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Is it possible to capture epistemic uncertainty in geological models?

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Geological maps and 3D models usually imply a misleading sense of certainty and accuracy. During geological mapping, decisions regarding a final geological model of the area of interest are made based on outcrop descriptions, structural measurements and heuristic knowledge. Therefore, the final result is only one of many possible interpretations of the observations. This aspect is well illustrated in the study of twelve years of geological mapping and modelling exercise results within an area near Alès, France (Courrioux et al., 2015), which reveals a high variability in the resulting geological models regarding layer interface positions and fault surfaces in 3D space.

This raises the question of the source of this variability – is the variation in the resulting models due to measurement errors or are important features missed during the mapping process? In other words, can the epistemic uncertainty observed in the twelve geological models be captured and, ideally, represented as an aleatory uncertainty?

This project aims to reproduce the observed variability in the final models constructed by classical methodologies (i.e. a geologist collects and interprets the available data and creates his best possible model). To this end, we propose the use of Monte Carlo error propagation as a way to encode mathematically the epistemic behavior. For this purpose, the initial geological model is parametrized using field measurements with accompanying estimates of the measurement (and interpretation) uncertainties. By the use of automatic interpolators we propagate this uncertainty to the geological models. In this way, we are able to obtain a quantifiable and reproducible estimate of model uncertainty. With the results we aim to analyze how well field data and the corresponding uncertainites can be represented with implicit geological models.