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A review of the quantification and communication of uncertainty associated with geological framework models

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Digital Geological Framework Models show geology in three dimensions, they can most easily be thought of as 3D geological maps. The volume of the model is divided into distinct geological units using a suitable rock classification in the same way that geological maps are. Like geological maps the models are generic and many are intended to be fit for any geoscience purpose. Over the last decade many Geological Survey Organisations (GSO's) worldwide have begun to communicate their geological understanding of the subsurface through Geological Framework Models and themed derivatives, and the traditional printed geological map has been increasingly phased out.

Building Geological Framework Models entails the assembly of all the known geospatial information into a single workspace for interpretation. The calculated models are commonly displayed as either a stack of geological surfaces or boundaries (unit tops, bases, unconformities) or as solid calculated blocks of 3D geology with the unit volumes infilled in with colour or symbols. The studied volume however must be completely populated so decisions on the subsurface distribution of units must be made even where considerable uncertainty exists

There is naturally uncertainty associated with any Geological Framework Model and this is composed of two main components; the uncertainty in the geospatial data used to constrain the model, and the uncertainty related to the model construction, this includes factors such as choice of modeller(s), choice of software(s), and modelling workflow. Uncertainty is the inverse of confidence, reliability or certainty, other closely related terms include risk commonly used in preference to uncertainty where financial or safety matters are presented and probability used as a statistical measure of uncertainty.

We can consider uncertainty in geological framework models to be of two main types:

Uncertainty in the geospatial data used to constrain the model; this differs with the distinct types of data and their quantity, quality and distribution.

Uncertainty in the model construction process, this includes factors such as choice of modeller(s), choice of software(s), and modelling workflow.

Taken together the two components comprise the interpretative (or overall) uncertainty and indicate that any one dataset may be underdeterminate or consistent with multiple interpretations or model realisations. Here we review available methods for the communication of uncertainty in Geological Framework Models