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Characterizing Geological Uncertainty with Stochastic Implicit Modeling

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Geological models are inherently uncertain due to limited access to subsurface information. Implicit modeling techniques enable rapid construction and assimilation of new data into geological models. Nevertheless, most techniques rarely account for the uncertainty associated with model predictions, and even fewer assess the reliability of uncertainty estimates. To address these issues, we propose a stochastic framework to characterize geological uncertainty in implicit modeling. First, our method creates an initial implicit model based on available drill hole information. Multiple alternative models are then generated by integrating additional synthetic data into the original model using geostatistical simulation. The ensemble of alternative scenarios is subsequently used to characterize geological uncertainty. Possible frameworks for calibrating model parameters and validating uncertainty estimates are discussed. The approach enables propagation of geological uncertainty into mineral resource estimation and provides additional information for decision-making in exploration and resource management. We demonstrate the approach with illustrative examples.