Geophysical Research Abstracts
Vol. 17, EGU2015-15002, 2015
EGU General Assembly 2015

Experimental and numerical investigation of the effect of basaltic dykes on transient saltwater intrusion

Antoifi Abdoulhalik, Ashraf Ahmed, and Gerrard Hamill
Queen′s University, Belfast, UK

Heterogeneity in porous media is one of the major factors that control mixing zone and saltwater wedge dynamics. Basaltic dykes are natural geological structures that can significantly affect groundwater flow and solute transport in coastal aquifers. Few recent studies have investigated the effects of heterogeneity on the freshwater-saltwater mixing zone. However, most of these studies have focused on steady-state conditions. Furthermore, as per our knowledge no one has so far completed experiments to study the impact of basaltic dykes on transient saltwater intrusion. In this study, we have performed experiments in a laboratory-scale aquifer model to study saltwater intrusion process under different heterogeneous settings; a dyke was set at different locations and several values of thickness and permeability were tested. Using a variable-head groundwater system, a head difference was imposed across the porous media and images of the transient saltwater-wedge were recorded at thirty second intervals. The experimental data sets were simulated using the MODFLOW-family variable density flow code SEAWAT. The results show that under intruding-wedge conditions, the width of the mixing zone is almost two orders of magnitude larger in the presence of the dyke than it is in the homogeneous case, while it is more than ten times larger under receding-wedge conditions. A slight increase of the toe length was observed (around nine percent) in the presence of the dyke under intruding-wedge and receding-wedge conditions. When the permeability of the dyke is further reduced, it acts as an impervious barrier that almost prevents the progression of the saltwater wedge. Thus, saltwater is accumulated along the side boundary, and then forced to drain along the bottom boundary. The results highlight the significant effects of macroscopic variations in aquifer properties (such as volcanic dykes) in the temporal evolution of mixing zone dynamics (widening and narrowing) and the production preferential flow paths which can lead to an increase of the toe length.