Do different geologists see the same fractures? Quantifying subjective bias in fracture data collection.

B. J. Andrews[1], J.J Roberts[1], Z.K. Shipton[1], S. Bigi[2], M.C. Tartarello[2], G. Johnson[1,3]

1) University of Strathclyde 2) Sapienza University of Rome 3) University of Edinburgh

E-mail: Billy.Andrews@strath.ac.uk

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How do we see fractures? Quantifying subjective bias in fracture data collection

Billy J. Andrews[1], Jennifer J. Roberts[1], Zoe K. Shipton[1], Sabina Bigi[2], M. Chiara Tartarello[2], and Gareth Johnson[1,3]

[1]Department of Civil and Environmental Engineering, University of Strathclyde, Glasgow, G11XJ, Scotland
[2]Department of Earth Science, Sapienza University of Rome, P.le Aldo Moro, 5, 00185 Rome, Italy
[3]School of GeoSciences, University of Edinburgh, Edinburgh, EH93FE, Scotland

Correspondence: Billy J. Andrews (billy.andrews@strath.ac.uk)

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If you want to know more…
…You can take a look at the paper

https://doi.org/10.5194/se-10-487-2019

Workflow for fracture modelling

Does subjective bias impact fracture observation?

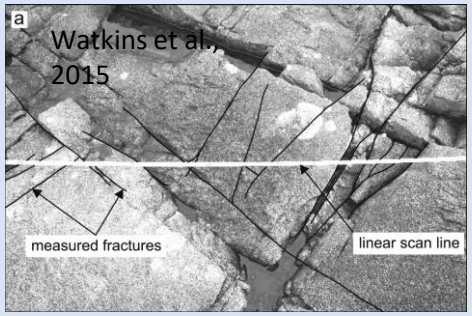
How much do output statistics vary between geologists?

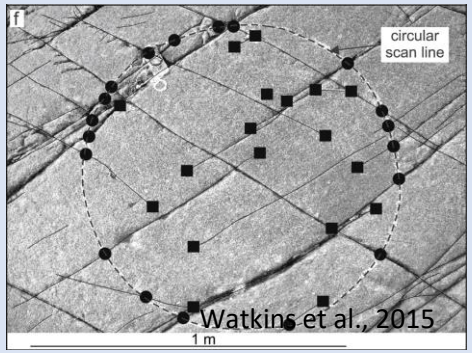
1. Lineament mapping

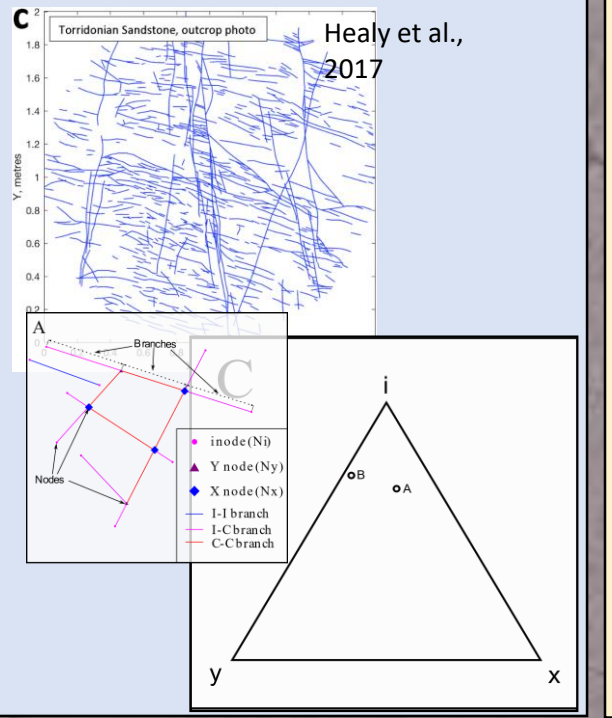
2. Data analysis (e.g. topology, trace length)

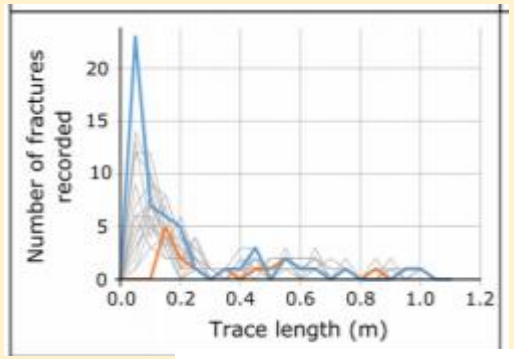
3. Fracture statistics (e.g. trace length distributions)

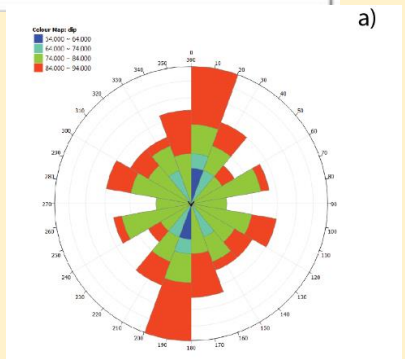
4. DFNs and upscaled permeability

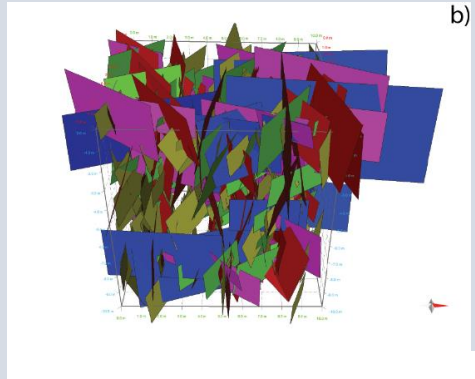


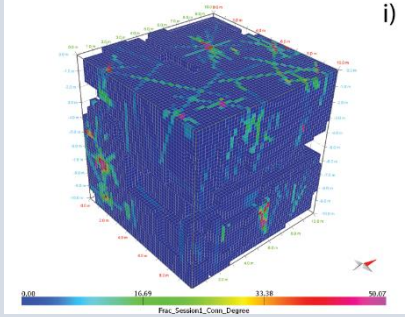












Inputs

Outputs

Do we all see the same fracture network?

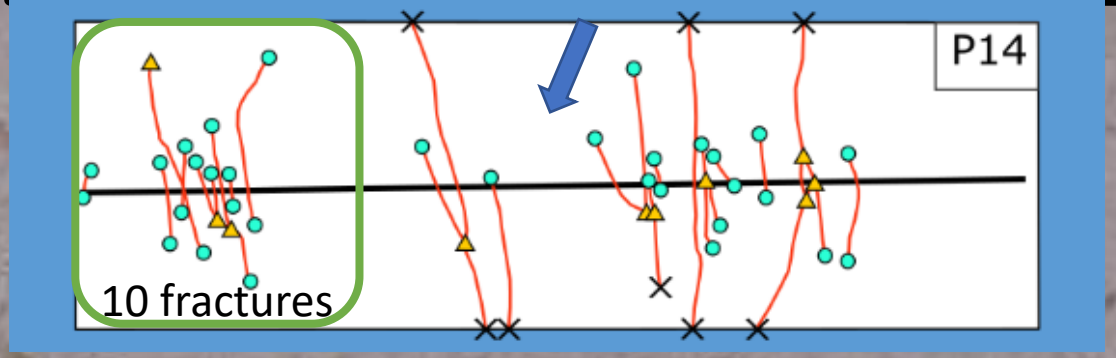
Clean scanline

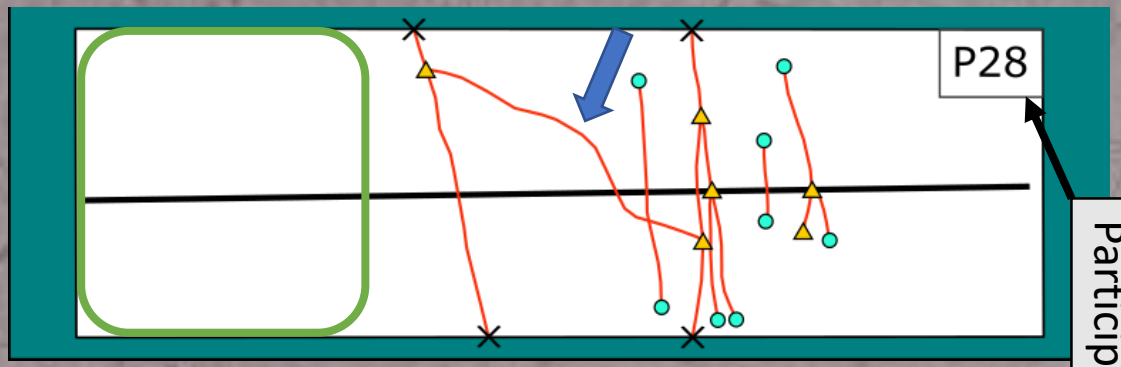
Dense or sparse fracture network?

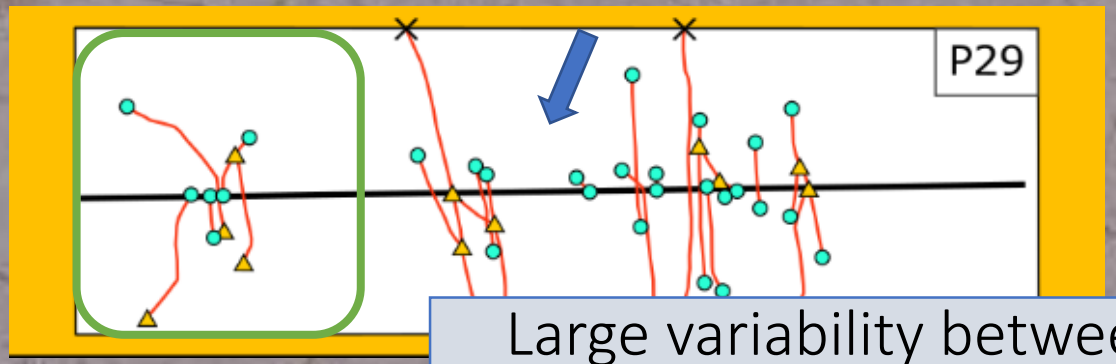
Is this a fracture?

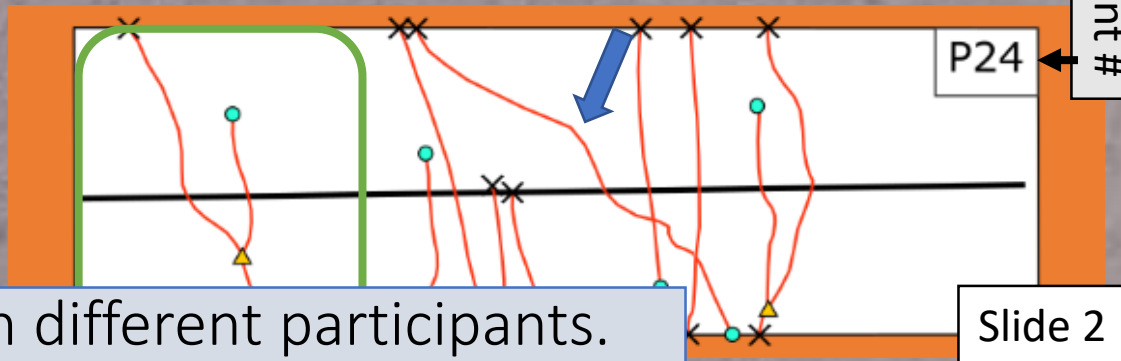
- Fracture termination obscured
- Fracture terminated into rock (i-node)
- Fracture abuts against another fracture (y-node)
- Fracture trace

Participant interpretations





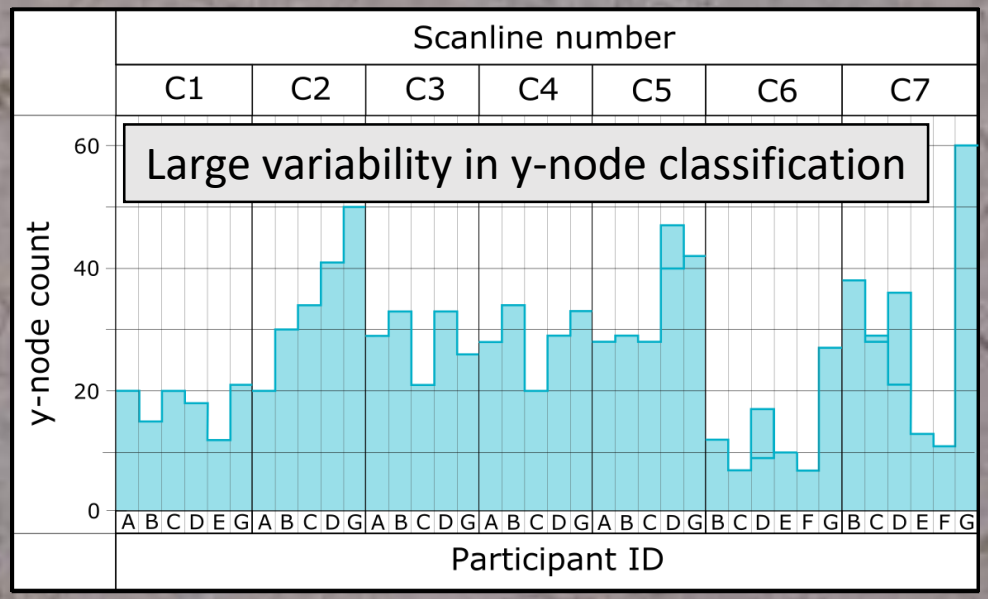


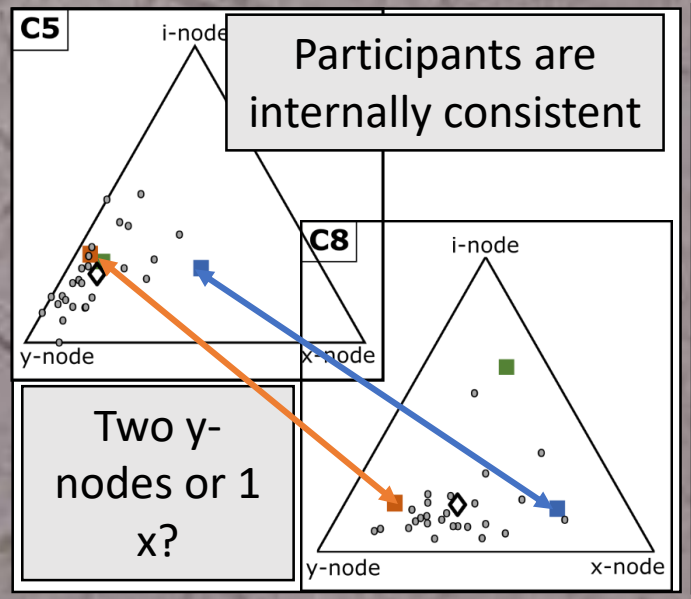


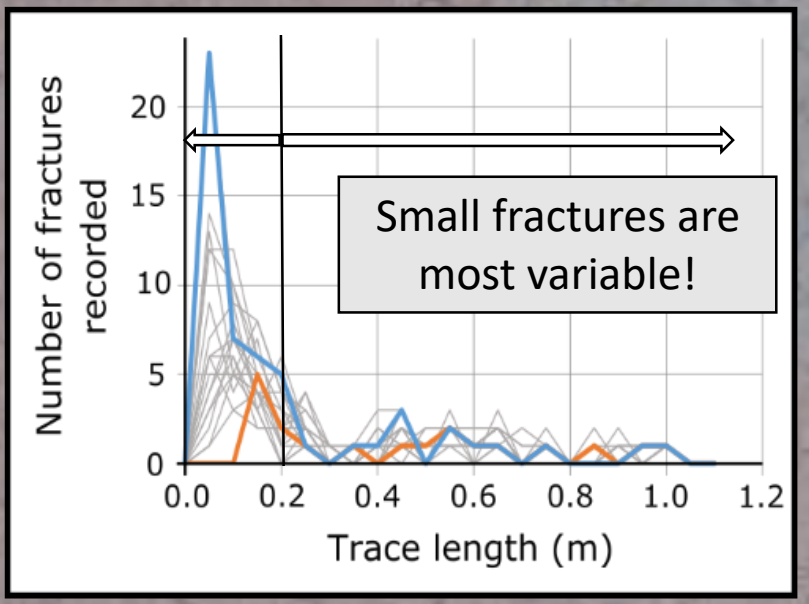
Participant #

Large variability between different participants.

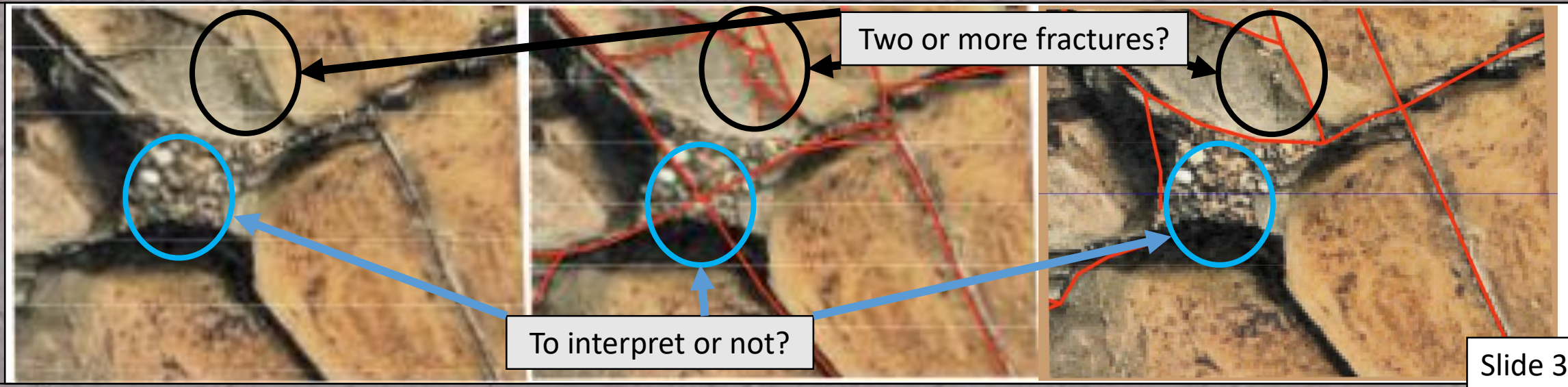
Why do we see different fractures?







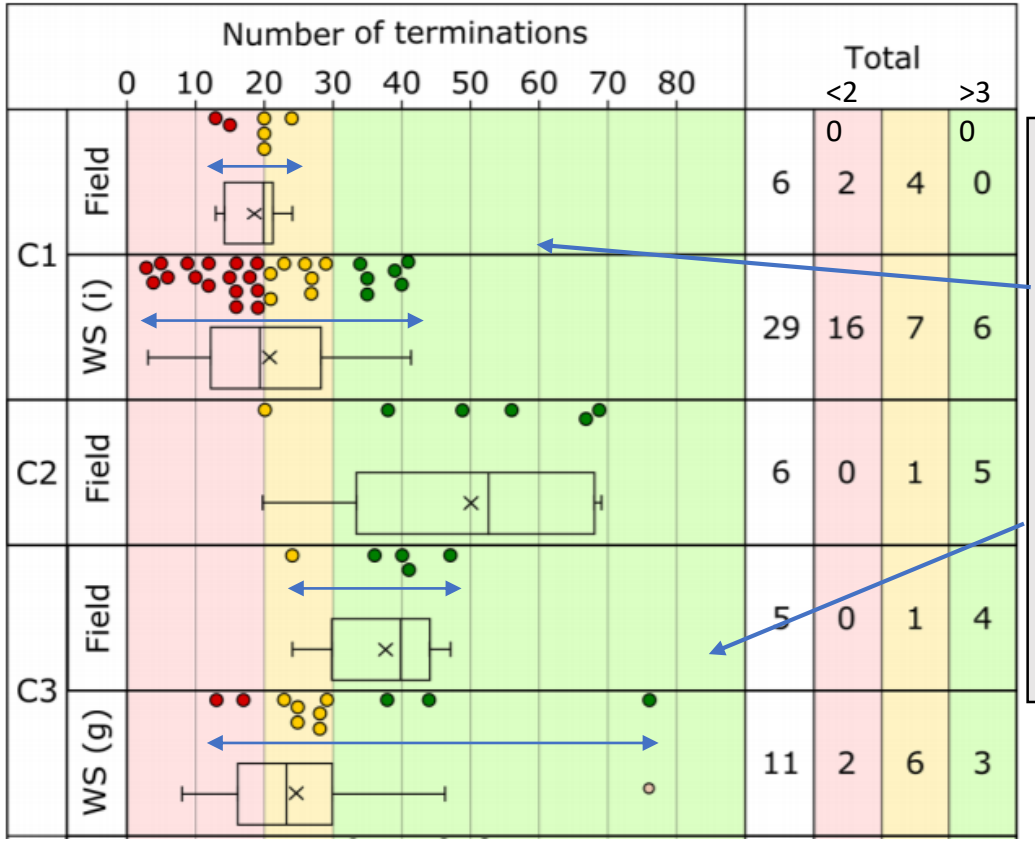
Areas of increased uncertainty



Slide 3

Is a circular scanline representative (Ni + Ny > 30)?

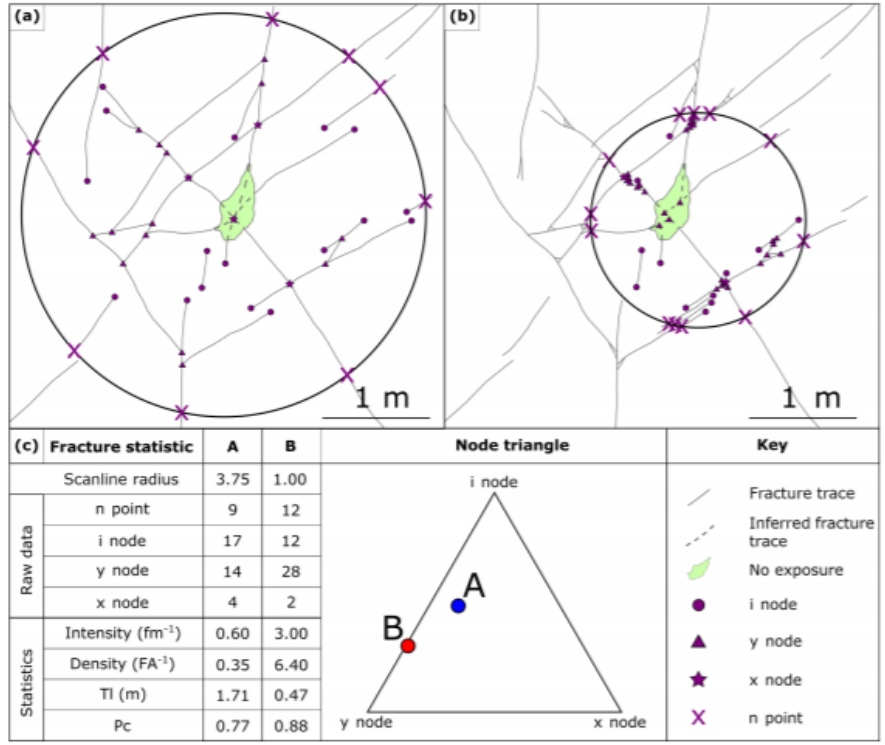
Variability between the number of recorded fracture terminations.



Subjective bias greatly effects fracture observation!

Both circles are representative (terminations > 30)

Large differences in statistics and topology



The diameter of a representative circular scanline is not only dependent on the fracture network, but also the geologist collecting the data.

RQ2: How does subjective bias impact output statistics?

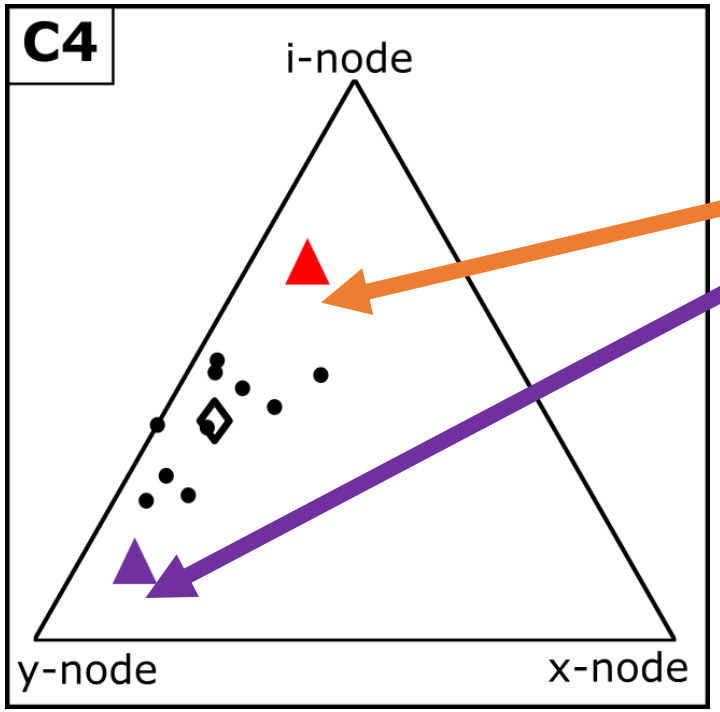
Statistic	Circular scanline – topology	Circular scanline – window	Linear scanline
Intensity	Very low to low variability when derived from field data and low to moderate when workshop data are used. For Circles 1, 4, and 5 the calculated intensity from workshop and field data were very similar; however, the calculated intensity for Circle 3 was much lower in the workshop. In all cases ranges are greater when workshop data are used, particularly for Circles 1 and 5.	Low spread between participants within circles. In all cases, apart from Circle 4, intensity calculated using window sampling is lower than that derived for node counting for a given circle.	Variability, which ranged from very low to high, depends on the scanline being sampled. For example, Lines 3–5 are all low intensity and have a small range.
Density and spacing	Low to high spread when derived from field data and moderate to very high when workshop data are used. Density calculated from workshop in all cases apart from Circle 1 is lower than when calculated from field data.	Moderate to high spread. Values consistently higher in workshop data when window sampling data are used compared to node counting, particularly Circle 8. Can be comparable to field density (Circle 4) or considerably higher (Circle 1).	Variability in mean spacing values depends on the scanline being sampled, ranging from very low to very high. Maximum reported spacing had low spread, whereas minimum spacing ranged from low to extreme variability depending on the scanline being sampled. Equally large range in workshops and field.
Mean trace length	Low to moderate spread when derived from field data and moderate to high when workshop data are used. How similar the range in reported values is between workshop and field data varies for different circles.	Moderate spread across all circles. The extremes in the ranges observed in mean trace length estimates are considerably lower than for node counting. Of all methods window sampling provides the smallest estimate for mean trace length.	Moderate to highly variable for most scanlines. Equally large range in workshops and field. Maximum reported trace lengths generally much larger than for other methods due to the different scale of observation.
Connectivity	Very low spread between circles, methods, and settings (field vs. workshop).	Not assessed separately from node classifications.	Spread depends on the scanline being sampled and ranges from very low to extremely variable. Equally large range in workshops and field.

- Output statistics are variably effected by subjective bias depending on the statistic and the method used to collect the fracture data.
- Less variability is observed in fracture data collected from the field.
- Trace length and fracture density are greatly effected by subjective bias, intensity is less so.
- Window sampling appears to be least impacted by subjective bias.

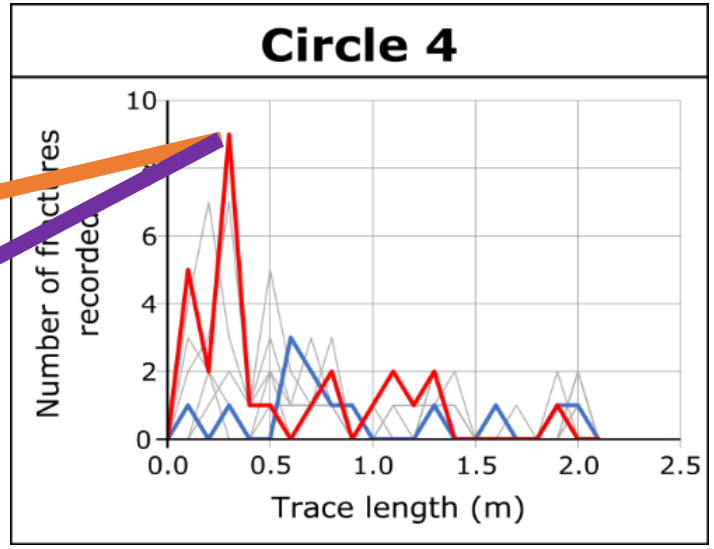
Recommendations for reducing subjective bias

1. Draw out the network in the field

2. Consider topology



3. Consider Tl distribution



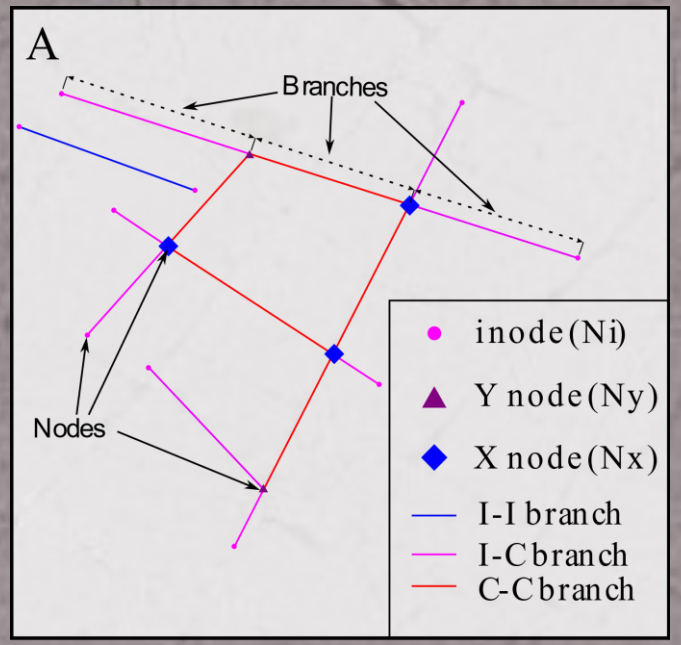
Small fractures isolated

Small fractures connected

4. Consider the cogitative biases of team members in collaborative work and amend fracture networks where applicable to reduce biases in output statistics.

Have a go.. How many fractures do you see?

How many fracture traces, n-, i-, y- and x-nodes would you interpret in the circle?



Lets discuss!

How would you interpret the age relationships?

Drone data courtesy of Dave Healy from the University of Aberdeen, Scotland