Abandoned Mine Program & Mercury Mine Investigation and Cleanup Strategy

Status Report

December 12, 2018
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EG, Groundwater Protection Division
Talk Outline

- Why we care
- Status of abandoned mines
- Desktop analysis and prioritization
- Inspections
- Innovative approaches
Why we care

Mines
New Almaden Quicksilver Mine, 1863 (Oakland Public Library)
California Mines

California Department of Conservation, Division of Mine Reclamation
California Gold & Mercury Mines

US Geological Survey (Alpers 2005)
Hydraulic gold mining

Carlton Watkins

Mix with liquid mercury in sluice box (~30% loss USGS)
Mercury from all directions

Mercury from ATMOSPHERE

Mercury from GOLD mining

Mercury from CINNABAR mining
Mercury impaired water bodies
Why we care

Mercury
Methylmercury biomagnifies up the food web

... and is a neurotoxin

Cossaboon et al., 2015
Climate Change Impact

Wildfires $\Rightarrow$ Erosion of mining waste

US Forest Service
Region 2 abandoned mine
Status
Our Mines

Abandoned Mines in Region 2

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Color</th>
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</thead>
<tbody>
<tr>
<td>Chromium</td>
<td>cyan</td>
</tr>
<tr>
<td>Copper</td>
<td>orange</td>
</tr>
<tr>
<td>Magnesium</td>
<td>red</td>
</tr>
<tr>
<td>Mercury</td>
<td>magenta</td>
</tr>
<tr>
<td>Silver</td>
<td>white</td>
</tr>
<tr>
<td>Sulfur</td>
<td>yellow</td>
</tr>
<tr>
<td>Manganese</td>
<td>purple</td>
</tr>
</tbody>
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Remediating by Water Board and others

Abandoned Mines in Region 2

Commodity

- Chromium
- Copper
- Magnesium
- Silver
- Coal
- Manganese
- Sulfur

Legend:
- Orange: Copper
- Red: Magnesium
- Purple: Manganese
- Pink: Mercury
- Yellow: Sulfur
Under Investigation by Water Board

Undergoing Water Board Cleanup

Abandoned Mines in Region 2

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Unaddressed Mines (2016)
Region 2 abandoned mine

2016-17 Prioritization
Desktop analysis and prioritization

- Evaluate available mine, hydrology, imagery data
  - Reports
  - GIS
  - Google Earth satellite

- Score mines based on 12 weighted factors, including
  - Mobile, toxic metal(loids)
  - Mining waste, volume, mobility
  - Connectivity to receiving waters, impairment

- Rank mines by score
Prioritize by Risk

Ranked by water quality threat

Low

Medium

High

Abandoned Mines in Region 2

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<tr>
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<th>Copper</th>
<th>Mercury</th>
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Commodity:
- Chromium
- Magnesium
- Silver
- Manganese
- Sulfur
Ranked by water quality threat

Low
Medium
High

Abandoned Mines in Region 2

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<tr>
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<tr>
<td>Copper</td>
<td>Orange</td>
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<tr>
<td>Magnesium</td>
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<td>Silver</td>
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Map showing locations of abandoned mines in Region 2 with different regions marked as Low, Medium, or High based on water quality threat.
Region 2 abandoned mine

Inspections
Inspections (screening investigations)

- Visual Observations
  - Mine features
    - Openings (adit, shafts...)
    - Structures
    - Waste - unnatural topo, soil characteristics, color, odor
  - Contaminant mobility
    - Erosion and erodability
    - Mine drainage, ARD

- Measurements
  - Distance/grade to water features
  - Solids
    - Metalloid(s) via X-Ray Fluorescence Spec.
  - Liquids (mine drainage, creeks, seeps...)
    - pH
    - EC
    - Potential contaminants
Hastings Mercury Mine Inspection with XRF

- Mining waste piles
- Ore processing area with contaminated soils and structures
- All located on slope above springs (groundwater seepage from slope)
- Drains to impaired water bodies

above human health or ecotox water quality criteria
Hastings mine and receiving waters... (by drone)
Region 2 abandoned mine

Innovative Approaches
X-Ray Fluorescence Spectrometer (XRF)

SCREEN
Hg IN SITU

QUICK & CHEAP

BETTER CHARACTERIZATION

Golder Associates
Guadalupe Mercury Mine Investigation
Guadalupe Mercury Mine  Potential Cleanup Strategy

Target erodible Hg first

High Erodibility
Medium
Low
Selective Sequential Extraction (SSE)

- **ID MOBILE, TOXIC Hg**
- **PRIORITIZE CLEANUP**
- **TARGET**

Hg POSES RISK
What’s next?

- One more high priority mine to inspect
  - Need dry conditions

- Prioritize for cleanup
  - Factors associated with impacts

- Consider interim remedial actions for egregious discharges

- Take advantage of current efforts/funds...
St. John’s Mercury Mine
St. John’s Mercury Mine Potential Brownfield Investigation
Wrap up

- 11 remediated
- 10 undergoing investigation or cleanup
- 20 case closed
- 7 prioritized

Strategy to address worst 1st using new tools and methods
Thanks!

Scientific Aides
Nicholas Piucci
Sarah Acker

“Freddie Mercury” by Pablo Bustos