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Empirical assessment of the uncertainty in a 3-D geological framework model

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Three-dimensional framework models are the state of the art to present geologists' understanding of a region in a form that can be used to support planning and decision making. However, there is little information on the uncertainty of such framework models. We report a statistically-designed experiment in which each of five geologists independently produced a framework model of a single region in the east of England. Each geologist used a unique set of borehole observations from which to make their model. Each set was made by withholding five unique validation boreholes from the set of all available boreholes. The models were then compared with the validation observations.

Between-modeller differences were not a significant source of variation in framework model error. There was no evidence of systematic bias in the modelled depth for any unit, but there was a statistically significant but small tendency for the mean error to increase with depth below the surface. The confidence interval for the predicted height of a surface at a point ranged from $\pm$5.6 m to $\pm$6.4 m. There was some evidence that the variance of the model error increased with depth, but no evidence that it differed between modellers or varied with the number of close-neighbouring boreholes or distance to the outcrop.

These results are specific to the area that has been modelled, with relatively simple geology, and they must also reflect the relatively dense set of boreholes available for modelling. The method should be applied under a range of conditions to derive more general conclusions, and benchmark quality measures for three-dimensional models of contrasting terranes.