Impacts and Stability of Iron in Icelandic Peat Areas

Presented by Kristen Almen
NDSU Geochemistry 2018
Background

- Peat is mainly made up of partially decomposed plant material
- Peat makes up a large portion of soil in Iceland and has an important impact on pollution
- Basaltic glass often deposits heavy metals within peat areas
- Iron in the form of ferrihydrite is able to adsorb these metals
  - Nearby rivers and streams have safe drinking water supplies
Peat in Iceland
Sample Location
Why Chose This Topic?

- Wetlands filter water, but how?
- What would happen to surrounding bodies of water without wetlands?
- How would the deposition of volcanic ash impact the composition of peat water?
Linke and Gislason studied the phases of iron present at various pH, salinity, and oxygen gradients from a water sample in Hvammsendi, Iceland. They modeled naturally occurring iron phases rather than the most stable. They also mixed the peat water sample with seawater to model sea level rise due to climate change.
Results of Previous Work Done

- Ferrihydrite was found to be the dominant form of iron in environmental conditions where peat is found.
- The heavy metals adsorbed by ferrihydrite were released as a result of mixing with seawater.
New Work Done

- What would happen in response to a volcanic eruption?
- How would the water sample change?
- Volcanic ash from the Grímsvötn volcano was mixed with the peat water sample and a sample from the Grímsá River.
- I expected the peat sample to buffer the addition of heavy metals.
Location of Volcanoes and Peat in Iceland
Differences Between the River and Peat Water Samples

- The pH of the peat sample was 6.39 while the pH of the river sample was 8.08
- The peat sample had sulfate, iron, lead, and cadmium present while the river sample did not
- Peat sample was taken from an anoxic environment
# PHREEQC Inputs

## SOLUTION 1
- **Peat water**
  - temp: 25
  - pH: 6.39
  - pe: 4
  - redox: pe
  - units: umol/L
  - density: 1
  - Ca: 350
  - Cl: 810
  - F: 2.82
  - Mg: 320
  - Na: 900
  - Si: 480
  - S(6): 240
  - Alkalinity: 1.17 meq/L
  - N(-3): 0.000746
  - N(3): 8.6e-005
  - N(5): 0.000145
  - Al: 0.634
  - Fe: 138
  - Mn: 7.01
  - Ba: 0.0205
  - Cd: 9e-005
  - Cu: 0.00478
  - Pb: 0.00012
  - Sr: 0.188
  - Zn: 0.0421
  - water: 1 # kg

- **Volcanic ash**
  - temp: 25
  - pH: 6.39
  - pe: 4
  - redox: pe
  - units: umol/L
  - density: 1
  - Cd: 1.3e-006
  - Cu: 0.00017
  - F: 0.72
  - Mn: 0.0071
  - Pb: 1.5e-006
  - Zn: 0.0011
  - water: 1 # kg

- **River water**
  - temp: 25
  - pH: 7
  - pe: 4
  - redox: pe
  - units: umol/L
  - density: 1
  - Cd: 1.3e-006
  - Cu: 0.00017
  - F: 0.72
  - Mn: 0.0071
  - Pb: 1.5e-006
  - Zn: 0.0011
  - water: 1 # kg

- **MIX 2 100 to 1 mix with ash**

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**SOLUTION 1 Grimsa River**
- temp: 25
- pH: 8.08
- pe: 4
- redox: pe
- units: umol/L
- density: 1
- Alkalinity: 0.405
- Na: 324
- Mg: 64.6
- Al: 0.313
- Si: 170
- K: 9.84
- Ca: 86.8
- Cl: 282
- water: 1 # kg
**PHREEQC Outputs**

### Peat water and ash

<table>
<thead>
<tr>
<th>Phase</th>
<th>SI**</th>
<th>log IAP</th>
<th>log K</th>
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</thead>
<tbody>
<tr>
<td>Fe(OH)3</td>
<td>1.23</td>
<td>6.13</td>
<td>4.89</td>
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<tr>
<td>Fe(OH)3(a)</td>
<td>1.65</td>
<td>9.76</td>
<td>8.11</td>
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<td>Gibbsite</td>
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<td>6.13</td>
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<td>Al(OH)3</td>
<td>3.16</td>
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<td>12.70</td>
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<tr>
<td>Siderite</td>
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<td>-10.89</td>
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### River water and ash

<table>
<thead>
<tr>
<th>Phase</th>
<th>SI**</th>
<th>log IAP</th>
<th>log K</th>
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<tbody>
<tr>
<td>Diaspore</td>
<td>1.18</td>
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<tr>
<td>AlOOH</td>
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<tr>
<td>Gibbsite</td>
<td>5.16</td>
<td>-64.60</td>
<td>-69.76</td>
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<tr>
<td>Al(OH)3</td>
<td>3.19</td>
<td>15.89</td>
<td>12.70</td>
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<tr>
<td>Kmica</td>
<td>3.16</td>
<td>-64.60</td>
<td>-69.76</td>
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<tr>
<td>Leonhardtite</td>
<td>5.16</td>
<td>-64.60</td>
<td>-69.76</td>
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<tr>
<td>Ca2Al4Si8O24:7H2O</td>
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### PHREEQC Outputs

#### Peat sample lead and cadmium species present

<table>
<thead>
<tr>
<th>Species</th>
<th>Molality</th>
<th>Activity</th>
<th>Log Molality</th>
<th>Activity</th>
<th>Log Gamma</th>
<th>cm³/mol</th>
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</thead>
<tbody>
<tr>
<td>Pb</td>
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<tr>
<td>PbCO3</td>
<td>5.632e-11</td>
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<td>-10.249</td>
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<tr>
<td>Pb+2</td>
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<tr>
<td>Cd</td>
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<td>Cd+2</td>
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<td>CdCl+</td>
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<td>CdSO4</td>
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<td>78.05</td>
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#### River sample lead and cadmium species present

<table>
<thead>
<tr>
<th>Pb</th>
<th>1.485e-14</th>
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<tbody>
<tr>
<td>PbCO3</td>
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<td>1.333e-14</td>
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<td>PbOH+</td>
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<td>Cd+2</td>
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<tr>
<td>CdCl+</td>
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<td>-15.554</td>
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<td>CdHCO3+</td>
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<td>-15.889</td>
<td>-0.014</td>
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</tbody>
</table>
Results

- The phases present varied in type and saturation level
- Lead and cadmium levels decreased in the peat sample
- Iron was not present in the river sample
  - Ferrihydrite was not present to adsorb heavy metals
Conclusions

- Peat water is able to act as a buffer against chemical additions
- Without peat areas, rivers and streams in Iceland may be contaminated by volcanic ash
- The decrease in the use of peat for horticulture and energy should continue in hopes of protecting water quality
References


Any Questions?