Selenium in Sediment and Soil

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Geochemistry

Properties of Selenium

- Atomic Number: 34
- Group VI on the Periodic Table, Chalcogen.
- Amorphous (red, black powdered), Monoclinic Crystalline (red), or Hexagonal Crystalline (metallic gray)
- Atomic Wieght: 78.96 g/mol
- Density: 4.79 g/cm^3
- Melting Point: 490.2 K
- Exhibits photovoltaic and photoconductive properties.

Properties of Selenium

- Six stable isotopes.
- Nine major radioactive isotopes. Se-79 has a half-life of 65,000 years. Se-75 has a half-life of 120 days. All other half-lives are less than 8 hours.

Stable Isotopes and Abundances	
Isotope	Abundance
Selenium-74	0.87%
Selenium-76	9.02%
Selenium-77	7.58%
Selenium-78	23.52%
Selenium-80	49.82%
Selenium-82	9.19%

Sources of Selenium in sediment and soil.

- Parent Material of Soil or Sediment (Geologic).
- Atmospheric
- Anthropogenic

Concentrations of Se in Soils, Rocks, and Other Natural Sources.		
Material	Mean (mg/kg)	Range (mg/kg)
Igneous Rocks (general)	0.35	0.09-1.08
Volcanic Rocks, notable locations in USA		
CO, CA, NM, ID, AK	<1.0	
HI	<2.0	
Sandstones (general)		<0.01-0.05
Carbonates	0.08	
Marine Carbonates	0.17	
Carbonaceous Materials		
Shales (W. USA)		<1-675
Shales (WY)	19.86	2.3-52.0
Shales (general)	0.05	
Mudstones		few-1500
Limestone (general)	0.03	
Phospate Rocks	1-300	
Coal		
USA	3.36	0.46-10.65
Australia	0.79	0.21-2.5
Oil		0.01-1.4
Soils		
USA (general)		<0.1-5000
USA (CA)	1.5	0.6-1.6
UK (general)	0.5	0.2-2.0
UK (Whales and Ireland)		30-3000

Atmospheric

Anthropogenic Sources

- Sewage sludge – minor.
- Industrial Waste – minor, isolated.
- Nuclear Waste – by product of nuclear fission.
- Agricultural Practices.
  - May enrich the soil through application or by harvesting methods.

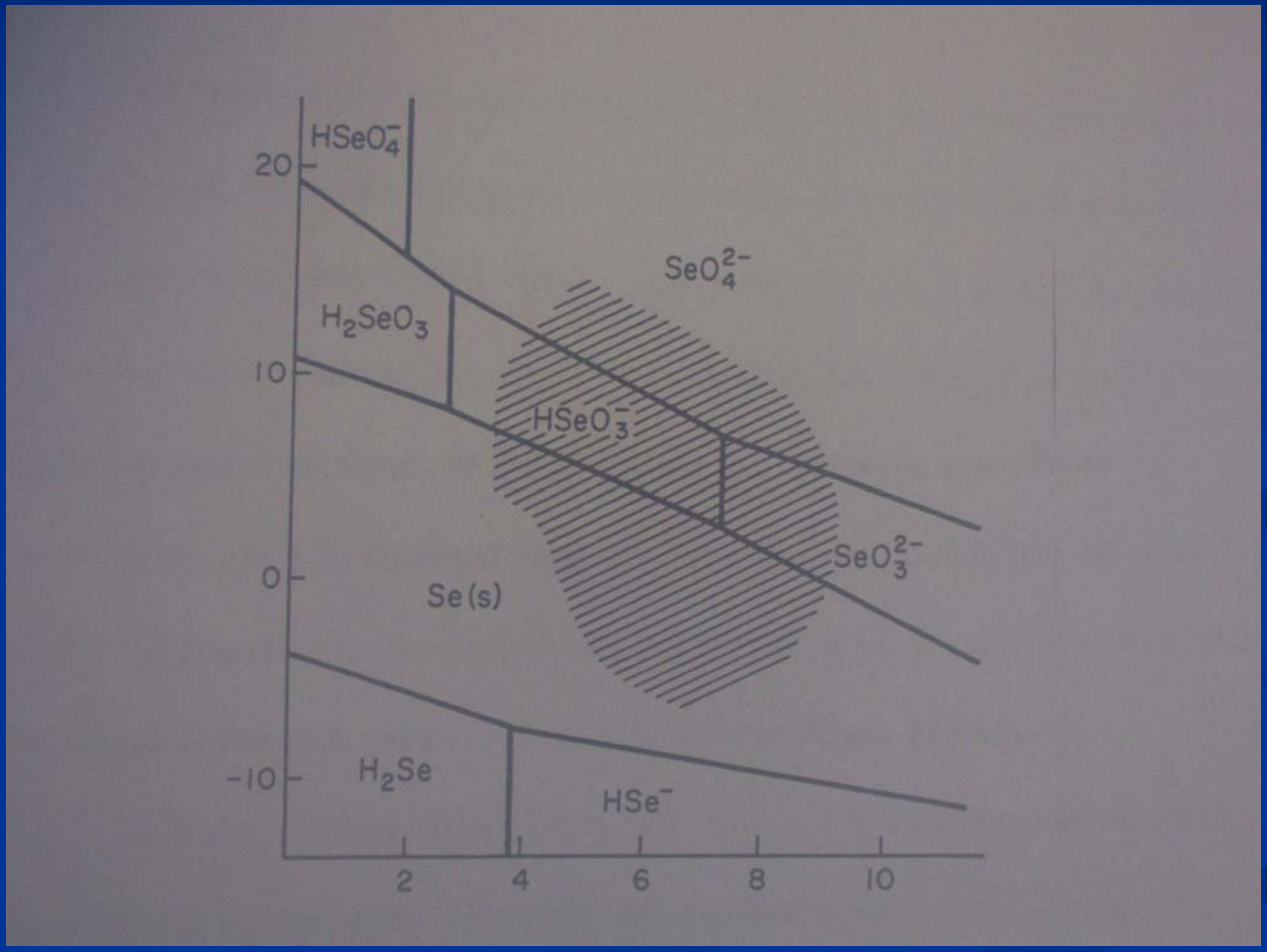
Speciation of Selenium

- Selenium may occur in four different oxidation states: II, III, IV, and VI.
- All species, as well as elemental Se, may be found in soils.
- The species present are controlled by soil conditions, especially Eh and pH.
- Under normal conditions, Se IV (Selenite) and Se VI (Selenate) are dominant.
- Organic selenium species are more volatile.

Controls on the Mobility of Se in Sediment and Soil

- Species of Se present.
- Microbial Processes
- Plant Processes
- Mineralogy of the soil or sediment.

Eh-pH Diagram of Se



Affects on Organisms

- Excesses:
  - Selenosis: gastrointestinal upset, hair loss, blotchy white nails, and mild nerve damage.
  - Severe overexposure results in death.

- Deficiencies:
  - Hair loss, skin disorders, muscle degradation, increased risk of cancer and heart disease, weakened immune system, osteoarthropathy, mental retardation, and death.

Conclusion

- Most Se in sediment and soil comes from source rocks.
- The speciation of Se is controlled by many factors, but pH seems most important.
- Selenate is the most mobile inorganic species in sediment and soil.
- Organic selenium is highly volatile.
- Naturally occurring Se only causes problems in areas of abnormally high Se concentrations.

Questions?