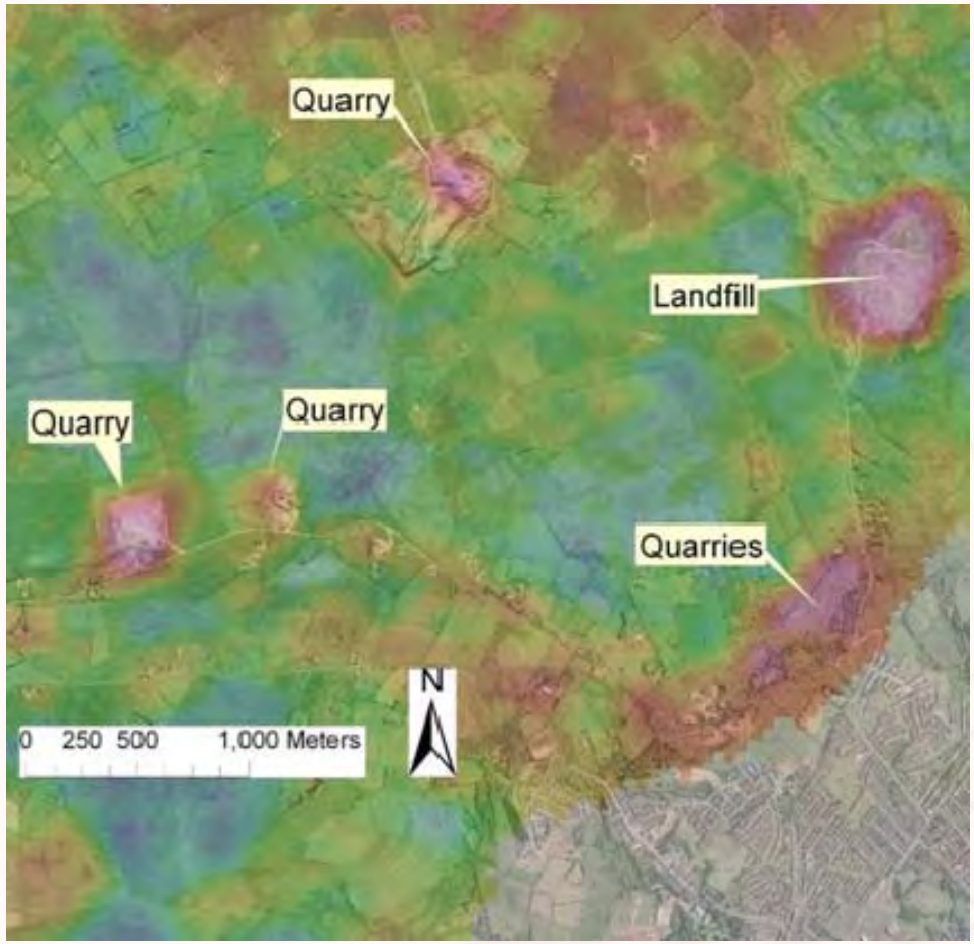




eTh ppm

High Town landfill and area: K % on air photos





Gamma Dose Rate- nGy/h

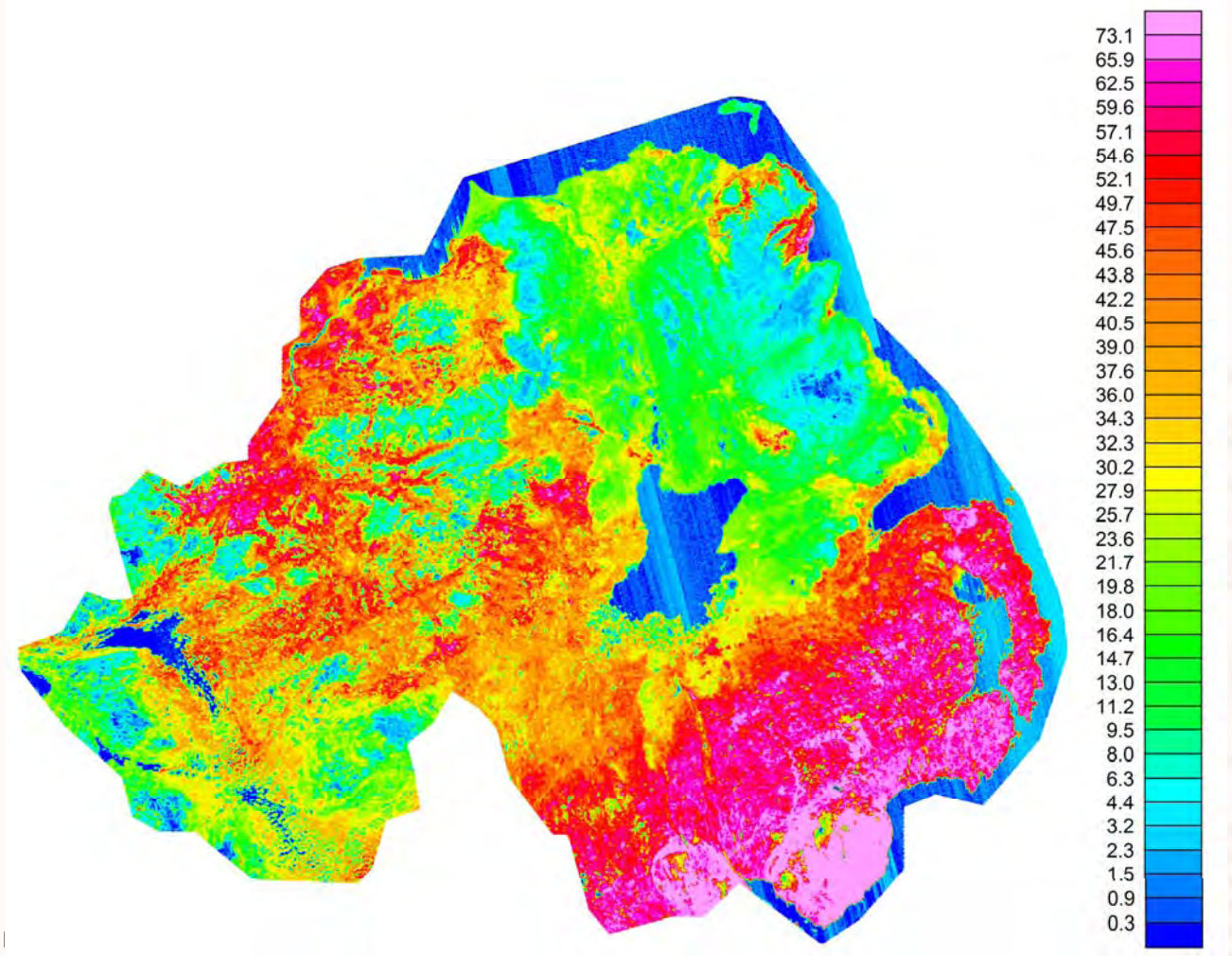
(Absorbed dose rate in air)

Gamma Dose Rate means nGy/h		
1. DOE for NI. 1989	2. NRPB GB survey 1989	**Tellus airborne**
23 (max 103)	34	31 (max 320)

1. Terrestrial Gamma-ray Dose Rates Out Of Doors in Northern Ireland. Department of the Environment of Northern Ireland, Environmental Protection Division Environmental Monitoring Report 2
2. Green, B.M., Lomas, P.R., Bradley, E.J., Wrixon, A.D., 1989. Gamma radiation levels outdoors in Great Britain. NRPB-R-191.

Gamma Dose Rate- nGy/h

- Variation in dose rates reflect the natural variation in the K, U and Th.



Radon Pilot Study

- Probability of houses in Northern Ireland having high indoor radon concentrations is currently estimated on the basis of results of in-house radon measurements, grouped by 5-km grid squares.
- Scope for using K, eU, eTh data and soil geochemical data to predict radon susceptibility.
- Data were compared statistically with the in-house radon measurements to determine the best combination of variables.
- Multivariate linear regression analysis was investigated as an alternative method for predicting indoor radon for areas where few indoor radon measurements are currently available.

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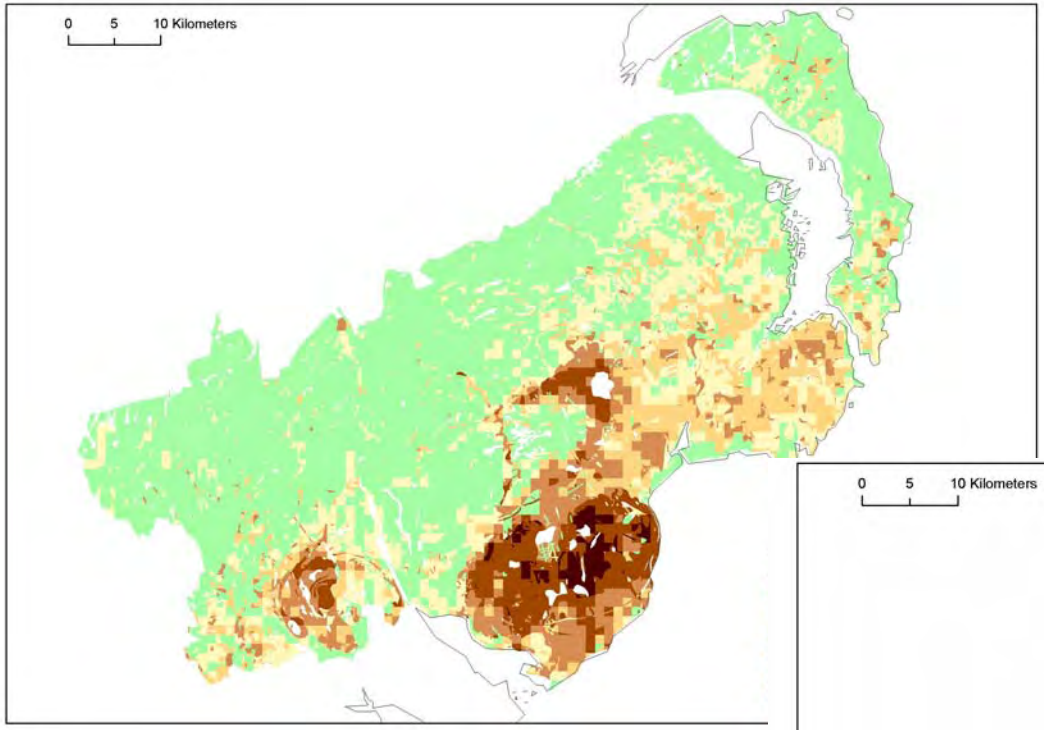
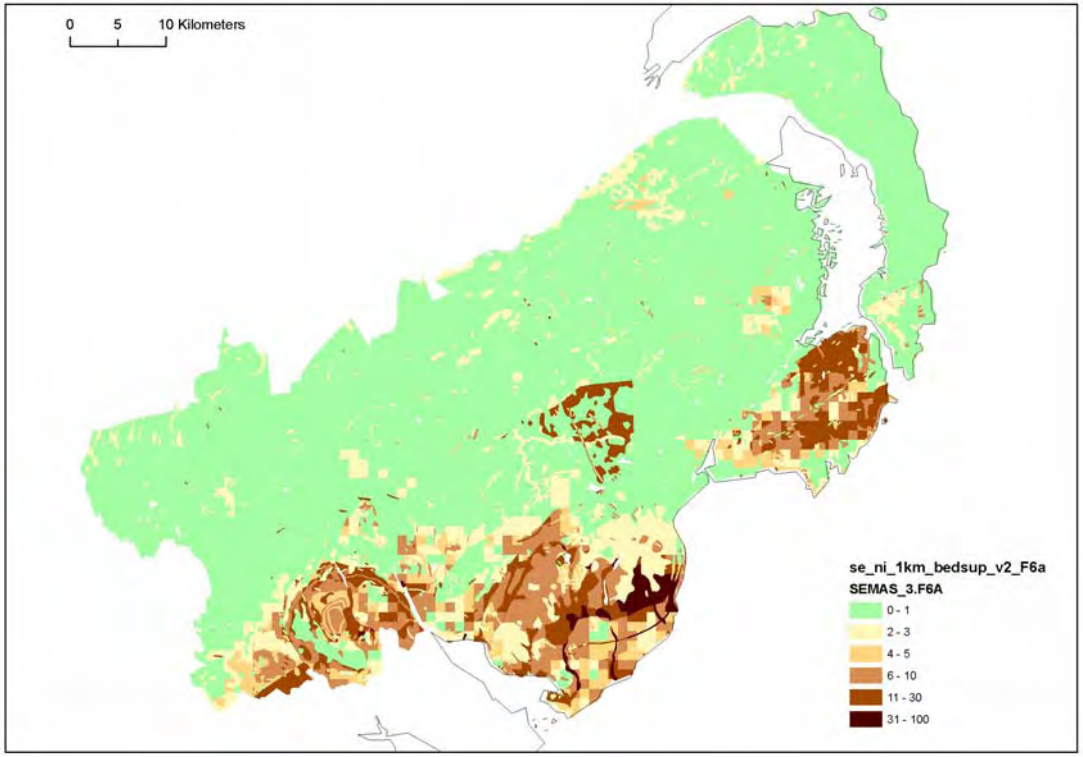


"These maps are provisional radon maps which should not be used in their present form for legislative (e.g. Building Regulations) purposes."

Provisional estimated probability of exceeding the radon Action Level
(Indoor radon measurements)

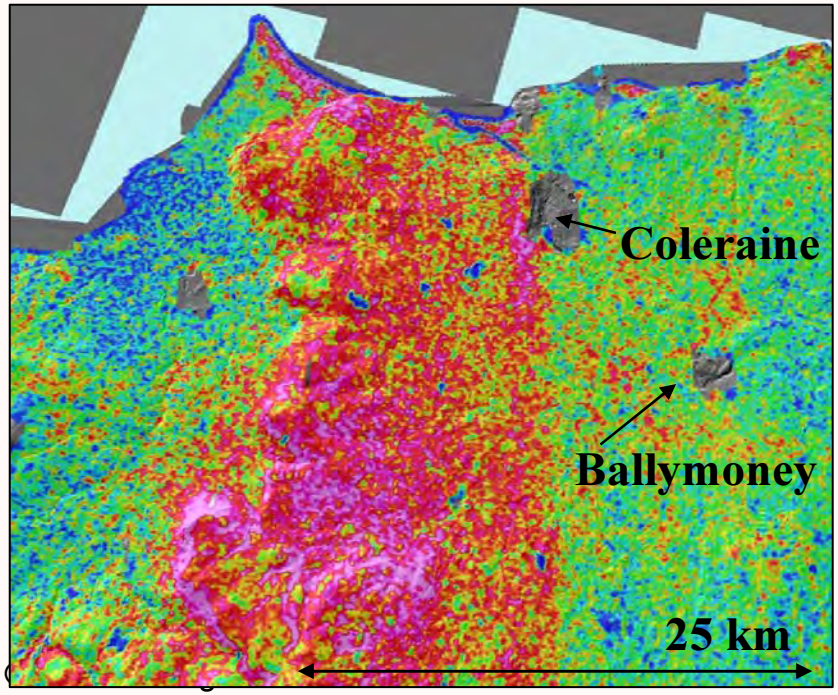


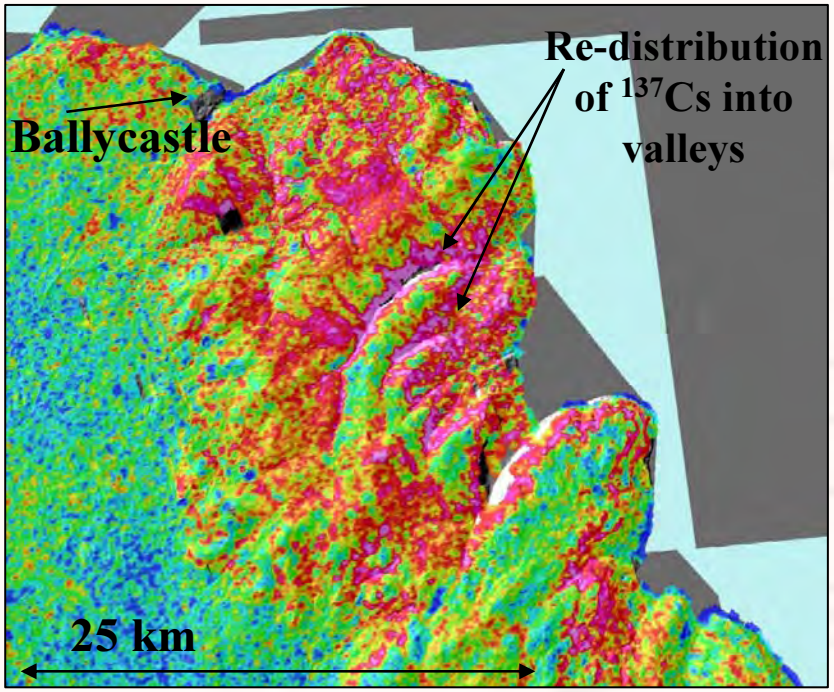
Modelled probability based on airborne eU-eTh-K, ground permeability, and soil Zr, Y, and SiO_2
(Tellus data)

^{137}Cs

- Man-made radionuclide (half-life of 30.17 years)
- Sources: atmospheric weapons testing, authorised discharges & accidental releases
- Chernobyl 1986: Sheep restrictions- lifted in 2000 in NI

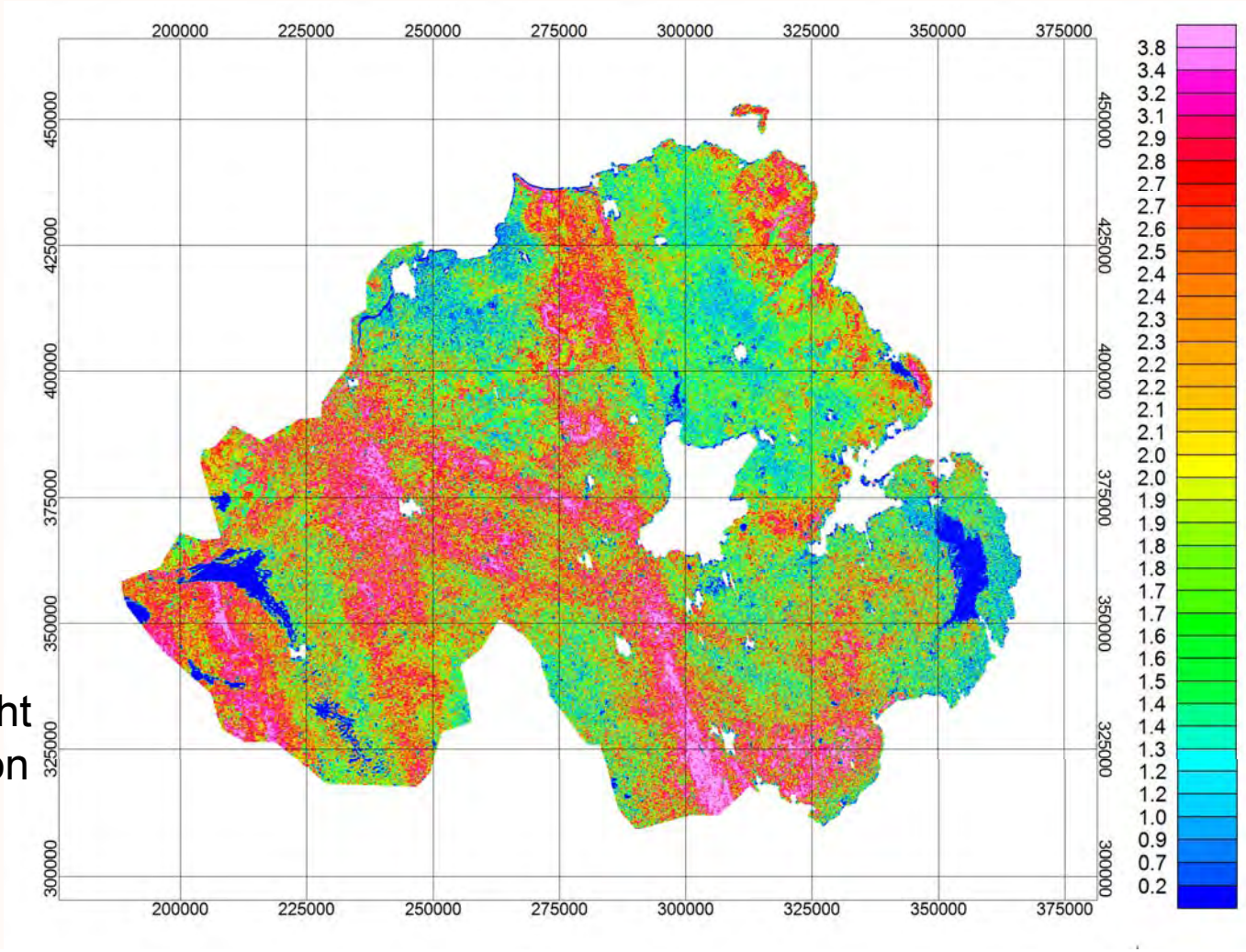
- **^{137}Cs:**
  - Wet deposition dominates (rainfall important)
  - Topographical controls
  - Coastal highs (marine discharges)
  - Post-depositional redistribution into valleys in areas of organic soil





Preliminary ^{137}Cs data

- National scale:
- Reflect rainfall (Chernobyl plume) (Long-term average-weapons testing)
- Processing artefact?
- Independent studies confirmed majority of data
- Highlighted some flight lines affected by radon in air



Conclusions

- Data show clear relationships to bedrock geology, superficial geology and soils.
- Human influence is seen from extractive and power generation industries, and waste disposal.
- Combined with geochemical and permeability data, can be used to help predict radon susceptibility.
- Provides valuable baseline data.
- Combined with other geophysical datasets, can aid mineral exploration, mapping and a wide range of environmental applications.