Effect of the connectivity of alluvial aquifers on groundwater flow and solute transport

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Abstract: The assumption that the heterogeneity of aquifers can be described with multilog-Gaussian distributions has been widely used (Law, 1944). However, the multilog-Gaussian assumption is inappropriate in alluvial aquifers (Zinn and Harvey, 2003). Alluvial aquifers, such as fluvial sediments containing paleochannels, present structures composed of interconnected bodies (Tidwell and Wilson, 1999). Alluvial aquifers can be described with binary distributions (Zinn and Harvey, 2003). Many authors have argued that the connectivity of alluvial aquifers is more important than the values of permeability K (Zappa *et al.*, 2006). The connectivity of alluvial aquifers induces a channeling leading to significant increase in average flow rates and even more significant reduction of contaminant first arrival times (Molinari *et al.*, 2019). Few works have performed three-dimensional detailed numerical simulations of groundwater flow and solute transport in binary distributions. In 2017, Jankovic *et al.* choose to study the effective permeability, the plume mean velocity, the BTC and the mass flux in multiLog-Gaussian, connected and disconnected K-fields introduced by Zinn and Harvey in 2003 (Jankovic *et al.*, 2017). The bulk of the BTC was predicted quite accurately by the solution of the advection dispersion equation based on the first order approximation. In this work, the asymptotic value of the longitudinal dispersivity αl is numerically estimated in three-dimensional multiLog-Gaussian, connected, intermediate and disconnected, K-fields from Monte Carlo parallel numerical simulations in advection – diffusion cases with a Peclet number $Pe = \langle u \rangle\ lc / dm = 100$ where $\langle u \rangle$ is the mean flow velocity, lc is the correlation length of K-fields and dm is the diffusion coefficient. The following figure shows that the evolution of αl with respect to the deviation p-pc presents a mountainous form in all the tested cases. p and pc are the volume fraction of low conductivity zones and the percolation threshold, respectively. The maximum value of αl is obtained just after the percolation threshold pc. A detailed analysis will be performed by comparing the numerical results with the first order approximation and the percolation theory (Sahimi *et al.*, 1986 ; Rubin, 1995).

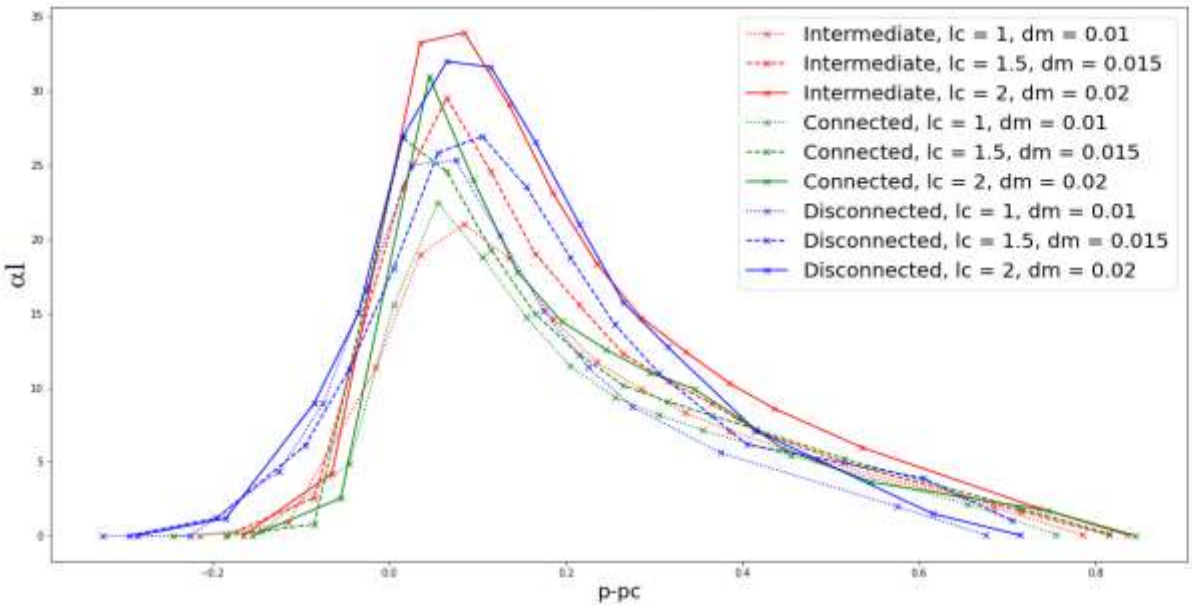

Fig. – *Evolution of the asymptotic value of the longitudinal dispersivity αl with respect to the deviation p-pc for a Peclet number Pe = 100 with three values of correlation length lc = 1, 1.5 and 2m, and three values of diffusion coefficient dm = 0.01, 0.015 and 0.02 m^2/day*.

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