Title

Geochemistry and Inorganic Carbon Transport of a Glacial Till Drumlin at a Road Salt Facility

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Abstract

Investigations were conducted at a salt/premix storage facility lying on top of a glacial drumlin near the coastline in eastern Massachusetts, to characterize salt contaminated groundwater. Groundwater hydrogeochemical variations at different depths were determined based on ten years of monthly or quarterly water quality data from 54 monitoring wells. Groundwater was grouped in three water categories – shallow, middle and deep. Hydrogeochemical characterization indicates that the dominant water types are Na-Cl, Na-Ca-Cl and Ca-HCO3 from the shallow to deep water group. Rock weathering is the dominant hydrogeochemical process for deep water group, whereas salt water percolation and cation exchange control chemical compositions of the shallow and middle water groups. Groundwater is classified as post-cation exchange, under-cation exchange and non-cation exchange groups.

Gaseous CO2 and total dissolved inorganic carbon (TDIC) transport in unsaturated and saturated zones of the glacial drumlin was also investigated. A measurement system with non-dispersive infrared gas sensors was used to monitor the recovery of CO2 concentration in the headspace of purged monitoring wells. The transient, radial diffusion of CO2 from surrounding soil to the monitoring well is analogous to an existing slug test theory when the headspace is fully mixed. A nested Fibonacci search was performed to calibrate equilibrium soil CO2 concentration and soil gas porosity near the water table. The results demonstrate that water table wells with partially submerged screens can facilitate the equilibrium between the gaseous and dissolved phase of CO2. In the saturated zone, a new model was developed to describe the vertical transport of TDIC in the groundwater. The vertical transport was considered to be a balance of uniform vertical advection and vertical dispersion, subject to a first order source term with two boundary conditions at depth and at the water table. Fifteen years of monthly or quarterly data from 28 monitoring wells in the southern part of the site were used to calibrate a vertical dispersivity α of 5.9 cm and a first order source constant λ of 8.2 x10-9 s-1. These values suggest minimal degassing of groundwater CO2 across the water table and till deposition during Late Wisconsinan deglaciation of the region.

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