Trace element chemistry of stream water from arctic Greenland reflecting lithology and mineralisation

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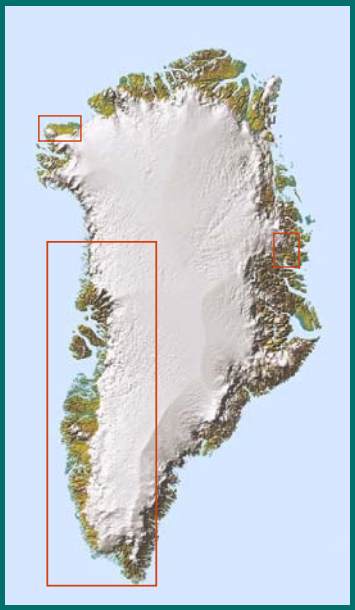
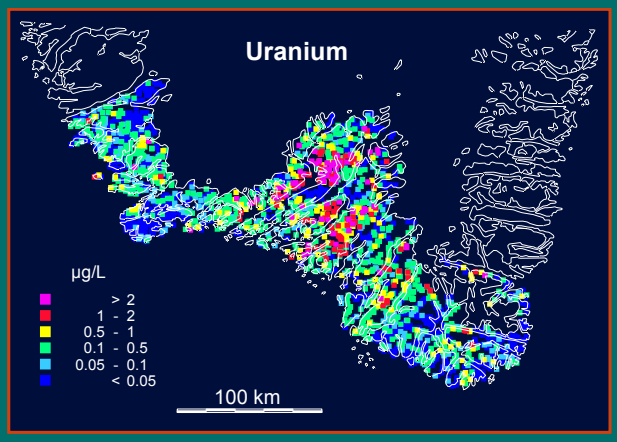
Background

Water samples collected at stream sediment localities over large parts of Greenland

Conductivity determined in all samples, F^- and U^{6+} in many



Background



Source: Armour-Brown et al. 1982: South Greenland uranium exploration project

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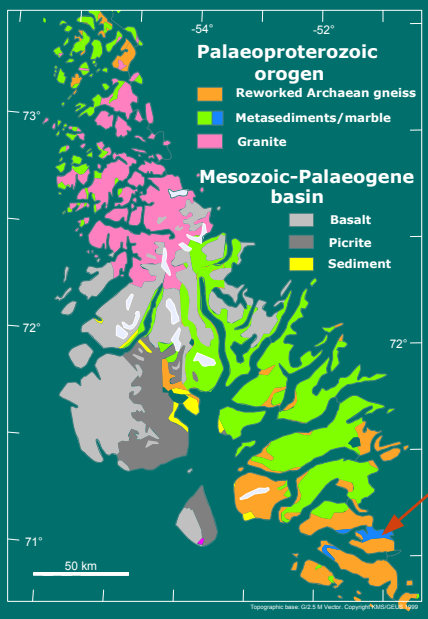
Geology of study area



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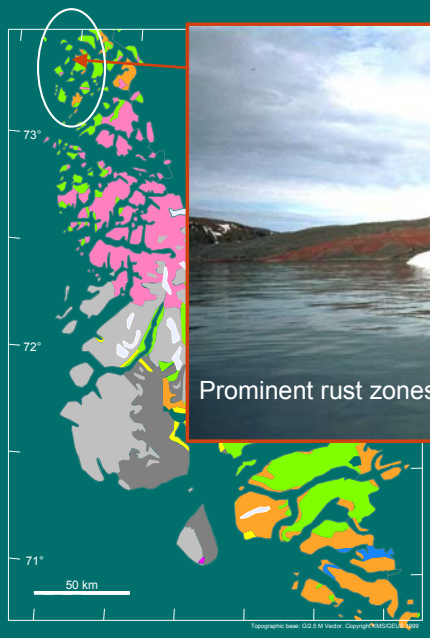
Geology of study area



Prominent rust zones, elevated Cu in stream sediment

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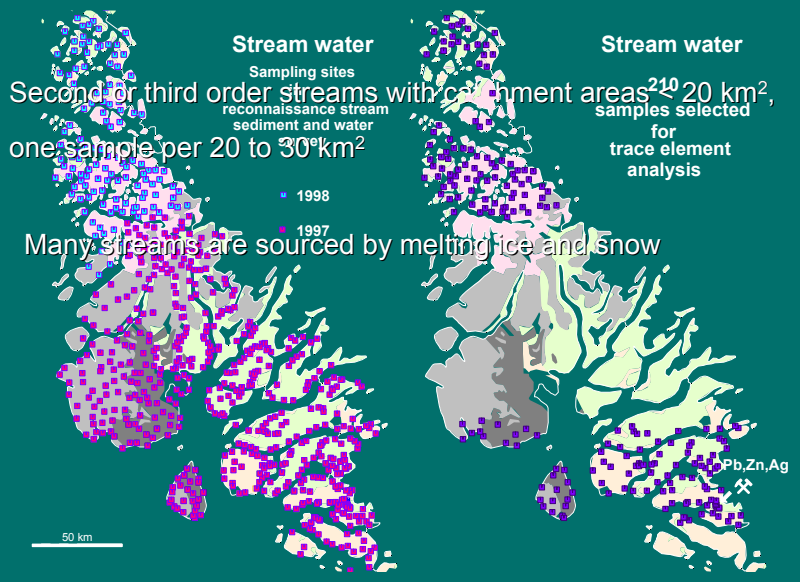
Stream water sample sites



Second or third order streams with catchment areas < 20 km^2, one sample per 20 to 30 km^2

Many streams are sourced by melting ice and snow

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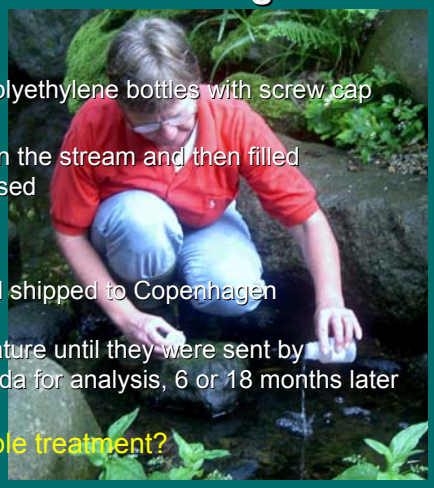
Sampling, sample treatment and storage at GEUS



- Samples were contained in 100 ml polyethylene bottles with screw cap
- Bottle and cap were carefully rinsed in the stream and then filled completely with stream water and closed
- No filtering, no acid
- Samples were packed into boxes and shipped to Copenhagen
- The bottles were left at room temperature until they were sent by air mail to Geological Survey of Canada for analysis, 6 or 18 months later

Any objections to sample treatment?

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Sample preparation and analysis at GSC

•Samples were filtered through 0.45 µm Durapore filters and returned to their original container (rinsed with DDI water first).

•A 10 mL sample was removed for conductivity measurement before the samples were acidified to 0.4% with double distilled HNO_3 from Seastar chemicals.

•The samples were left for about 2 weeks prior to analysis by ICP-MS to allow the nitric acid to desorb any elements from container walls.

•ICP-MS was done with a VG PlasmaQuad 2+, calibration against standards in 0.4% HNO_3 also.

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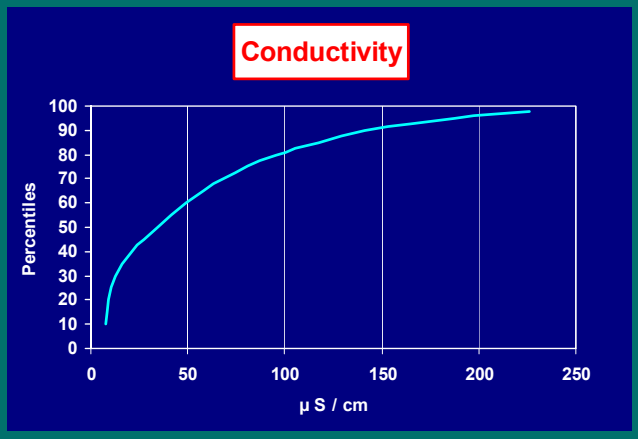
Determined elements and concentration levels



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Determined elements and concentration levels

Al, Fe plus 41 trace elements:

Al	Cu	Li
Pb	Rb	Sr
Y	Zn	Nd

Be	Co	Cr
Mo	Sb	Th
V	Er	Yb

Fe	Mn	Ba
U	La	Ce
Pr		

As	Cd	Cs
Re	Eu	Gd
Tb	Ho	Tm
Lu		

Ni	Ti	Tl
Sm	Dy	

Ag	In	Se

% above lower detection limit

- 100
- 90
- 70
- 50
- 30
- 0

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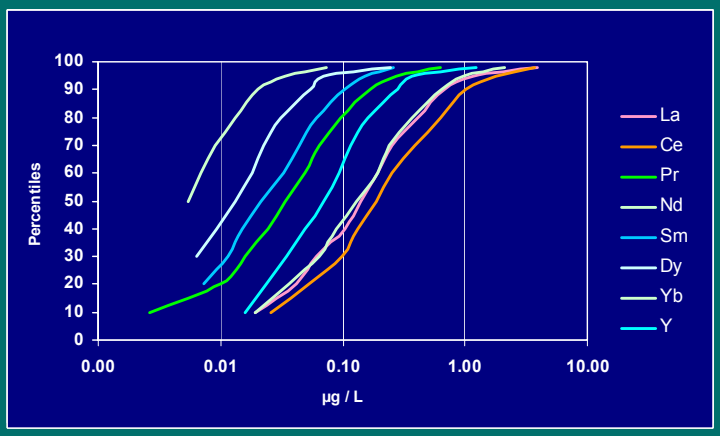
Determined elements and concentration levels



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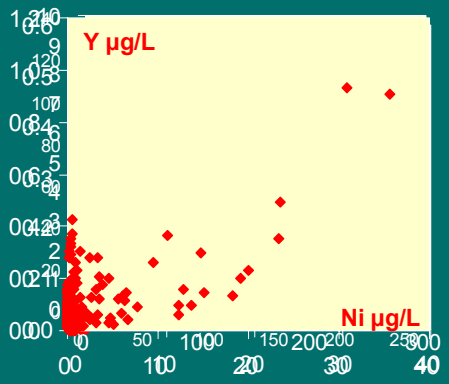
Determined elements and concentration levels

Correlation coefficients higher than 0.8:

Al-Be	Mn-Co	Y-Co
Al-Co	Mn-Ni	Y-Ni
Al-Ni	Mn-Cu	Y-Cu
Fe-Cr	Mn-Y	Y-REE
Co-Cu-Ni	Mn-REE	REE-REE



Highest correlation with conductivity: Sr 0.76

Fe-Mn: 0.46

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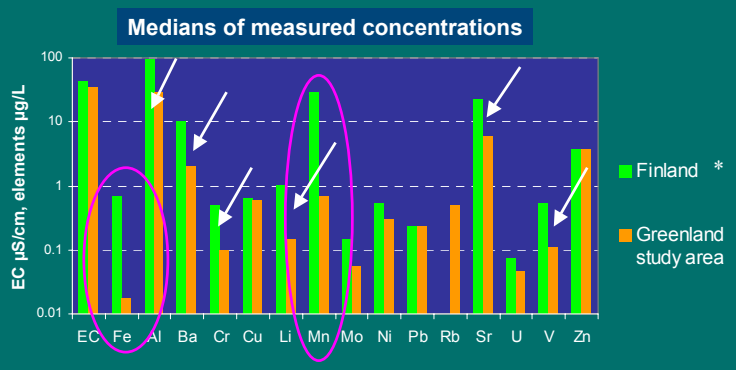
Determined elements and concentration levels

Comparison with levels in temperate climate



*Lahermo et al.1996: Geochemical Atlas of Finland, part 3

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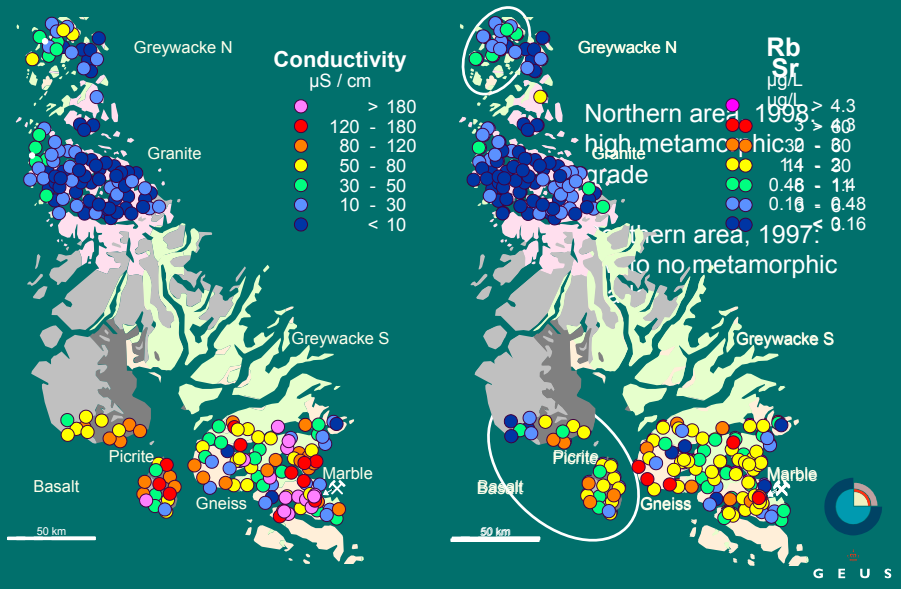
Regional distribution



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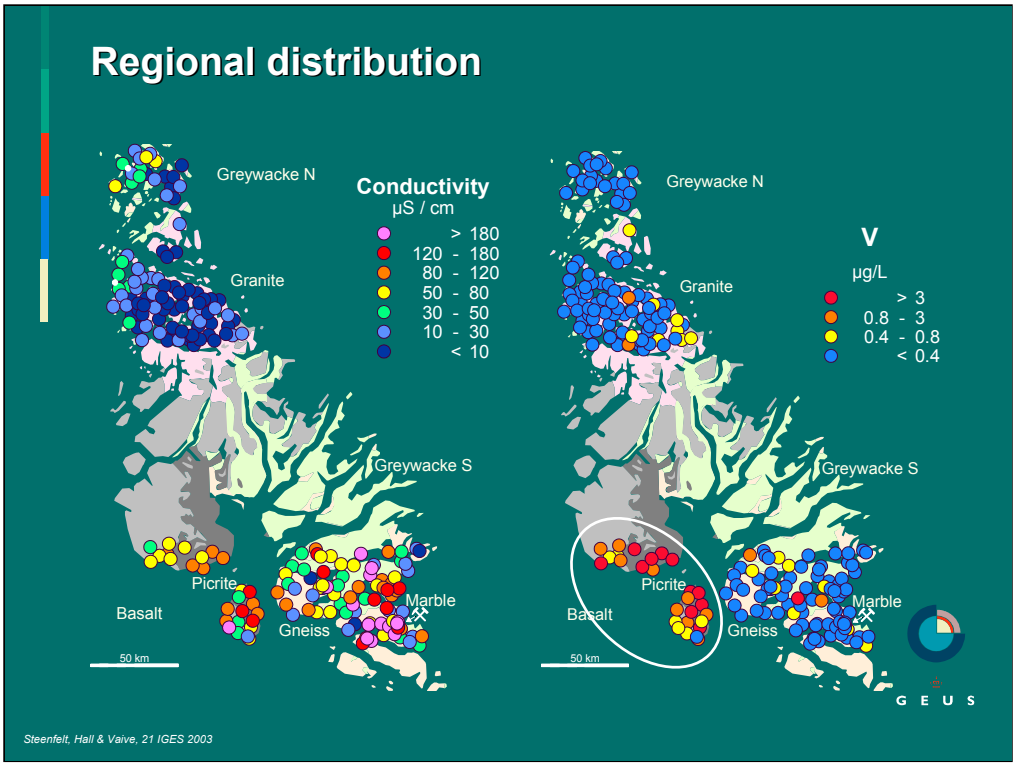
Regional distribution
Greywacke N
Granite
Greywacke S
Picrite
Basalt
Gneiss
Marble
50 km
Conductivity
µS / cm
> 180
120 - 180
80 - 120
50 - 80
30 - 50
10 - 30
< 10
V
µg/L
> 3
0.8 - 3
0.4 - 0.8
< 0.4
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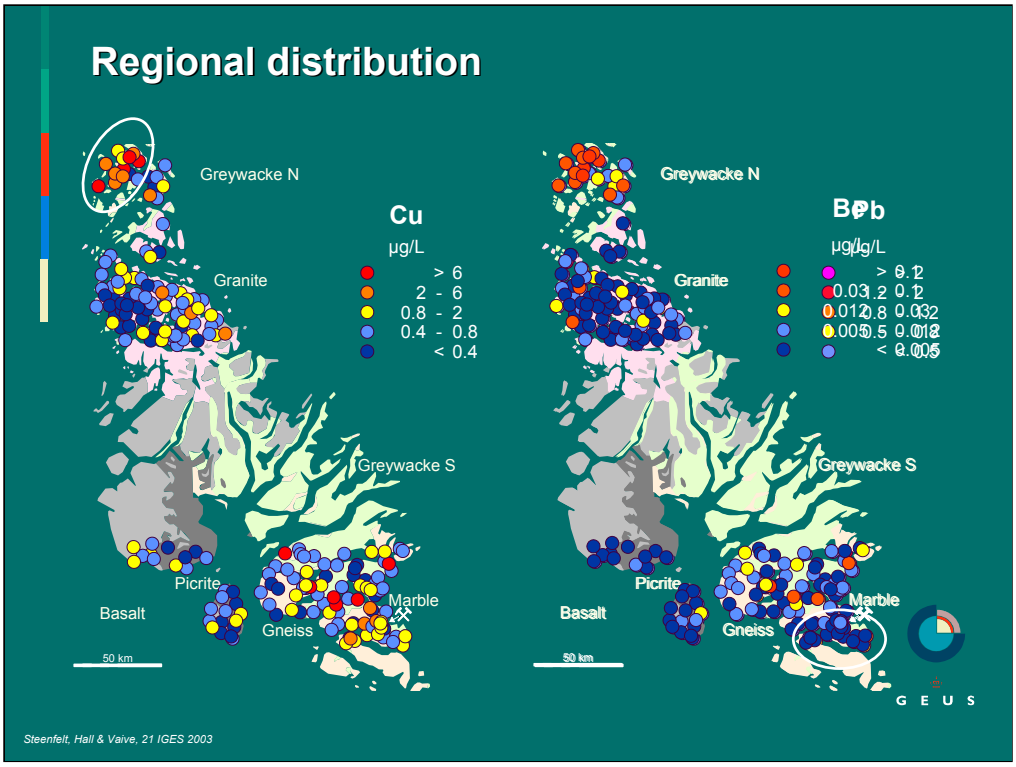
Regional distribution
Greywacke N
Granite
Greywacke S
Picrite
Basalt
Gneiss
Marble
Cu
µg/L
> 6
2 - 6
0.8 - 2
0.4 - 0.8
< 0.4
50 km
Greywacke N
Granite
Greywacke S
Picrite
Basalt
Gneiss
Marble
50 km
G E U S
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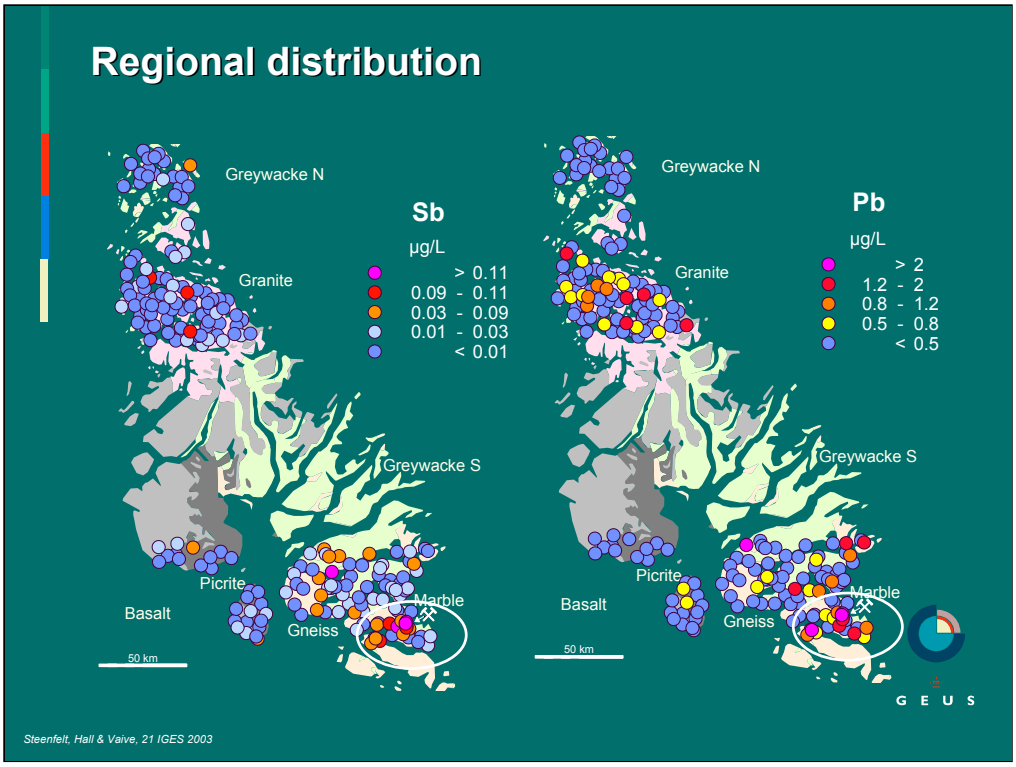
Regional distribution
Greywacke N
Granite
Greywacke S
Picrite
Basalt
Gneiss
Marble
50 km
Sb
µg/L
> 0.11
0.09 - 0.11
0.03 - 0.09
0.01 - 0.03
< 0.01
Greywacke N
Granite
Greywacke S
Picrite
Basalt
Gneiss
Marble
50 km
Pb
µg/L
> 2
1.2 - 2
0.8 - 1.2
0.5 - 0.8
< 0.5
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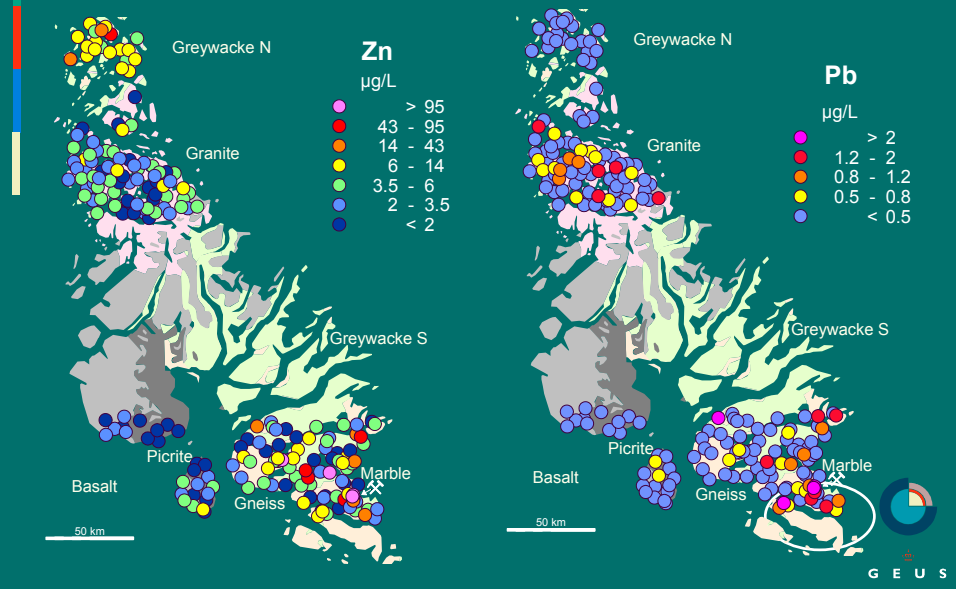
Regional distribution



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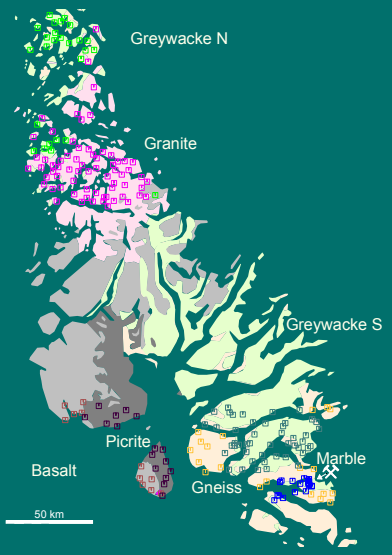
Hydrogeochemical signatures



Samples are grouped according to main geology of catchment area

Medians of element concentrations for each group are normalised against the corresponding median of all samples

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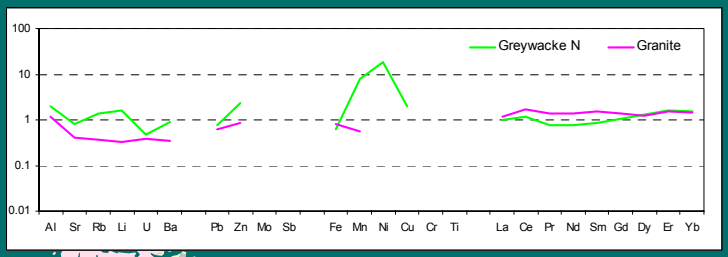
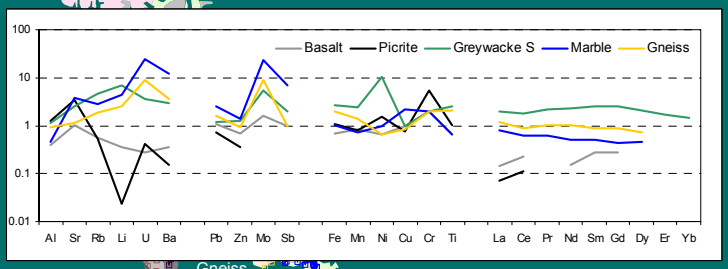
Hydrogeochemical signatures





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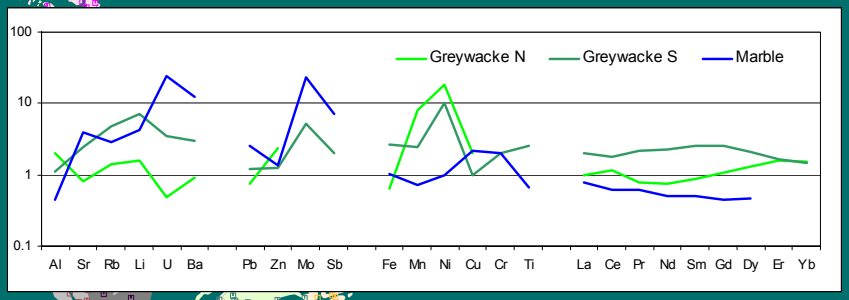
Hydrogeochemical signatures

Greywacke N



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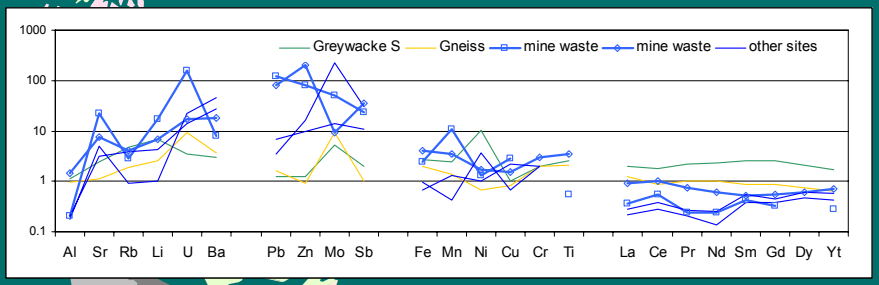
Hydrogeochemical signatures

Greywacke N



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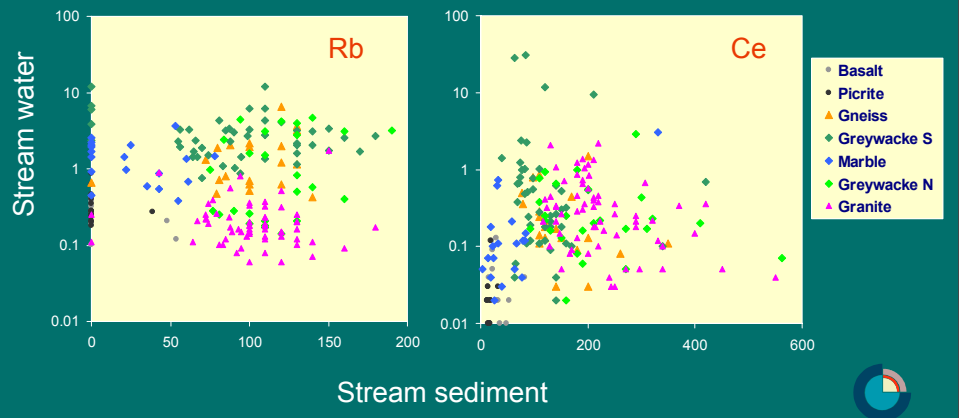
Comparison with stream sediment



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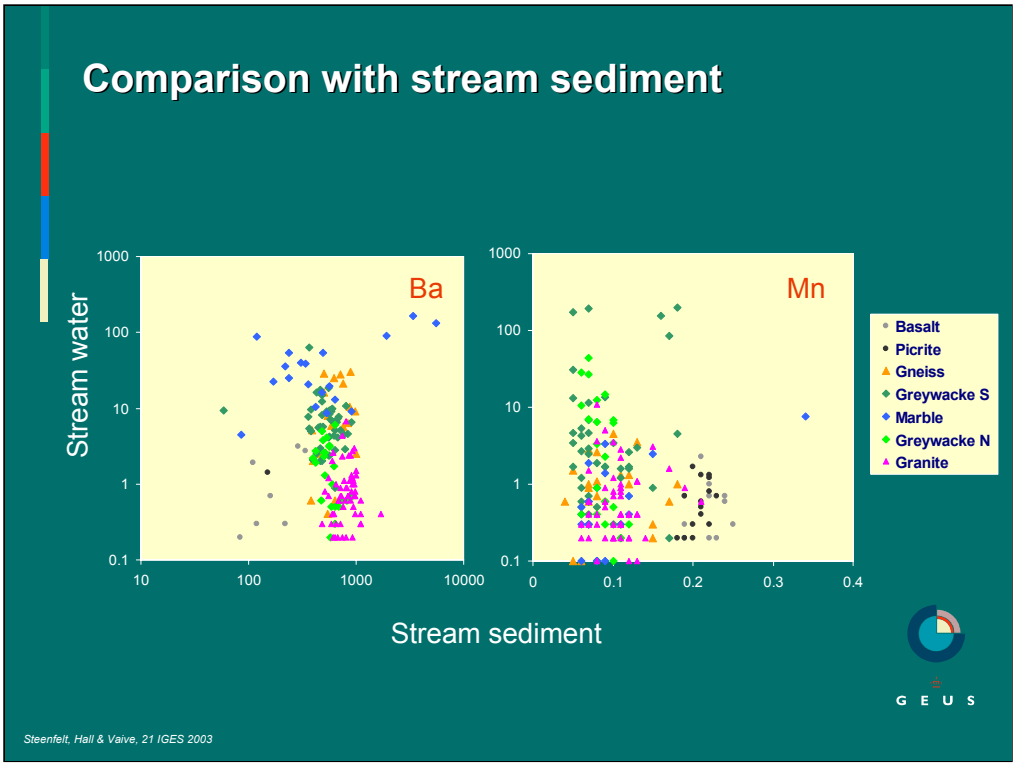
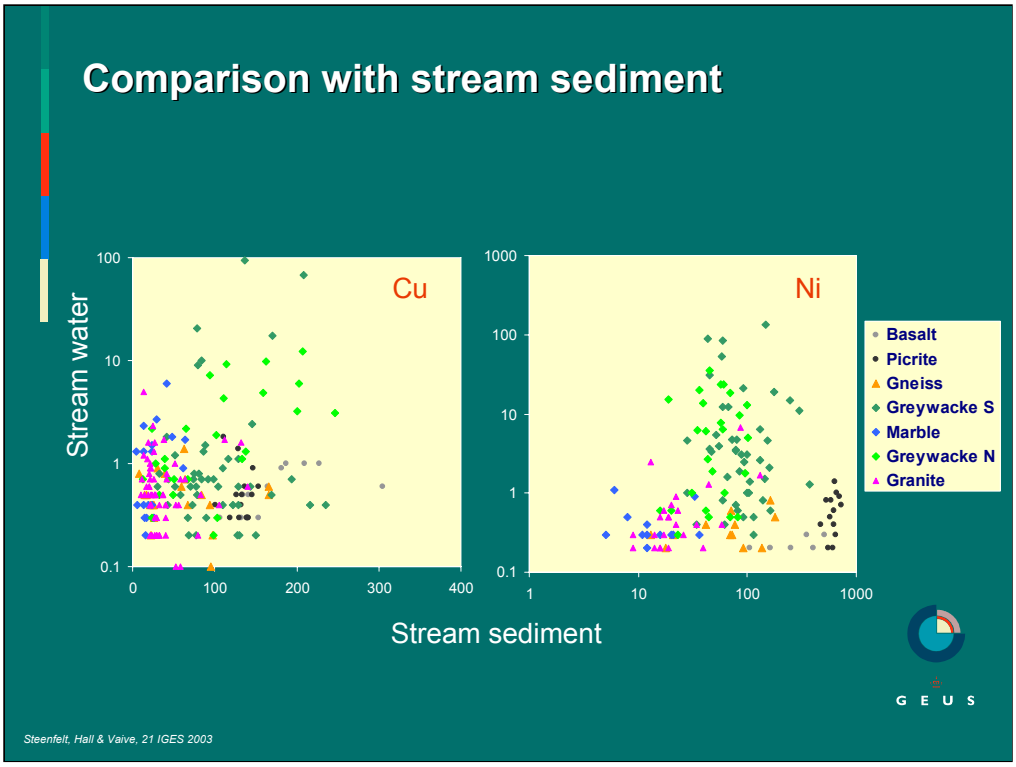


In the case of Ba, the stream water data distinguishes the marble much better than the stream sediment where only the highest values lie outside the bulk.

There is no correlation between sediment and water for Mn. Only three greywacke localities and one marble loclity are anomalous in both media. If the high Mn



No correlation between water and sediment for Cu except for high values in greywacke. This is interpreted as indicative of mineralisation. With regard to Ni, granite and greywacke samples show some correlation. In basalt and picrite Ni is contained in olivine and not expected to contribute to Ni in water.

Response to mineralisation

Stream sediment
mg/kg

	Pb	Zn	Contrast
Mine waste	3700	10000	c. 100
Mineralisation	69	669	Pb 3.5 Zn 6.7
Background (median)	28	97	

Stream water
µg/L

Pb	Zn	Contrast
27, 19	300, 750	Pb c. 100 Zn c. 140
3.5	8.5	Pb 15.2 Zn 2.3
0.23	3.7	

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Conclusions

- A long suite of trace elements were detected in ICP-MS analysis of stream water from northern West Greenland
- Many element concentrations range two to three orders of magnitude
- Regional variations in trace element concentrations can be related to lithological variation and mineralisation
- Stream water data are complementary to stream sediment data
- Despite that sample treatment did not follow the book, the results appear reliable and stream water is regarded a useful medium in geochemical mineral exploration in Greenland

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