Oral presentation

Reducing uncertainty in fracture modelling: assessing the sensitivity of inputs from outcrop analogues

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The conceptual understanding gained from outcrop analogues provides crucial insights into natural fracture networks, which are difficult to appreciate from borehole data alone, especially in areas of exploration where wells are sparse and knowledge of the reservoir is minimal. However, the interpretation of geological data almost invariably involves human input, which introduces interpreter bias into the workflow (Bond et al. 2007a,b). Therefore to reduce the uncertainty that is inherent in data derived from analogue outcrop studies, the degree to which different interpreters may affect the resultant outputs must be understood, and non-geological variations need to constrained and mitigated. We apply this approach to quantify the variability in fracture network interpretations derived from satellite imagery, using a population of geologists of varying levels of expertise and experience.

In each example within this study we asked all participants to pick fractures from the same satellite image, and then compared their results. Two examples are shown in Figs. 1A and 1B. We selected examples of different fractured carbonate units with varying degrees of image quality. The interpreters picked the areas of interest under the same conditions. In our analysis of the results, we focus on the variations in topology, orientation, intensity and length within the resultant fracture network that each participant picked. We illustrate the implications of the variability with respect to DFN modelling, and suggest strategies to standardise fracture interpretations to reduce picker-bias, by post-processing the picks using a topological correction and linkage algorithm. We also asked participants to complete a short questionnaire to assess their level of background knowledge of structural geology and experience of fracture picking; however at this stage in our analysis we are only able to make preliminary inferences on causes of the variations, due to small sample sizes.

As expected, we see significant variability in the interpretative picks from different geologists (e.g. Figs. 1C and 1D). The degree to which this variability affects fracture modelling is addressed with respect to orientation, connectivity, and length-intensity scaling. The biggest variation arose as a consequence of how different people digitised closely spaced fractures (fracture arrays), and which fractures people chose to pick (affecting intensity, for example). Two endmember styles were present in the interpretative picking of fracture arrays; either to pick many segmented co-aligned fractures, or to pick a single fracture spanning long distances. This difference in picking style has a profound effect on inferred size-intensity scaling relations, and there is an approximate three-fold range in picked fracture intensity within a single area of interest.

By applying a topological and linkage correction to the picked data the variance in the measured parameters decreased. However, significant variations in bulk fracture properties still existed in the post-processed interpretations. Variability might be further mitigated by improved training of inexperienced pickers by fracture experts, or by expert-led implementation of machine learning algorithms. Understanding the use-case for a specific fracture study is important: the human aspect of uncertainty in fracture modelling can and should be minimised at all stages in the interpretation process.

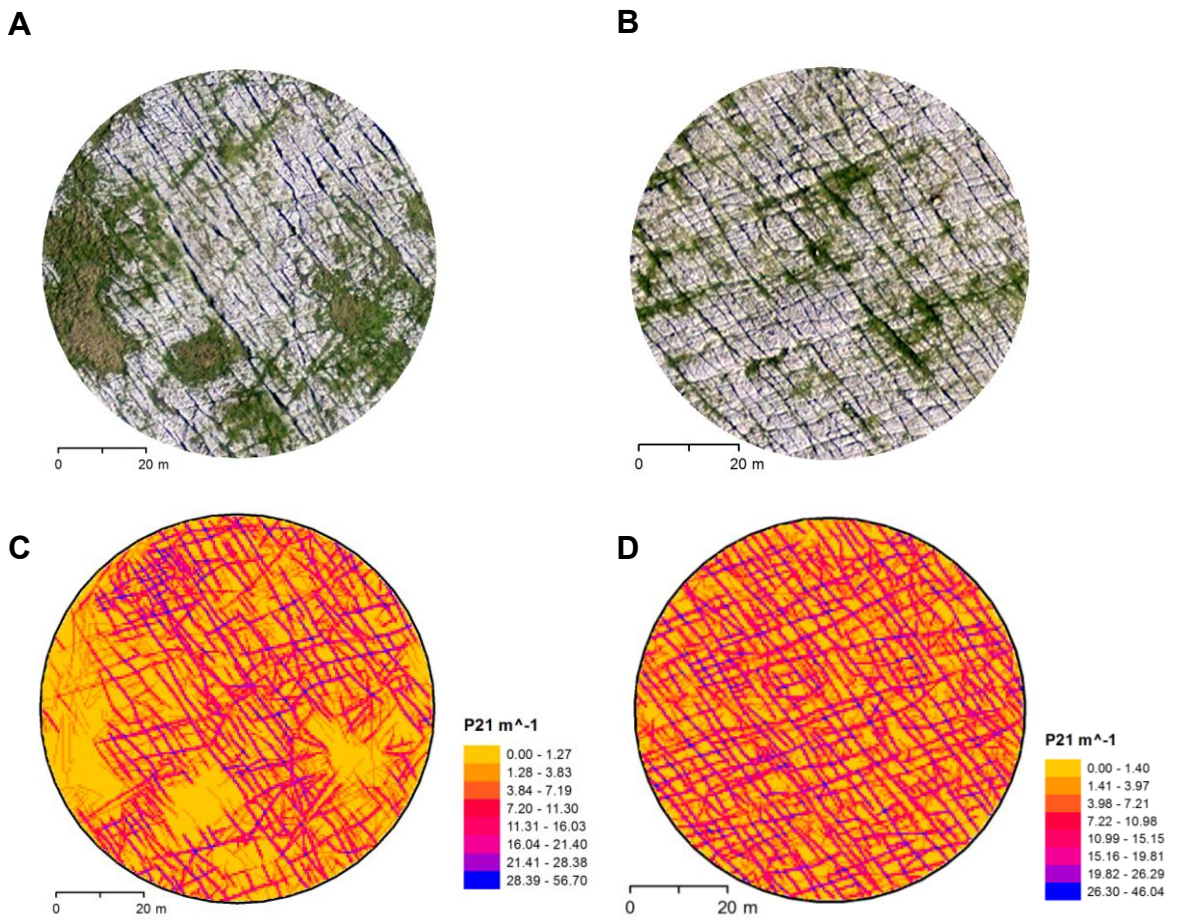

Fig. 1.(A, B) Two examples of areas of interest (with varying amounts of vegetation cover that degrade the quality of outcrop). (C, D) Variation in intensity of all the picked fractures for the two areas of interest in A & B respectively. Darker colours represent areas picked by more people.

References

Bond, C.E., Gibbs, A.D., Shipton, Z.K. and Jones, S., 2007. What do you think this is? ”Conceptual uncertainty" in geoscience interpretation. GSA today, 17(11), p.4.

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