Coal Mine Effluent Regulations: Geochemistry and Water Quality Considerations

Alan J. Martin, M.Sc., P.Geo., R.P.Bio.
Principal, Senior Geochemist/Biologist
&
Justin Stockwell, M.Sc.
Senior Hydrogeochemist

Lorax Environmental Services Ltd., Vancouver, Canada

Proposed Name Change

Selenium: ***from "selene", meaning moon***

Senelium: ***from "senelis" (latin) meaning to drive one crazy***

Proposed Regulated Parameters and Their Sources

- Total Suspended Sediments:
  - Overland erosion
  - In-stream erosion/resuspension
  - Waste material weathering
- Total Nitrate:
  - Leaching of residual blasting residues (e.g., incomplete combustion of Ammonium Nitrate Fuel Oil).
- Total Selenium:
  - Weathering (oxidation) of mine waste materials (waste rock, tailings, plant refuse, pit walls, coal stockpiles).
  - Weathering of unsaturated spoils represents largest loading source.

Focus of Presentation

Nitrate

- Proposed Maximum Monthly Mean Concentration
  - 10 mg-N/L (Existing Mines)
  - 3 mg-N/L (New Mines and Expansions)
- Limit for new mines and expansions = BC Aquatic Life Guideline (also 3 mg-N/L)
- Coal Mines in BC/Alberta
  - Waste rock seepage: 30-250 mg/L
  - Sediment Ponds (Final Points of Discharge): 10-100 mg/L.

In absence of extremely effective source control, treatment will be required

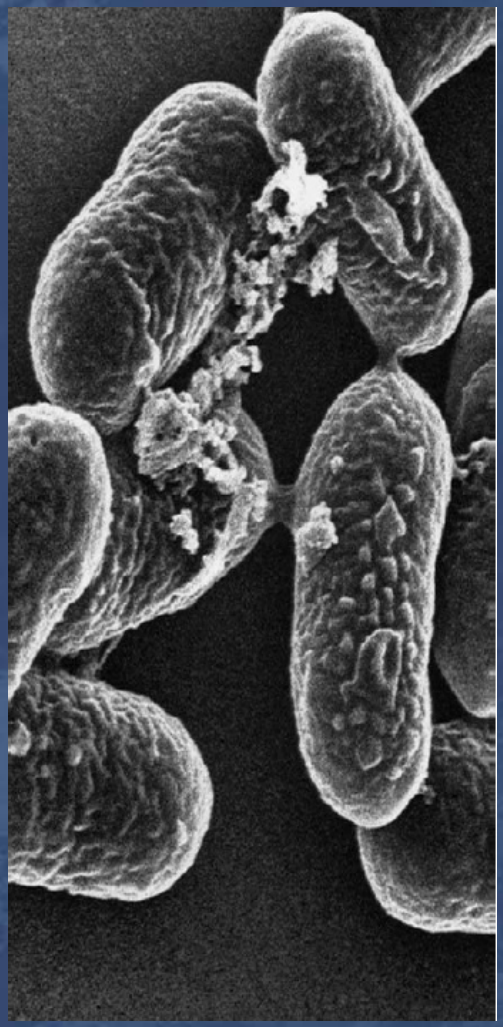
Selenium

- Proposed Maximum Monthly Mean Concentration
  - 5 to 10 µg/L (Existing Mines)
  - 5 µg/L (New Mines and Expansions)
- Water quality guidelines:
  - British Columbia: 2 µg/L
  - Alberta: 2 µg/L
  - USEPA: 1.5 µg/L (lentic); 3.1 µg/L (lotic)
- Coal Mines in BC/Alberta
  - Waste rock seepage: 300 to 800 µg/L
  - Sediment Ponds (Final Points of Discharge): 100 to 500 µg/L.

In the absence of extremely effective source control, treatment will be required for both existing and new mines to meet effluent limits.

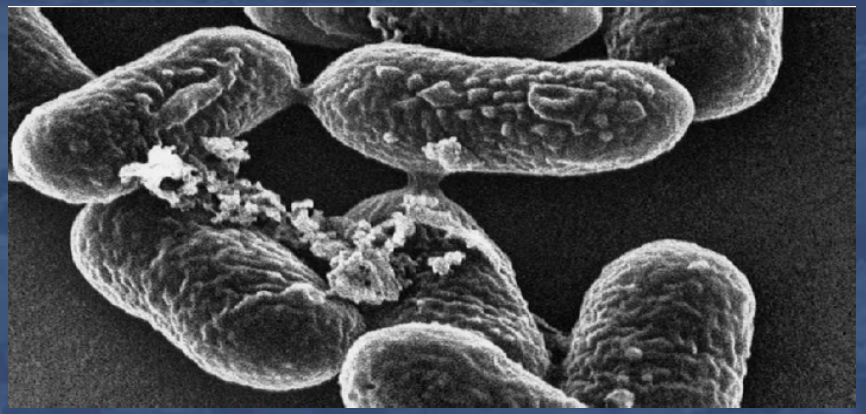
Selenium and Nitrate Source Control

- Conditions conducive to Se source control also conducive to nitrate.
- Se and nitrate bio-reduction are microbially mediated.
- Strongly dependent on redox conditions.
- Suboxia is required for effective removal.
- Denitrification and Se bio-reduction have been shown to occur simultaneously.



Source Control – Saturated Fills

- The saturated zones of backfilled pits can provide optimum environments for the attenuation of Se and nitrate.
- The oxygen demand imposed by residual carbon (e.g., coal), in conjunction with relatively-long water residence times, can promote the development of suboxic conditions.
- Under conditions of suboxia, Se is host to a suite of microbially-mediated processes that favour the removal of dissolved Se from solution.
- Reaction rates can be accelerated through addition of organic carbon



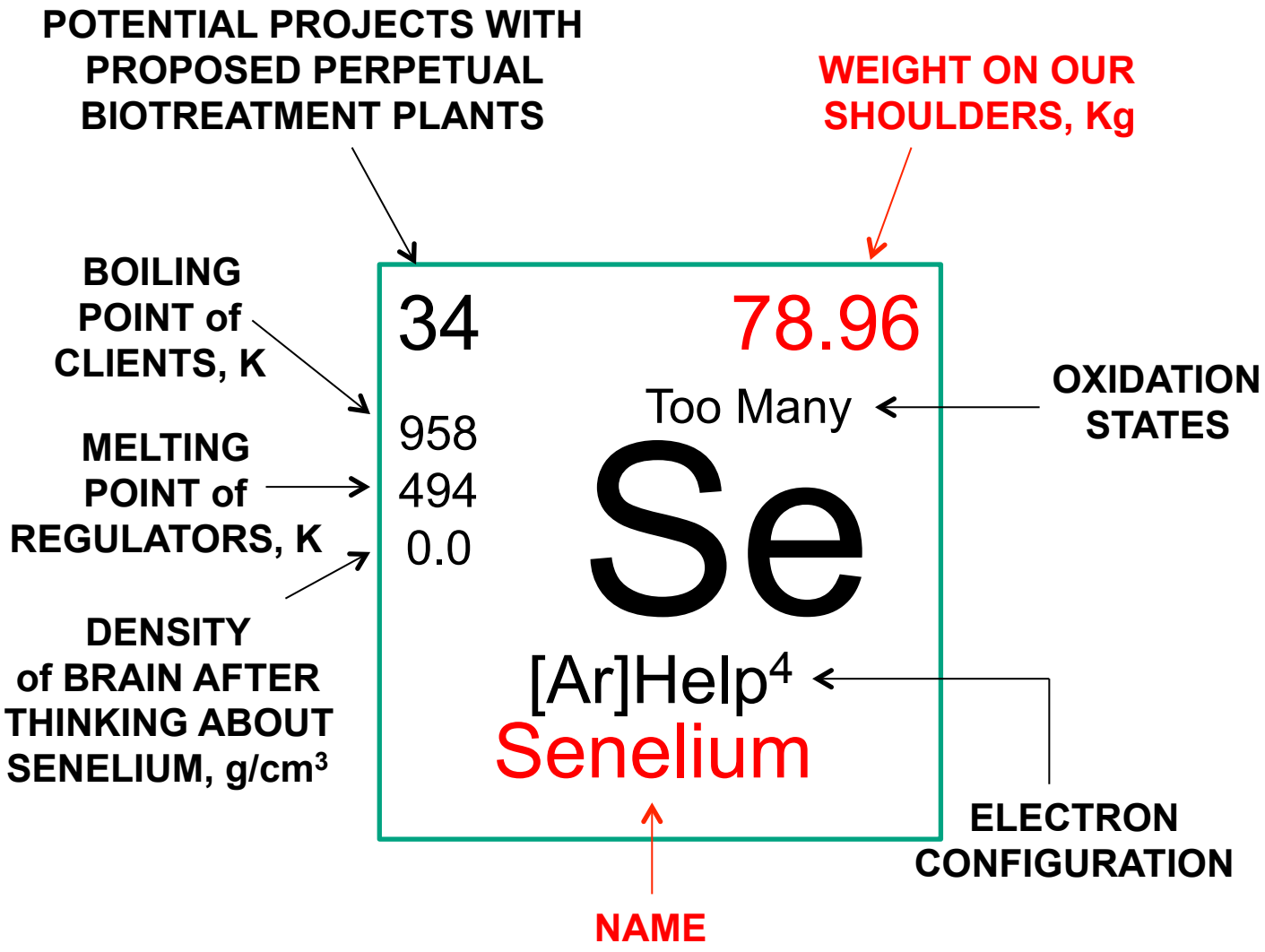
Source Control – Mine Planning

- Maximize saturated storage volume (pit design)
- Maximize pit backfill (reduce footprint of ex-pit dumps)
- Maximize passive drainage of contact flows reporting to saturated zones (waste placement, water management, pit design)
- Coordinate mine plan to allow for early availability of in-pit storage (design of pits, mine sequencing)
- Maximize potential for suboxia in unsaturated spoils (e.g., bottom-up (plug) waste dump construction)
- Minimize oxygen ingress and net infiltration into spoils (e.g., engineered cover systems).

Nitrate Source Control – Explosives Management

- Objective: complete and efficient detonation of explosives.
- Minimize N losses via:
  - Avoidance of miss fires
  - Spill prevention
  - Dewatering of blast zones
  - Control (diversion) of surface water in blast zones
  - Explosive selection (dry vs. wet conditions)
  - Use of blast hole liners
  - Diligent monitoring (explosive consumption and losses)
  - Training and education

Thank You!


POTENTIAL PROJECTS WITH PROPOSED PERPETUAL BIOTREATMENT PLANTS
WEIGHT ON OUR SHOULDERS, Kg
BOILING POINT of CLIENTS, K
MELTING POINT of REGULATORS, K
DENSITY of BRAIN AFTER THINKING ABOUT SENELIUM, g/cm3
OXIDATION STATES
ELECTRON CONFIGURATION
NAME
34
78.96
Too Many
958
494
0.0
Se
[Ar]Help4
Senelium