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Integration of Geophysical Data into Structural Geological Modelling through Bayesian Networks

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Structural geological models are widely used to represent the spatial distribution of relevant geological features. Several techniques exist to construct these models on the basis of different assumptions and different types of geological observations (e.g. Jessell et al., 2014). However, two problems are prevalent when constructing models: (i) observations and assumptions, and therefore also the constructed model, are subject to uncertainties, and (ii) additional information, such as geophysical data, is often available, but cannot be considered directly in the geological modelling step. In our work, we propose the integration of all available data into a Bayesian network including the generation of the implicit geological method by means of interpolation functions (Mallet, 1992; Lajaunie et al., 1997; Mallet, 2004; Carr et al., 2001; Hillier et al., 2014). As a result, we are able to increase the certainty of the resultant models as well as potentially learn features of our regional geology through data mining and information theory techniques. MCMC methods are used in order to optimize computational time and assure the validity of the results.

Here, we apply the aforementioned concepts in a 3-D model of the Sandstone Greenstone Belt in the Archean Yilgarn Craton in Western Australia. The example given, defines the uncertainty in the thickness of greenstone as limited by Bouguer anomaly and the internal structure of the greenstone as limited by the magnetic signature of a banded iron formation. The incorporation of the additional data and specially the gravity provides an important reduction of the possible outcomes and therefore the overall uncertainty.

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