British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

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

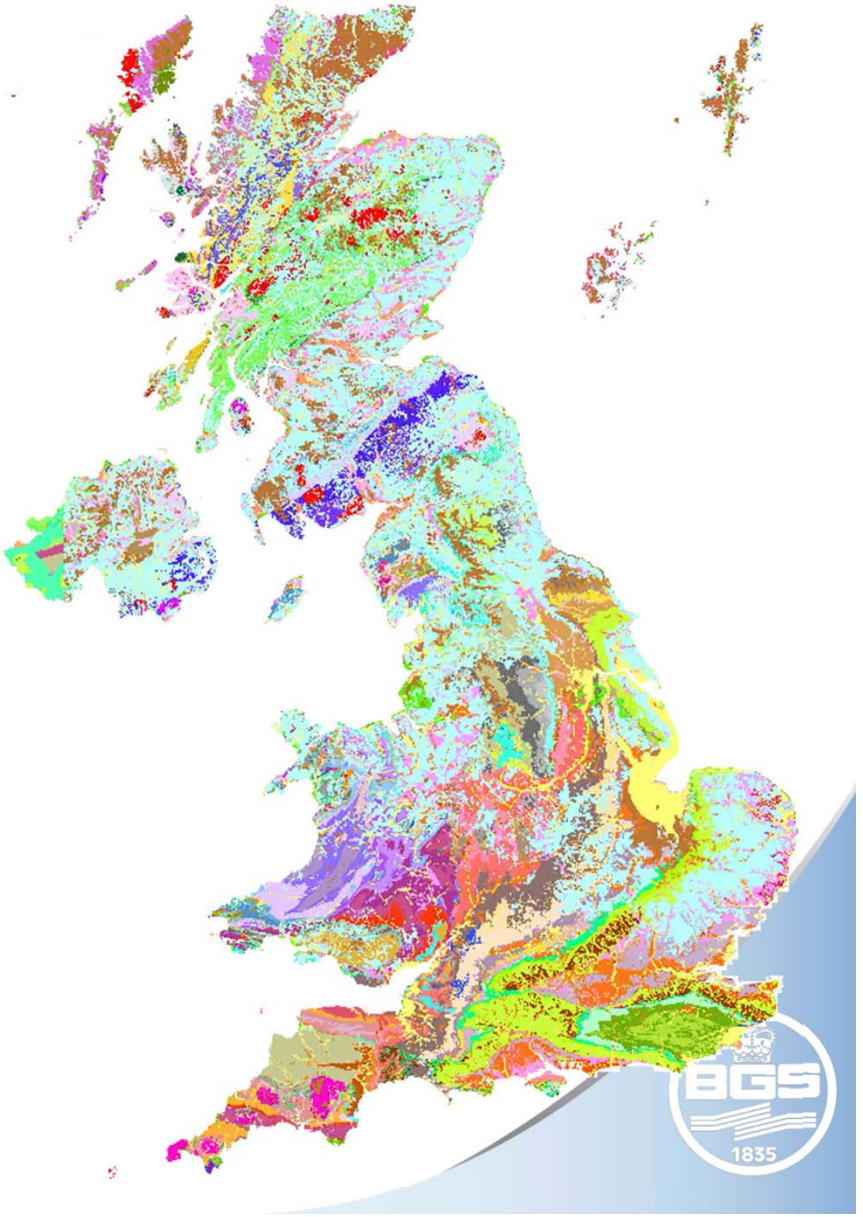
Russell Lawley, Mark Barron and Katy Lee

© NERC All rights reserved

View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by NERC Open Research Archive

Overview

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



© NERC All rights reserved

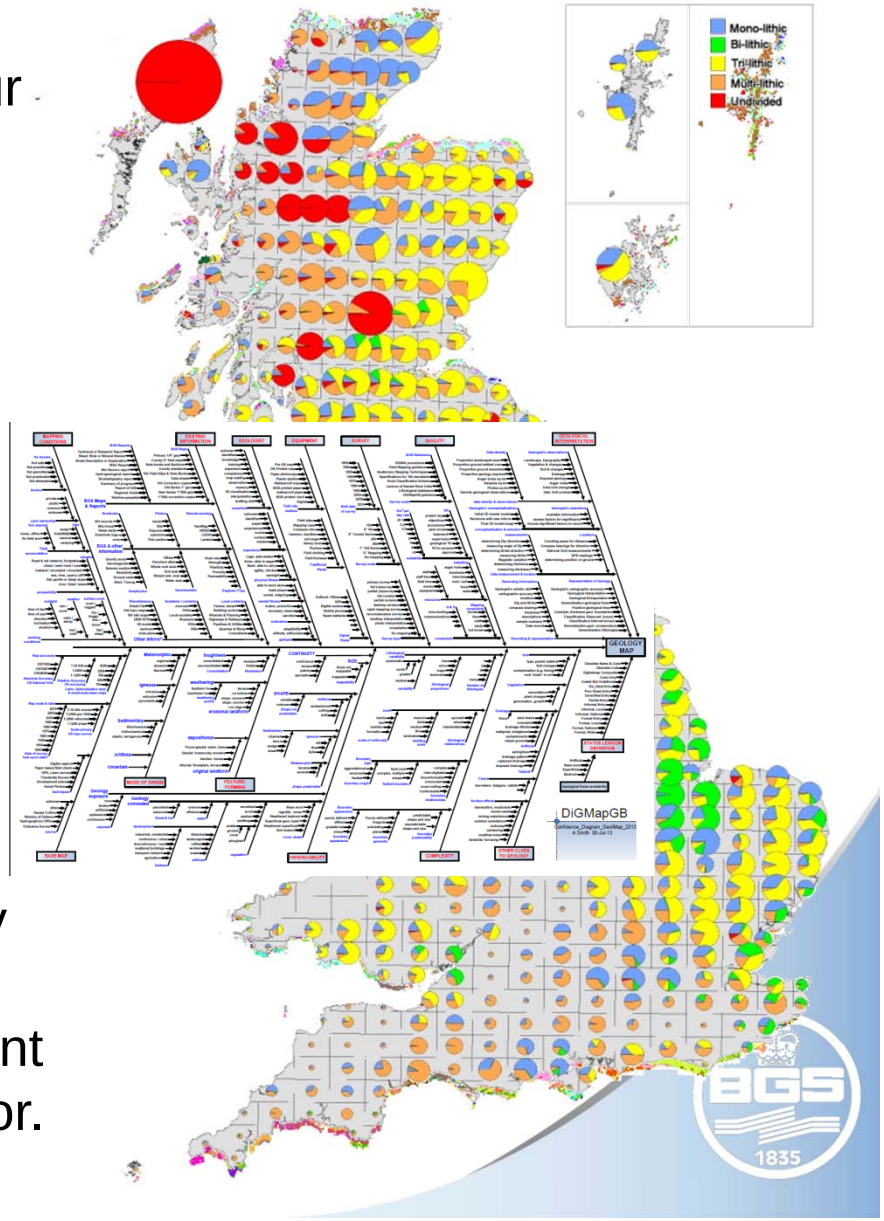
Drivers and Previous Use of EE

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.



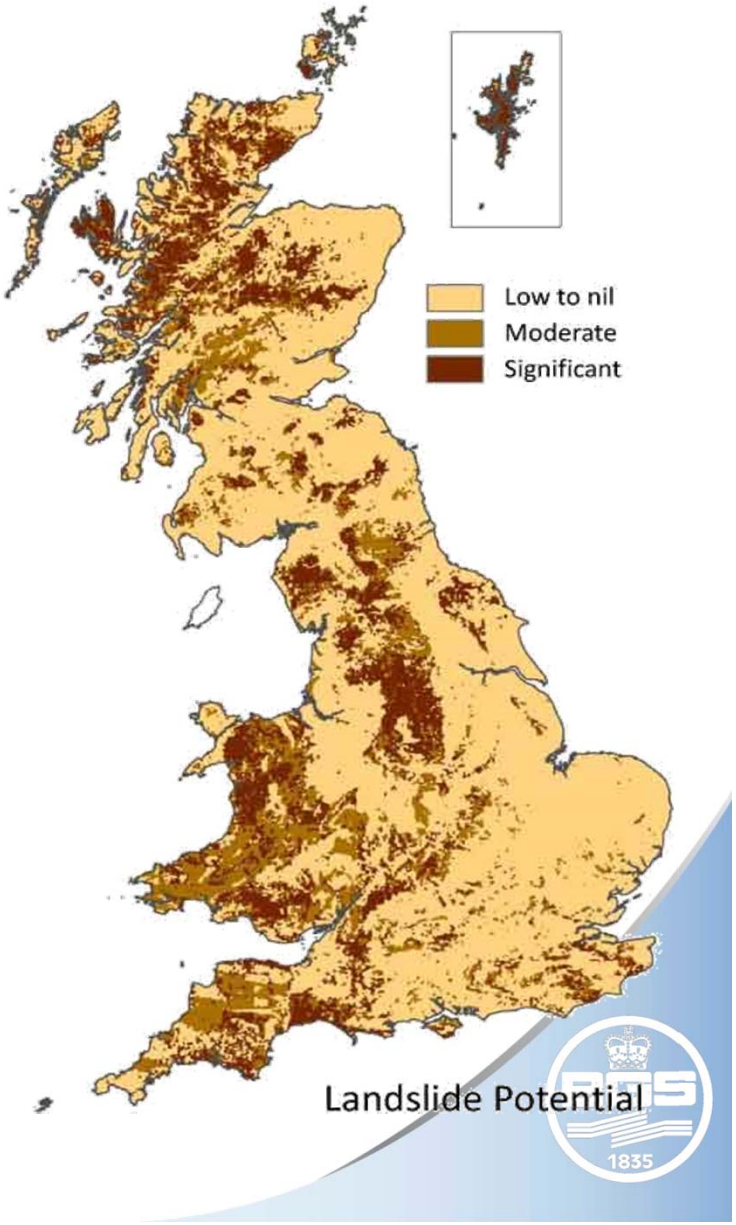
© NERC All rights reserved

Drivers and Previous Use of EE

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

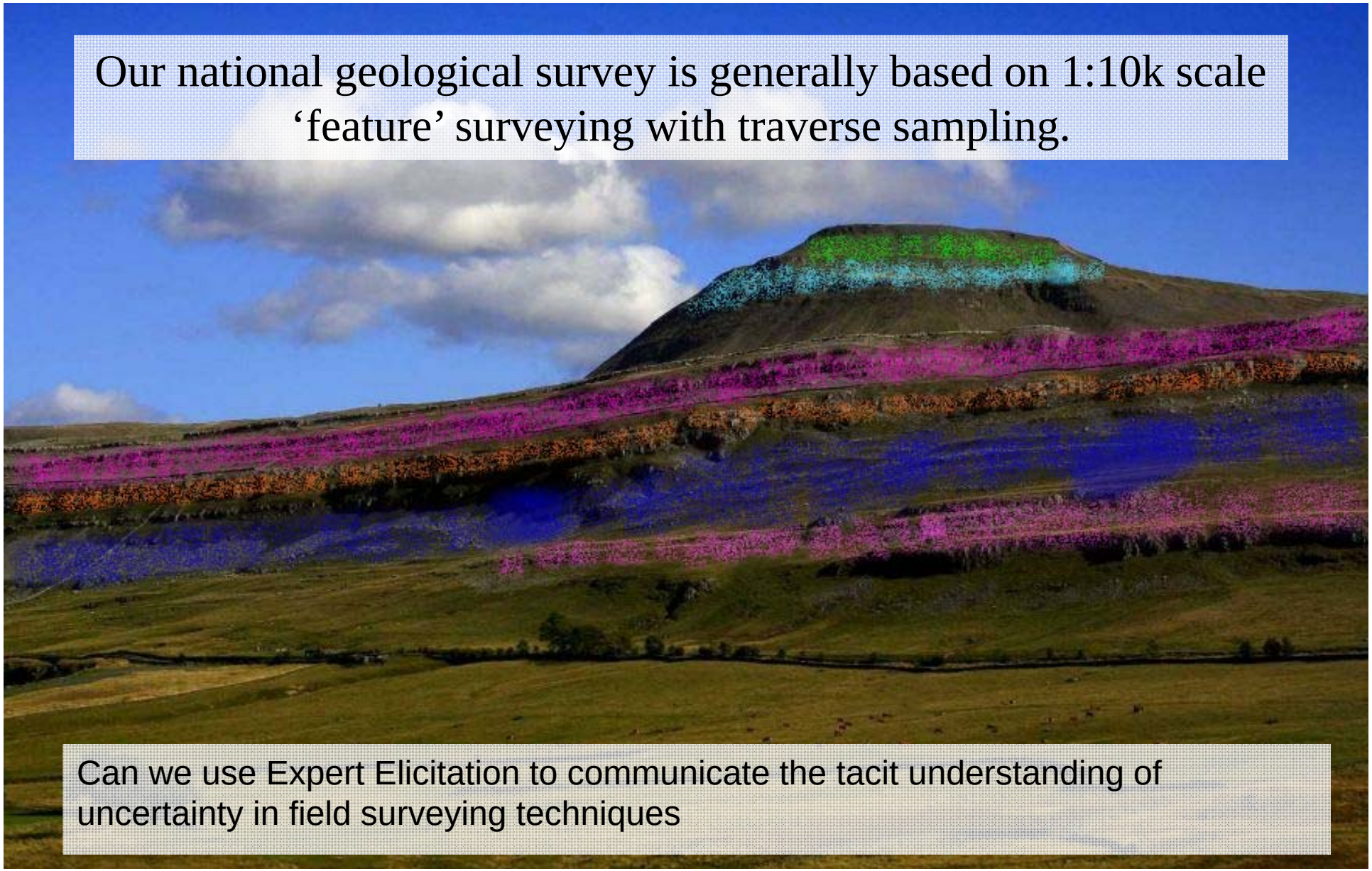
Modern surveying techniques capture some uncertainty metrics, but the mainstay of the survey is feature mapping.

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.



© NERC All rights reserved

Background



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

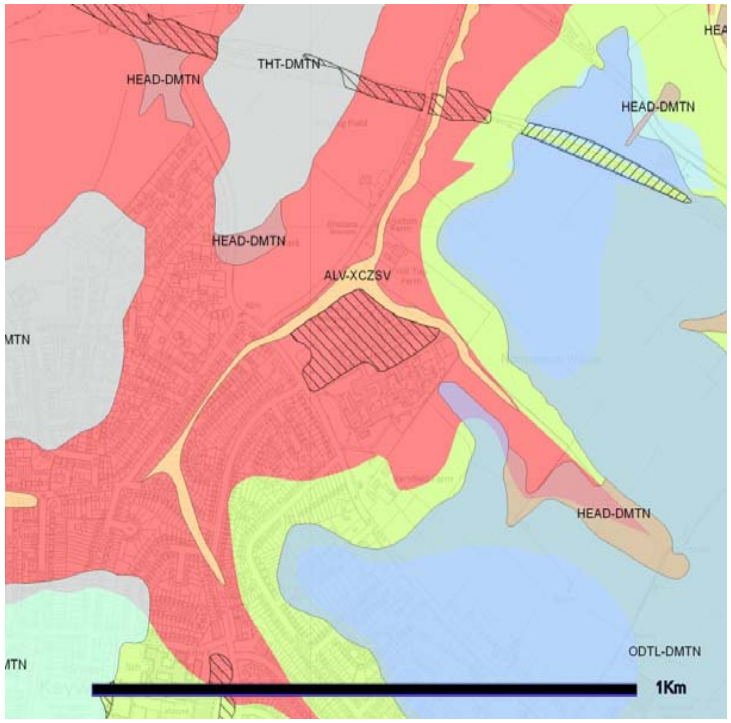
Can we use Expert Elicitation to communicate the tacit understanding of uncertainty in field surveying techniques

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

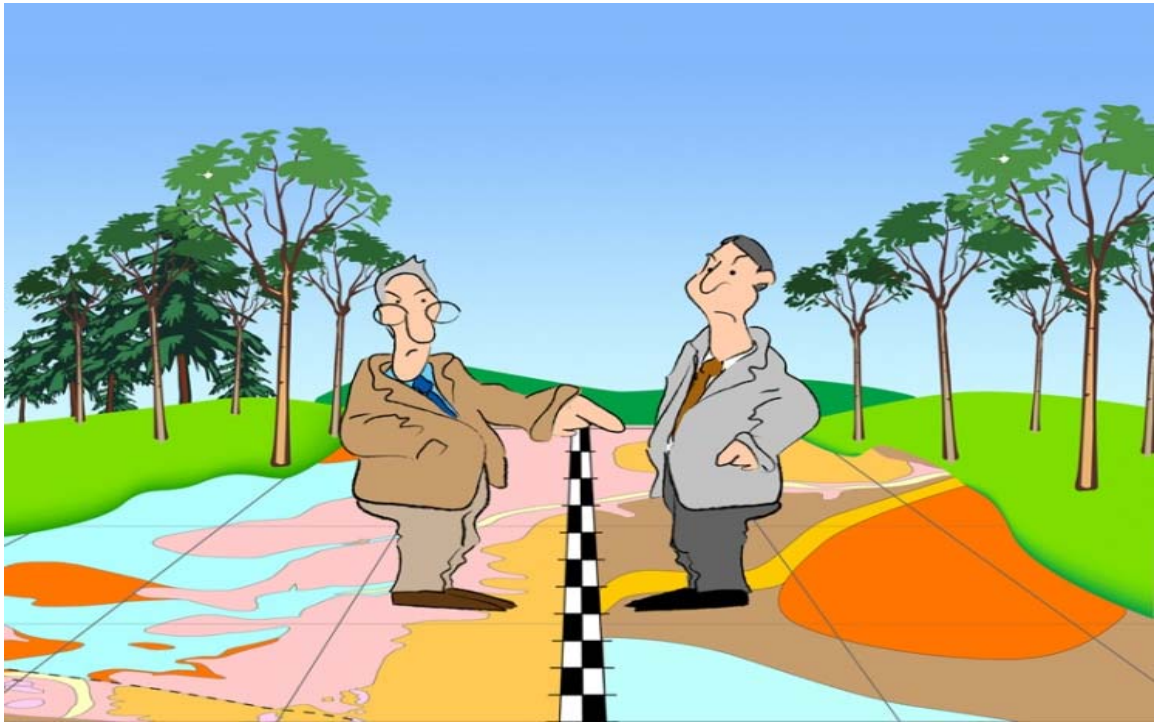


DiGMapGB-10
1:10,000 Scale

© NERC All rights reserved

SHeffield ELicitation Framework (SHELF)

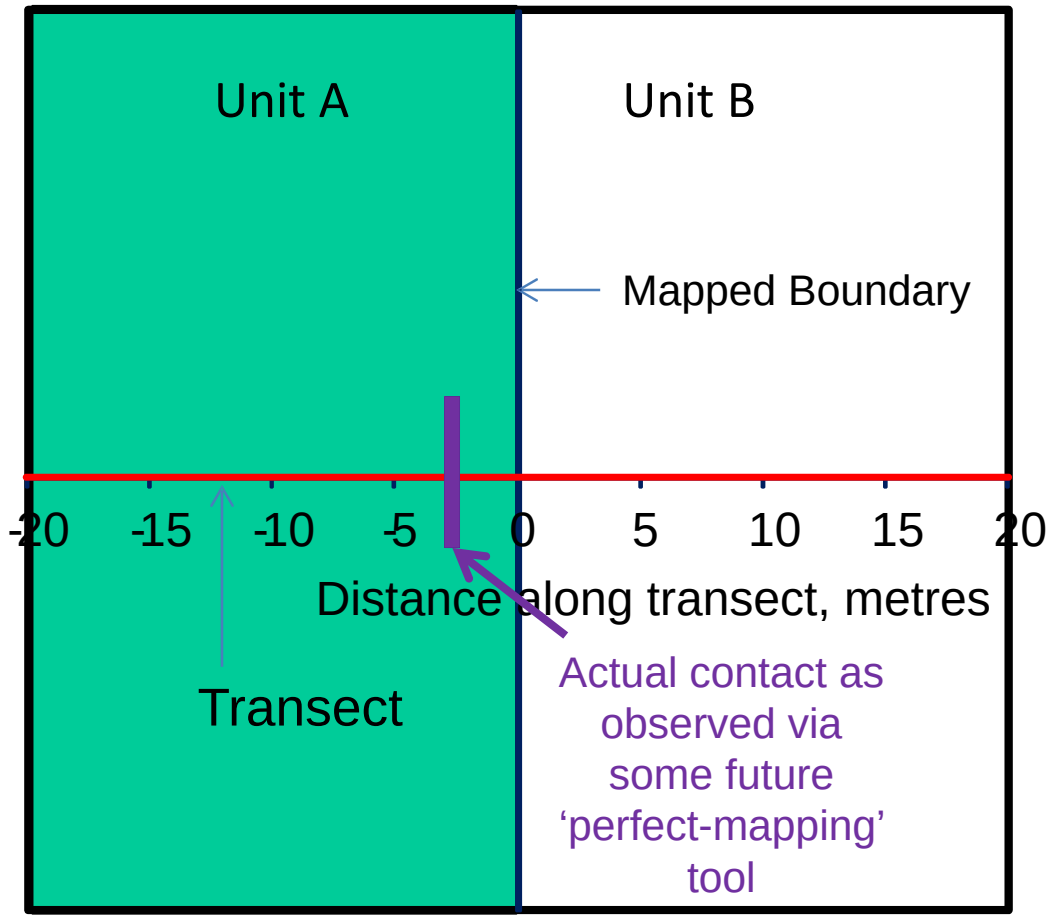
- SHELF quartile method using the R platform
- 5 experienced geologists with 130 years+ experience
- 2 facilitators
- A familiarisation exercise
- Structured, scripted analysis of each scenario



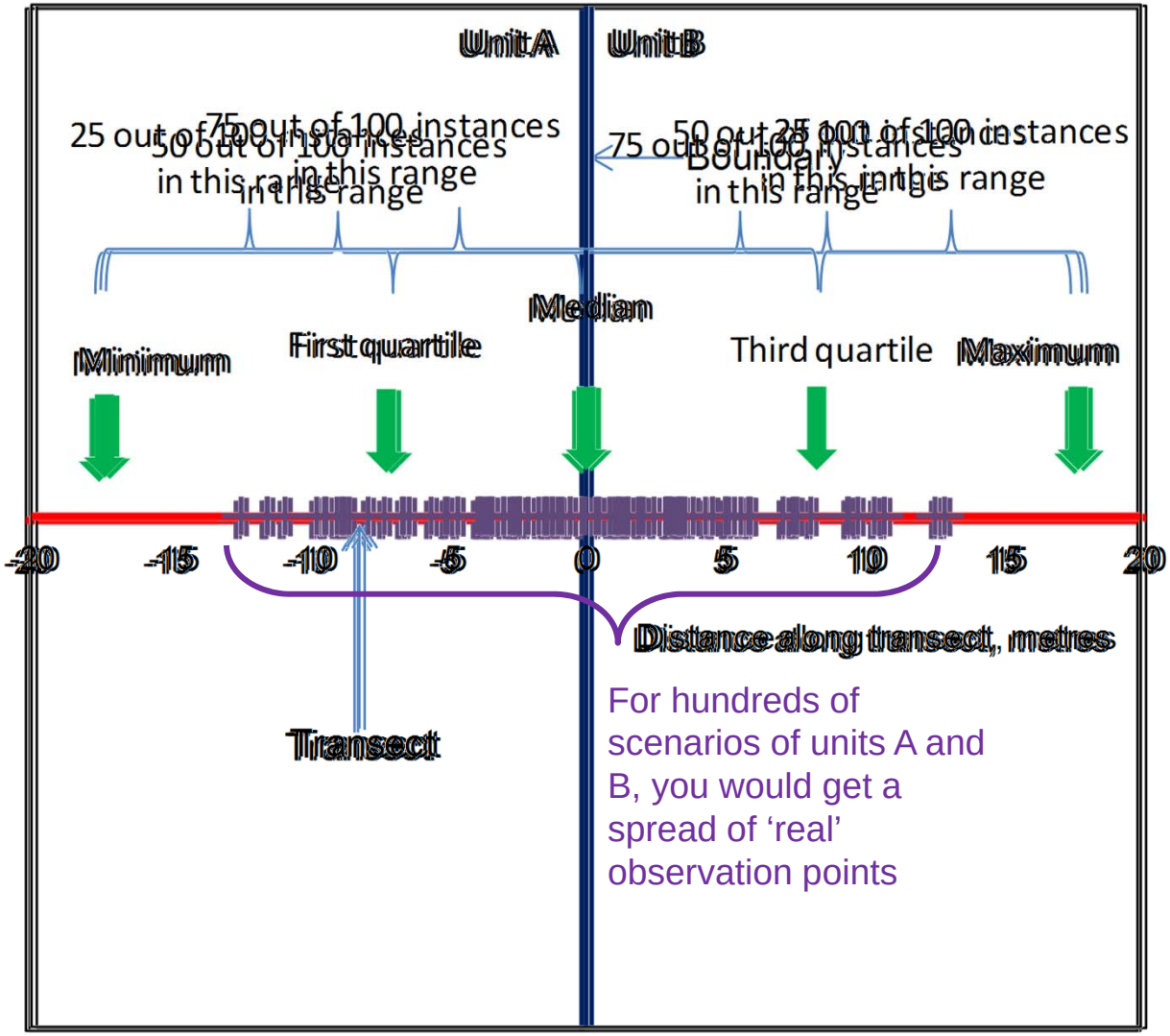
Oakley and O'Hagan, 2010 *R Development Core Team, 2008*

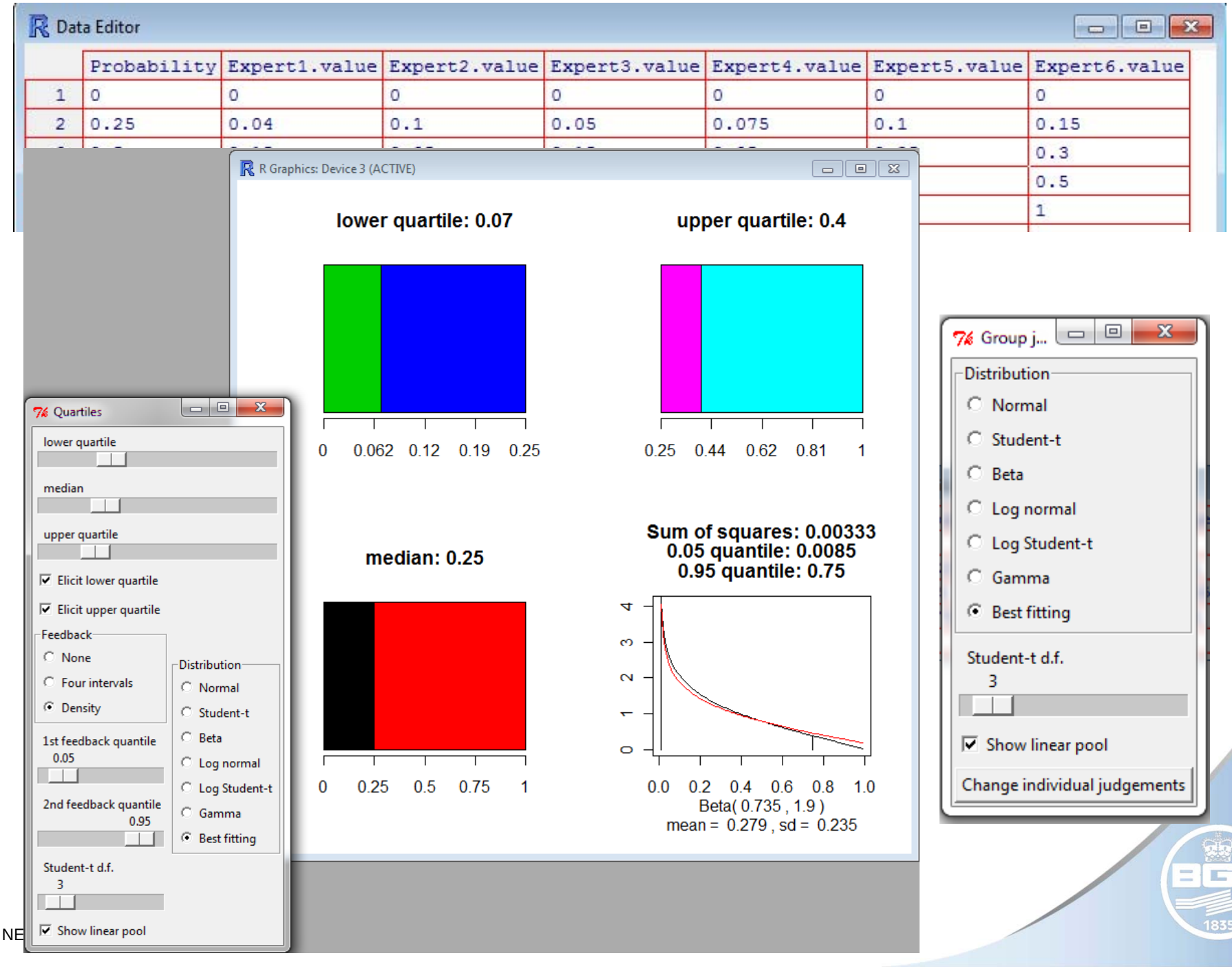
SHeffield ELicitation Framework (SHELF)

Consider a simple mapped boundary between 2 units



SHeffield ELicitation Framework (SHELF)



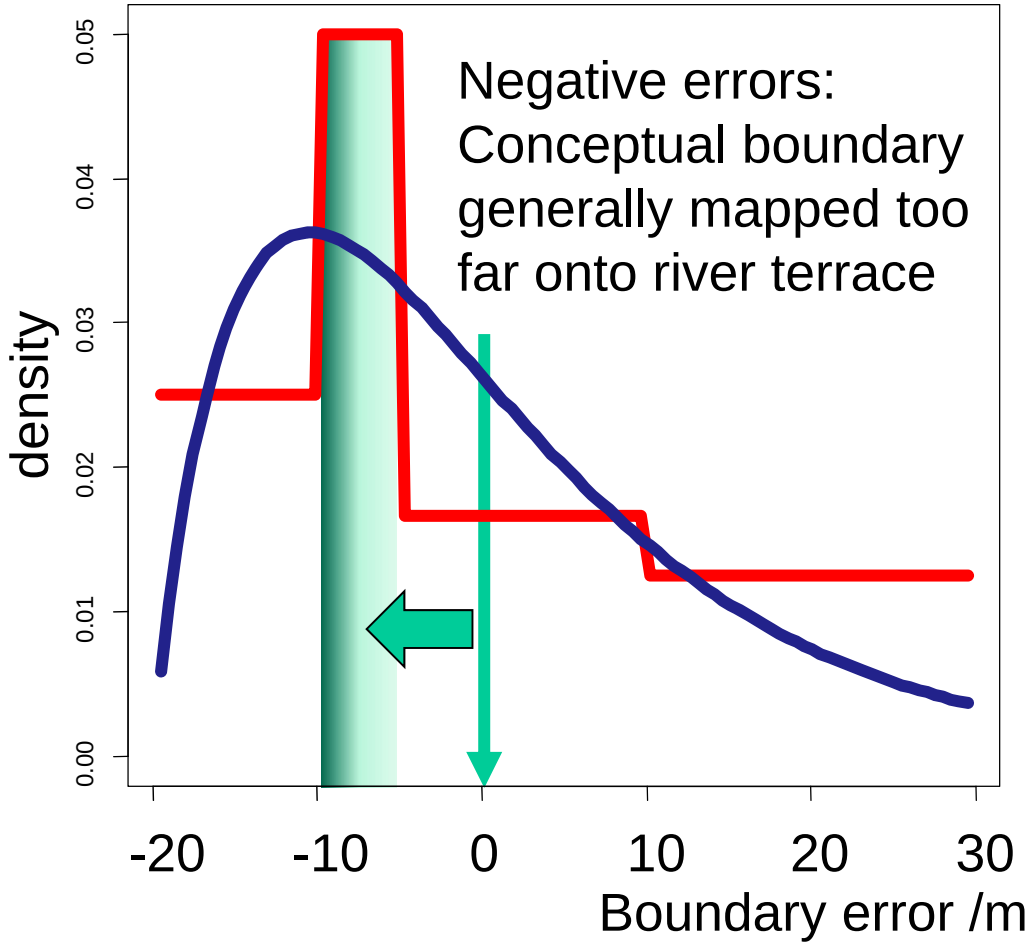

Data Editor
Probability Expert1.value Expert2.value Expert3.value Expert4.value Expert5.value Expert6.value
1 0 0 0 0 0 0 0
2 0.25 0.04 0.1 0.05 0.075 0.1 0.15
0.3
0.5
1
R Graphics: Device 3 (ACTIVE)
lower quartile: 0.07
0 0.062 0.12 0.19 0.25
upper quartile: 0.4
0.25 0.44 0.62 0.81 1
median: 0.25
0 0.25 0.5 0.75 1
Sum of squares: 0.00333
0.05 quantile: 0.0085
0.95 quantile: 0.75
0 1 2 3 4
0.0 0.2 0.4 0.6 0.8 1.0
Beta(0.735 , 1.9)
mean = 0.279 , sd = 0.235
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

© NE

Scenario outputs

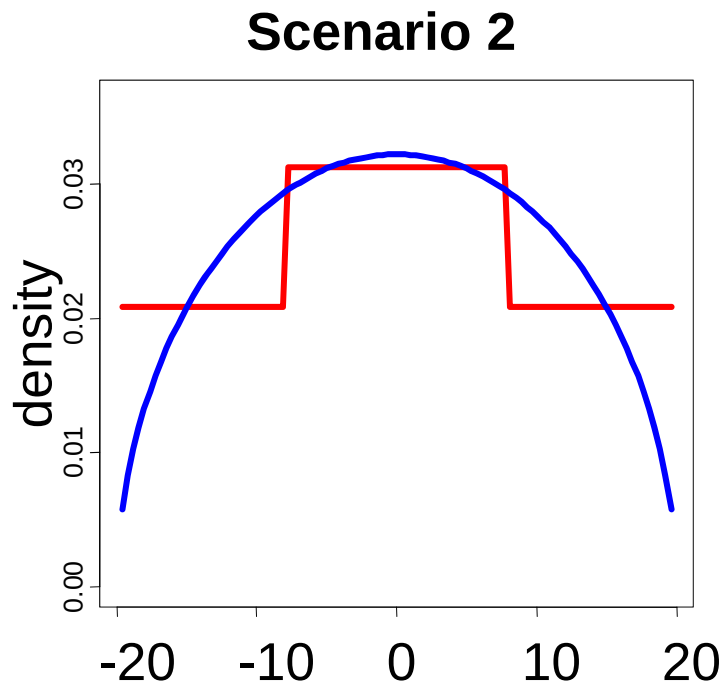
Pronounced cluster of boundary errors between 5 and 10 m onto the river terrace

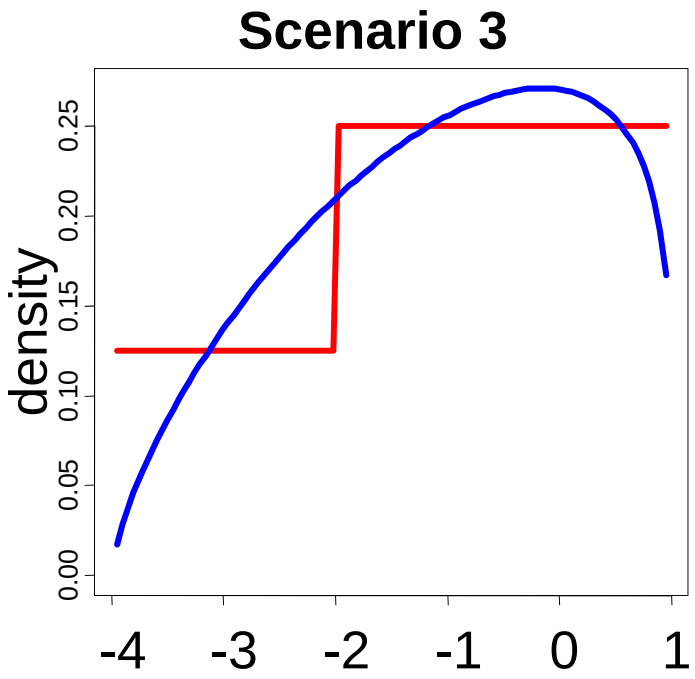
Scenario 1

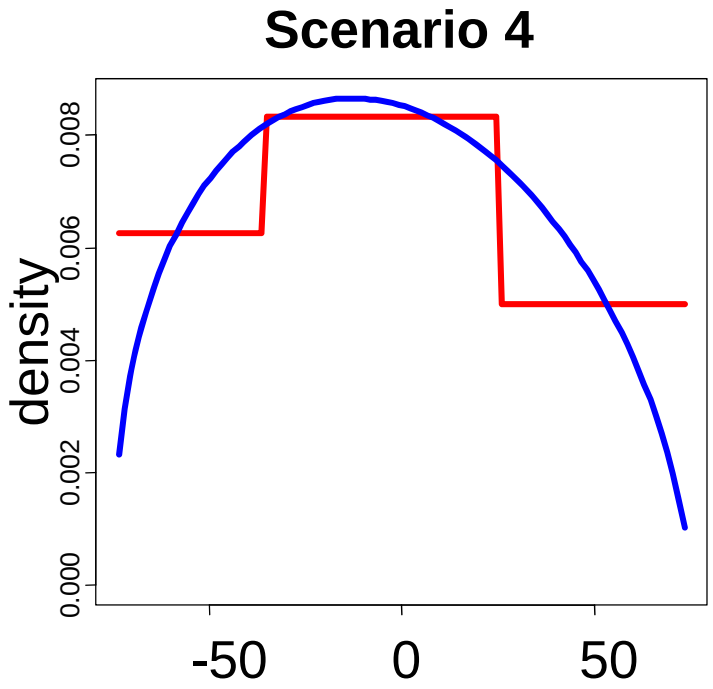


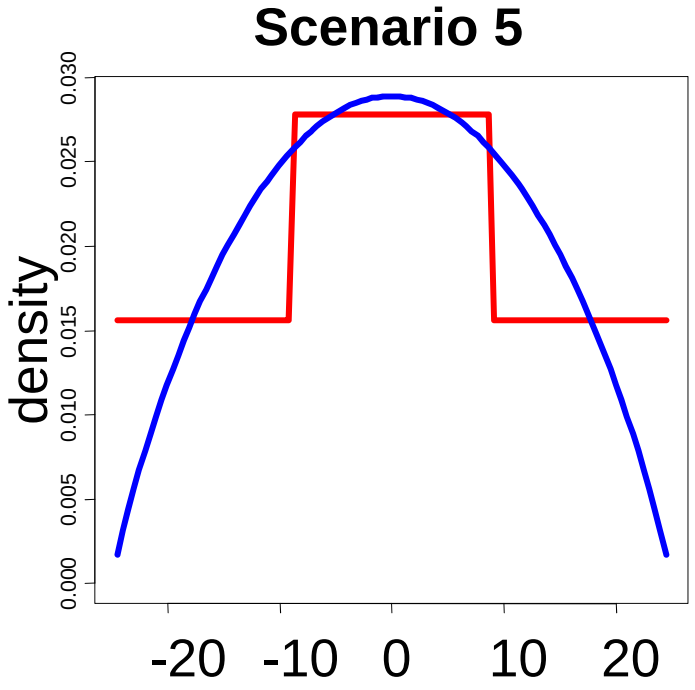
Quartile 1: –10; Median: –5; Quartile 3: 10.
Interval expected to include 95% of all intersections [–17.8,37.2]

© NERC All rights reserved

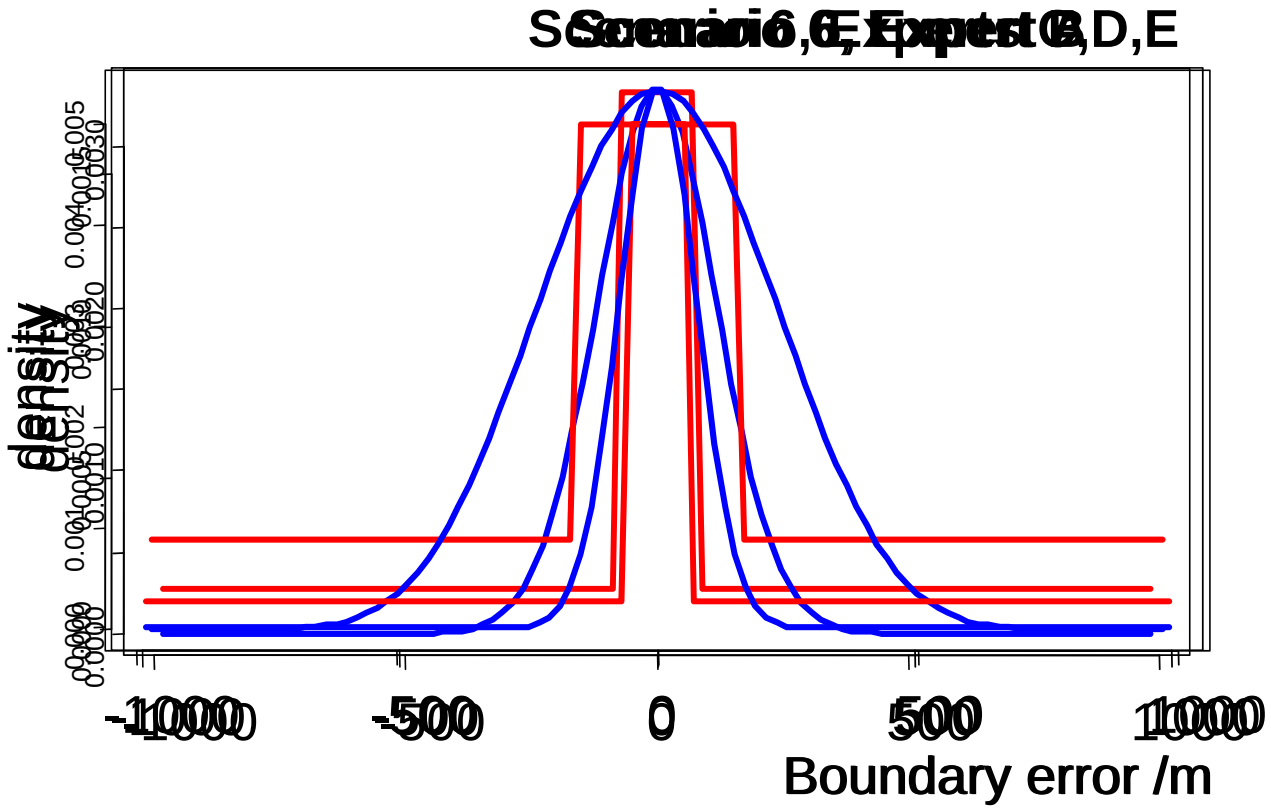

Scenario 2
density
0.00
0.01
0.02
0.03
-20
-10
0
10
20


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



© NERC All rights reserved

Findings

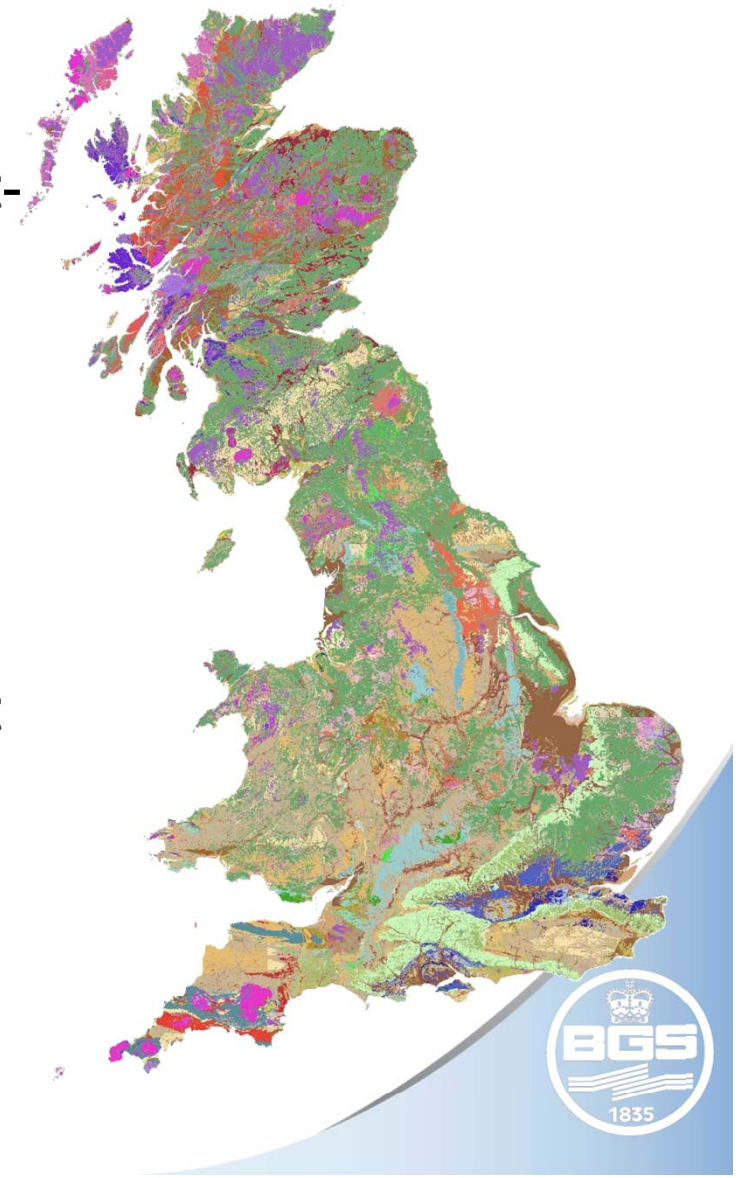
Scripting of scenarios needs to be precise and it takes time for the experts to step out of solving mapping ‘problems’ to imparting their tacit understanding of uncertainty.

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



© NERC All rights reserved

Any questions?

© NERC All rights reserved