Simulation of Uranium Tailing Leaching using VS2DRT

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Presentation outline

- Introduction
- Description of VS2DRT model
- Uranium Tailings leaching case
- Result and discussions
- Conclusion

Introduction

- Uranium
- The first half of the 20th century
- 1940s to 1960s
- Environmental impact of uranium mining
  - Olympic Dam had released up to 5 million m³ of contaminated water into soil (IAEA, 2004)
  - Sotkamo, Kainuu province, Finland leakage uranium concentrations in near by Snow River exceeding more than ten-folds of the allowable level.

Description of VS2DRT model

- VS2DRT is a 2D reactive transport model for variably saturated porous media.
- It couples solute transport model VS2DT and heat transport model VS2DH with PHREEQC.
- It uses non-iterative operator splitting approach.
- It has capabilities to simulate equilibrium and kinetic reactions.

Uranium Tailings leaching case

Figure 1 Schematic representation of uranium tailing problem

Figure 2 van Genuchten hydraulic parameters used for the soil and tailing piles

Table 2 Initial and boundary solutions for uranium tailing problem

<table>
<thead>
<tr>
<th>Species</th>
<th>Inside the Tailing (mole/kg of water)</th>
<th>Outside the Tailing (mole/kg of water)</th>
<th>Boundary solution (mole/kg of water)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca$^{2+}$</td>
<td>$1.0 \times 10^{-2}$</td>
<td>$1.0 \times 10^{-2}$</td>
<td>$1.0 \times 10^{-3}$</td>
</tr>
<tr>
<td>CO$_3^{2-}$</td>
<td>$1.0 \times 10^{-2}$</td>
<td>$1.5 \times 10^{-3}$</td>
<td>$1.5 \times 10^{-3}$</td>
</tr>
<tr>
<td>UO$_2^{2+}$</td>
<td>$5.0 \times 10^{-4}$</td>
<td>$1.0 \times 10^{-7}$</td>
<td>$1.0 \times 10^{-8}$</td>
</tr>
<tr>
<td>PO$_4^{3-}$</td>
<td>$1.0 \times 10^{-6}$</td>
<td>$1.0 \times 10^{-6}$</td>
<td>$1.0 \times 10^{-6}$</td>
</tr>
<tr>
<td>SO$_4^{2-}$</td>
<td>$2.0 \times 10^{-1}$</td>
<td>$2.0 \times 10^{-2}$</td>
<td>$1.0 \times 10^{-4}$</td>
</tr>
<tr>
<td>H$^+$</td>
<td>$3.5 \times 10^{-2}$</td>
<td>$1.0 \times 10^{-7}$</td>
<td>$1.0 \times 10^{-7}$</td>
</tr>
<tr>
<td>Fe$^{2+}$</td>
<td>$2.0 \times 10^{-1}$</td>
<td>$1.0 \times 10^{-3}$</td>
<td>$1.0 \times 10^{-3}$</td>
</tr>
</tbody>
</table>
Result and discussions

Figure 3 Pressure head profile at 0 days

Figure 5 Uranium profile at 250 days

Figure Uranium profile at 0 days

Figure 6 Uranium profile at 500 days
Result and discussions

Figure 6 Uranium profile at 1000 days

Conclusion

- Uranium Tailing leaching is a serious environmental problem
- Reactive transport models like VS2DRT are useful tool to visual the spatial and temporal distribution of contaminants in the subsurface.
- The accuracy of the model depends on the input hydrological and chemical properties, initial and boundary conditions.
- In decision making processes if possible compare results with observed values at selected locations.

Thank You!