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

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The characterisation of natural fracture networks using outcrop analogues is important in understanding subsurface fluid flow and rock mass characteristics in fractured lithologies. It is well known from decision sciences that subjective bias can significantly impact the way data is gathered and interpreted, introducing scientific uncertainty.

This study investigates the scale of and nature of subjective bias on fracture data collected by geoscientists using four commonly used approaches (linear scanlines, circular scanlines, topology sampling and window sampling) both in the field and in workshops using field photographs.

We observe considerable variability between each participant's interpretation of the same scanline, and this variability is seen regardless of participants' level of geological experience. Geologists appear to be either focussing on the detail or focussing on gathering larger volumes of data; personal character traits that affect the recorded fracture network attributes. As a result, the fracture statistics that are derived from field data can vary considerably for the same scanline, depending on which geologist collected the data. Additionally, the personal bias of geologists collecting the data affects the scanline size (minimum length of linear scanlines, radius of circular scanlines or area of a window sample) needed to collect a statistically representative amount of data.

Based on our findings and on understanding of bias reduction in decision sciences, we suggest protocols to recognise, understand and limit the effect of subjective bias on fracture data biases during data collection.

Our work shows the capacity for cognitive biases to introduce uncertainty into observation-based data. Fracture statistics derived from field data often inputs into geological models that are used for a range of applications, from understanding fluid flow to characterising rock strength, and so these uncertainties have ramifications for propagation into a range of outcomes. Importantly, our findings that personal bias can affect data collection have implications well beyond the geosciences.