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Geological uncertainty: a mean to reduce potential field ambiguity?

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We have identified the need for a better integration of geological data into 3D geological modelling and especially during potential field inversions. To be reliable, 3D models need to reconcile all relevant & available geological and geophysical data. Current practices involve building a 3D geological model from geological and some geophysical data and assume that the geometries and more importantly the topology of the model produced are correct. This reference model is then inverted against potential field data and in the end no check is proposed with respect to the input data. The uncertainty attached to geological data is not taken into account. In this paper, we investigate the idea of combining geological uncertainty with potential field data ambiguity in order to produce 3D geological models with a reduced geophysical ambiguity and more importantly an estimated geological uncertainty. We propose to calculate multiple reference geological models using geological data variability; some of which derives from varying models explaining the structural evolution of the considered area (with implications on the model topology). We need to emphasize that as structural geologists, we can utilise structural information (such as fold axes, axial surfaces, cleavages, etc.) to predict where a given lithology should be in 3D space, therefore predicting the spatial variation of a given rock property (density or magnetic susceptibility). These structural elements derive directly from the considered structural evolution model. In other words, we are testing "what if" scenarios as proposed in the literature against geological datasets and consequently geophysical datasets during potential field inversions. The robustness of the models is going to be estimated with respect to a (low) deviation of the modelled geology from the input data. This requires the development of geological penalty functions that will estimate this deviation and the potential variability of the models. Our proposed process allows for the production of a 3D variability map similar to a sensitivity analysis of the input data on the geometry/topology predicted by the models. This process helps investigate a larger part of the parameter space defined by geology (geometry of rock packages), petrophysical properties and geophysics during inversion. We will present some of the preliminary uncertainty cubes produced out of simple scenarios.