Geophysical Research Abstracts
Vol. 17, EGU2015-10570, 2015
EGU General Assembly 2015

Estimation of uncertainties in a 3D geological model of the Sandstone Greenstone Belt, Yilgarn Craton, Western Australia

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Geological models representing the structure of the subsurface are becoming a regular product of geological surveys. 3-D models combine information from geological field mapping and interpretations of geophysical data, including gravity, aerial magnetic surveys, and seismic and magnetotelluric studies. It is widely accepted that the sparse data at depth and the ambiguity of structural interpretations of geophysical data lead to inherent model uncertainties. The analysis and visualisation of model uncertainties is therefore the scope of current research.

We apply here a recently developed method to estimate uncertainties in 3D structural geological models to a model of the Sandstone Greenstone Belt in the Archean Yilgarn Craton in Western Australia. The geological modelling method is based on an implicit potential-field approach in order to handle complex structures in this region, including multiply deformed stratigraphic units and complex fault networks. We then identify uncertainties in relevant geological parameters and apply a random method to sample probable structural model realisations.

The ensemble of generated models is then used as a basis for uncertainty investigations. We apply several methods for uncertainty quantification and visualisation, including unit probabilities, stratigraphic distances, and cell information entropies. The analysis shows that it is feasible to use these measures as indications of model uncertainties in 3D visualisations, as well as composite measures of uncertainties on maps. With the range of novel approaches analysing uncertainties in structural geological models, we are optimistic that uncertainty evaluations can form an integral part of future geological modelling products of geological surveys.