Geophysical Research Abstracts
Vol. 16, EGU2014-1712, 2014
EGU General Assembly 2014

Geological maps and models: are we certain how uncertain they are?

Steve Mathers, Colin Waters, and Fiona McEvoy
British Geological Survey United Kingdom (sjma@bgs.ac.uk)

Geological maps and latterly 3D models provide the spatial framework for geology at diverse scales or resolutions. As demands continue to rise for sustainable use of the subsurface, use of these maps and models is informing decisions on management of natural resources, hazards and environmental change. Inaccuracies and uncertainties in geological maps and models can impact substantially on the perception, assessment and management of opportunities and the associated risks .

Lithostratigraphical classification schemes predominate, and are used in most geological mapping and modelling. The definition of unit boundaries, as 2D lines or 3D surfaces is the prime objective. The intervening area or volume is rarely described other than by its bulk attributes, those relating to the whole unit. Where sufficient data exist on the spatial and/or statistical distribution of properties it can be gridded or voxelated with integrity. Here we only discuss the uncertainty involved in defining the boundary conditions.

The primary uncertainty of any geological map or model is the accuracy of the geological boundaries, i.e. tops, bases, limits, fault intersections etc. Traditionally these have been depicted on BGS maps using three line styles that reflect the uncertainty of the boundary, e.g. observed, inferred, conjectural. Most geological maps tend to neglect the subsurface expression (subcrops etc). Models could also be built with subsurface geological boundaries (as digital node strings) tagged with levels of uncertainty; initial experience suggests three levels may again be practicable. Once tagged these values could be used to autogenerate uncertainty plots.

Whilst maps are predominantly explicit and based upon evidence and the conceptual the understanding of the geologist, models of this type are less common and tend to be restricted to certain software methodologies. Many modelling packages are implicit, being driven by simple statistical interpolation or complex algorithms for building surfaces in ways that are invisible and so not controlled by the working geologist. Such models have the advantage of being replicable within a software package and so can discount some interpretational differences between modellers. They can however create geologically implausible results unless good geological rules and control are established prior to model calculation. Comparisons of results from varied software packages yield surprisingly diverse results. This is a significant and often overlooked source of uncertainty in models.

Expert elicitation is commonly employed to establish values used in statistical treatments of model uncertainty. However this introduces another possible source of uncertainty created by the different judgements of the modellers. The pragmatic solution appears to be using panels of experienced geologists to elicit the values.

Treatments of uncertainty in maps and models yield relative rather than absolute values even though many of these are expressed numerically. This makes it extremely difficult to devise standard methodologies to determine uncertainty or propose fixed numerical scales for expressing the results. Furthermore, these may give a misleading impression of greater certainty than actually exists.

This contribution outlines general perceptions with regard to uncertainty in our maps and models and presents results from recent BGS studies