

DISCRETE VEIN MODELLING

Geology driven resource estimation for vein hosted mineral deposits

1. M. Munro, Technical Director, GMEK, Gold Coast QLD 4227. Michael.munro@gmek.com.au

2. J. van Dijk, Principal Geologist, OCRE, The Hague, Netherlands. Janpietervandijk@live.com

Keywords: #vein modelling #fracture modelling #low-impact mining #critical minerals

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Discrete Vein Modelling presents an innovative geology driven 3D modelling method for quantification of vein hosted mineral deposits, with far-reaching potential for critical mineral supply and low-impact resource extraction.

This paper focusses on the application of a new methodology for resource assessment which introduces a culmination of data driven technologies, including:

- a novel domaining technique based on vein potential, orientation distribution, and lithology
- a vein analysis protocol incorporating parameters such as size, spacing, orientation and truncation relationships (all significant drivers of vein density)
- a discrete vein network modelling protocol which honours specific geological associations and dependencies to create a more feasible model

In addition, Discrete Vein Modelling utilises mathematical models described in numerous papers to apply the various scale dependant relationships and vein distributions patterns observed in nature, which are readily defined for use in volumetric assessments.

The 3D models produced are both deterministic with observed features, and probabilistic with statistically distributed features. This mixed data-model driven approach however presents fundamental differences to conventional geo-statistical methods used estimating vein and fracture hosted mineral deposits, relying less on bootstrapping of models to isolated datapoints.

This is achieved by introducing more of the observed structural features directly into the model, and honouring geological relationships that govern statistical distributions within the domains. This constitutes a step change from traditional methods which utilise the spatial trends in grade distribution as an indirect means of defining the structural continuity, offering only limited, or sometimes no connection to these key geological drivers of the vein distribution. Included grade estimation processes are readily integrated with machine learning methods for dimensionality reduction, including principal component analysis (PCA), and provide more direct means of calibration to bulk sampling or grade control data where available.

Examples are provided, demonstrating the significance of these key geological drivers, in terms of their overall effect on vein network topology and density across a 3D volume at the deposit scale.

A new and practical workflow is presented, combining these data-model driven technologies to deliver discrete 3D models of the vein network for use in volumetric resource assessments. Further implications to the way in which we conduct vein and fracture analysis, sampling, and model calibrations are also discussed, along with applications of this new technology to high resolution modelling for low footprint mineral extraction opportunities.



Michael Munro is a co-founder and director of GMEK, a technical consultancy based in QLD Australia, specializing in ground modelling and engineering services for the resources sector.

A Fellow of the Geological Society London, Michael has obtained a BSc (Hons) in Exploration and Resource Geology from Cardiff University, and an MSc in Mining Geology from the Camborne School of Mines. With over 15 years broad ranging industry experience, Michael has been able to develop and apply several innovative modelling solutions for a range of mineral commodities, geotechnical, and hydrothermal industry sectors.



Janpieter van Dijk graduated and obtained his PhD degree at Utrecht University (the Netherlands), and has 28 years of worldwide experience in exploration and modelling for the energy sector, carbon capture storage, and renewables.

He published numerous research papers and 2 books on tectonostratigraphy, structural geology, basin evolution, geodynamics, history of science and technology, and computer modelling. He is a major world expert in Fractured and Faulted Reservoir Characterization and Modelling. Furthermore, he regularly organizes courses and field workshops, holds lectures on conferences and is member of a number of editorial boards and peer review committees.