Experimental Investigation to Characterize Simple Vs Multi Scaling Analysis of Hydraulic Conductivity at a Mesoscale

Guglielmo Federico Antonio Brunetti  
University of Calabria: Universita della Calabria

Samuele De Bartolo  
University of Salento: Universita del Salento

Carmine Fallico  
University of Calabria: Universita della Calabria

Ferdinando Frega  
University of Calabria: Universita della Calabria

Maria Fernanda Rivera Velásquez  
Escuela Superior Politécnica de Chimborazo: Escuela Superior Politecnica de Chimborazo

Gerardo Severino (severino@unina.it)  
University of Naples, FEDERICO II  
https://orcid.org/0000-0003-4281-6596

Research Article

Keywords: Scaling behavior, hydraulic conductivity, slug test, power law

Posted Date: June 8th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-554776/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License

Version of Record: A version of this preprint was published at Stochastic Environmental Research and Risk Assessment on August 21st, 2021. See the published version at https://doi.org/10.1007/s00477-021-02079-w.
Abstract

The spatial variability of the hydraulic properties of aquifers can be satisfactorily described by means of scaling law(s). The latter enables one, among the others, to relate the small (typically laboratory) scale to the larger (typically formation/regional) ones, therefore leading de facto to an upscaling procedure.

In the present study, we are concerned, with the spatial variability of the hydraulic conductivity $k$ into a strongly heterogeneous porous formation. A strategy, allowing one to identify correctly the single/multiple scaling of $k$, is applied for the first time to a real case of a large caiison where a strongly heterogeneous medium was packed. In particular, we show how to identify the various scaling ranges with special emphasis to the determination of the related cut-off limits. Finally, we illustrate how the heterogeneity enhances with the increasing scale of observation, by identifying the proper law accounting for the transition from the laboratory to the field scale.

Results of the present study are of paramount utility for the proper design of pumping tests in formations where the degree of spatial variability of the hydraulic conductivity does not allow regarding them as “weakly heterogeneous”, as well as for the study of dispersion mechanisms in solute transport.

Full-text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures

Figure 1

a) Planimetric layout of the piezometers; b) Stratigraphic layout; c) Experimental apparatus.
Figure 2

Fitted scaling laws of K data sets and corresponding values of s, relative to each injection volume.

Figure 3

Possible limit scale values of trend change, for the data sets (K, scale) related to the injection volumes considered.
Figure 4

Scaling laws related to the I and II ranges, for the six injection volumes considered.

Figure 5
Scaling laws related to the I, II and III ranges, for the injection volumes of 0.07 L, 0.08 L and 0.09 L, assuming a division of the investigation range into three parts.

Figure 6

Scaling laws, relating to the I and II ranges, of the Group No. 1, with global scaling law and 95% and 99% confidence intervals.

Figure 7
Scaling laws, relating to the I and II ranges, of Group No. 2, with global scaling law and 95% and 99% confidence intervals.

**Figure 8**

Scaling law, relating to the I and II ranges, of the Group No. 3.

**Figure 9**

Global scaling laws of Groups No. 1, No. 2 and No. 3, for the I and II ranges.