



## **Quantitative characterization of fracture networks using terrestrial lidar data, an example from high porosity sandstones at Appleby, UK**

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Quantifying spatial variations in fracture orientations and fracture density with respect to position in a rock unit is an important part of the complete description of a 3D fracture network. We interpret terrestrial lidar data obtained from an outcrop of fractured Permo-Triassic aeolian red sandstone in the Vale of Eden half graben at George Gill, Appleby, located east of the Lake District in NW England. This work extends a previous study that used measured fractures manually along a single 1D transect. The lidar point clouds are preprocessed using RiSCAN PRO software. Deformation band traces are picked manually from the lidar data and used to calculate spatial attributes of fracture orientations. The digital nature of the data also allows re-sampling and effective filtering to derive fracture network parameters that are traditionally measured from outcrops, including size distributions, fracture spacing and clustering statistics. The orientation statistics derived from lidar data are used to investigate three aspects of spatial heterogeneity: geometrical clustering, spatial variation and spatial correlation using bootstrap, variogram and hierarchical analysis methods. The study suggests a qualitative relationship between fracture orientation and fracture sizes at different scales.