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Borehole Heat Exchangers: a potential trigger for aquifer cross-contamination?

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The number of Ground Source Heat Pumps (GSHPs) has been growing steadily in the last 20 years, and so has the number of Borehole Heat Exchangers (BHEs), which perform the heat exchange between the ground and the heat pump. BHEs are generally about 100 m deep and, hence, they can cross different aquifers. Concerns have been raised about the possible preferential flow of contaminants that can occur through boreholes, also known as cross-contamination. The strength of such phenomenon depends on the vertical hydraulic gradient between the aquifers and the hydraulic conductivity of the grout filling. Therefore, we developed a numerical flow and solute transport model in severe conditions to assess to which extent a BHE can induce cross-contamination between a shallow contaminated aquifer and a deep uncontaminated one, separated by an aquiclude. The results show that the leakage flow and the contaminant spatial distribution in the deep aquifer are well reproduced with analytical formulae, which can therefore be used to assess the potential impact of cross-contamination. Results also confirm that the geothermal grouts available in the market, with hydraulic conductivities well below 10^{-6} m/s, guarantee a sufficient protection from preferential flow through borehole heat exchangers.