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Assessment of uncertainty and degasification efficiency in coal seam gas drainage through stochastic reservoir simulation

C. Özgen Karacan
CDC/NIOSH, Pittsburgh, United States (cok6@cdc.gov)

Coal seam degasification improves coal mine safety by reducing the gas content of coal seams and also by generating added value as an energy source. Coal bed reservoir simulation, as a reservoir management and forecasting tool, is one of the most effective ways to help with these two main objectives. However, as in all modeling and simulation studies, reservoir description and whether observed productions can be predicted are important considerations.

Using geostatistical realizations as spatial maps of different coal reservoir properties is a more realistic approach than assuming uniform properties across the field. In fact, this approach can help with simultaneous history matching of multiple wellbores to enhance the confidence in spatial models of different coal properties that are pertinent to degasification. The problem that still remains, however, is the uncertainty in geostatistical, and thus reservoir, simulations originating from partial sampling of the seam that does not properly reflect the stochastic nature of coal property realizations.

This study demonstrates the use of geostatistical realizations generated through sequential Gaussian simulation and co-simulation techniques and assesses the uncertainty in coal seam reservoir simulations with history matching errors. 100 individual realizations of 10 coal properties were generated using geostatistical techniques. These realizations were used to create 100 realization bundles (property datasets). Each of these bundles was then used in coal seam reservoir simulations for simultaneous history matching of degasification wells. History matching errors for each bundle were evaluated and the single set of realizations that would minimize the error for all wells was defined. Errors were compared with those of E-type and the average realization of the best matches. The study helped to determine the realization bundle that consisted of the spatial maps of coal properties, which resulted in minimum error. In addition, it was shown that both E-type and the average of realizations that gave the best match for individual wells approximated the same properties reasonably well. The methodology is illustrated with an example from the Seelyville coal seam, Indiana, USA.