British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Geological linework: communicating a surveyor's tacit understanding of uncertainty via expert elicitation

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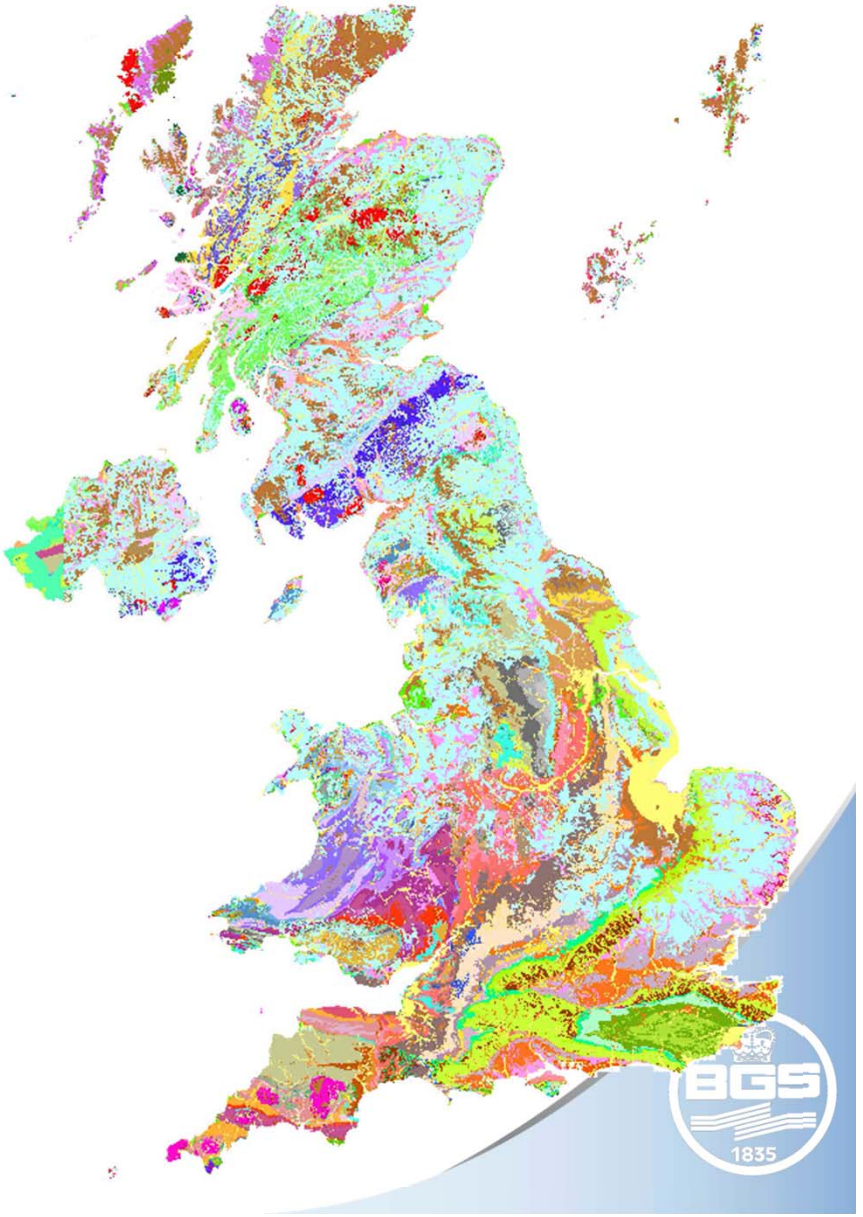
Overview

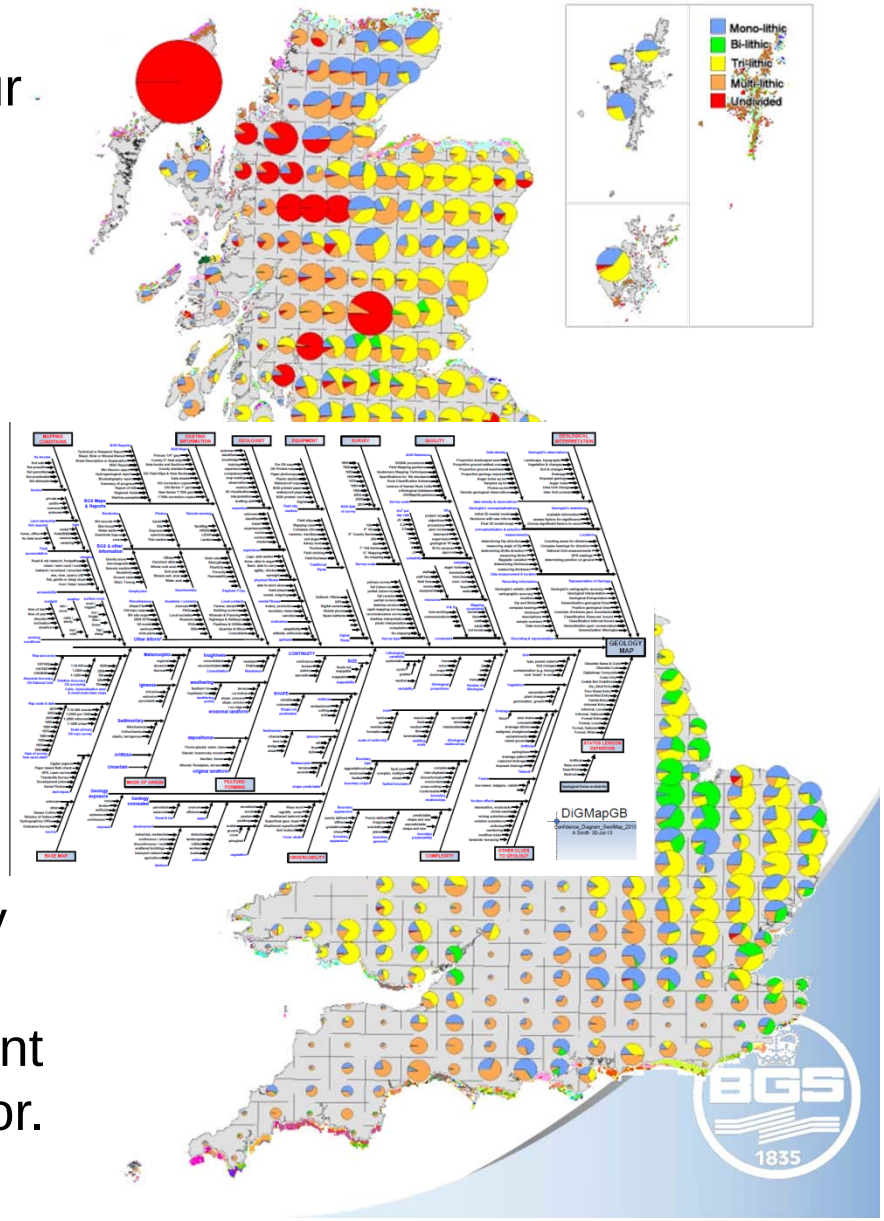
- Drivers
- Background
- Geological scenarios
- SHELF elicitation
- Scenario models
- Findings
- Forward look



Drivers and Previous Use of EE

Need to communicate uncertainty from our source mapping

- •Propagation of uncertainty
- •Improved user understanding
- •Targeted updates
- •Improved techniques



Previous studies have been heavily focussed on data densities, survey methods, empirical limits.....

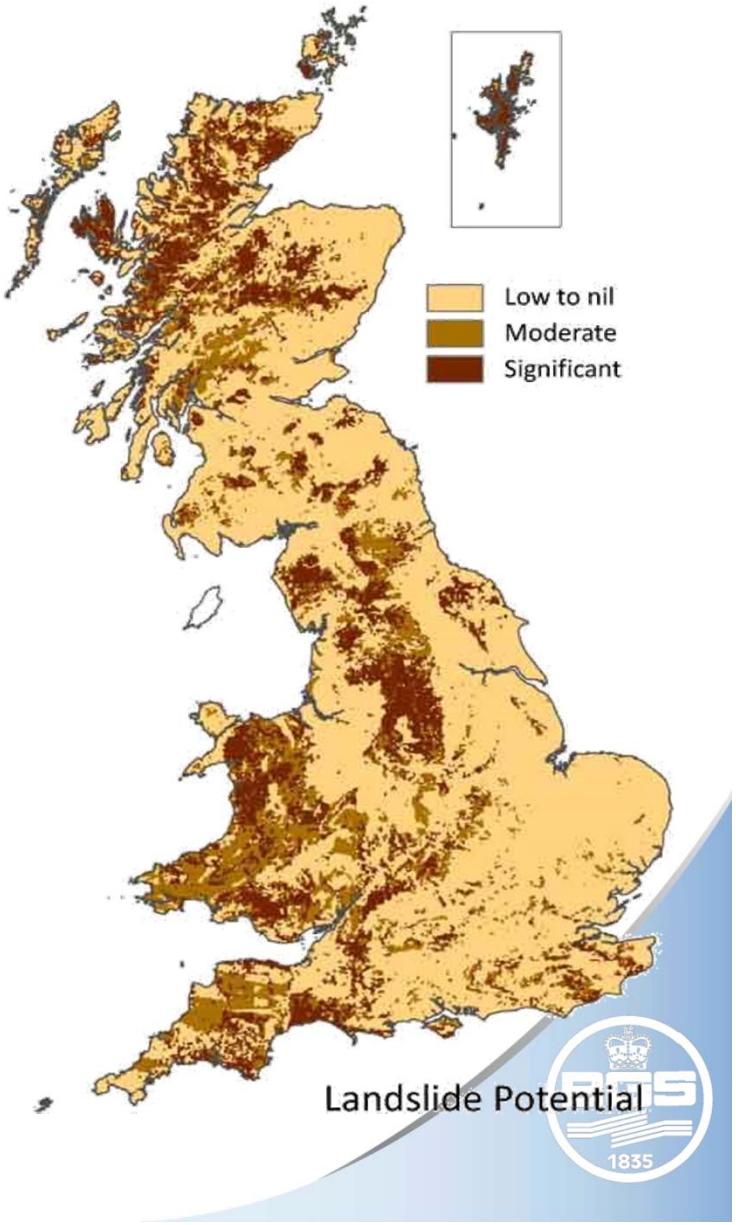
These have proved useful for isolating single, critical, factors but do not generally succeed in evaluating geological mapping ‘in the round’, because they cannot account for the ‘conceptual’ skill set of the surveyor.

Drivers and Previous Use of EE

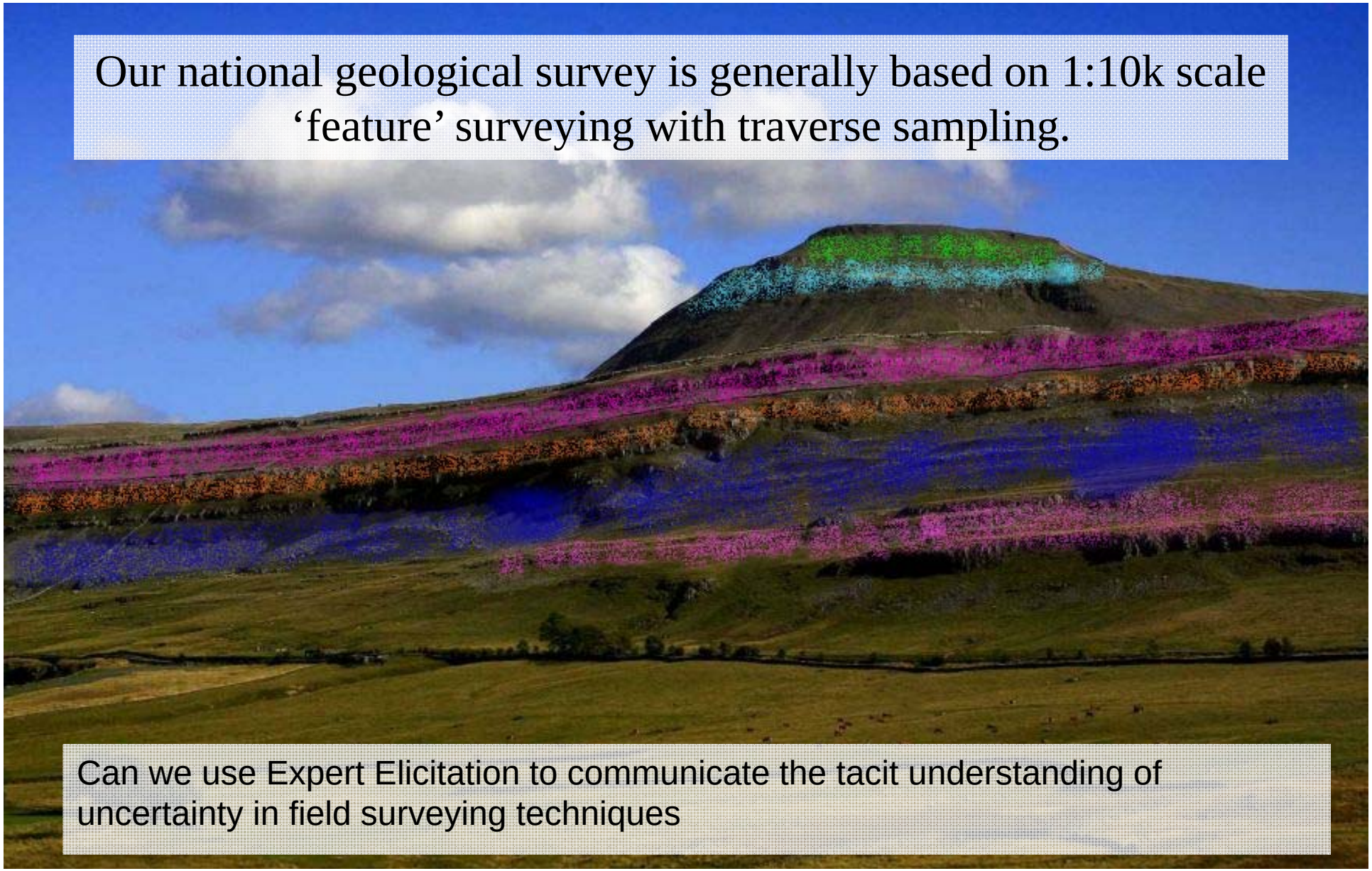
Expert Elicitation (EE) has been previously used to communicate geohazard susceptibility to UK insurance sector.

Modern surveying techniques capture some uncertainty metrics, but the mainstay of the survey is feature mapping.

The expert elicitation approach starts with the assumption that experienced surveyors have an intuitive sense of the uncertainty of the boundaries that they map, based on a tacit model of geology and its complexity and the nature of the surveying process.



Background



Our national geological survey is generally based on 1:10k scale ‘feature’ surveying with traverse sampling.

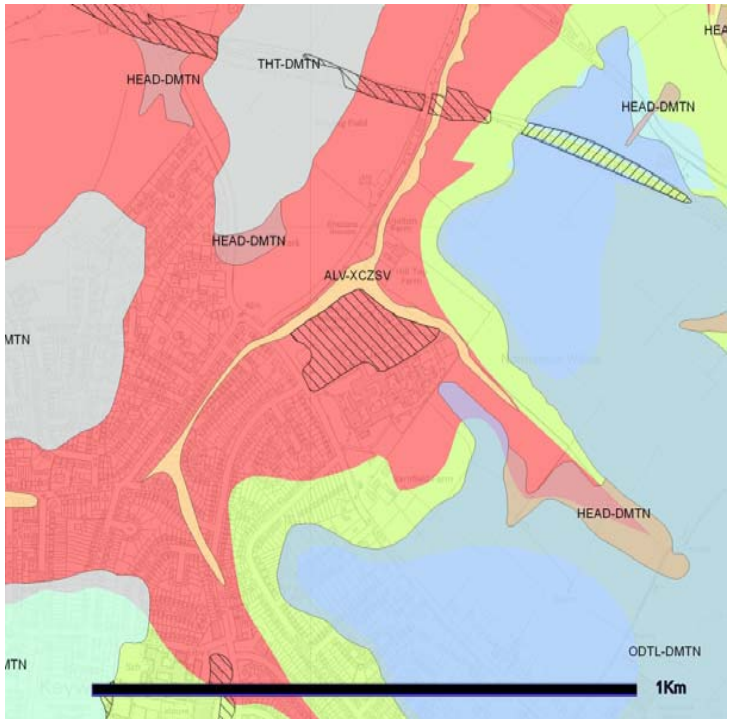
Can we use Expert Elicitation to communicate the tacit understanding of uncertainty in field surveying techniques

Geological Scenarios

This is an initial phase of **a long term study.**

Identified a long-list of typical mapping-scenarios, from which we selected 6 of the most commonly surveyed geological boundaries

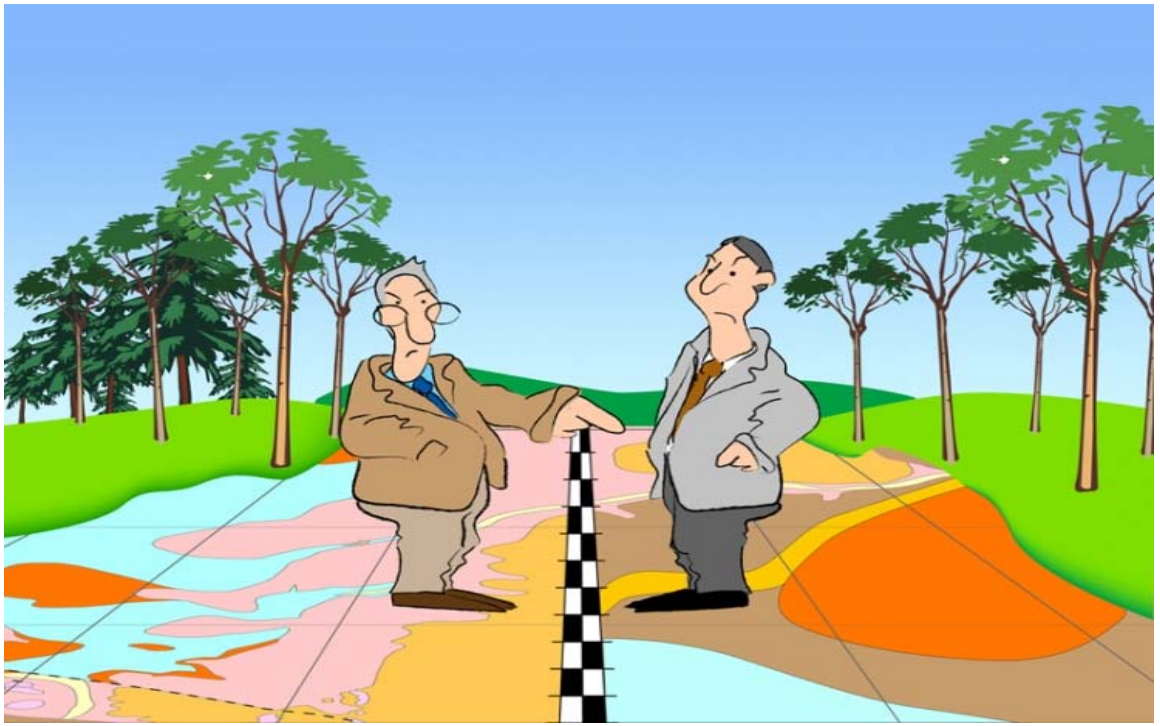
- Widespread boundaries seen in the UK
- Range of challenges when being surveyed
- Differing survey skills required
- Generally considered to be ‘simple’
- Ideal for building a ‘collective’ understanding of their uncertainty
- A good starting point to focus the expert-group



DiGMapGB-10
1:10,000 Scale

SHeffield ELicitation Framework (SHELF)

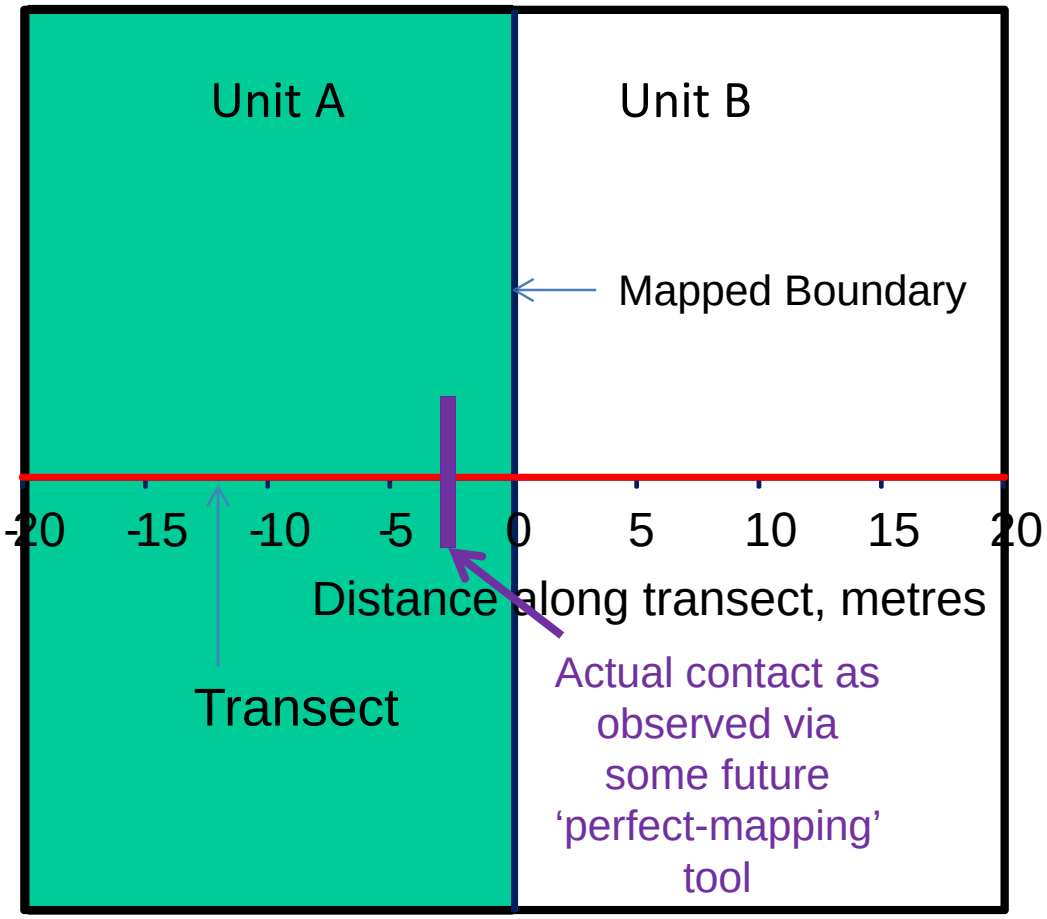
- SHELF quartile method using the R platform
- 5 experienced geologists with 130 years+ experience
- 2 facilitators
- A familiarisation exercise
- Structured, scripted analysis of each scenario



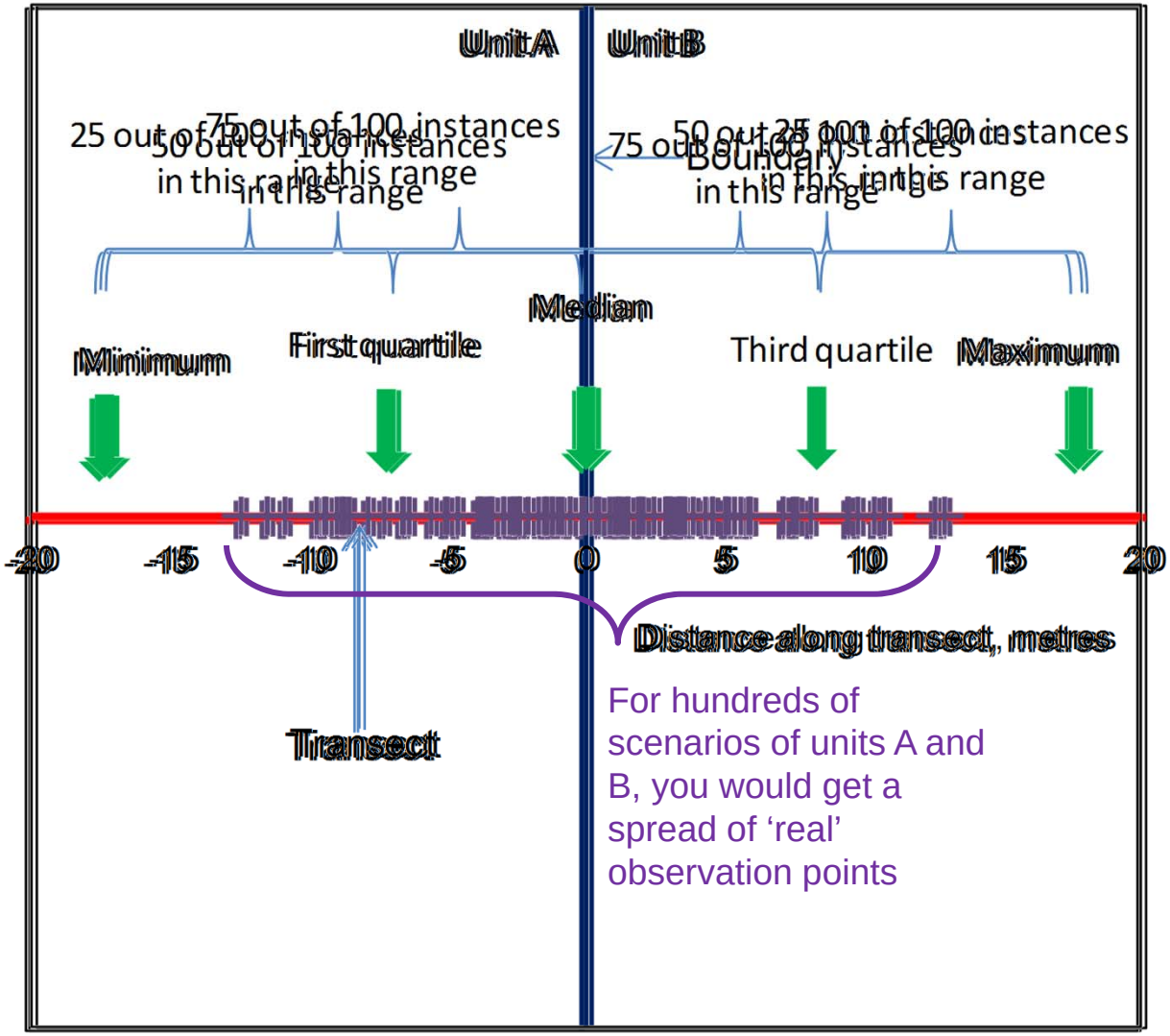
Oakley and O'Hagan, 2010 *R Development Core Team, 2008*

SHeffield ELicitation Framework (SHELF)

Consider a simple mapped boundary between 2 units

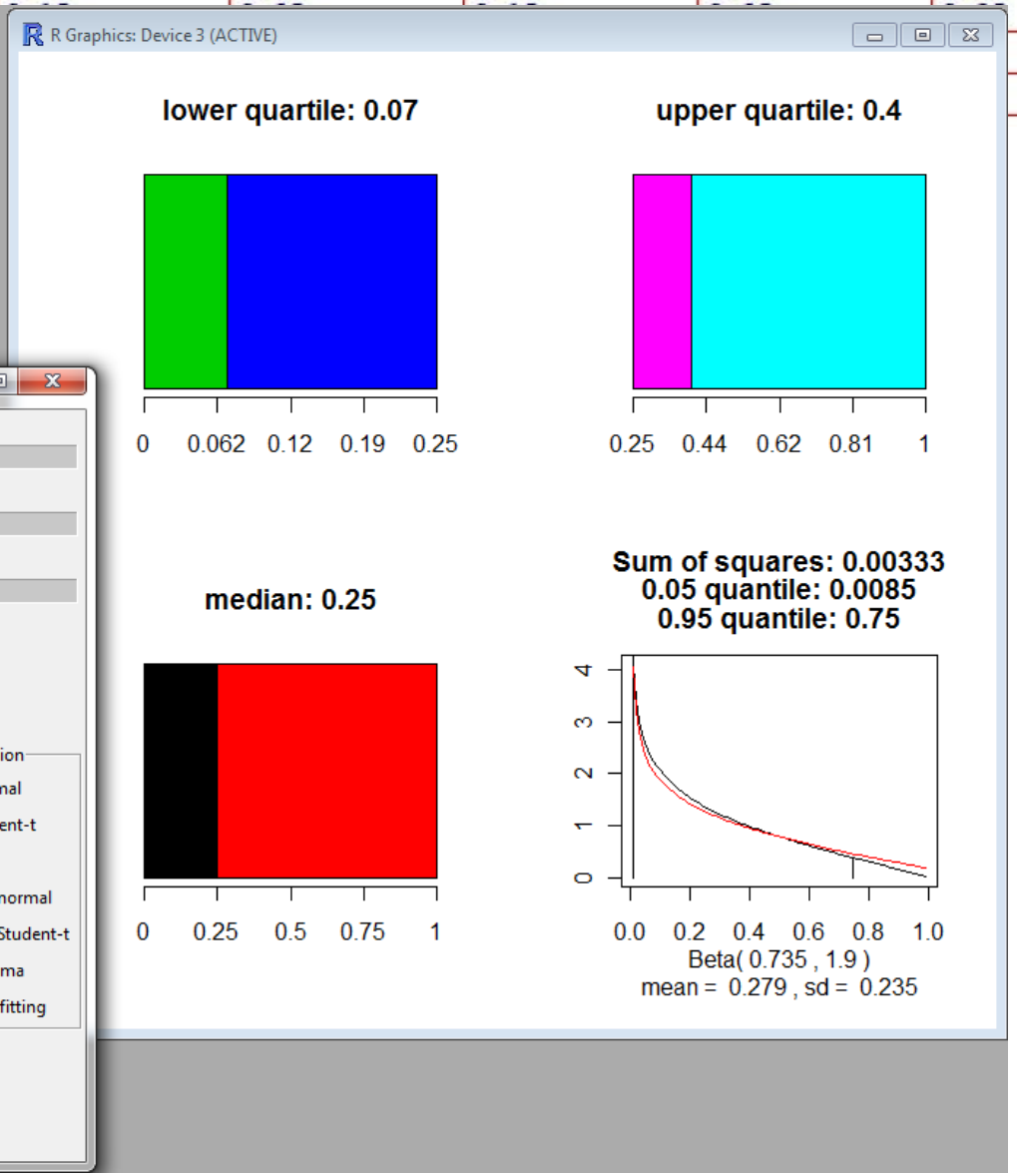


SHeffield ELicitation Framework (SHELF)



Data Editor

	Probability	Expert1.value	Expert2.value	Expert3.value	Expert4.value	Expert5.value	Expert6.value
1	0	0	0	0	0	0	0
2	0.25	0.04	0.1	0.05	0.075	0.1	0.15
							0.3
							0.5
							1



Quartiles

lower quartile

median

upper quartile

Elicit lower quartile

Elicit upper quartile

Feedback

None

Four intervals

Density

1st feedback quantile

0.05

2nd feedback quantile

0.95

Distribution

Normal

Student-t

Beta

Log normal

Log Student-t

Gamma

Best fitting

Student-t d.f.

3

Show linear pool

Group j...

Distribution

Normal

Student-t

Beta

Log normal

Log Student-t

Gamma

Best fitting

Student-t d.f.

3

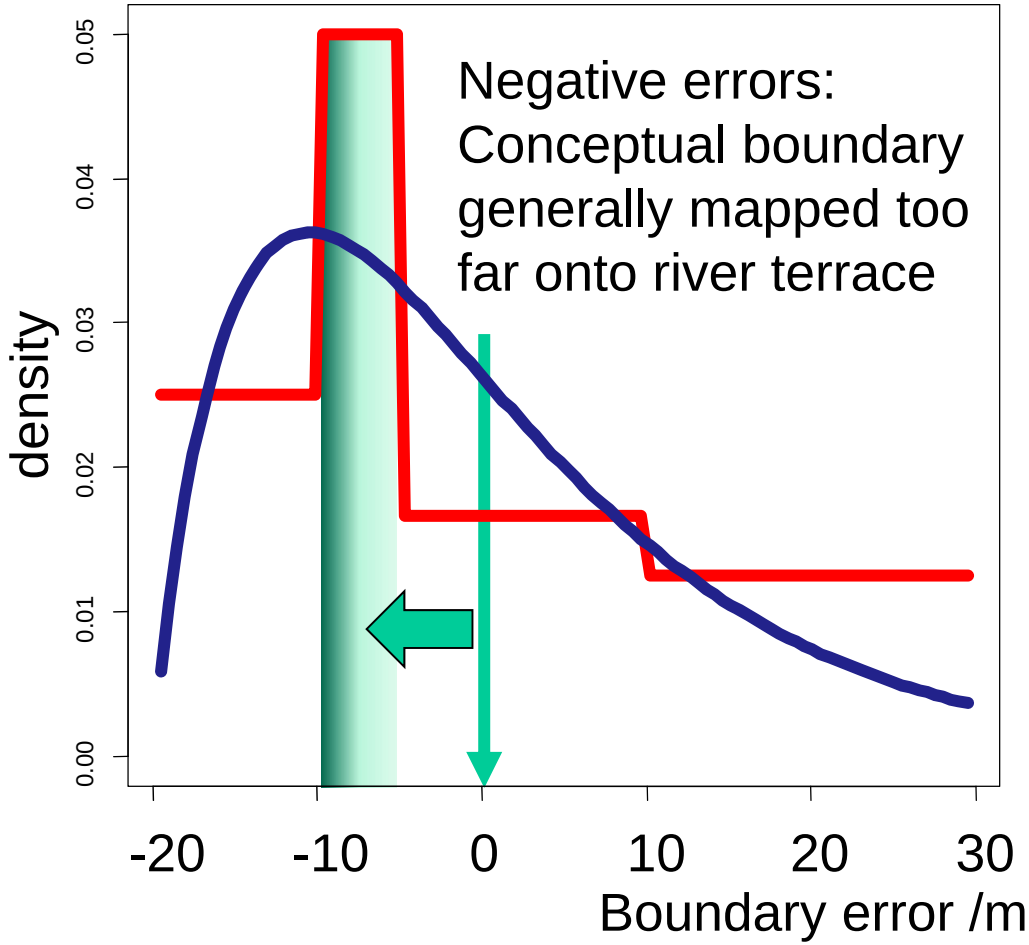
Show linear pool

Change individual judgements

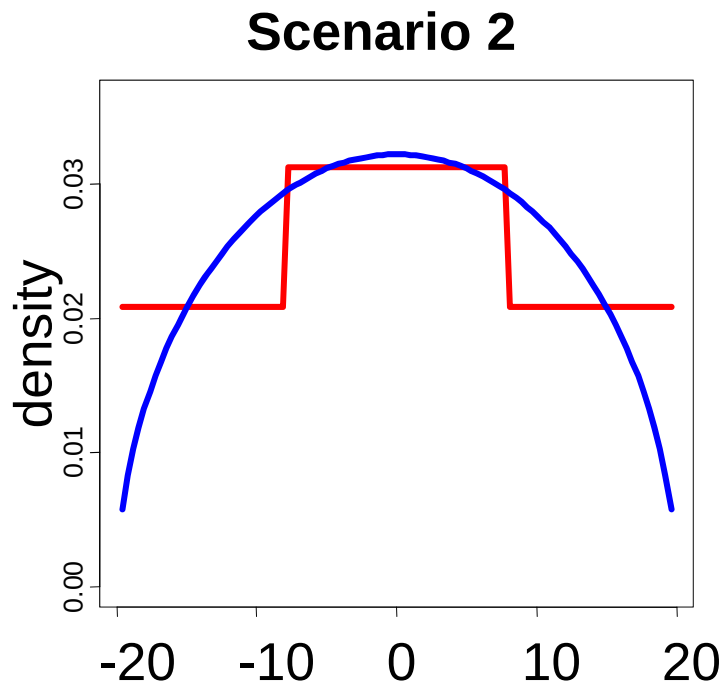
Scenario outputs

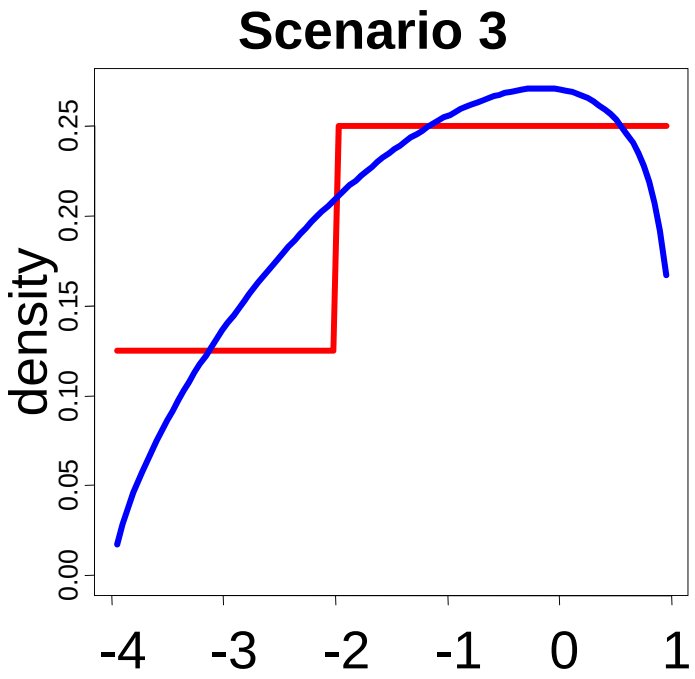
Pronounced cluster of boundary errors between 5 and 10 m onto the river terrace

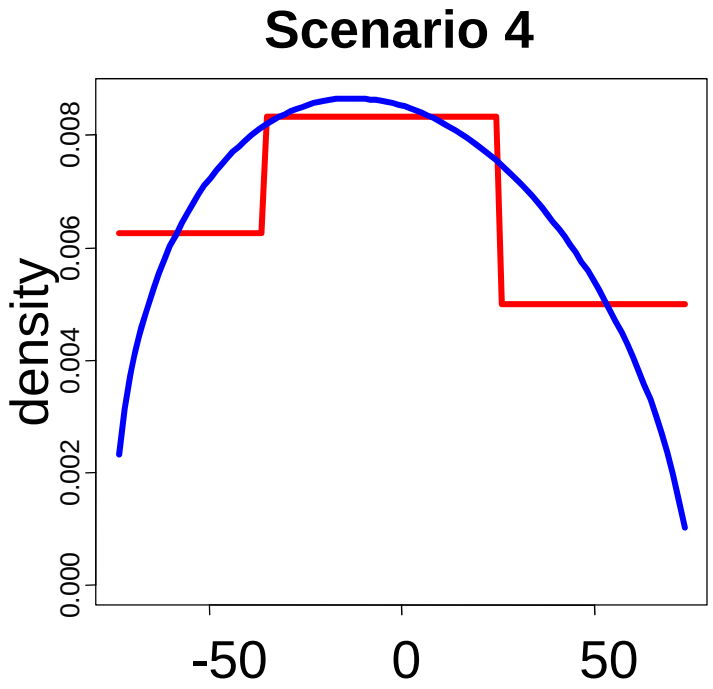
Scenario 1

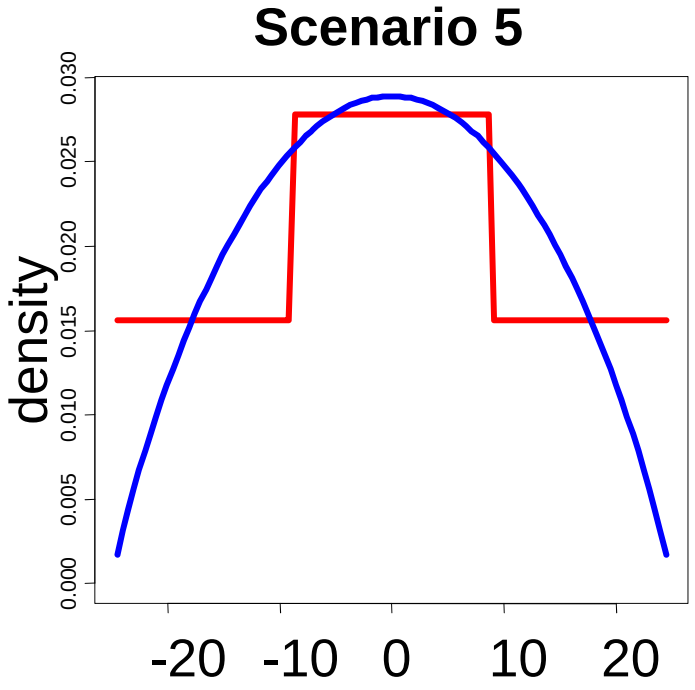


Quartile 1: –10; Median: –5; Quartile 3: 10.
Interval expected to include 95% of all intersections [–17.8,37.2]

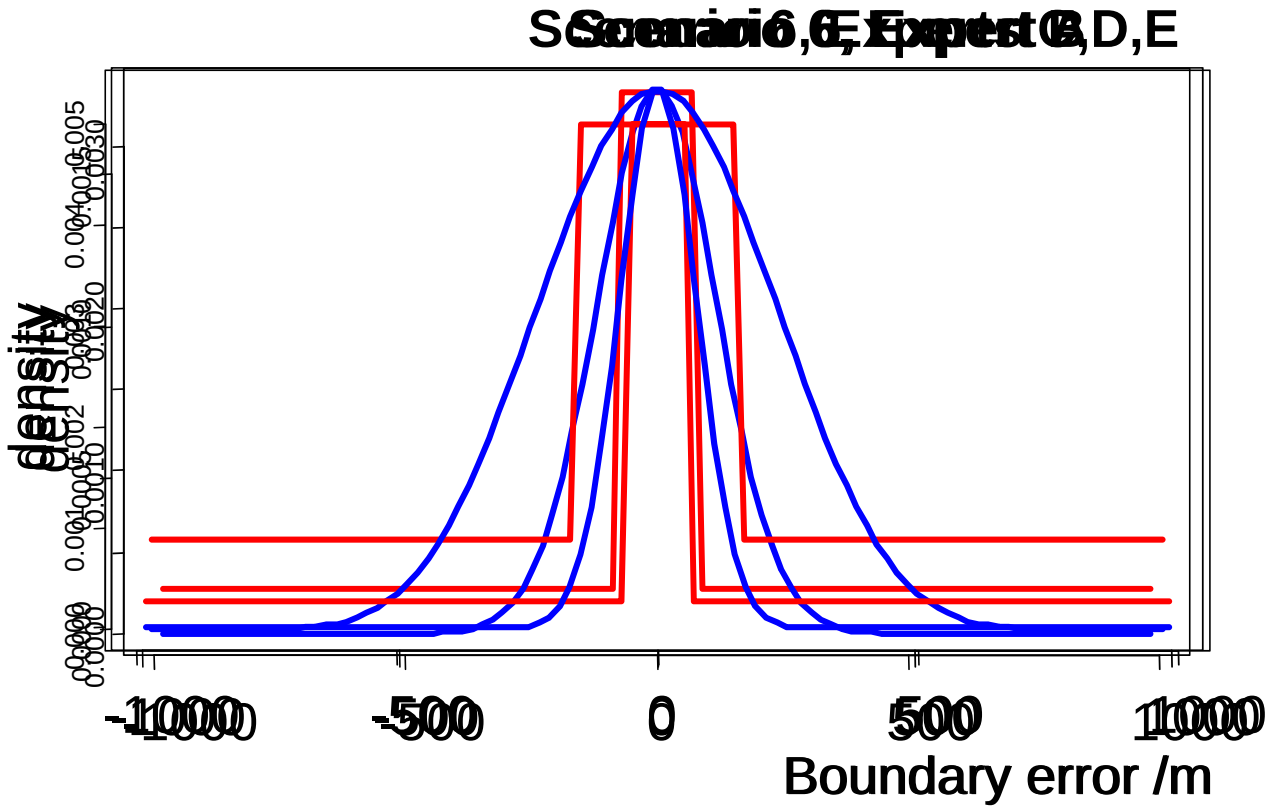

Scenario 2
density
0.00
0.01
0.02
0.03
-20
-10
0
10
20


Scenario 3
density
0.00
0.05
0.10
0.15
0.20
0.25
-4
-3
-2
-1
0
1


Scenario 4
density
0.000
0.002
0.004
0.006
0.008
-50
0
50


Scenario 5
density
0.000
0.005
0.010
0.015
0.020
0.025
0.030
-20
-10
0
10
20

The one that got away



Findings

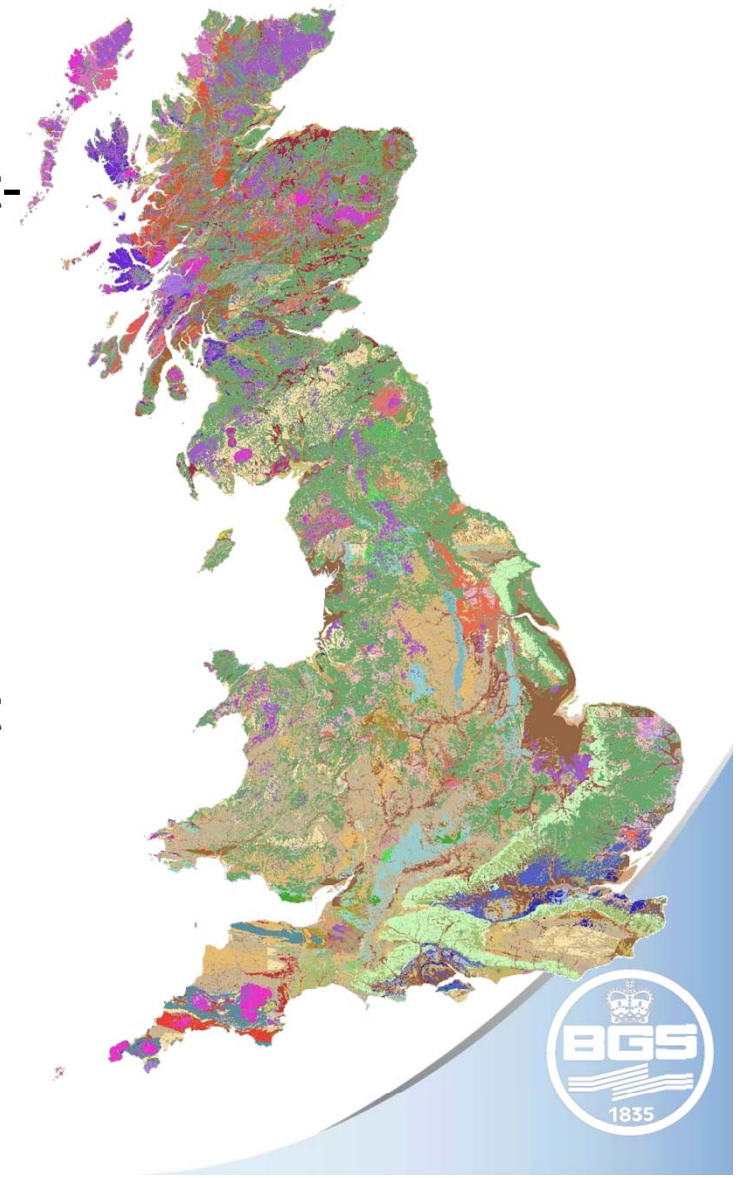
Scripting of scenarios needs to be precise and it takes time for the experts to step out of solving mapping ‘problems’ to imparting their tacit understanding of uncertainty.

In five cases it was possible to arrive at a consensus model, in a sixth case experts with different experience took different views of the nature of the mapping problem.

Structured elicitation can be used as a mechanism for knowledge transfer between experts and to others.

Next steps

- Complete further scenarios from the long-list
- Carry out a similar exercise where post-hoc geophysics (perhaps analysis of existing data) would allow us to compare the elicitation and a more objective measure of uncertainty
- Rethink how we try and explain uncertainty to users
- Consider visualisation mechanisms that we could use
- Utilise this technique to assist in knowledge transfer as staff demographic changes



Any questions?