Geophysical Research Abstracts,
Vol. 11, EGU2009-7776, 2009
EGU General Assembly 2009

Fractal analysis of the hydraulic conductivity on a sandy porous media reproduced in a laboratory facility.

S. De Bartolo, C. Fallico, S. Straface, S. Troisi, and M. Veltri
Università della Calabria, Dipartimento di Difesa del Suolo, Rende, Italy (straface@unical.it, +39+0984+494050)

The complexity characterization of the porous media structure, in terms of the “pore” phase and the “solid” phase, can be carried out by means of the fractal geometry which is able to put in relationship the soil structural properties and the water content. It is particularly complicated to describe analytically the hydraulic conductivity for the irregularity of the porous media structure. However these can be described by many fractal models considering the soil structure as the distribution of particles dimensions, the distribution of the solid aggregates, the surface of the pore-solid interface and the fractal mass of the “pore” and “solid” phases. In this paper the fractal model of Yu and Cheng (2002) and Yu and Liu (2004), for a saturated *bidispersed* porous media, was considered. This model, using the *Sierpinsky-type gasket* scheme, doesn’t contain empiric constants and furnishes a well accord with the experimental data.

For this study an unconfined aquifer was reproduced by means of a tank with a volume of $10 \times 7 \times 3$ m^3, filled with a homogeneous sand (95% of SiO2), with a high percentage (86.4%) of grains between 0.063mm and 0.125mm and a medium-high permeability. From the hydraulic point of view, 17 boreholes, a pumping well and a drainage ring around its edge were placed. The permeability was measured utilizing three different methods, consisting respectively in pumping test, slug test and laboratory analysis of an undisturbed soil cores, each of that involving in the measurement a different support volume. The temporal series of the drawdown obtained by the pumping test were analyzed by the Neuman-type Curve method (1972), because the saturated part above the bottom of the facility represents an unconfined aquifer. The data analysis of the slug test were performed by the Bouwer & Rice (1976) method and the laboratory analysis were performed on undisturbed saturated soil samples utilizing a falling head permeameter. The obtained values either of the fractal dimension of the area of the pores (D_f) or of the fractal dimension of capillary tortuosity (D_T), very similar to those reported in literature (Yu and Cheng, 2002; Yu and Liu, 2004; Yu, 2005) and falling in the *range* of definition ($1 < D_f < 2$), resulted very close to those carried out in a previous study performed on the same apparatus but with a limited number of values (De Bartolo et al., in review). In fact in the present study the laboratory analysis were performed on other 10 undisturbed soil samples and moreover three new values of slug test and 12 new of pumping test were considered.

Moreover the trend of D_T growing with the scale length (L) was confirmed, as well as the invariability of, due to the homogeneity of the considered porous media.

The linear scaling law of the permeability (k) close to scale length was investigated furnishing more reliable results. However for a better definition of a law of scale for D_f, D_T and k several number of scale length are need and a greater number of experimental data should be carried out. For this purpose the considered experimental apparatus is limited from its restricted dimensions and geometric bounds; therefore further investigations in experimental field are desirable.

Bibliografy

Bouwer, H. & Rice, R. C. 1976. A Slug Test for Hydraulic Conductivity of Unconfined Aquifers With Completely or Partially Penetrating Wells, *Water Resources Research*, **12**(3).

De Bartolo, S., Fallico, C., Straface, S., Troisi, S. & Veltri M. (in review). Scaling of the hydraulic conductivity measurements by a fractal analysis on an unconfined

aquifer reproduced in a laboratory facility, *Geoderma Special Issue 2008*.

Neuman, S.P. 1972. Theory of flow in unconfined aquifers considering delayed response of the water table, *Water Resources Research*, **8**(4), 1031-1045.

Yu, B.M. 2005. Fractal Character for Tortuous Streamtubes in Porous Media, *Chin. Phis. Lett.*, **22**(1), 158.

Yu, B.M. & Cheng, P. 2002. A Fractal Permeability Model for Bi-Dispersed Porous Media, *Int. J. Heat Mass Transfer* **45**(14), 2983.

Yu, B.M. & Liu W. 2004. Fractal Analysis of Permeabilities for Porous Media, *American Institute of Chemical Engineers* **50**(1), 46-57.