Analysis of Yucca Mountain Pore-Water Chloride Data

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Research Objectives

Distribution of chemical constituents in the unsaturated zone (UZ) system of Yucca Mountain, Nevada, depends on many factors, such as hydrological and geochemical processes of surface precipitation, evapotranspiration, the water-fracture-matrix interactions, large-scale mixing via lateral flow and transport, and the history of climate changes. This study analyzes pore-water chloride-concentration data and models the transport processes. The model results are then used to calibrate the UZ flow model with the aim of refining the infiltration distribution and percolation fluxes to the potential repository.

Approach

The major chemical data used in this study were pore-water chloride (Cl) concentrations. The sensitivity of this conservative tracer to the UZ flow system is well known. This constituent was directly incorporated into a three-dimensional dual-permeability flow model. Chemical transport properties were taken into account. The surface flux of chloride was determined by the total amount of precipitation reaching the surface and chemical concentration in the precipitation. The entire flow system was divided into domains based on the distribution of pore-water chemical data, infiltration data, hydrogeological and hydrostructural features. Model calibration proceeded by adjusting the site-scale infiltration map and anisotropy permeabilities to reach a satisfying agreement between the simulated subsurface chloride distribution and measured data.

Accomplishments

The modeled pore-water chloride distributions are compared with the measured data. The results using the calibrated flow fields are more favorable than those using the one without calibration. The attached figure shows the 3-D simulations of pore-water Cl concentrations, using anisotropy permeabilities (kh/kv=10 and kh/kv=100) within the Paintbrush nonwelded (PTn) hydrogeologic units, against the measured data at borehole UZ#16. The simulation results using isotropic PTn permeabilities (kh/kv=1) are also shown in the same figure for comparison. The model calibrated by pore-water chloride data indicates a smoother distribution of infiltration rates and more lateral flow diversion effects within the PTn than model results without calibration.

Significance of Findings

The percolation flux at the potential high-level nuclear waste repository is one of the main issues in the Yucca Mountain UZ study. The long-term performance of the repository is determined in part by the timing of subsurface fluid percolation. Percolation flux strongly depends on the rock properties, the infiltration rates and their spatial and temporal distributions. The spatial distribution of chloride concentration suggests a relatively uniform percolation flux beneath the PTn. A uniform percolation flux at the repository horizon could potentially reduce seepage into waste emplacement drifts. This refined flow model is therefore useful for further study of percolation flux, flow pathways, and transport time, and can also be important for future integrated repository assessment.

Related Publications

Liu, J., Analysis and modeling of pore-water chemical data. Analysis/Model Report "UZ MDL-NBS-HS-000006, Section 6.4, Lawrence Berkeley National Laboratory, 2000.

Acknowledgements

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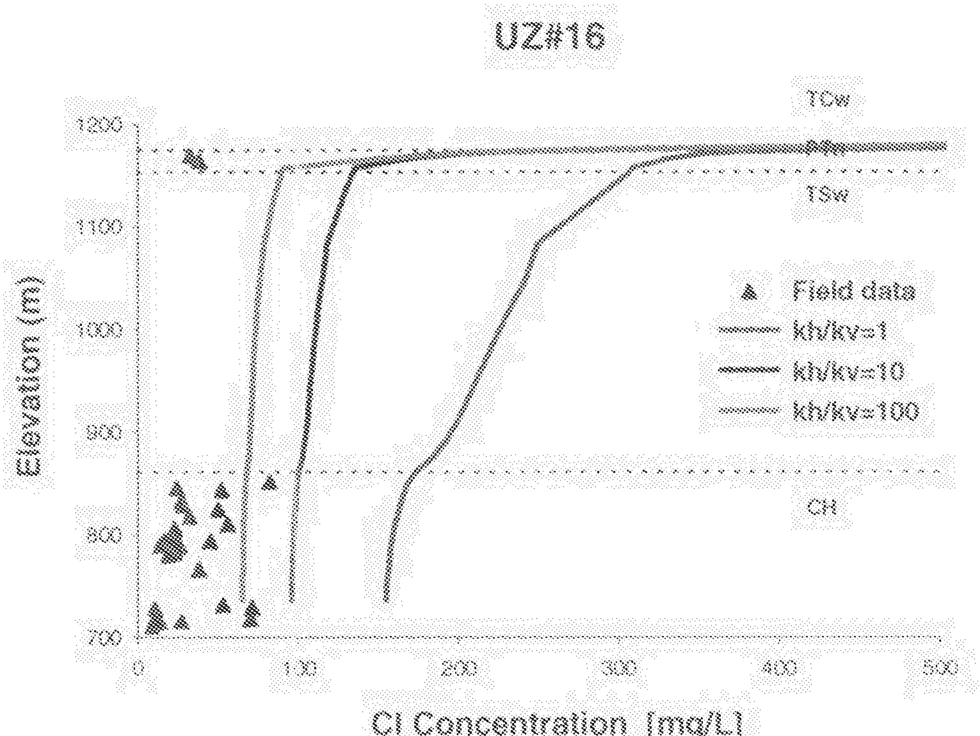

Figure 1. Observed and simulated chloride (Cl) values at borehole UZ#16.