Tellus Border project: A preview of results from regional geochemical mapping

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Presentation outline

Tellus Border geochemistry programme in Ireland

- Sampling, analyses, data processing
- Readying data for general release

Preview of new topsoil geochemical data

- Data for mineral exploration
- Agricultural applications
- Applied research into environmental geochemistry & health

Next steps

- Applied data for research
- Future data releases
- Making information accessible

Soil sampling on Inishowen Peninsula, Co. Donegal

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Sampling & progress

- Sample types routinely analysed:
  - Topsoil (*c.*5–20 cm depth)
  - Wet sieved stream sediment (<150 µm fraction collected)
  - Stream water (<0.45 µm filtered)
- Also collected & stored:
  - Subsoil (*c.*35–50 cm depth)
  - Panned heavy minerals concentrate
  - Vegetation (twig) samples
- Geochemical analyses *just* complete
- Data QA/QC & conditioning are *underway*
- Mapping & publications *to follow*

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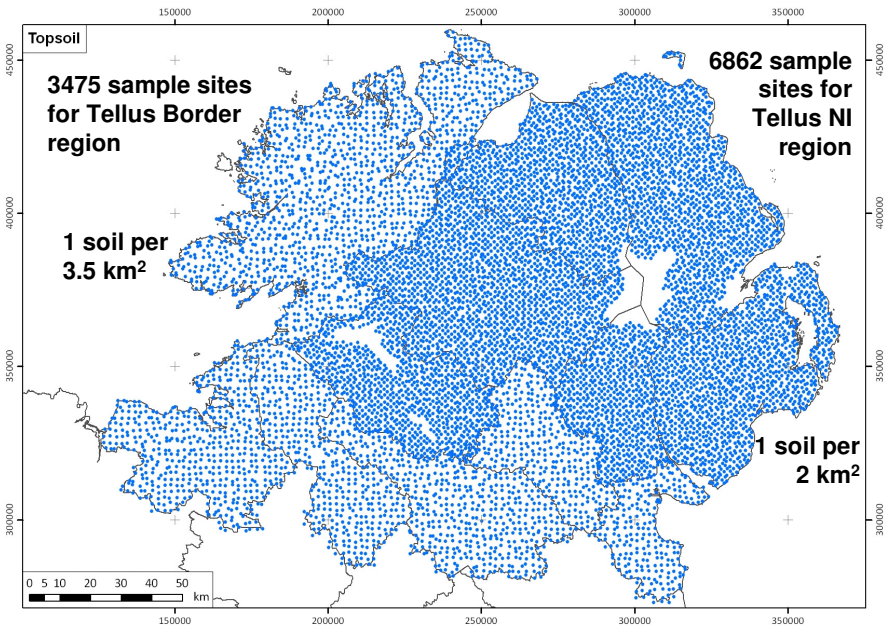
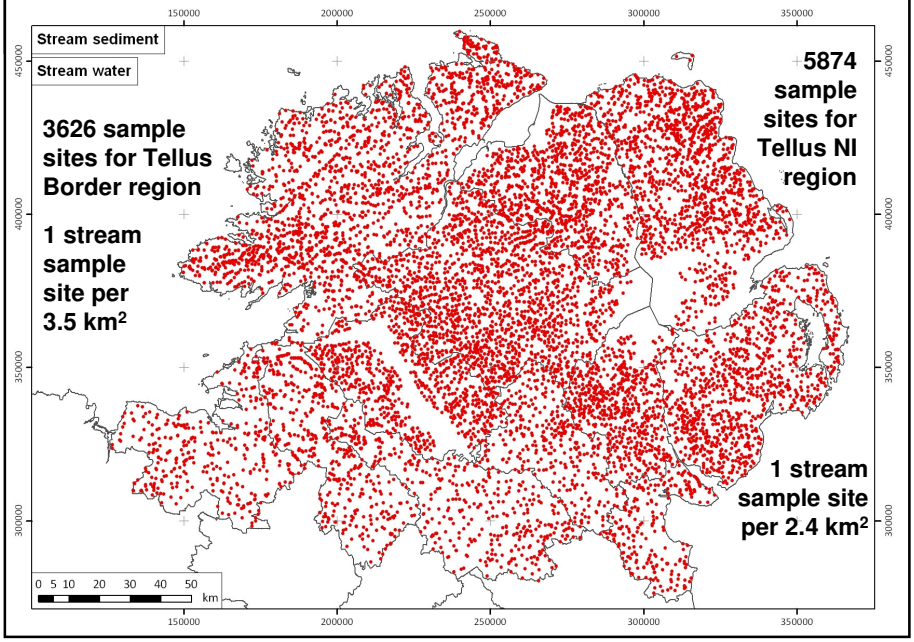
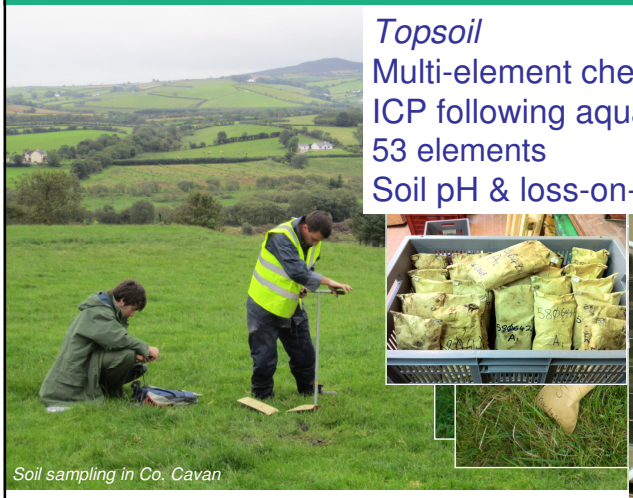
Soil sample locations in NI and RoI



Stream sample locations in NI and RoI



Chemical analyses – what & how


Soil sampling in Co. Cavan

Topsoil

Multi-element chemical analyses:
ICP following aqua regia extraction
53 elements
Soil pH & loss-on-ignition (~ % C)

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Chemical analyses – what & how

Stream sediment sampling in Co. Leitrim

Steam sediment

Multi-element chemical analyses:
XRFS (total concentrations)
53 elements

Stream water

Multi-element chemical analyses:
65 analytes
IC, ICP-MS, NPOC
pH, alkalinity, SEC

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QA/QC & data conditioning - 'fit for purpose'

Receipt of raw data from lab

Create & manage a working database

Error checking & initial validation

Data quality control (QC)
Use of control samples

Time-series analyses plots
ANOVA statistical analyses of data reproducibility
Confidence for spatial mapping & interpretation

Quality assurance (QA)
Accept/reject the batch

Data levelling / conditioning
Calculate the uncertainties and trueness of the results
Apply a conditioning factor to each analyte as appropriate

Preliminary mapping – first steps!

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Baseline data: scales & applications

Key applications of baseline geochemical datasets

- Agricultural productivity e.g. understanding trace element deficiencies and excesses, improved land management
- Animal health
- Ecological assessments & sensitive habitats
- Economic geology – mineral exploration & locating enrichment zones
- Mining waste – dealing with mining/spoil legacy issues
- Human health & medical geology
- Underpinning research e.g. radon gas prediction models

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Complimentary environmental geochemical datasets

Small scale:

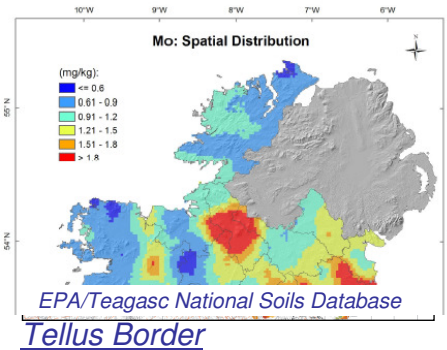
- Many small-scale, targeted mineral exploration surveys
- Contaminated land investigations – urban, site specific
- Farm / field soil surveys

National-scale:

- National Soil Database

European-scale

- FOREGS, GEMAS



EPA/Teagasc National Soils Database

Tellus Border

- Places local surveys into context
- Regional enough to give "big picture" with respect to geological controls

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Agricultural applications

Evidence for trace element issues in Irish agricultural soils

Support research & applications: Teagasc, IFA, agri consultancies, vets, *etc* to learn more…

Data availability & communication

Micronutrients on the agenda

- Copper deficiency (cattle and sheep)
- Cobalt deficiency (cattle and sheep)
- Selenium – optimum for development (cattle and horses)
- Molybdenum toxicity (cattle)
- Cu-Mo-Se-(S) complexing & affects to livestock esp. sheep
- Manganese deficiency (cereals)

- Productivity pressures
- Application of minerals/feed enhancers

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Baseline data: scales & applications

Revealing the chemical make-up of the near-surface environment

- Defining a baseline – quantifying what's typical, "normal" & "natural"
- Geogenic (*i.e.* geological) sources
- Key geochemical processes and controls on element mobility
- Comparing sample media – chemical distribution through rock-soil-sediments-water
- How we define anomalies (both highs & lows) & map spatial trends

Copper (Cu)	
Percentile	(mg kg^{-1})
99–100	120– >1200
95–99	80.4–120
90–95	62.0–80.4
75–90	39.0–62.0
50–75	25.0–39.0
25–50	12.4–25.0
15–25	7.0–12.4
10–15	5.2–7.0
5–10	3.6–5.2
0–5	<0.5–3.6

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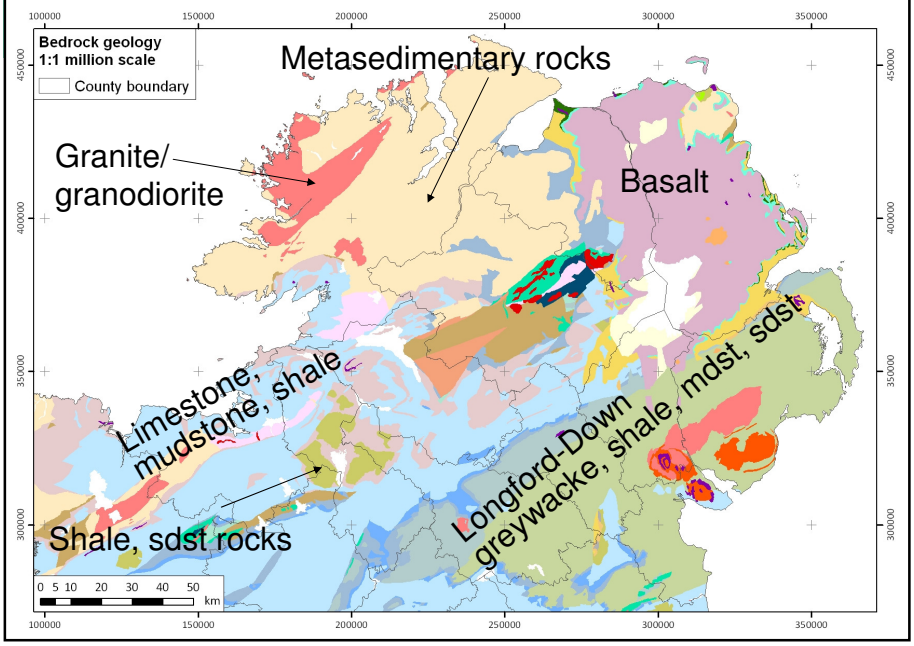
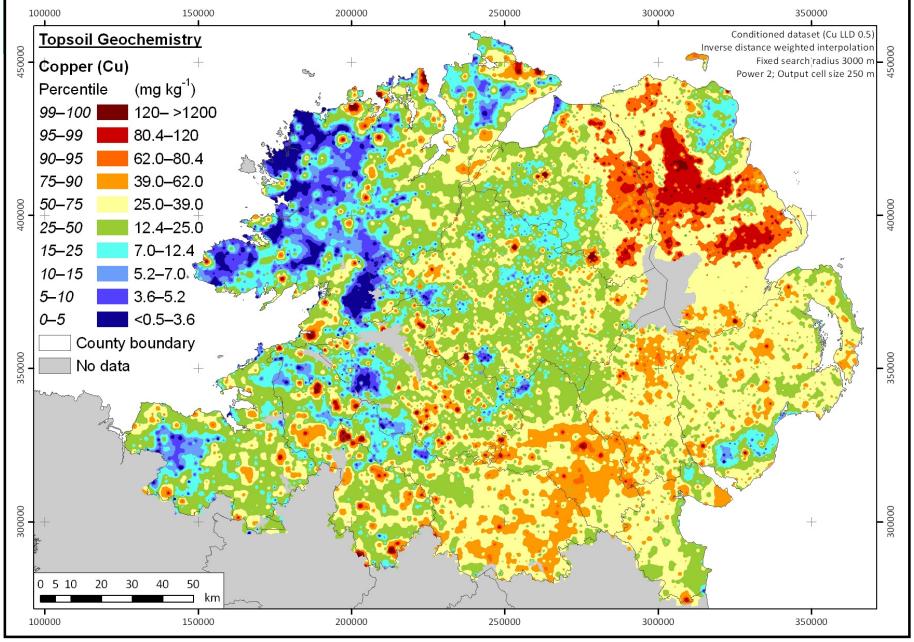
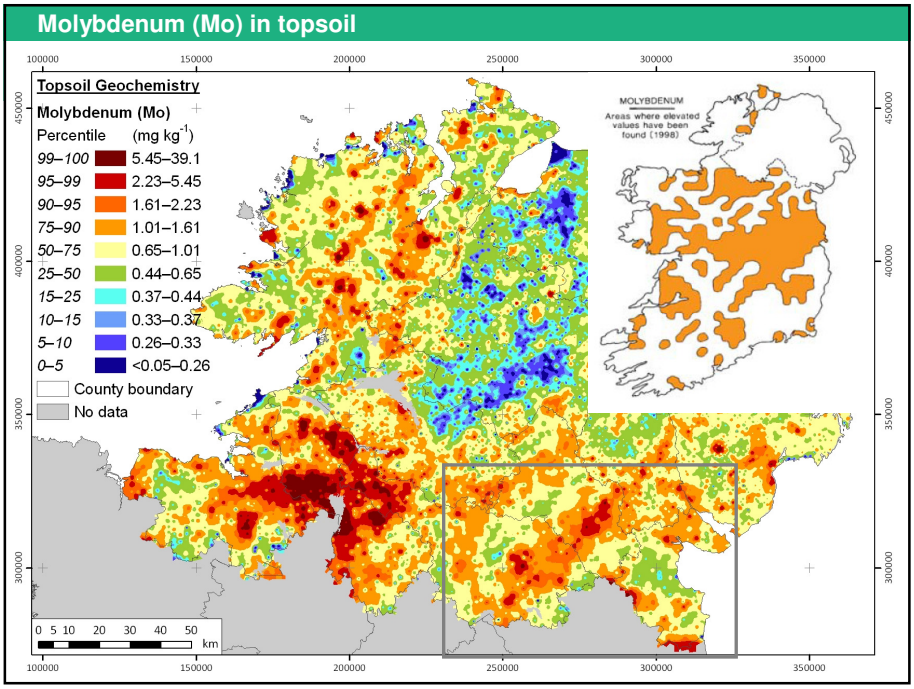
Simplified bedrock geology of the northern region of Ireland (1:1 million scale)



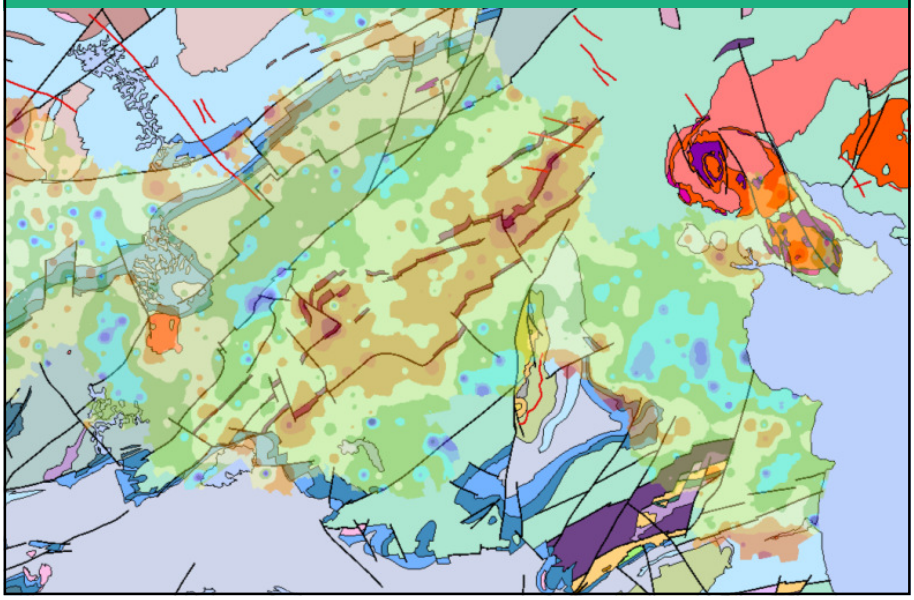
Copper (Cu) in topsoil



Molybdenum (Mo) in topsoil



Shales: Mo sources



Geochemical data for mineral exploration

More analyses for
Au Pt Pd
(*later in 2013*)

Base metals
Pb Zn Cu

Rare earth elements

Precious pathfinders
As Sb Bi
U Mo Cu Ni

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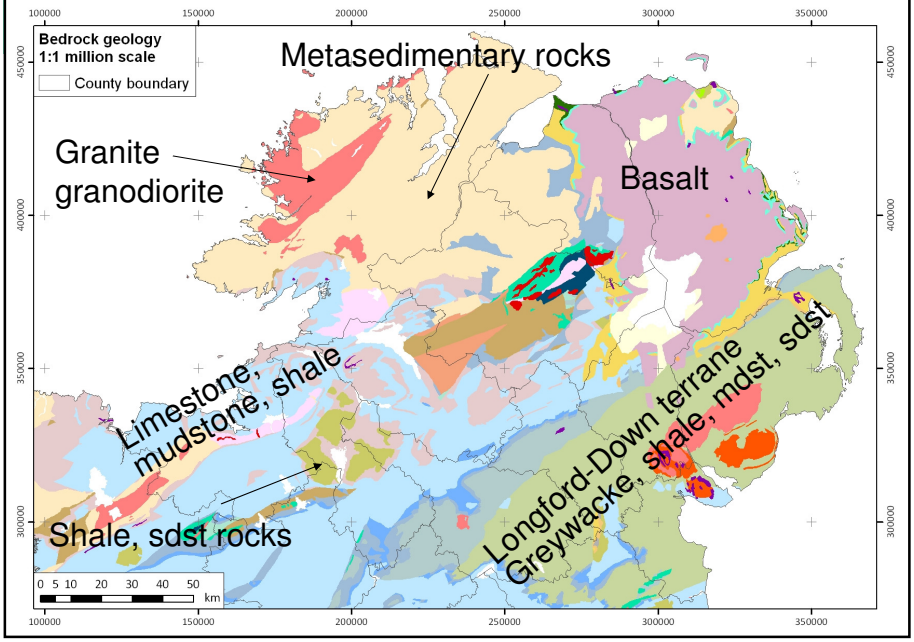
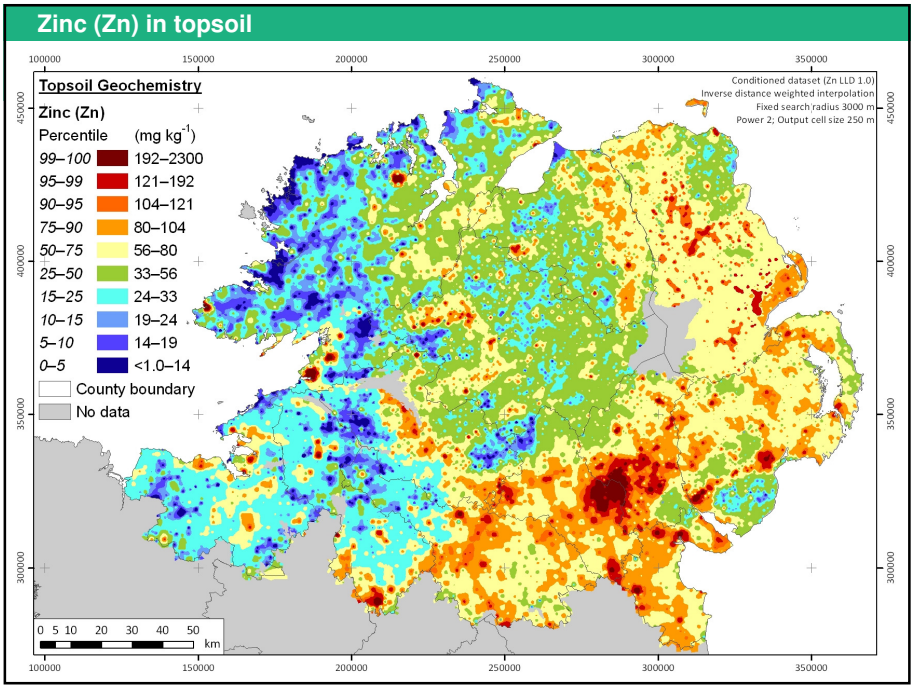
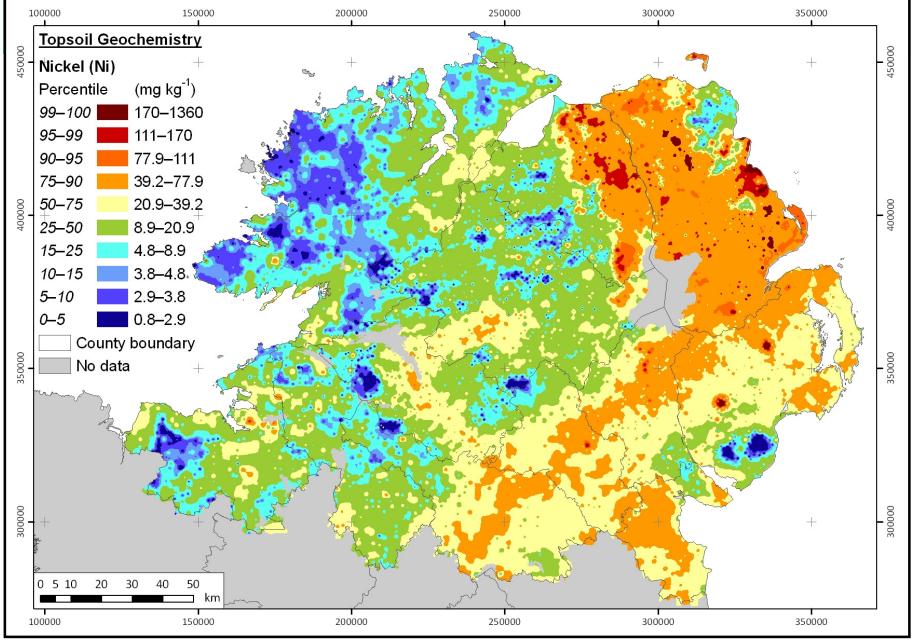


Zinc (Zn) in topsoil



Nickel (Ni) in topsoil



Applied research: environment & health

External collaborators, research proposals?

- Trace element deficiencies in livestock/cereals
- Fluoride and fluorosis – dental health and drinking water
- Arsenic in the environment
- Uranium in drinking waters
- Potentially harmful elements in soils
- Lithium & human health

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Summary & upcoming milestones

Identifying areas for data application & research
Tangible economic benefits to the Irish economy

- Strong geogenic controls for many elements in soil, sediment and water
- Elevated regional baseline over mineralised lithologies – known & suspected
- Evidence from NI that stream sediment signatures often better define smaller/limited spatial anomalies than soil dataset
- Underpin further research

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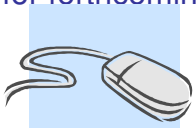
Free data – coming soon

- Data shall be free and openly available via www.tellusborder.eu
- Please register your interest for forthcoming data releases

Online data viewer



Available today…

- Explore new topsoils data for the Tellus Border survey area
- Compare with the bedrock geology
- Investigate trends across the different chemical elements

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www.tellusborder.eu

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Questions?

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Geological Survey of Northern Ireland

GSI
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