

# 3D hydrogeological parametrization using sparse piezometric data

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The manuscript is well structured and well written.

In my opinion, the main novelty of the manuscript is the following: estimation of hydrodynamic characteristics ( $k$  and  $n$ ) of a 3D flow model comparing the calibrated 2D transmissivities rather than the hydraulic head measurements.

At the beginning, the transmissivities of a 2D flow model are estimated comparing sparse measurements of hydraulic heads obtained by means of piezometers (actually the aquifer in this study is synthetic) with the heads calculated by the 2D flow model. According to vertical logs data collected in the piezometers a 3D reconstruction of litho-facies is obtained and a 3D flow model realized. In order to estimate the hydraulic conductivity values for each element of the 3D model an inverse procedure involving the transmissivities is implemented: the hydraulic conductivity in each facies is calculated optimizing the distance between the 2D inversion transmissivities and the 3D transmissivities.

In literature already exist studies in which the aquifer is conceptualized as a multiple-continuum, where the volumetric fraction of a geo-material within a cell of the numerical flow model is calculated by Multiple Indicator Kriging and the hydraulic head data are embedded jointly within a three-dimensional inverse model of groundwater flow: model parameters ( $k$  and  $n$ ) are estimated by a Maximum Likelihood fit between measured and modeled - vertically average - hydraulic heads, resulting in a spatially heterogeneous distribution of hydraulic conductivity (Guadagnini et al., 2004; Straface et al., 2011).

The authors should support their approach, i.e., the transmissivities versus the hydraulic heads conditioning, comparing the two inversion strategies and showing the advantage to compare the 2D transmissivities rather than the vertically averaged hydraulic heads.

I haven't any concerns about the mathematical description of the equations presented herein and the inversion procedures, nevertheless I recommend the above mentioned comparison before its publication.

## References

- Guadagnini L., Guadagnini A, Tartakovsky DM (2004). *Probabilistic Reconstruction of geologic facies*. J. of Hydrol., 294, 57-67.
- Straface S., Chidichimo F., Rizzo E., Riva M., Barrash W., Revil A., Cardiff M., Guadagnini A. *Joint inversion of steady-state hydrologic and self-potential data for 3D hydraulic conductivity distribution at the Boise Hydrogeophysical Research Site*. Journal of Hydrology, 2011, Vol. 407, pp. 115–128.