Mobility of Arsenic in Sediments of Coalbed Natural Gas (CBNG) Disposal Pond Playas in the Powder River Basin (PRB), Wyoming

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Continuation of previous studies of water and sediment quality in CBNG outflow ponds in PRB

- Sampled dried ponds (playas) in five sub-basins

- Collected sediment samples from seven pond playas and prepared them for fractionation experiment

- Investigating the leaching potential of Arsenic (As) in the sediments in CBNG playas
PBR Basin Environment

- Semi arid basin
  Annual Precipitation
  30-60 cm (12-24 in)
- Loamy soils
- Soil pH 7.2
- Moderately to well draining
- Northern Mixed Grass Prairie
> 4,000 impoundments in operation to manage CBNG water in Wyoming at end of 2010

- Impoundments are used to manage an estimated 65% of CBNG produced water in PRB
Sample site example in LPR

2004–2009 studies

Summer 2013
Methods

- The CBNG holding pond sediments will be sampled during the summer months of 2013
- Collect sediment samples, in duplicate, from seven of the representative playas of CBNG discharge ponds in the PRB
- Will use the collection procedure given in US EPA (2005) guidelines
- Duplicate samples will be taken from the lowest elevation of each playa
- Sediment samples will be taken from the surface to approximately 20 cm depth
- These samples will be divided into 2 sections, each 10 cm in length
- Then cooled to 2°C for transport back to the Water Quality Lab at the University of Wyoming in Laramie, WY
- Samples will be aired dried and sieved to < 2mm for testing
Involves the extraction of trace elements from the sample sediments associated with different fractions:

- Water soluble As
- Surface absorbed As
- Fe- and Al-associated As
- Carbonate – bound As
- Residual As

Multistep procedure to completely extract trace element (As) and determine accurate concentration under different conditions.
Air-dried sediment ( < 2 mm)

EDXRF (total content)

Sequential extraction

Ultrapure Water
16 hours shaking

Water soluble As

0.5 NaHCO₃
16 hours shaking

Surfaced Absorbed As

0.1 M NaOH
16 hours shaking

Fe- and Al associated As

1 M HCL
16 hours shaking

Carbonate-bound As

32% HNO₃

Residual
Results—Surfaced Absorbed

- LPR 162
- LPR 164
- CR 170
- TR 188
- BFR 168
- BFR 173
- PR 178

Arsenic ppb

Depth:
- 10 inch
- 20 inch
Results - Fe and Al

Arsenic ppb

<table>
<thead>
<tr>
<th>Sample</th>
<th>Arsenic (10 inch)</th>
<th>Arsenic (20 inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPR 162 DY</td>
<td>1500</td>
<td>2000</td>
</tr>
<tr>
<td>LPR 164 DY</td>
<td>1200</td>
<td>1800</td>
</tr>
<tr>
<td>CR 170 ArCl</td>
<td>800</td>
<td>1200</td>
</tr>
<tr>
<td>TR 188 DUN</td>
<td>500</td>
<td>1000</td>
</tr>
<tr>
<td>BFR 168 DVS</td>
<td>3500</td>
<td>4500</td>
</tr>
<tr>
<td>BFR 173 DHM</td>
<td>2000</td>
<td>3000</td>
</tr>
<tr>
<td>PR 178 IBR</td>
<td>1000</td>
<td>1500</td>
</tr>
</tbody>
</table>

10 inch depth
20 inch depth
Results – Carbonates

![Bar chart showing arsenic ppb at different depths for various locations.](image-url)
Results - Residuals

- LPR 162
- LPR 164
- CR 170
- TR 188
- BFR 168
- BFR 173
- PR 178

Arsenic ppb

- 10 inch depth
- 20 inch depth
All Results

Water Soluble | Surface-Absorbed | Fe and Al | Carbonate Bound | Residual
--- | --- | --- | --- | ---
0% | | | | |
10% | | | | |
20% | | | | |
30% | | | | |
40% | | | | |
50% | | | | |
60% | | | | |
70% | | | | |
80% | | | | |
90% | | | | |
100% | | | | |
Continuing Project Work
Results
pH and Total Arsenic

![Bar Chart]

<table>
<thead>
<tr>
<th>Location</th>
<th>Arsenic ppm</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPR 162</td>
<td>162</td>
<td></td>
</tr>
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</tr>
<tr>
<td>CR 170</td>
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<tr>
<td>BFR 168</td>
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</tr>
<tr>
<td>BFR 173</td>
<td>173</td>
<td></td>
</tr>
<tr>
<td>PR 178</td>
<td>178</td>
<td></td>
</tr>
</tbody>
</table>

Average Arsenic (ppm)
Average pH
Results
Total Arsenic
10 cm Watershed Control and 10 cm Sample

ppm

LPR 162 WtShd Ctrl
LPR 162 DY Ave-010
LPR 164 Wt Shd Ctrl
LPR 164 DY Ave-010
BFR 173 WtShd Ctrl
BFR 173 DHM Ave-010
CR 170 WtShd Ctrl
CR 170 ArCl Ave-010
TR 188 Wtshd Ctrl
TR 188 DUN Ave-010
BFR 168 WtShd Ctrl
BFR 168 DVS Ave-010
The sequential extraction procedure has provided information on the amount of arsenic associated with different sediment fractions.

As expected most of the arsenic is being held in residual and Fe and Al oxide fraction and will not mobilize.
References


Questions?