Hydrological Characterization of the Nelson Tunnel Mine Drainage Creede, Colorado

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Willow Creek Reclamation Committee

Local citizens
• Zinc loads 169-375 Lbs/Day
• Up to 75% load W. Willow
• Cadmium up to 50% of load
Dueling Conceptual Model

The source of water producing the mine discharge is....

• Predominantly new water from snowmelt and summer precipitation

• Predominantly older regional groundwater flow

• Accurate characterization will impact remediation options!
Outline

• Geological characterization
• Mine complex characterization
• Hydrologic characterization
• Hydrogeologic conceptual model
• How can we use this information?
From Byington, 2012
Commodore Tunnel following Amethyst fault
2009-2010
Surface water sampling sites

- Equity Mine
- Emerald Ranch
- Emerald Ranch Spring
- Midwest Spring
- Weaver Spring
- Nelson Portal
2012-2013
Surface water sampling sites
Vertical view of Commodore Mine
Nelson Tunnel Sample Sites

Sample Site w/ # of samples collected

MINE POOLS:
A. Nelson Portal Blockage
B. Nelson Portal Pool
C. Bachelor Blockage
D. Lower Mine Pool
E. Noname Blockage
F. Upper Mine Pool
Hydrologic Characterization

• Stable water isotopes ($\delta^{18}$O/$\delta$D)

• Radioactive water isotopes ($^3$H – Tritium)

• Radiocarbon dating ($^{14}$C of DIC and DOC)

• Strontium isotopes (86Sr/87Sr)

• Metals and solute chemistry
Creede dD v. d18O: Kiowa Lab Samples

- Rain
- Snow
- Mine Water
- Spring Water
- Surface Water
- Well Water

D (per mil)

-20 -15 -10 -5 0

D18O (per mil)
Tritium Values of Nelson Tunnel Sample Sites

Sample size in parentheses
<table>
<thead>
<tr>
<th>Depth</th>
<th>% modern water</th>
<th>Water age years</th>
</tr>
</thead>
<tbody>
<tr>
<td>-65</td>
<td>13.25</td>
<td>16,250</td>
</tr>
<tr>
<td>-60</td>
<td>13.5</td>
<td>16,100</td>
</tr>
<tr>
<td>-40</td>
<td>13.92</td>
<td>15,850</td>
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</tbody>
</table>

Radiocarbon ages from DIC of mine waters:

<table>
<thead>
<tr>
<th>% modern water</th>
<th>Water Age years</th>
</tr>
</thead>
<tbody>
<tr>
<td>28.41</td>
<td>10,100</td>
</tr>
<tr>
<td>33.3</td>
<td>8,830</td>
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<tr>
<td>19.86</td>
<td>13,000</td>
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</tbody>
</table>
HYDROGEOLOGIC CONCEPTUAL MODEL

Recharge occurs in higher elevations – infiltration of snow melt

GW entering workings is old – based on tritium & 14C

Temperatures of water in NT is 18-20°C

Flowpaths – deep? slow? geology?

Dense extension fractures / faults create porosity / permeability

Groundwater flow direction