Improving multiple-point-based a priori models for inverse problems by combining Sequential Simulation with the Frequency Matching Method

In order to move beyond simplified covariance based a priori models, which are typically used for inverse problems, more complex multiple-point-based a priori models have to be considered. By means of marginal probability distributions ‘learned’ from a training image, sequential simulation has proven to be an efficient way of obtaining multiple realizations that honor the same multiple-point statistics as the training image. The frequency matching method provides an alternative way of formulating multiple-point-based a priori models. In this strategy the pattern frequency distributions (i.e. marginals) of the training image and a subsurface model are matched in order to obtain a solution with the same multiple-point statistics as the training image. Sequential Gibbs sampling is a simulation strategy that provides an efficient way of applying sequential simulation based algorithms as a priori information in probabilistic inverse problems. Unfortunately, when this strategy is applied with the multiple-point-based simulation algorithm SNESIM the reproducibility of training image patterns is violated. In this study we suggest to combine sequential simulation with the frequency matching method in order to improve the pattern reproducibility while maintaining the efficiency of the sequential Gibbs sampling strategy.

We compare realizations of three types of a priori models. Finally, the results are exemplified through crosshole travel time tomography.