Geophysical Research Abstracts
Vol. 18, EGU2016-10145, 2016
EGU General Assembly 2016

Groundwater recharge dynamics in unsaturated fractured chalk: a case study

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The heterogeneity of the unsaturated zone controls its hydraulic response to rainfall and the extent to which pollutants are delayed or attenuated before reaching groundwater. It plays therefore a very important role in the recharge of aquifers and the transfer of pollutants because of the presence of temporary storage zones and preferential flows. A better knowledge of the physical processes in the unsaturated zone would allow an improved assessment of the natural recharge in a heterogeneous aquifer and of its vulnerability to surface-applied pollution.
The case study regards the role of the thick unsaturated zone of the Cretaceous chalk aquifer in Picardy (North of France) that controls the hydraulic response to rainfall. In the North Paris Basin, much of the recharge must pass through a regional chalk bed that is composed of a porous matrix with embedded fractures.
Different types of conceptual models have been formulated to explain infiltration and recharge processes in the unsaturated fractured rock.
The present study analyses the episodic recharge in fractured Chalk aquifer using the kinematic diffusion theory to predict water table fluctuation in response to rainfall.
From an analysis of the data, there is the evidence of 1) a seasonal behavior characterized by a constant increase in the water level during the winter/spring period and a recession period, 2) a series of episodic behaviors during the summer/autumn.
Kinematic diffusion models are useful for predict preferential fluxes and dynamic conditions. The presented approach conceptualizes the unsaturated flow as a combination of 1) diffusive flow refers to the idealized portion of the pore space of the medium within the flow rate is driven essentially by local gradient of potential; 2) preferential flow by which water moves across macroscopic distances through conduits of macropore length.