Conditioning the geostatistical simulation of the Paskapoo formation with lithologs, paleo-current statistics and pumping tests for stochastic regional groundwater modeling

Amir Niazi, Laurence R. Bentley, Masaki Hayashi
University of Calgary, Calgary, Alberta, Canada

ABSTRACT
In the conventional modeling approach, a single hydrogeological model is constructed based on a single geological model and the uncertainty in geological heterogeneity is not explicitly taken into account. In contrast, Monte-Carlo analysis (MCA) is a method to account for the uncertainty associated with heterogeneity of local geology in groundwater models. In MCA, a suite of stochastic representations of the geology is generated by geostatistical simulation. In this presentation, we present a Markov chain method to generate and condition a suite of stochastic representations of the highly heterogeneous and non-stationary fluvial bedrock aquifer in the Paskapoo formation. All available information, including paleo-current statistics, sand fraction, lithologs and pumping tests, are used to generate the simulations.
In this methodology a lithologic model is constructed and conditioned with hard data using transition probability geostatistics. Subsequently, a segment of the simulation around a pumping well was used to generate a numerical groundwater flow model. A single well pumping test was modelled using the flow model, and hydraulic conductivity and specific storage of sand channels and mudstone were estimated by using an inverse model. The original simulated lithology model was updated to match the pumping test results by locally deforming the lithology distribution using the probability perturbation method and again iteratively performing the inverse parameter estimation. This loop was executed until our optimization function was minimized and our prior knowledge about hydraulic properties of the hydrofacies was satisfied.
By using this method, we constrain the uncertainty in the lithologic model and obtain estimates of local hydraulic properties of the hydrofacies (sandstone and mudstone) in the aquifer which later can be used to calibrate a regional groundwater model.

ECHN