Regional Geochemical Mapping in the Caledonides of southeast Ireland

Patrick O'Connor & Vincent Gallagher

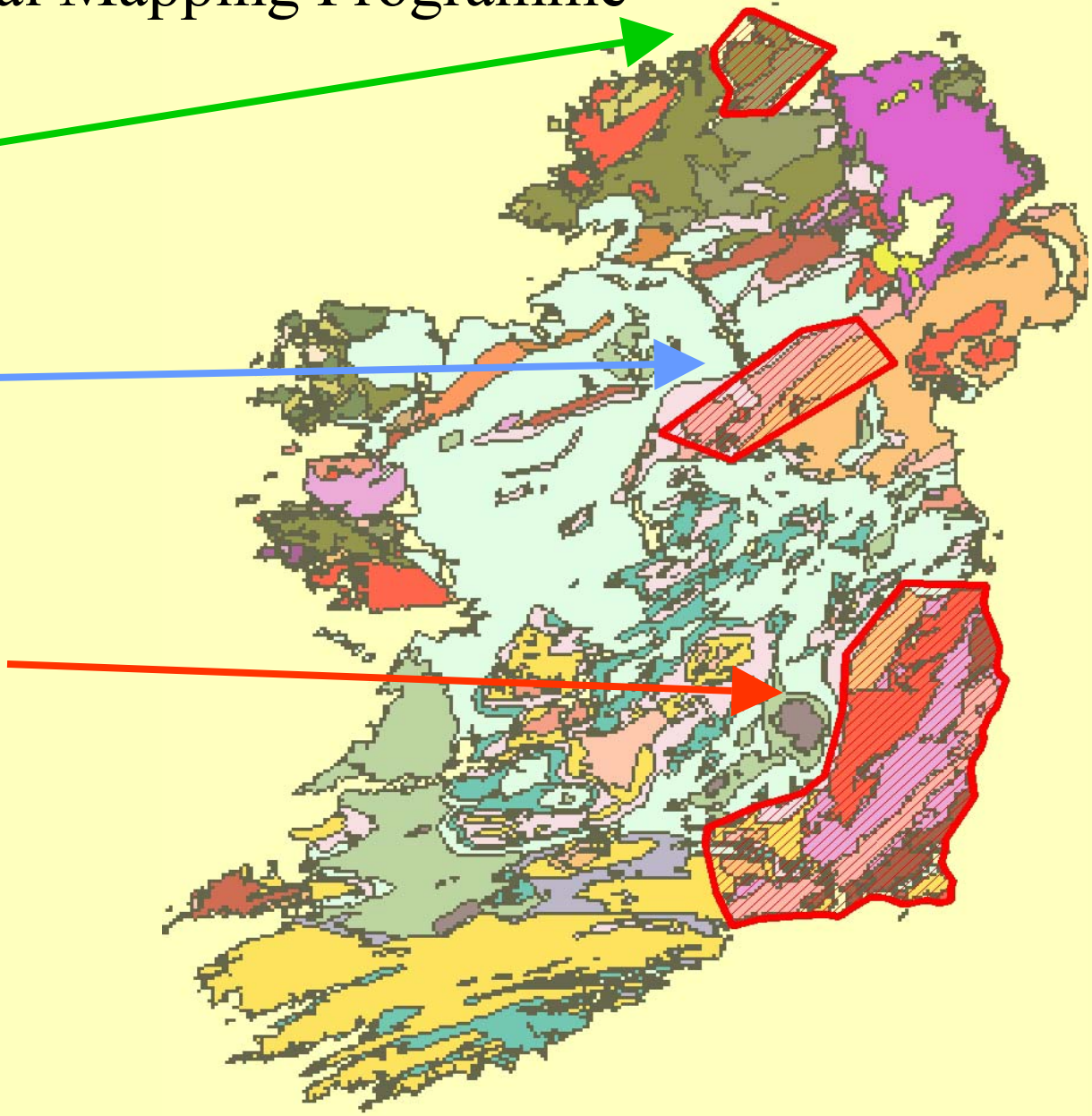
Geological Survey of Ireland

GSI Regional Geochemical Mapping Programme

Inishowen 1985
- 200 stream sediments

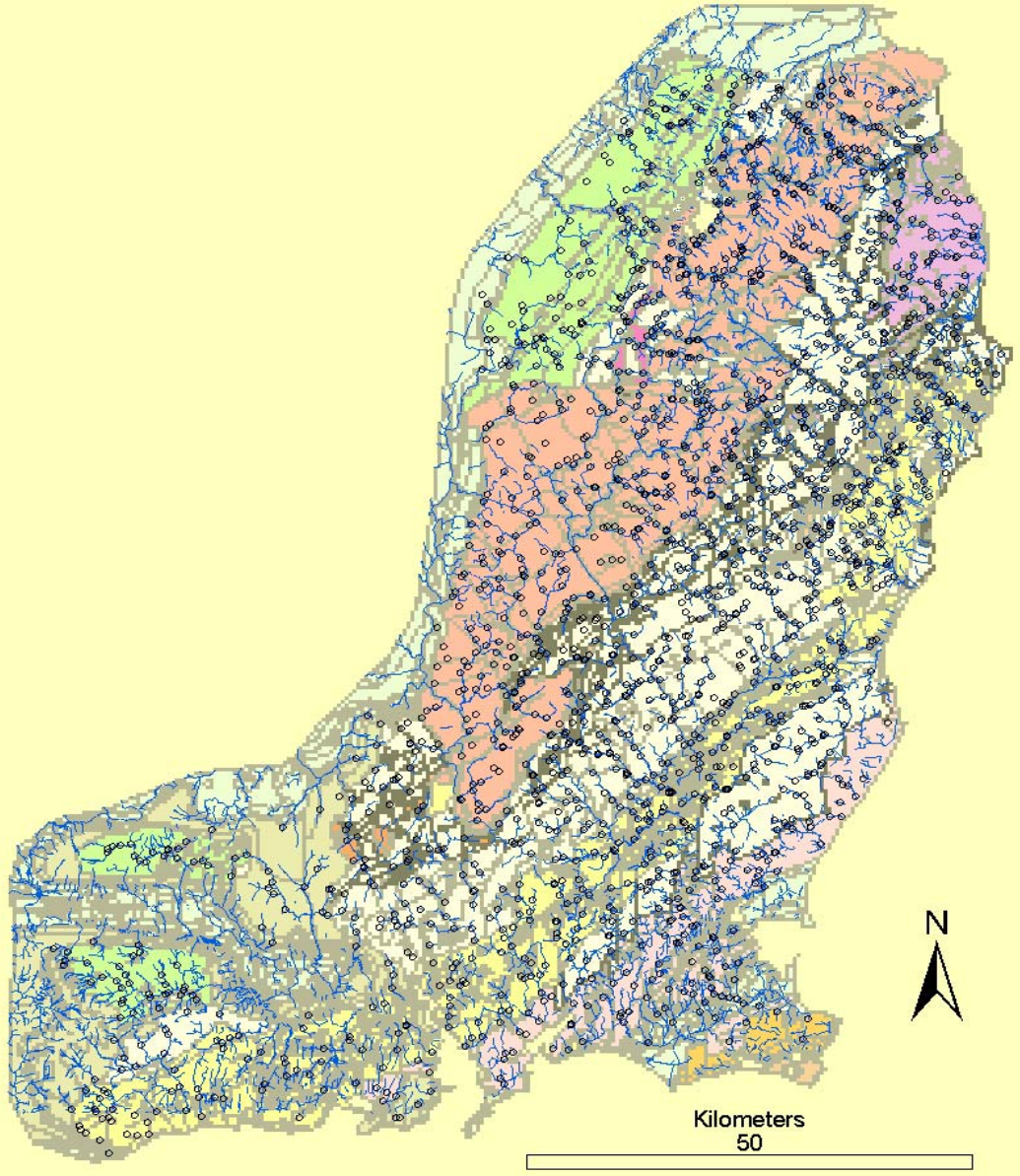
Longford-Down 1984/91
- 386 stream sediments

Southeast Ireland 1973-93
- 1884 stream sediments
- 517 rocks



Southeast Ireland: Drainage & stream sediment sample sites

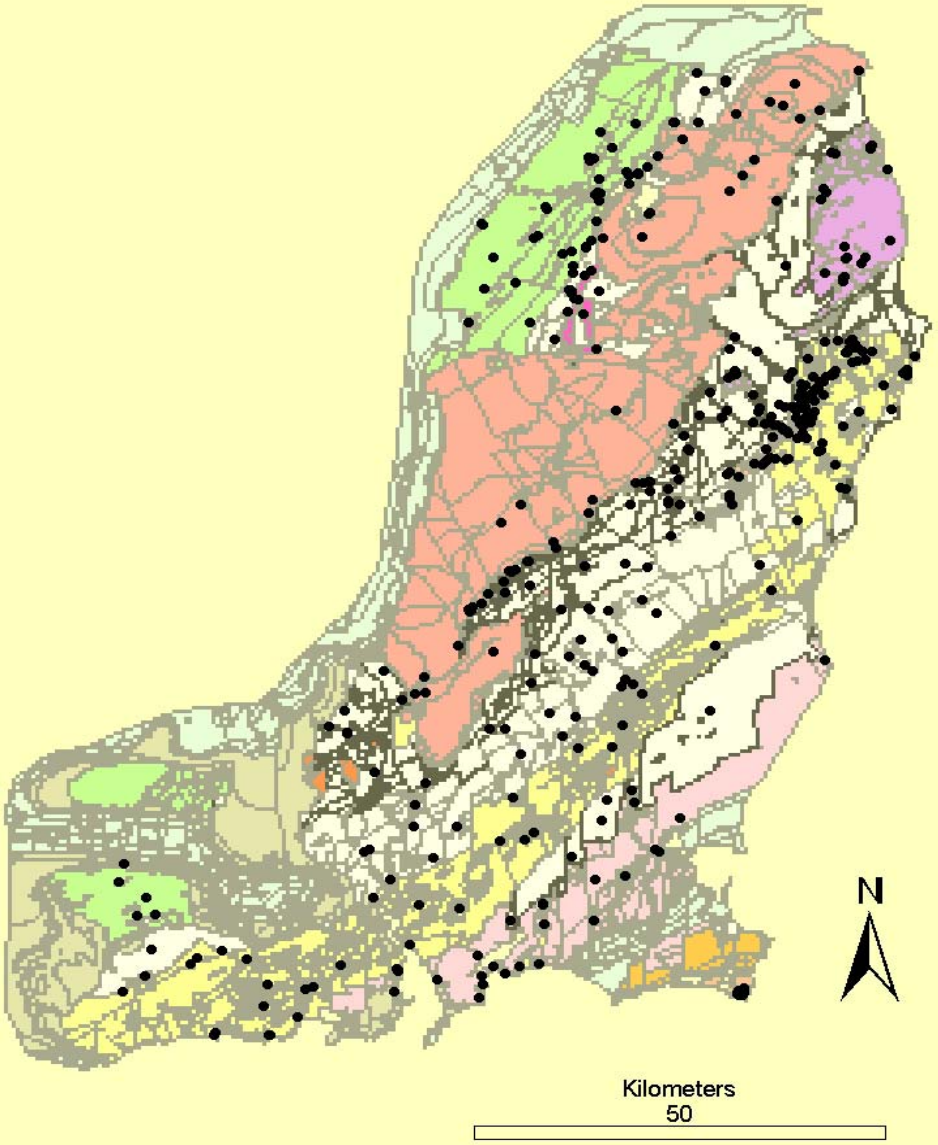
- 1884 locations
- 2200 samples incl. replicates
- Total area of 6000 km^2
- First/second order streams
- < 150 μm fraction collected



Lithogeochemistry
517 samples

1. Igneous suites (1973-1989), including:
- Granites (40)
- Dolerites (37)
- Avoca district (89)
- Lr. Pal. Volcanics (36)
- Diorites (13)
- Appinites (10)
- Li pegmatites (22)

2. Sedimentary rocks (1993):
- 238 samples
- Most major formations



Geochemical Analysis – 35 elements

1. INAA

Bondar Clegg, Canada

- Na, Rb, Cs, Ba, Ta
- As, Mo, Ag, Sn, Sb, Te, W, Au
- Zr, Hf
- U, Th
- Sc, La, Ce, Sm, Eu, Tb, Yb, Lu

2. AAS

Mercury Analytical, Ireland

- Cu, Pb, Zn, Fe, Mn
- Li, Co, Cr, Ni, V

Standard BL4, batches 15-45, n = 21					
	Cu	Pb	Zn	Fe	Li
χ	68.1	366	87.8	5.13	12.5
δ	6.88	22.5	7.44	0.25	0.87
δ %	10.1	6.1	8.5	4.9	7.0

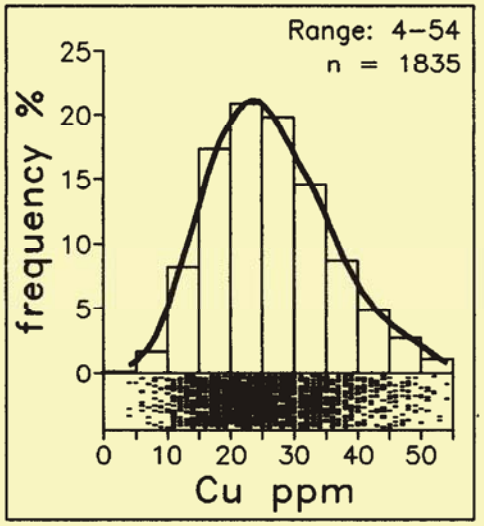
Quality control

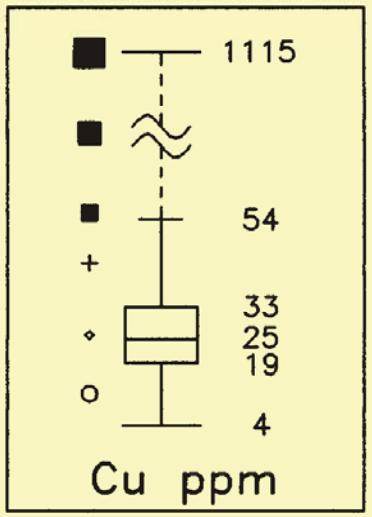
1. Samples in batches of 20 – batch analysis
2. GSI stream sediment standard in every batch
3. Analytical lab standards SO1, BL4
4. Field replicate (stream sediments) in each batch
5. Laboratory duplicate in each batch

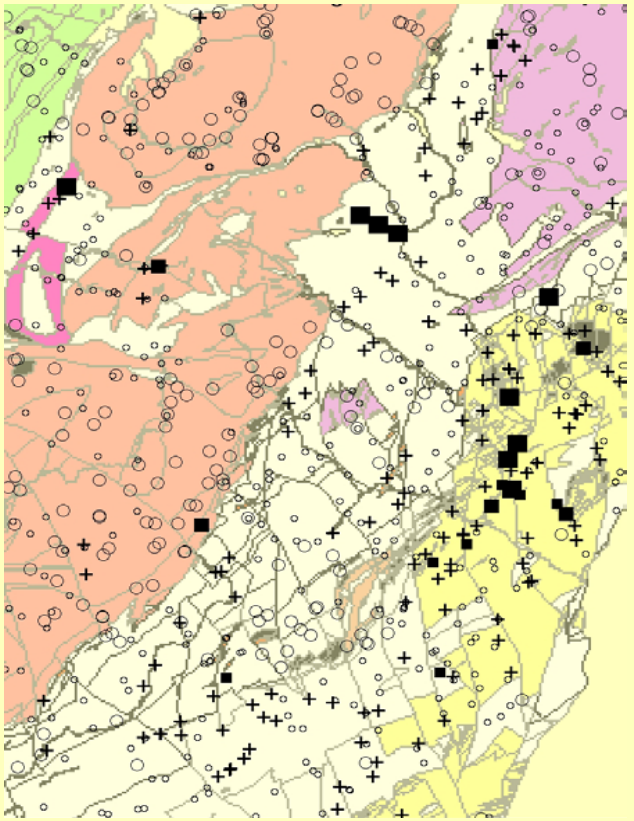
Stream sediments: Data Analysis and Mapping

Exploratory Data Analysis (EDA) (Tukey 1977)

- Resistant, robust statistics
- Especially suited for "soft" data with many inconsistencies
- Non-parametric – no assumptions about data behaviour
- Outlier definition and class selection that uncover inherent data structures







Geology

Precambrian Rosslare Complex
- Basement of uncertain age/provenance
- Ortho- and paragneiss cut by dolerite dykes

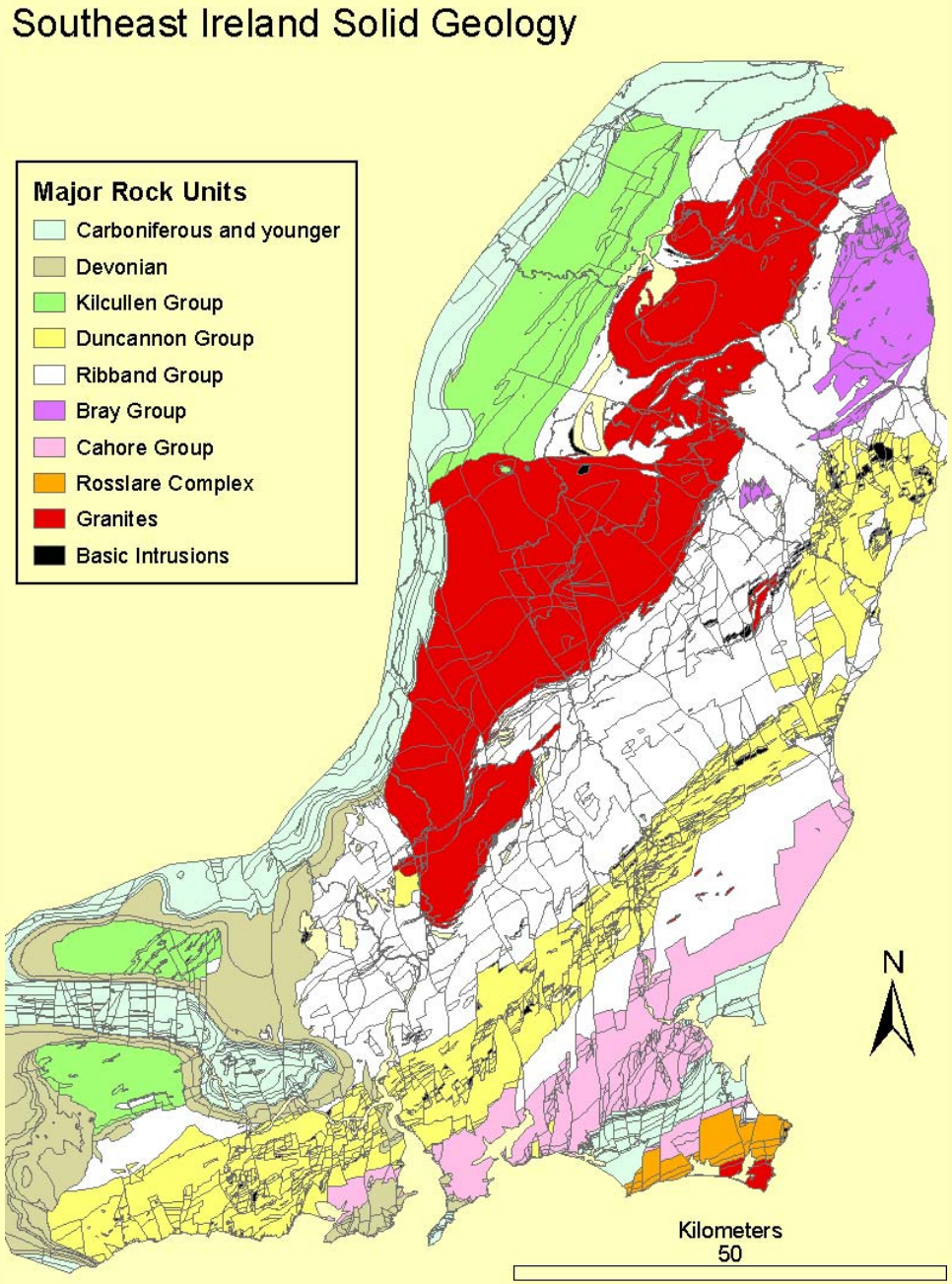
Cambrian Bray and Cahore Groups
- Turbiditic greywackes and mudstones
- Massive sandstone units (quartzites)

Cambrian – Lr. Ordovician Ribband Group
- Deepwater mudstones, minor sandstones

Ur. Ordovician Duncannon Group
- Mainly rhyolites and rhyolitic tuffs
- Andesitic lavas and tuffs

Silurian Kilcullen Group
- Turbiditic greywackes

Caledonian Intrusions
- Croghan Kinshelagh granite: 464 Ma
- Carnsore Granite: 430 Ma
- Carrigmore Diorite: 410 Ma
- Leinster Granite: 405 Ma

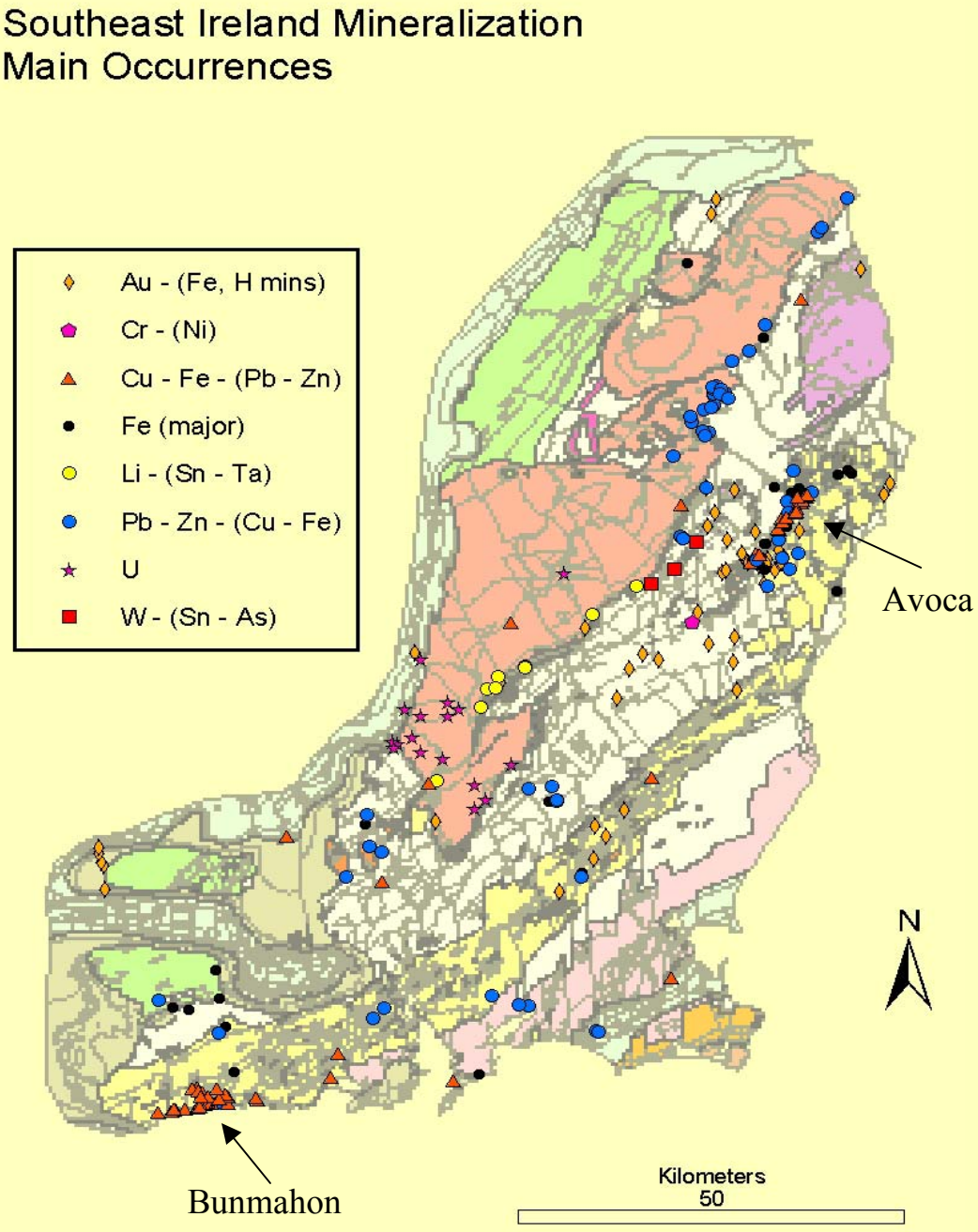


1. Duncannon Group volcanic rocks:
- Avoca: stratabound Cu-Fe-(Pb-Zn)
- Bunmahon: vein-hosted Cu
- Minor Pb-Zn, Au

2. Leinster Granite:
- Pb-Zn in quartz veins at margin
- Li pegmatites
- Secondary U

3. Microtonalites:
- W (scheelite) in quartz veins

4. Ribband Group
- Au with arsenopyrite in quartz veins in shear zones
- Pb-Zn in veins

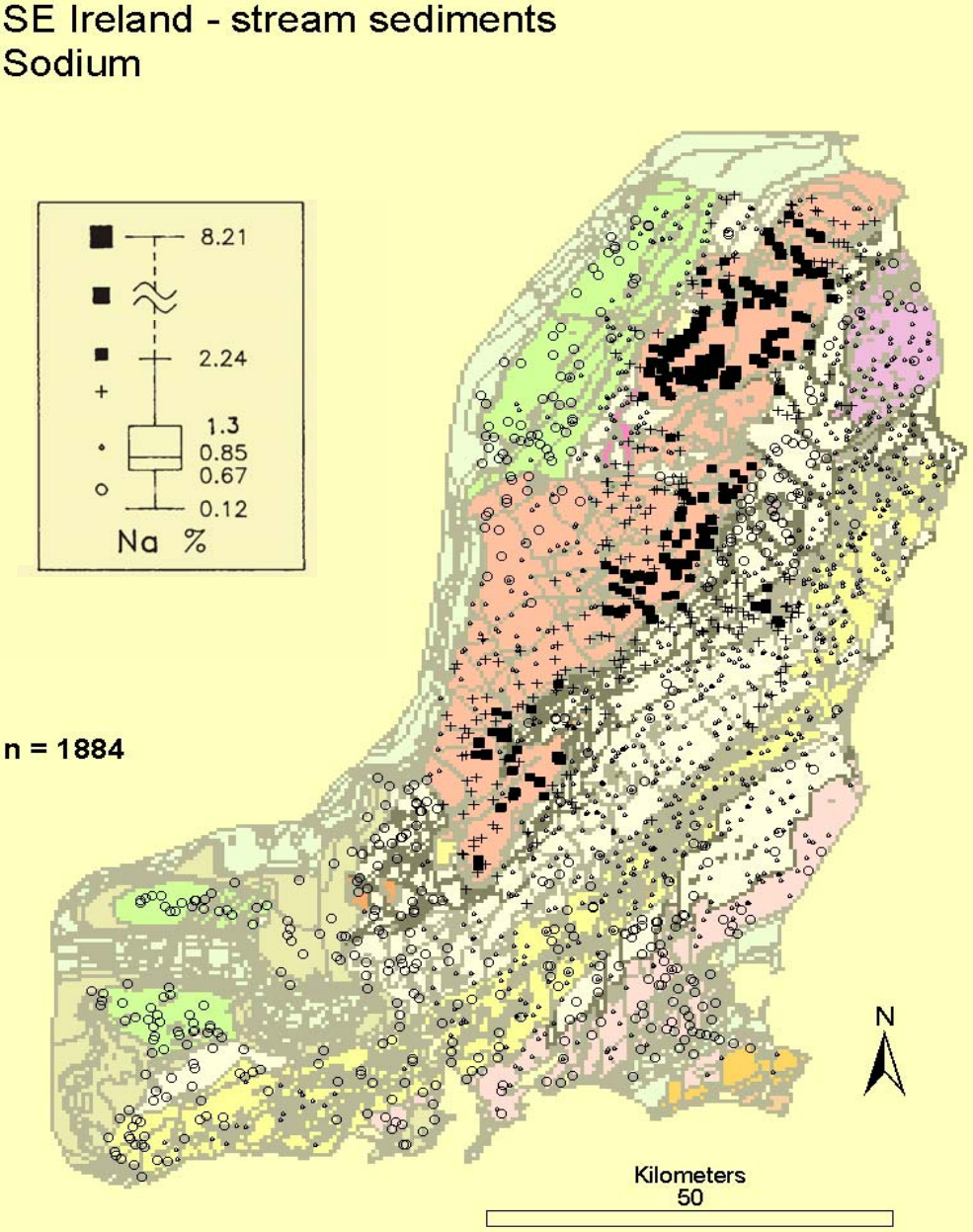


Stream sediments v. Geology
e.g. Na

1. Leinster Granite / Ribband Group
- Granite high Na, Ribband Group moderate
- Sharp boundary control

2. Bray, Cahore, Kilcullen Groups
- High "sandstone" content
- Low Na, good boundary control

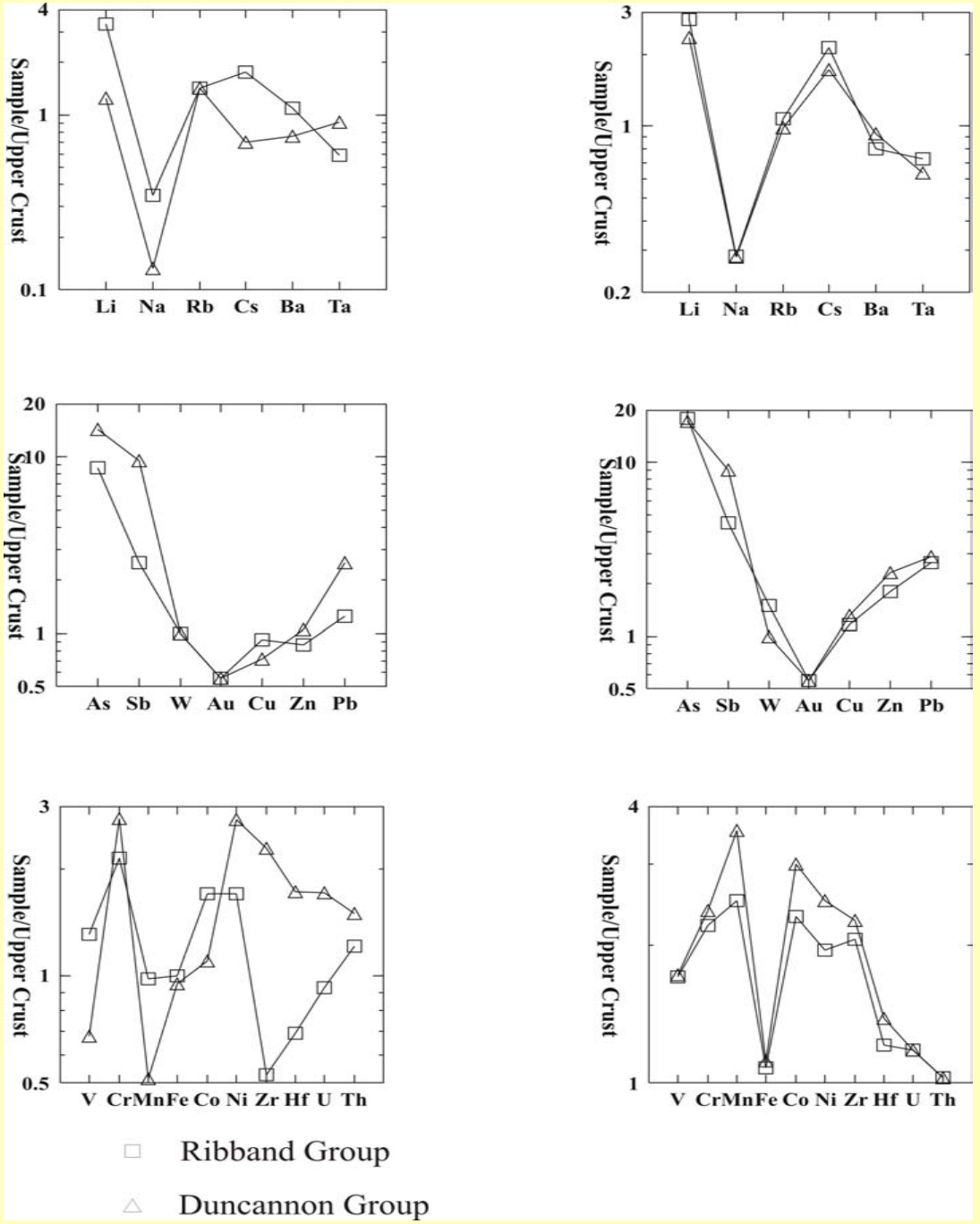
3. Duncannon / Ribband Groups
- Within-group variation in Na



Stream sediments v. Rocks

1. Strong coherence between rock and stream sediment data

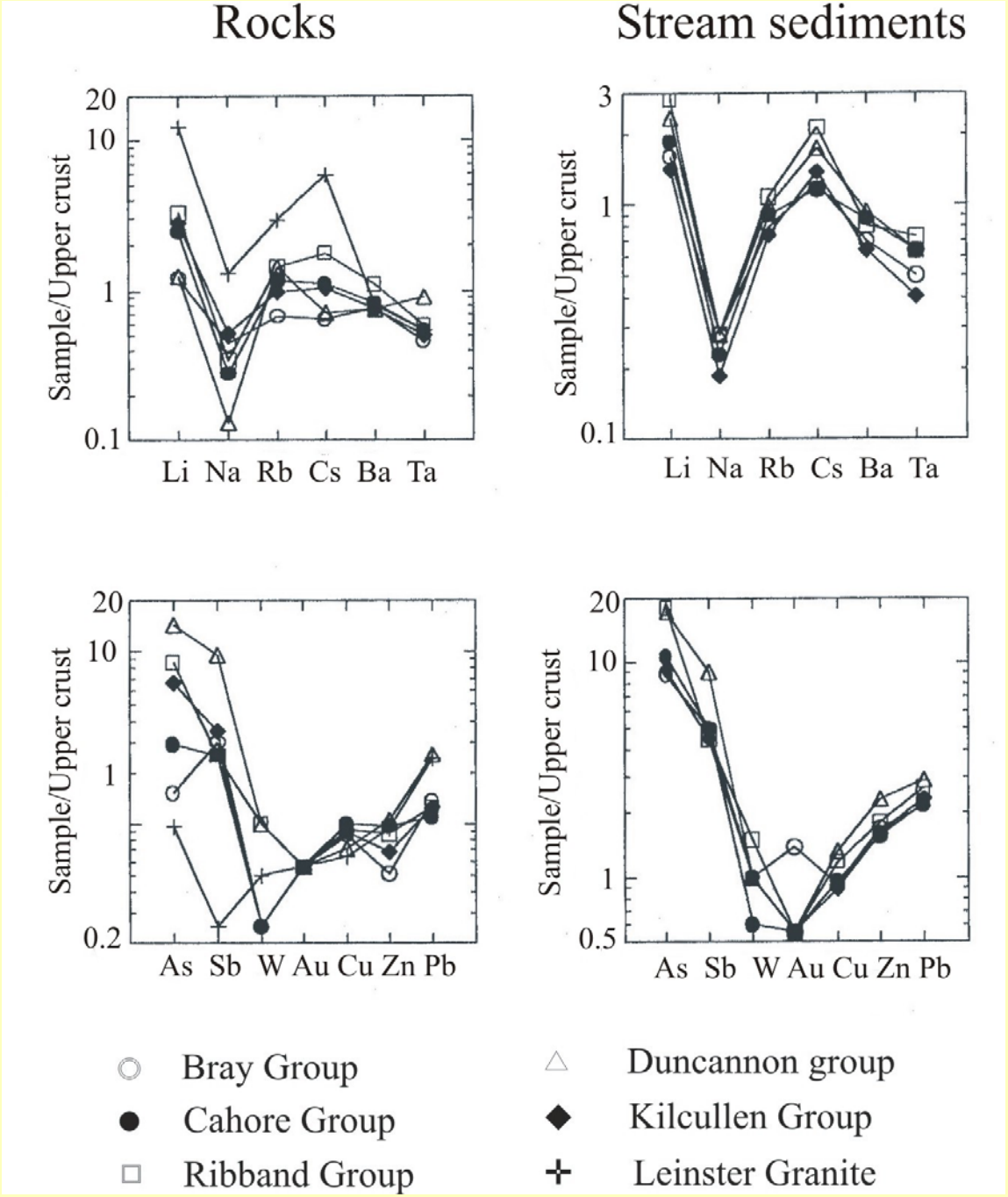
2. Implies that stream sediment data provide accurate overview of chemical composition of upper crust in SE Ireland



SE Ireland – Crustal chemistry

When compared to the average composition of the upper crust, most rock units in SE Ireland are:

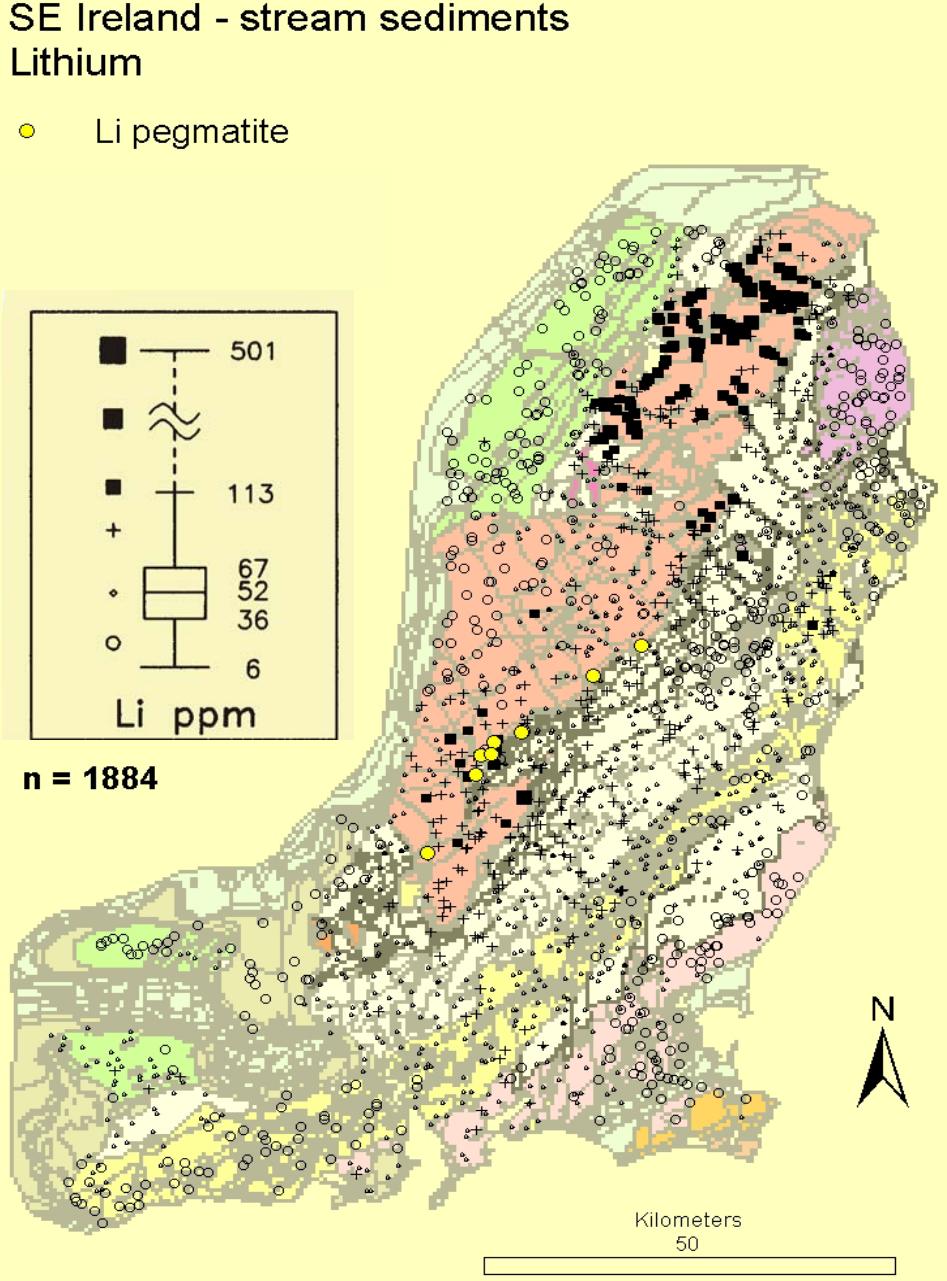
1. Enriched in Li, As, Sb
2. Depleted in Na (except Leinster Granite)
3. Poss depleted in W, Au, Cu



Controls on mineralization 1:
Li: Granite v. Country rock source?

1. Stream sediments
- Li pegmatities within or close to Leinster Granite
- Li anomalies mainly within Granite
- Many sedimentary units have low Li

2. Rocks
- Leinster Granite: 85 – 2124 ppm Li, median 247 ppm (av. crust 50 ppm)
- Most other rock units close to or below crustal average



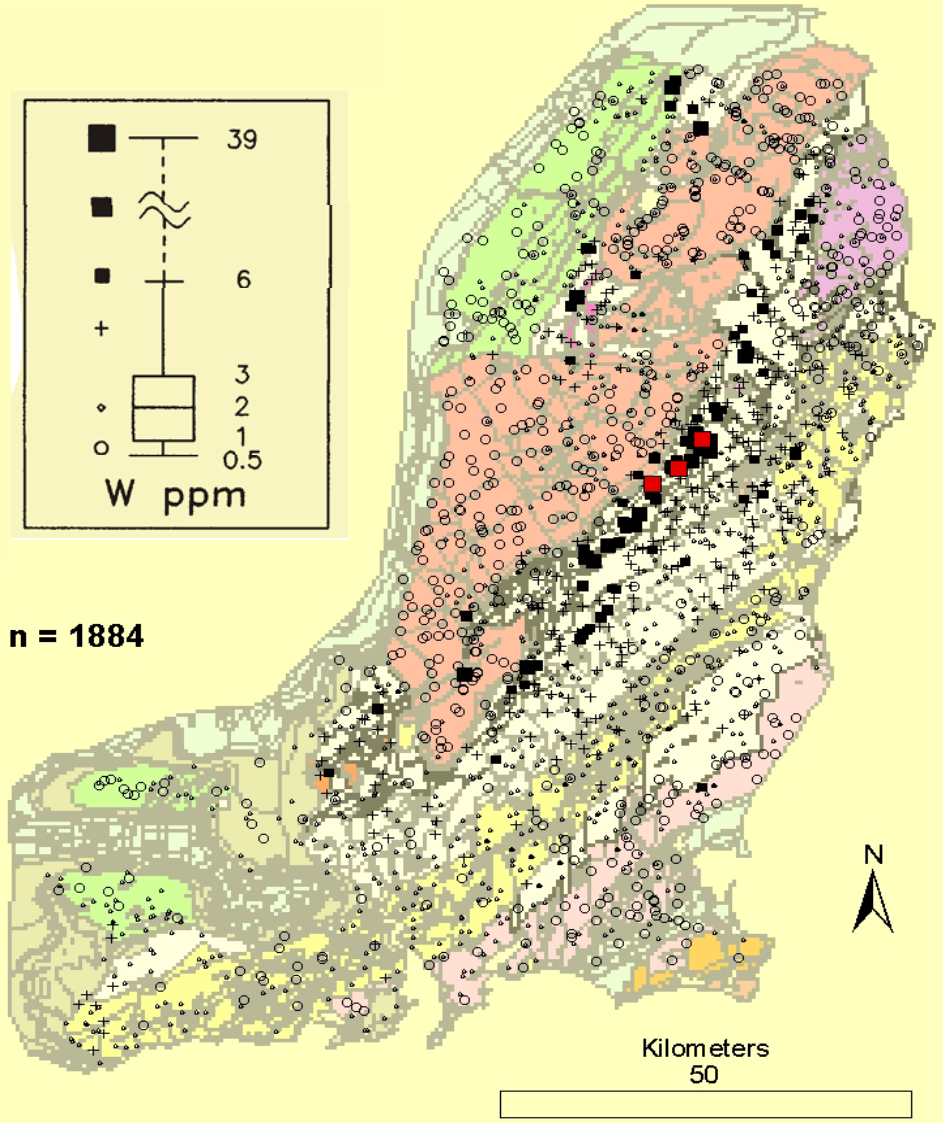
Controls on mineralization 2:
W: Host Tonalite v. Country rock source?

1. Stream sediments

- W anomalies around mineralized tonalites and widespread within Ribband Group
- Leinster Granite low in W
- Other rock units low in W

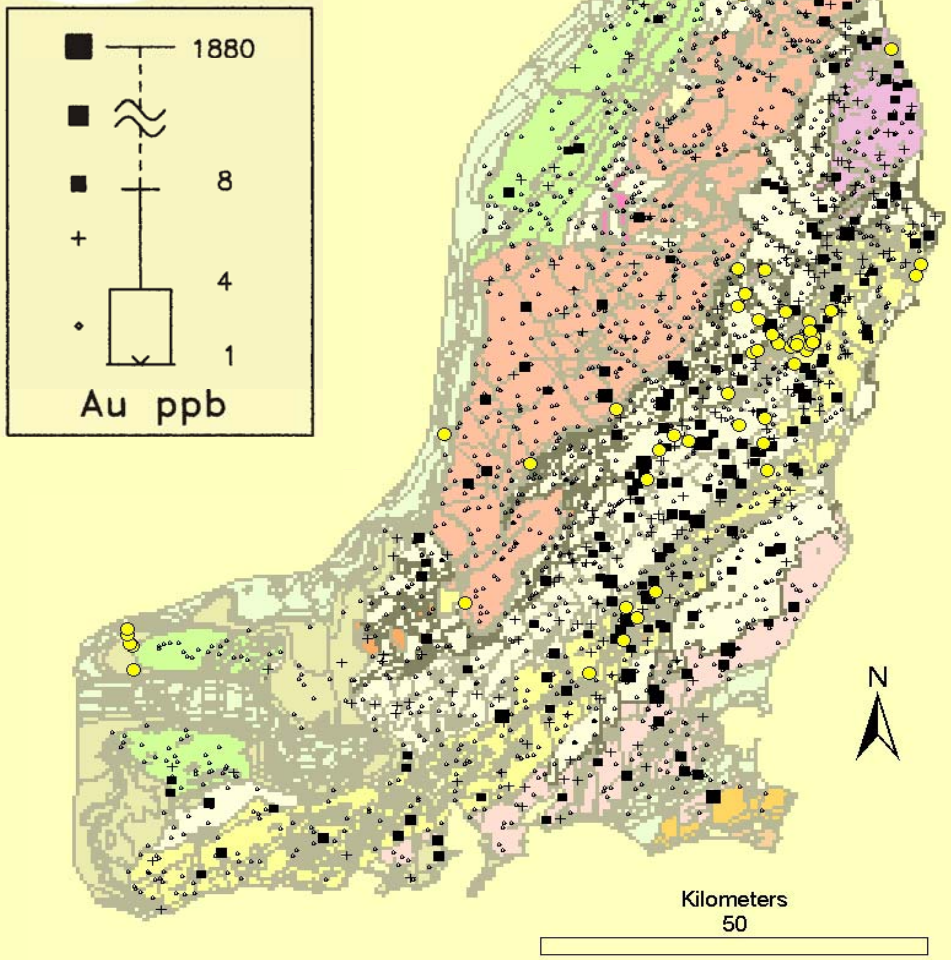
2. Rocks

- Ribband Group has highest median (2 ppm) and range (0.5 – 32 ppm)
- Avoca Fm median = 2 ppm
- Leinster Granite median = 1 ppm
- Most other rock units below crustal average (2 ppm)

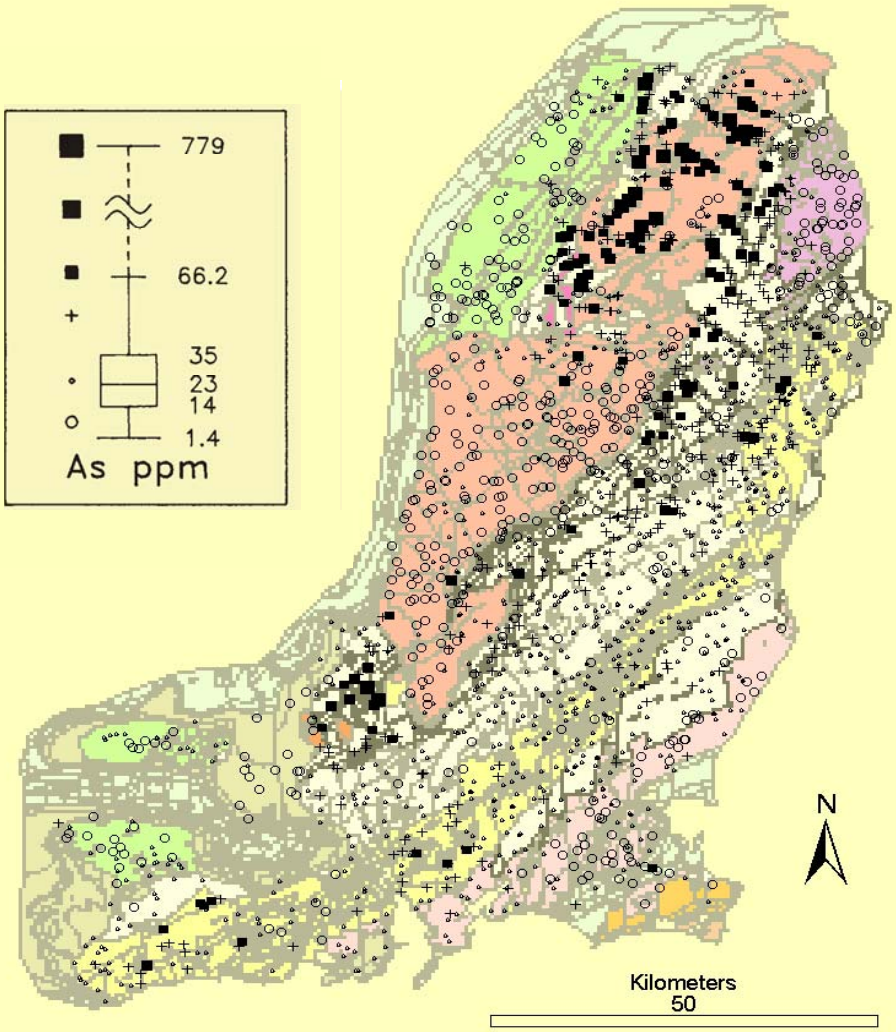


SE Ireland - stream sediments
Gold n = 1884

Au - localities

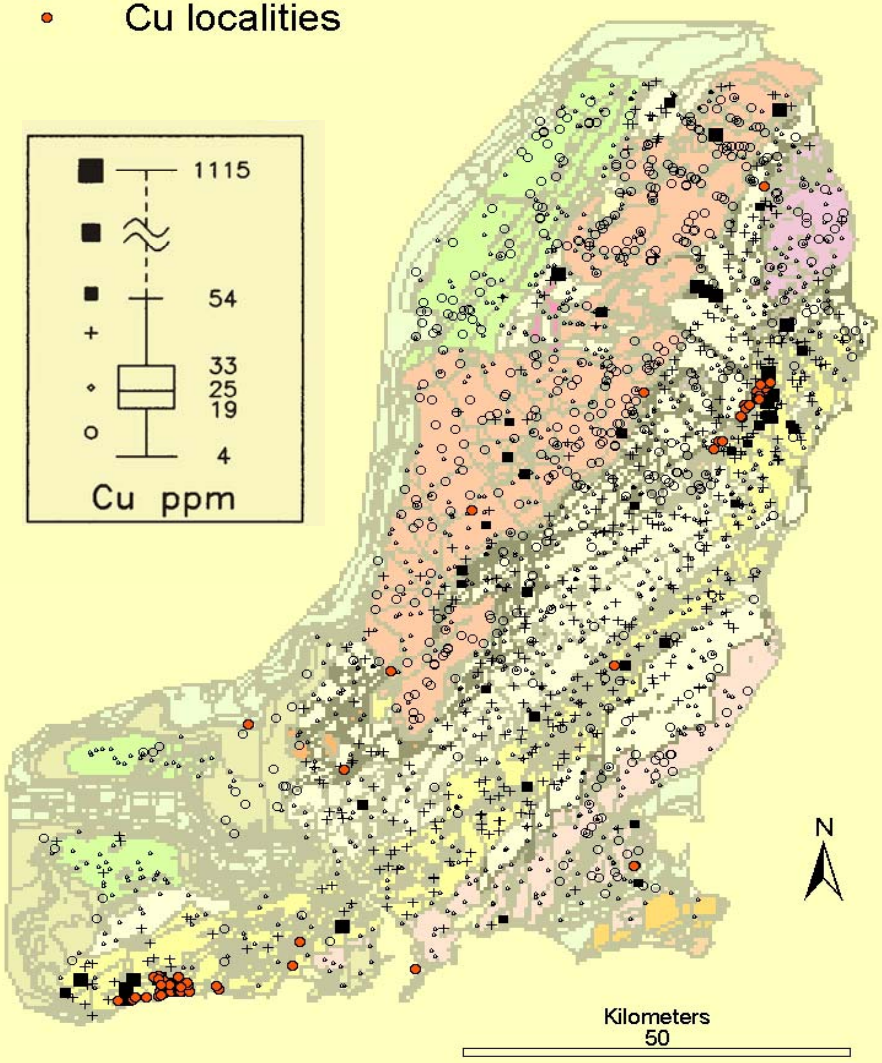


SE Ireland - stream sediments
Arsenic n = 1884

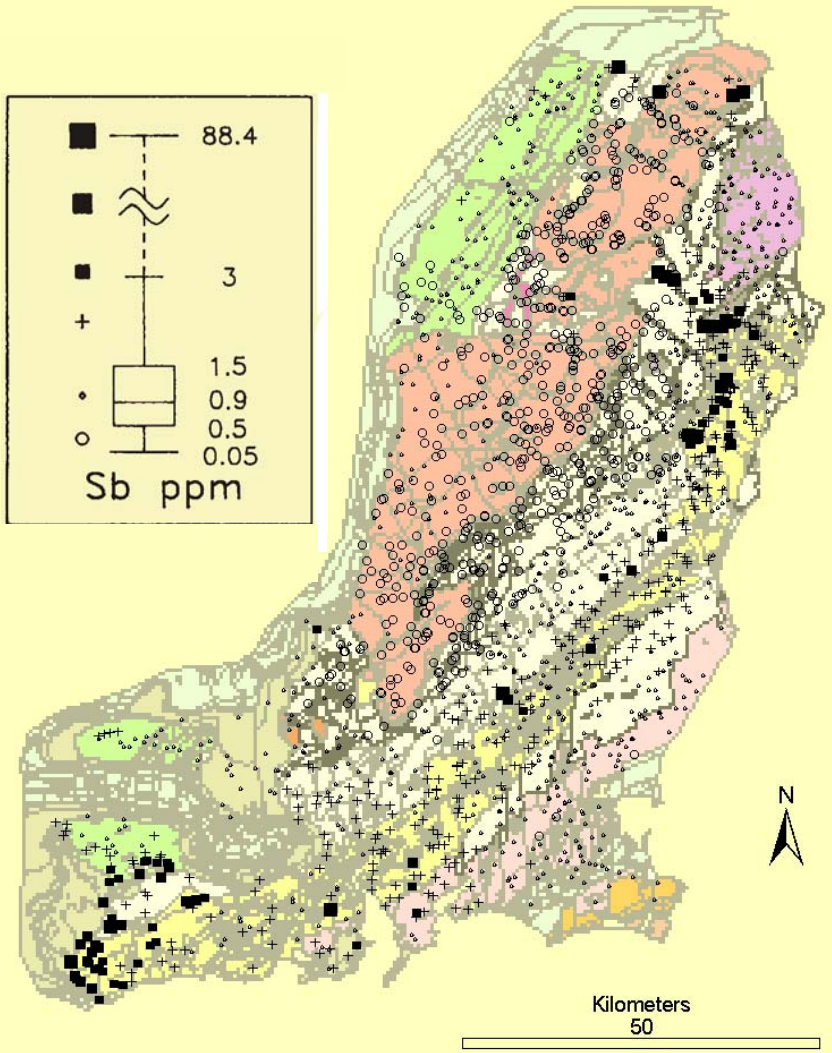


SE Ireland - stream sediments
Copper n = 1884

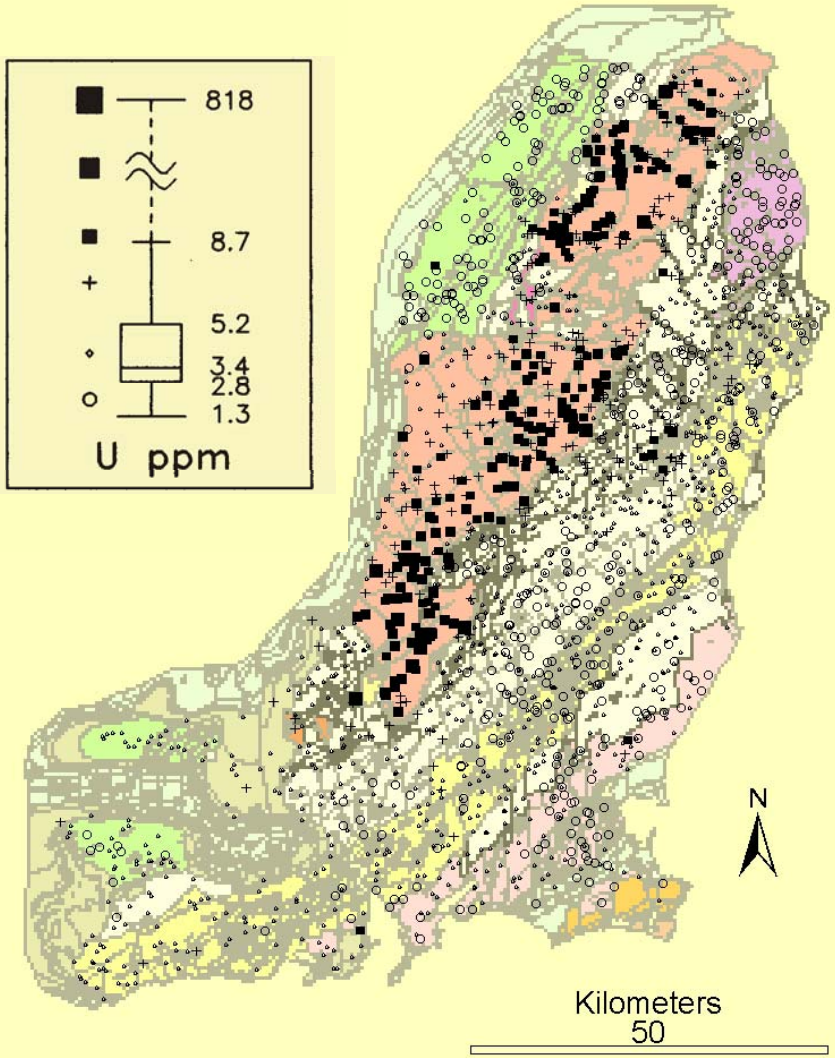
- Cu localities



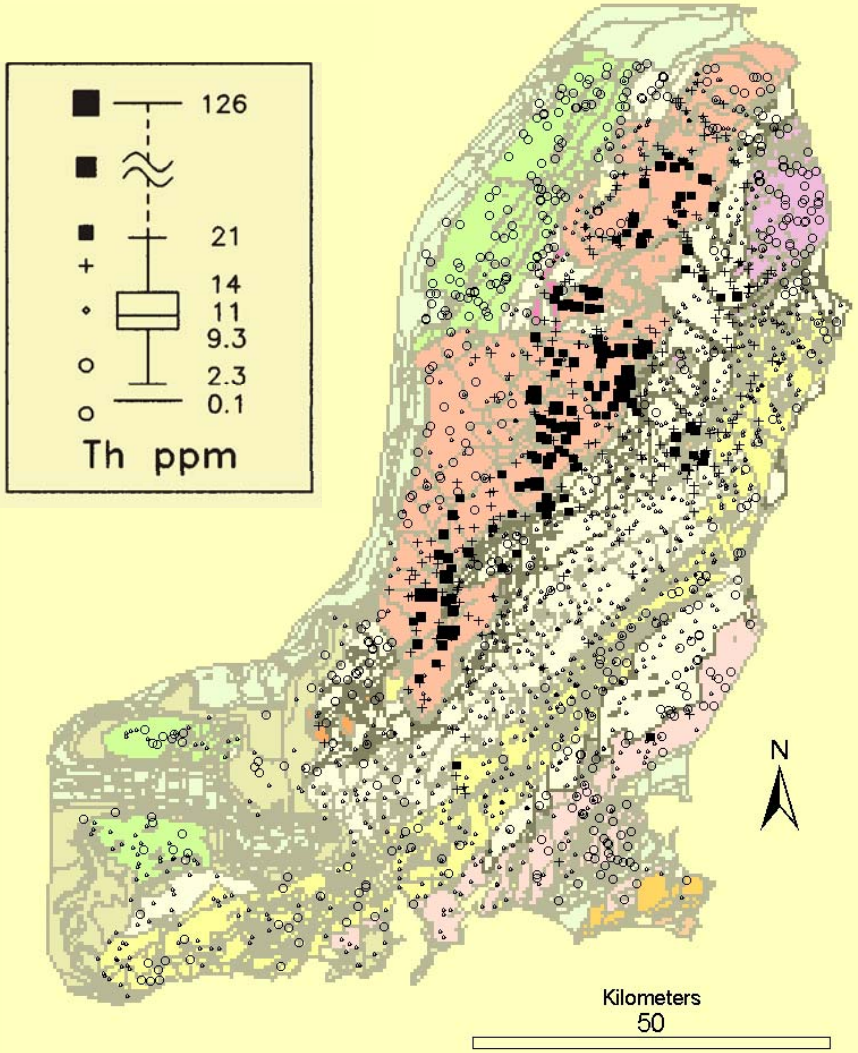
SE Ireland - stream sediments
Antimony n = 1884



SE Ireland - stream sediments
Uranium n = 1884



SE Ireland - stream sediments
Thorium n = 1884



Conclusions

1. At a sample density of 1 per 3 km^2, the geochemical mapping method used has identified:
- all the major rock units;
- all the significant mineralization types known and
- the main individual mineral deposits in the region.

2. There is a robust coherence between rock data and stream sediment data, despite the glacial history of the region.

3. Stratigraphic control of stream sediment distribution for some elements may help refine correlations where discrepancies exist with lithostratigraphic interpretations

4. When their element concentrations are compared to average upper crustal values, major stratigraphic groups and many formations in SE Ireland display strong geochemical coherence, both for stream sediments and rocks. Some notable contrasts with average crustal values are:
- Leinster Granite and most sediment-dominated groups are enriched in Li.
- All stratigraphic groups are enriched in As and Sb.
- All stratigraphic groups are depleted in Na.