Conditioning Facies Simulation from Training-Images on Flow Data

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Calibration of geologic facies against flow data poses a challenging nonlinear inverse problem, where discrete maps of facies indicators have to be adjusted to match the observed data. The problem is further complicated when the facies maps consist of complex connectivity patterns, such as curvilinear fluvial features, as preserving such connectivity during model calibration is mathematically not trivial. In the last decade, multiple-point statistical (MPS) methods have been developed and used to simulate complex facies connectivity patterns using a training image (TI), i.e. a conceptual model of geologic connectivity. While conditioning MPS simulation on hard (well) data and soft (seismic) data is straightforward, calibration against nonlinear production data is not straightforward.

We discuss two strategies to incorporate the production data into MPS facies simulation to generate flow-conditioned model realizations. In the first approach, we first obtain a facies probability map by inverting the flow data, and then use it (as soft conditioning data) to constrain the results of the MPS facies simulation. In the second approach, we use the flow data to estimate the facies types at strategically placed pilot points throughout the domain and use the estimated facies types at the pilot point locations as conditioning data in MPS simulation. The two strategies convert the flow data to conditioning data types that can be conveniently incorporated into MPS simulation. Several numerical experiments are presented and discussed to evaluate the performance of the developed methods.