

Selenium in Mine Drainage

Chemistry and Behavior

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History of Selenium

Discovered in 1818 by Berzelius

Isolated from pyrite from Falun mine in Sweden

Named after the moon (tellurium after the earth)

Few uses until technology age. A semiconductor.

Xerography

Photocells

Shampoo (Selenium Sulfide, 1%)

Selenium Chemistry and Behavior

Selenium Species

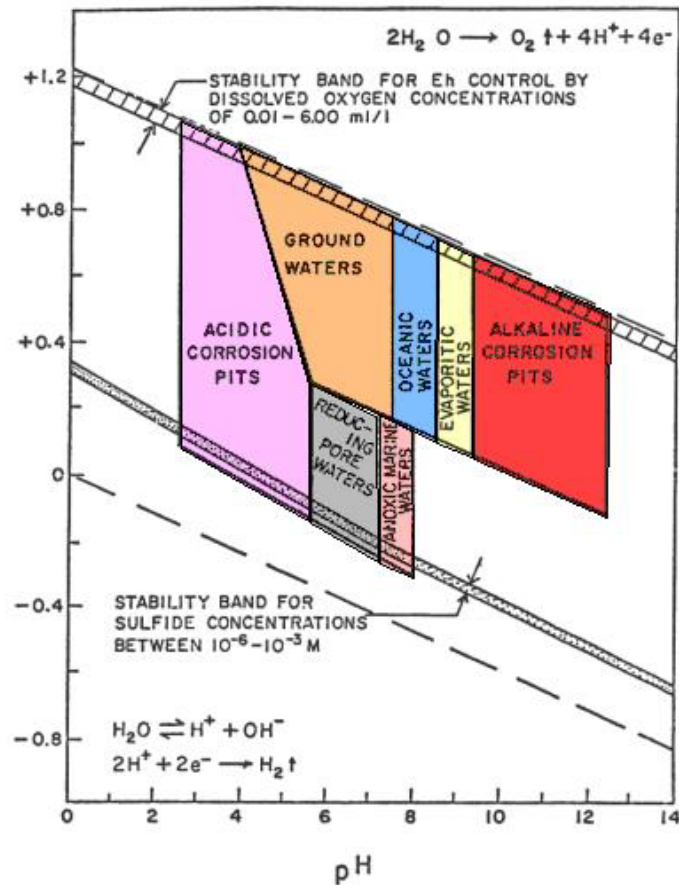
- Selenide, Se (-II)
- Selenium, Colloidal Se (0)
- Selenite, Se (IV)
- Selenate, Se (VI)
- Diverse organic forms

Chemical Interconversions

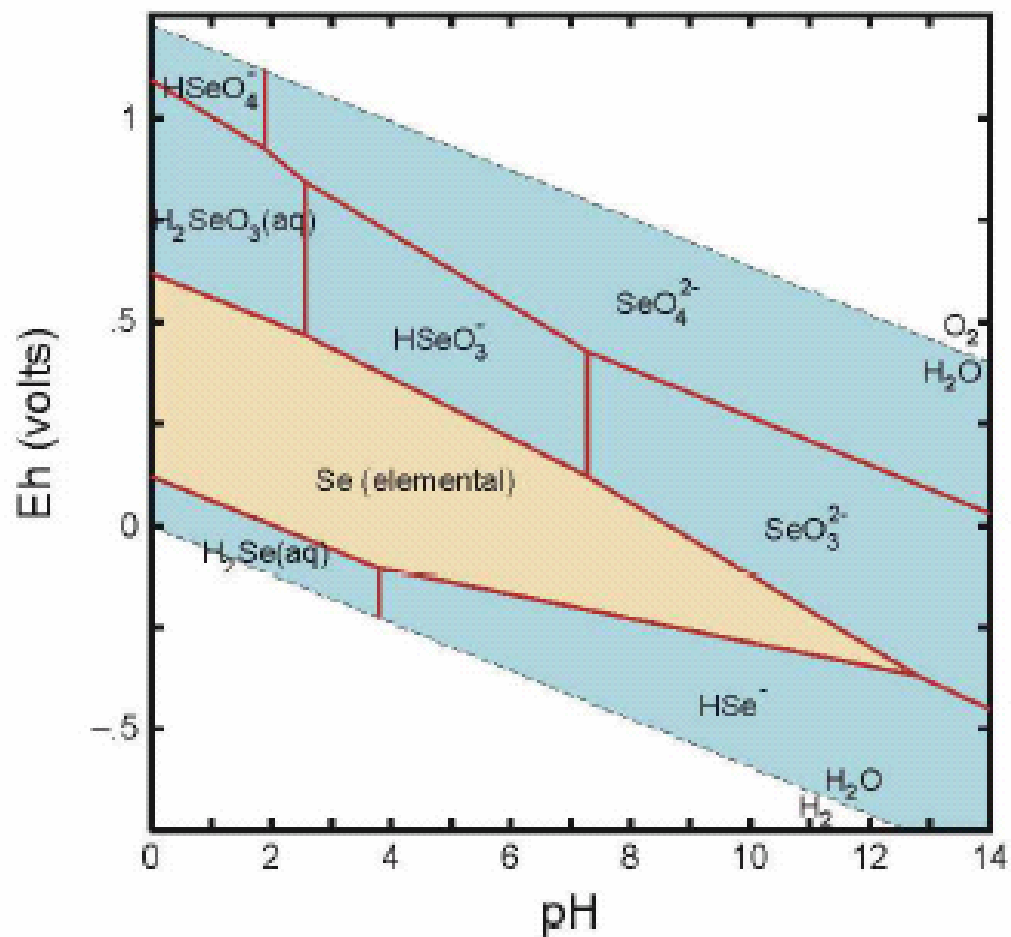
Physical Interactions

Biotic Transformations

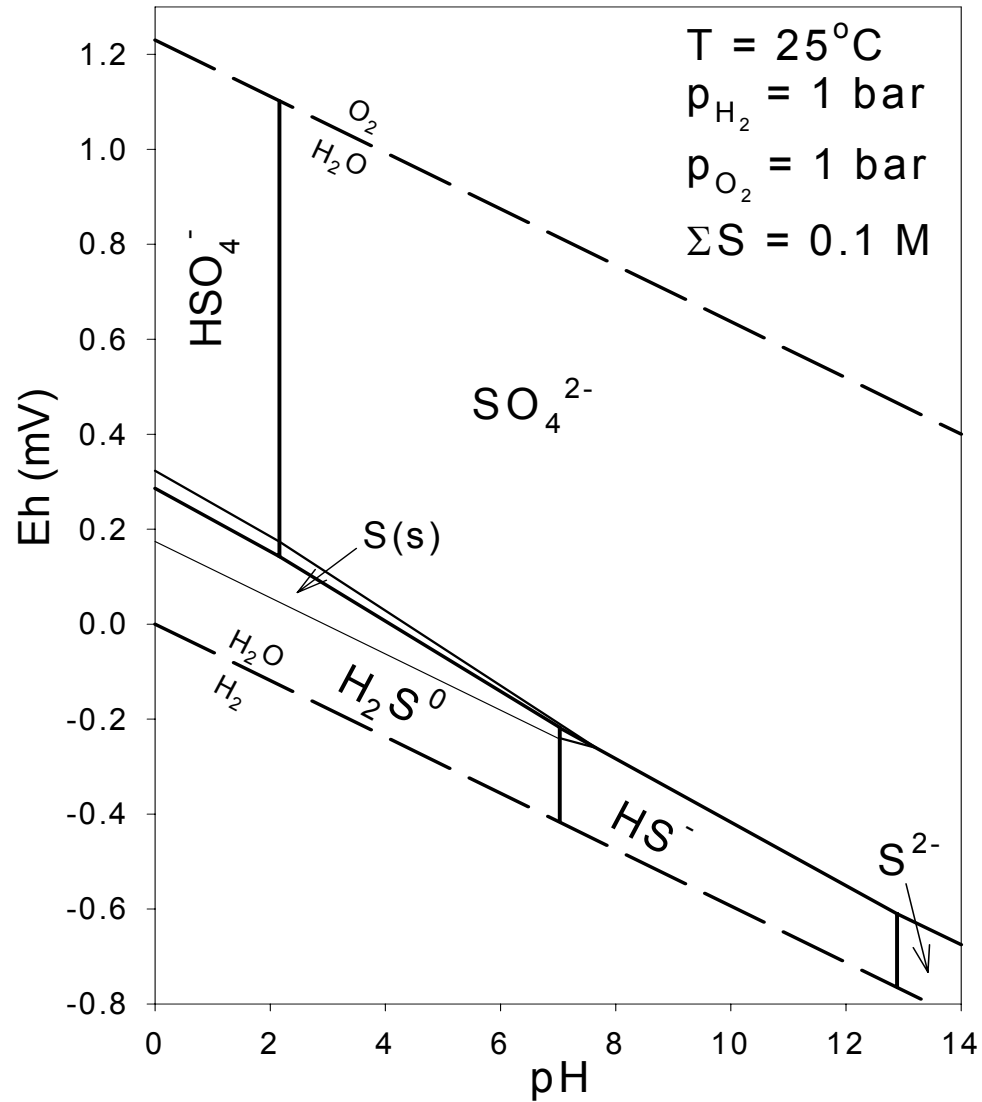
Representative Natural Waters



Selenium Stability Diagram

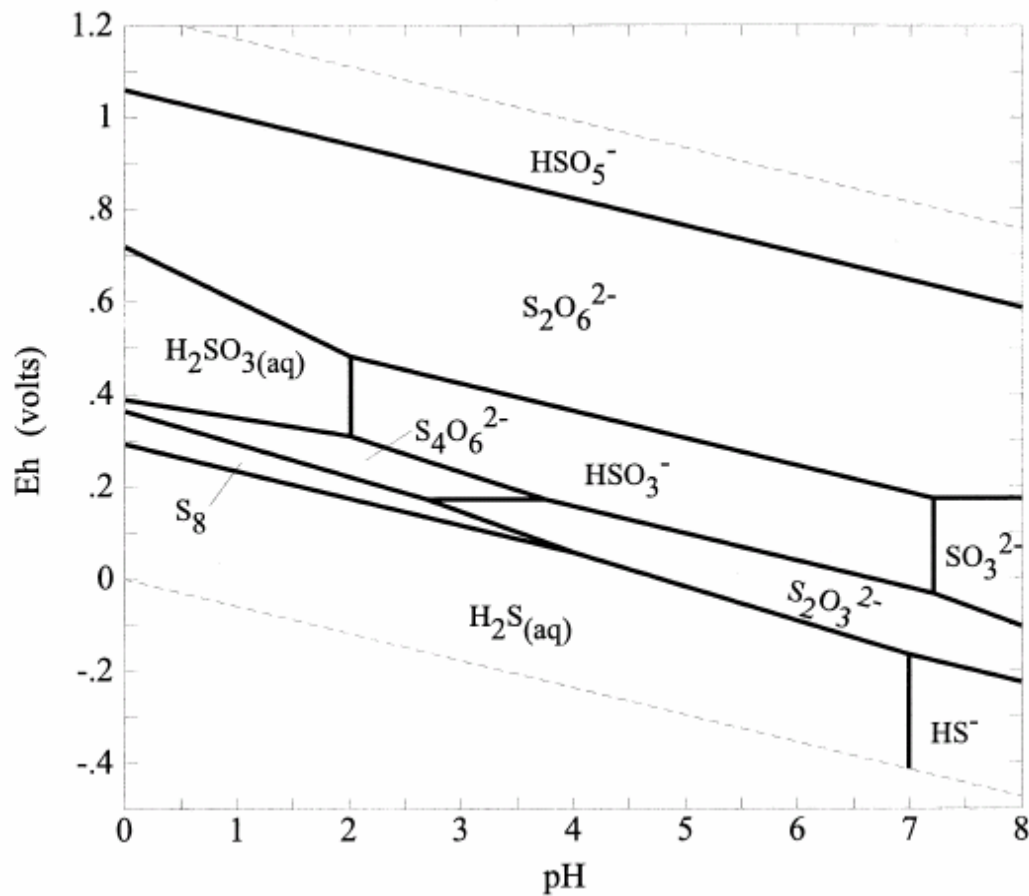


Sulfur Stability Diagram



Sulfur Reaction Intermediates

G. K. DRUSCHEL et al. *Geochimica et Cosmochimica Acta*, Vol. 67, No. 23, pp. 4457–4469, 2003



Observations on Se Chemistry

Wide range of Se (0) stability for AMD conditions

Acid (pH=2) waters likely have Se(0) as major species

Neutral (pH=6) waters likely have Se(IV) as major species

Selenite is widely stable and has no sulfur analogue

Selenate is much more reactive than sulfate (Fe(0)?)

Physical Processes

Adsorption

- Iron hydroxides/oxides

- Alumina

- Soil

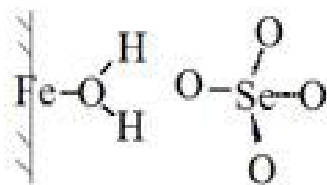
Inclusion

- Flocculants

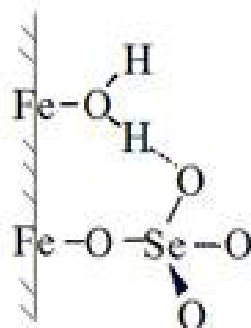
Transport

- Se(0)

Inner and Outer Sphere Adsorption



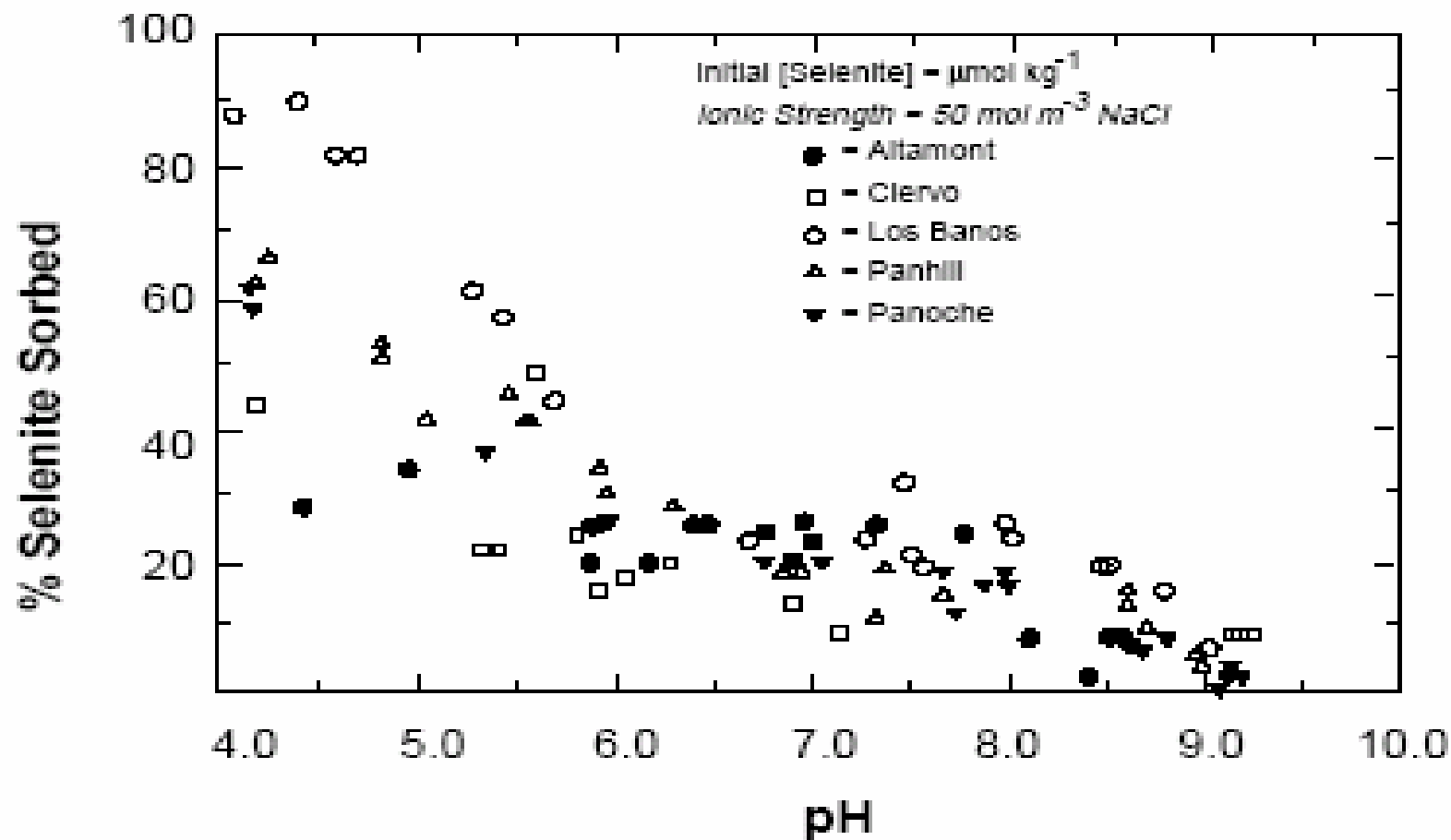
Outer-sphere



Monodentate with H-bonding
to adjacent site

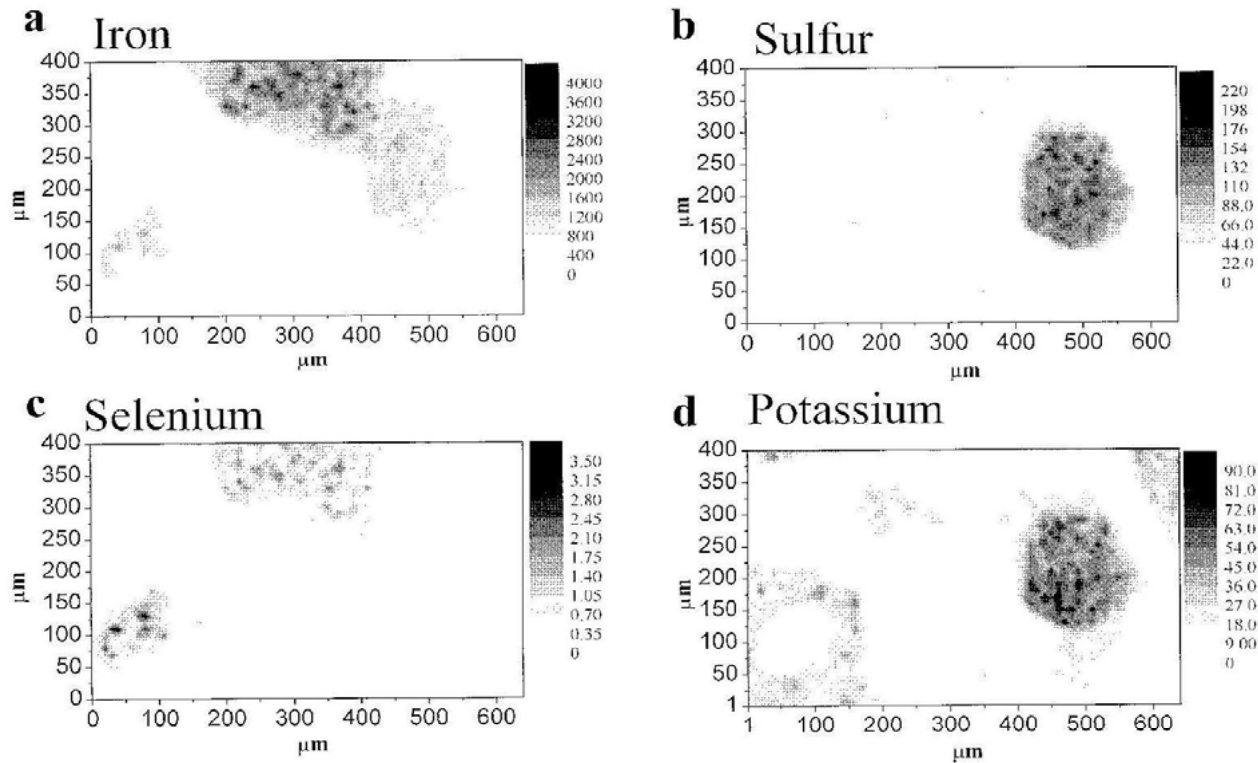
Selenite Adsorption to Soils

Neal, R. H., et al. Soil Sci. Soc. Am. J.51:1161-1165.



Location of Selenium in Soil Inclusions

D. Strawn, et al., *Geoderma*, 108, 237-257 (2002)



Physical Processes for Selenium in Mine Waters

Selenite, Selenate associate strongly with iron

Stability uncertain

Alumina, others, may be influenced by high sulfate

Chloride, phosphate known to dislodge Se species

Se(0) transport properties are unknown

Colloidal in bacterial systems

Biological Processes

Organisms

Bacteria

Algae

Plants

Animals

Products

Selenocysteine (sulfur substitutes)

Volatile species (dimethylselenide)

Se(0)

Other selenium species

Reduction of DMSe Production by Sulfate

P. M. NEUMANN, et al., *Plant, Cell and Environment* (2003) **26**, 897–905

