GIS based fault and fracture network analysis

[1] Ulrich Kelka[1] Stefan Westerlund, [1] Luk Peeters,
[1] *Deep Earth Imaging Future Science Platform, CSIRO*
Uli.Kelka@csiro.au

Fault and fracture networks channel or impede fluid flow in the subsurface. They become major drivers of the flow dynamic in low-porosity rocks, in which their geometry and topology govern the flow pattern on a regional scale. The objective of this study is to design an efficient and robust method to characterise geometry and topology of discontinuity networks that are represented by vector data. Linking raster data (i.e. elevation, magnetic or gravity data) to the network components allows for further characterization of the lineaments and preliminary assessment of dominant fluid pathways.

We present an automated framework for data extraction and analysis, based on graph representations of 2D fault and fracture networks. Initially, the consistence of the vector data is tested and flaws such as segmented discontinuity traces are automatically corrected. In the subsequent steps of the analysis the geometric parameters are extracted, and their distributions are determined. In addition to the geometric analysis we investigate the spatial arrangement and network topology. The spatial arrangement is analysed in terms of density and fractal dimension. In order to characterise the connectivity a georeferenced graph is produced. This data structure can also be linked to raster data for further lineaments characterisation. In addition, we show how standard graph algorithms (such as shortest path and maximum flow) allow for assessing fluid flow. Following the generation of the descriptive statistics, a 2D finite element mesh is generated from the vector data. This allows for more detailed studies on fluid flow in the networks and evaluation of the predictions obtained through graph analysis.

In summary, our analytical framework allows for characterising geometric and topological properties of lineament networks, determines potential sub-networks, and applies standard graph algorithms to obtain additional information on the fluid flow properties. We compare the predictions obtained from the graph analysis with fluid flow simulations performed on the generated meshes.