Case Study

Schlumberger WATER SERVICES

About Schlumberger Water Services

We offer innovative groundwater solutions through professional expertise to meet the advancing technological requirements of today's professionals.

Schlumberger's Water Services division specializes in assessing, developing, and managing groundwater resources using some of the finest, advanced and cost-effective technologies available today.

Whether you're looking for field-scale data collection, data management, modeling, or resource decision-making solutions, our teams of specialists are here to help you address all your groundwater projects safely and efficiently.

Applied Technologies:

- FEFLOW
- ArcGIS

Transport Modeling in a Faulted, Karstic Environment

Jamaica

Investigating groundwater contamination at a mine site in Jamaica

Highlights:

- Assess severity of groundwater contamination from mine waste deposits
- Characterization of subsurface through the development of groundwater model to better understand groundwater flow patterns
- Simulation of fate and transport to assess the development of vertical movement of the solute plume
- Evaluate alternative remediation scenarios with the calibrated model to simulate contaminant migration within 30 years

Background

Near the south shore of Jamaica, a mining operation was assessing on-site conditions to determine the level of groundwater contamination resulting from waste deposits stored on site. Part of the investigation also focused on the potential long-term affects of mining waste.

The geologic setting is a faulted horst-graben valley, resulting in a series of major faults along the axis of the valley and non-orthogonal transverse faults. Groundwater flow is focused in the most heavily faulted zones. In addition, the limestone reef formations are understood to be karstic, particularly at the watertable elevation, which varies from 0 to greater than 305m below ground surface. The mine wastes are deposited as a slurry of spoil material and inorganic, processing bi-products with solute concentrations in excess of 10,000 mg/l generating a dense solute plume.

Challenges

To understand the degree of contamination and predict the potential long-term affects to the groundwater system, a clear understanding of the hydrogeologic and geologic conditions of the area are required.

Some of the challenges surrounding this mining investigation include:

- addressing density-dependent groundwater transport of the contaminant of concern
- understanding the geologic complexity of the area
- identifying groundwater flow patterns
- assessing current level of contamination
- predicting future potential risks to groundwater quality and the surrounding natural environment

For additional information, contact:

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Case Study: Transport Modeling in a Faulted, Karstic Environment

Solution

As part of the investigation, a contaminant fate and transport model was developed by Schlumberger Water Services to identify the groundwater plume migrating from the waste deposits. The development of the numerical model was particularly challenging due to the geological complexity of the area and the dense nature of the mine wastes.

Preferential Flow and Transport Along Fault Zones

The region contains numerous faults and karst solutions features, which influence preferential groundwater flow within the aquifer system. The limestone aquifer is susceptible to the formation of karst features, particularly where the pH is low and/or in high velocity portions of the aquifer.

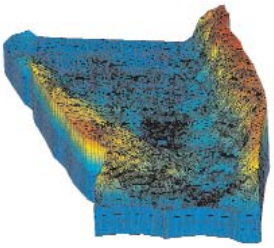
Density Effects on Transport

Due to the solute plume density (similar to brackish water) coupled flow and transport is essential in simulating the plumes vertical movement and extent. After 30 years, the simulation developed shows the plume migrates downward deep into the limestone formation near the source area and then horizontally along the faulted zones. This is primarily due to the higher density of the effluent relative to the freshwater aquifer. This can create the potential for high concentrations of solute to travel large distances very deep in the aquifer and then resurface at pumping wells, where vertical gradients draw the solute to shallower depths.

Results

As a result of the finite element model, the mine operation was able to project the solute plumes migration through the faulted zones. The calibrated model can also be used as a tool to evaluate possible remediation scenarios.

Groundwater Model Development Considerations

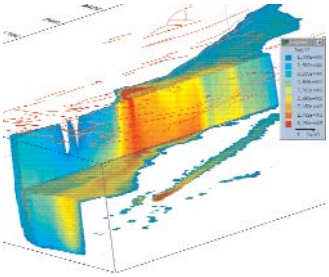


Mapped high K fault zones

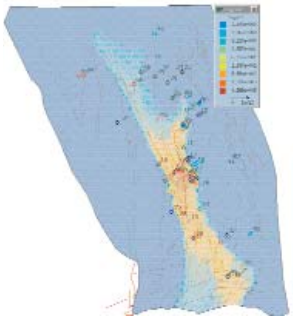
* Finite Element (FE) model locally refined around mine ponds, rivers, and fault zones
* Steep relief is not a problem for FE models

Finite element model structure

* Mapped fault zones represented as high K zones
* Models calibrated to water levels and 30 year solute levels



Model cutaway of 30 year solute plume



Solute plume after 30 years

Mine waste tailings are a source of large quantities of sodium

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