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Metal Recovery from Waste Streams

Kathleen S. Smith, Philip L. Hageman, Alan E. Koenig, James G. Crock, Tracy J.B. Yager, and Geoffrey S. Plumlee

The Geological Society of America
2013 Annual Meeting, Denver, CO

U.S. Department of the Interior
U.S. Geological Survey

Waste Streams

Waste stream **is a term that describes the total flow of various waste products that humans produce (homes, businesses, institutions, manufacturing plants, etc.) from generation to treatment to final disposition**

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Why Metal Recovery?

- Metal recovery is not a new idea…
- Perhaps the time has come
  - ✓ Environmental pressures
  - ✓ Increasing costs and potential liability for storage and disposal
  - ✓ Long-term sustainability

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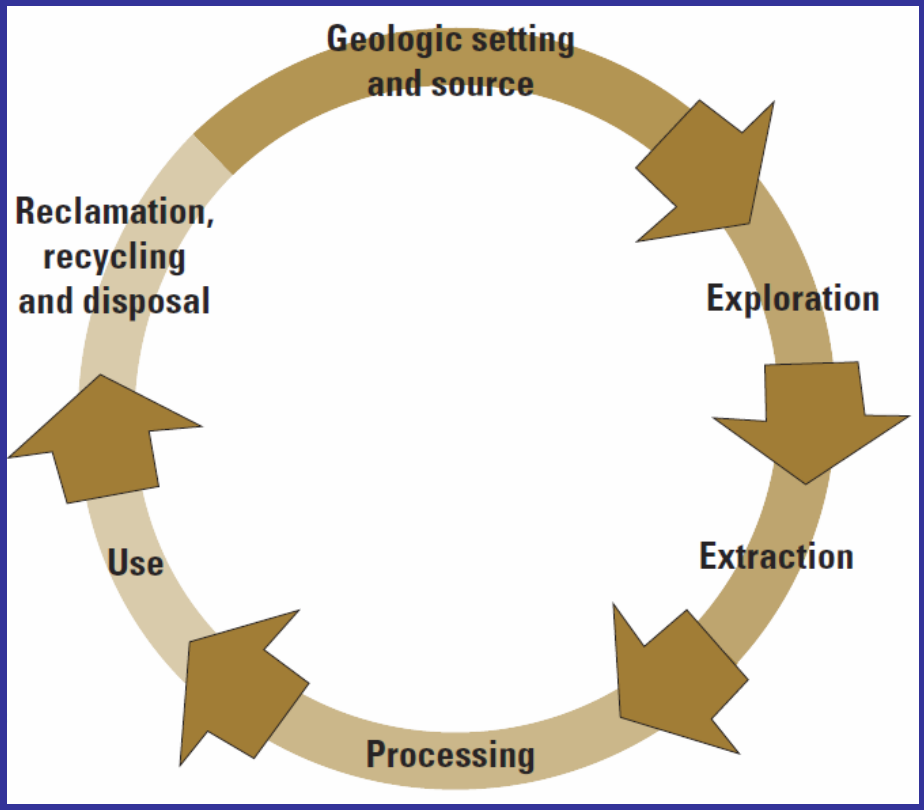
Resource Life Cycle

This work is part of a USGS effort to examine the life cycle of mineral resources



Life cycle traces flow of resources from generation and occurrence through interaction with society and the environment to final disposition and disposal

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U.S. Geological Survey energy and minerals science strategy: U.S. Geological Survey Circular 1383–D, 2013

Overview of Presentation

Characterization of metals in:

1) **Mining influenced water (and associated treatment sludge)**
2) **Municipal biosolids**

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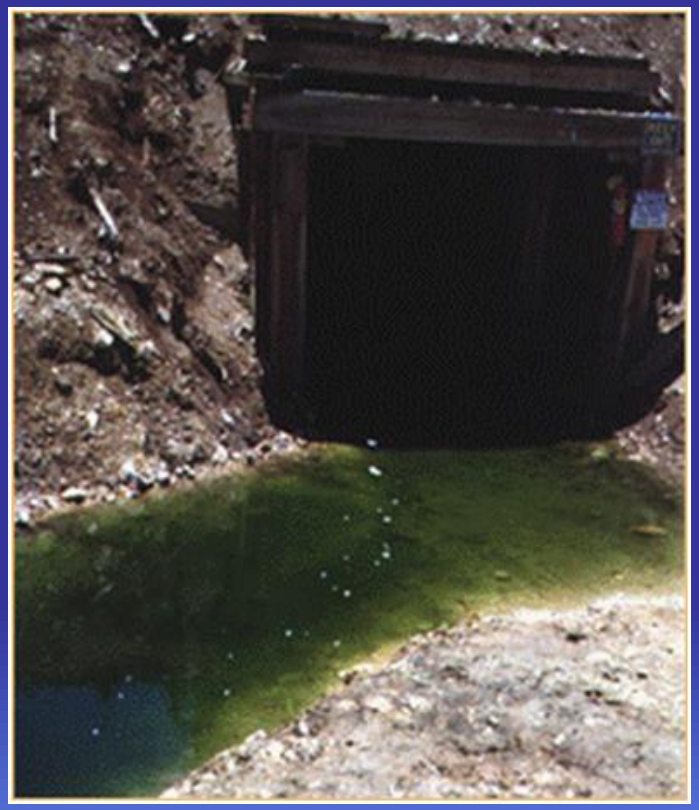
Mining Influenced Water and Treatment Sludge



Reynolds Adit,
Summitville, CO
(August 1993)

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Why Consider Metal Recovery from Mining Influenced Water?

- Many waters require treatment "in perpetuity"
- Many waters contain metals that could be resources
  - ✓ Minor metals may be recoverable as byproducts
- Post-closure considerations
  - ✓ Economic or technological changes
  - ✓ Changes in regulations
  - ✓ Buried liability
  - ✓ Long-term behavior of storage systems
    - Climate change
    - Chemical and physical stability
    - Inter-mine flow
- Shareholders
  - ✓ Short-term financial return vs long-term protection

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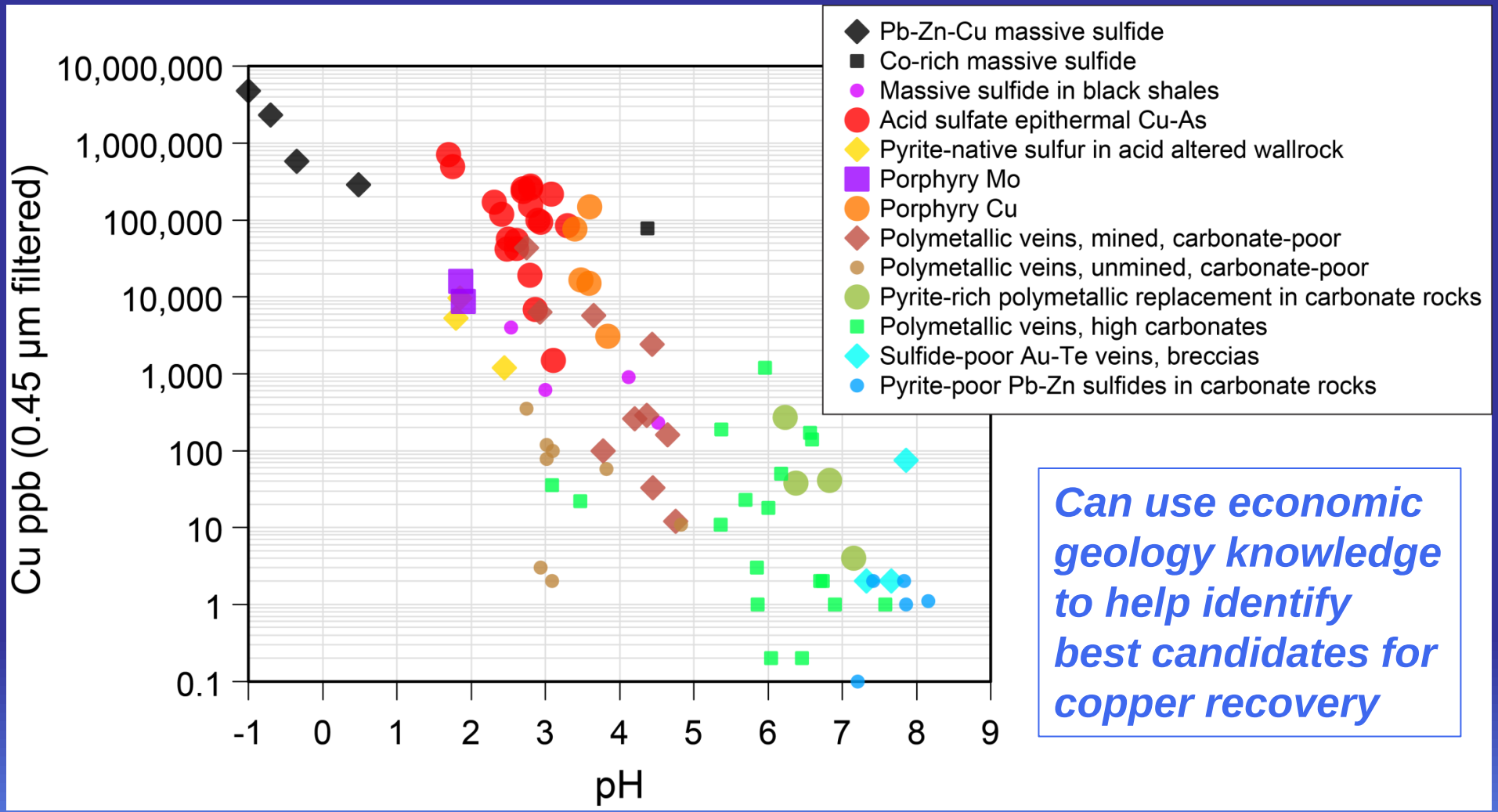
Copper Concentration in Mining Influenced Water as a Function of Mineral Deposit Type



Can use economic geology knowledge to help identify best candidates for copper recovery

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Minor, Strategic, and Critical Metals

- **Minor metals**
  - ✓ Global production relatively small compared to base metals
  - ✓ Commonly extracted as byproducts of base metals
- **Strategic and critical metals**
  - ✓ Integral to technology, national defense, aerospace, or energy
  - ✓ Threatened by supply disruptions due to limited domestic production

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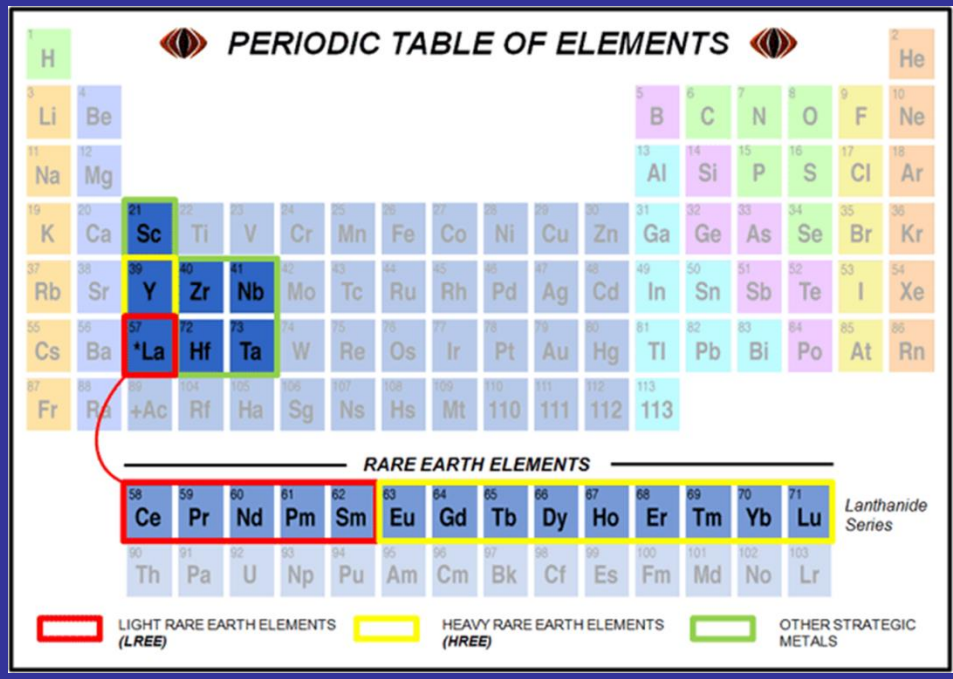
Rare Earth Elements (REEs)

United States Usage (2008)

Metallurgy and alloys	29 %
Electronics	18 %
Chemical Catalysts	14 %
Phosphors (monitors, TVs, lighting)	12 %
Catalytic converters	9 %
Glass polishing	6 %
Permanent magnets	5 %
Petroleum refining	4 %
Other	3 %



MRI

Solar

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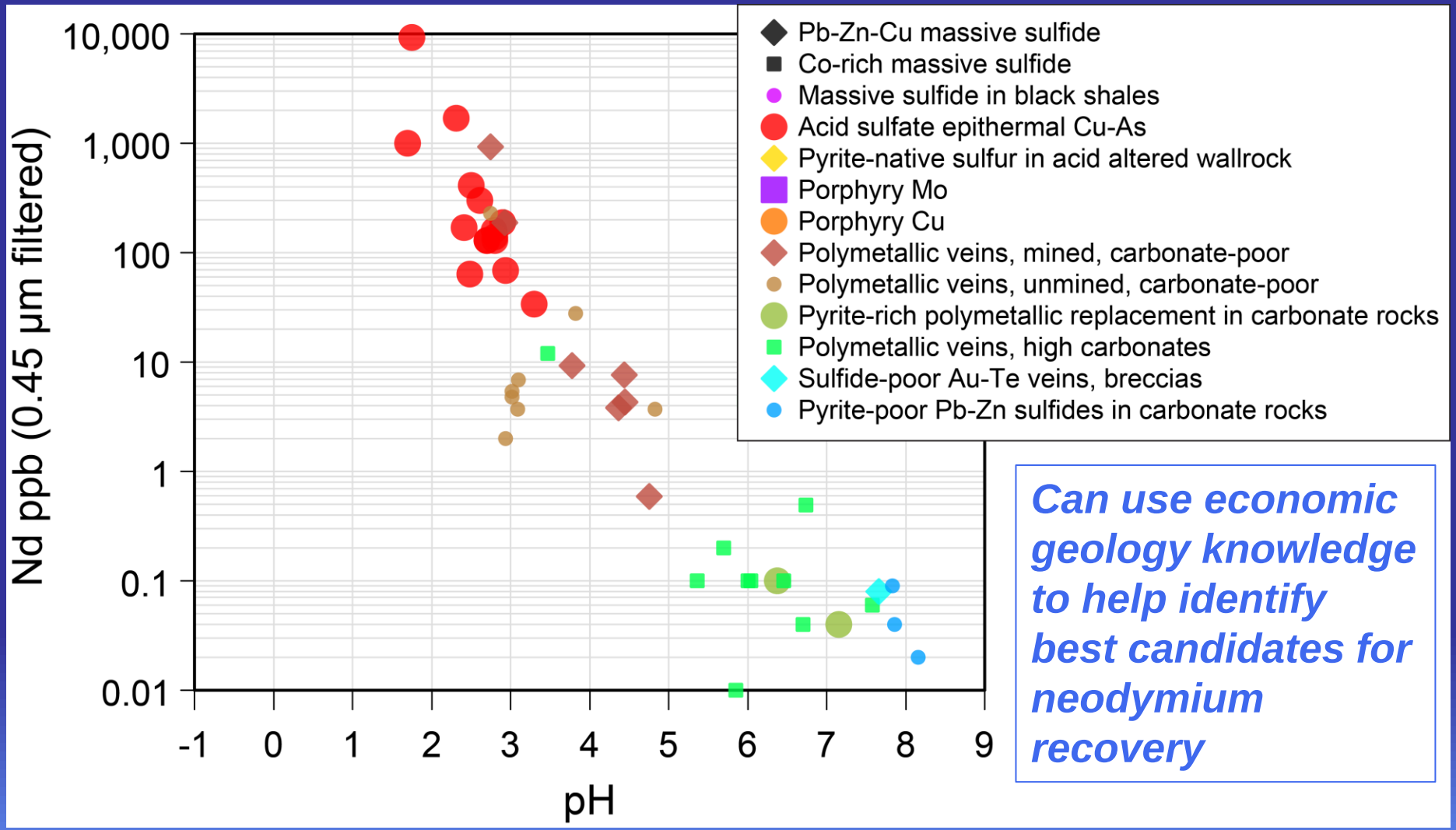
from www.tasmanmetals.com/s/RareEarth.asp

Neodymium Concentration in Mining Influenced Water as a Function of Mineral Deposit Type



Can use economic geology knowledge to help identify best candidates for neodymium recovery

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Ongoing effort to characterize historical mining wastes (results pending…)

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Municipal Biosolids

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Why Consider Metal Recovery from Biosolids?

- ***Biosolids*** **= solid organic matter recovered from a sewage-treatment process that meets regulatory criteria for beneficial use (e.g., fertilizer)**
  - ✓ **Nutrient-rich organic material**
  - ✓ **According to U.S. EPA, approximately 7,100,000 dry tons of biosolids are generated each year in the U.S.**
  - ✓ **Contains metals**

- **Biosolids used as fertilizer and soil amendment**
  - ✓ **About 50% of all biosolids are being recycled to land**
  - ✓ **Some risks due to metals (regulatory limits)**
  - ✓ **Metals could be removed and recovered prior to use as a fertilizer**
    - **Removing regulated metals (e.g., Cu) from biosolids prior to application might extend the application period for the applied fields**

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Biosolids from a Metropolitan Wastewater District

- Influent is municipal, commercial, and (pretreated) industrial sewage from a metropolitan area (no stormwater)
- Treatment
  - ✓ Primary (screening, skimming, and settling)
  - ✓ Secondary (activated sludge: microbiological removal of suspended and dissolved organic matter)
  - ✓ Anaerobic digesters stabilize the solids
  - ✓ Polymer added and centrifugation to dewater prior to application
- Analyzed for major elements and some trace elements by the USGS (1999-2010)*

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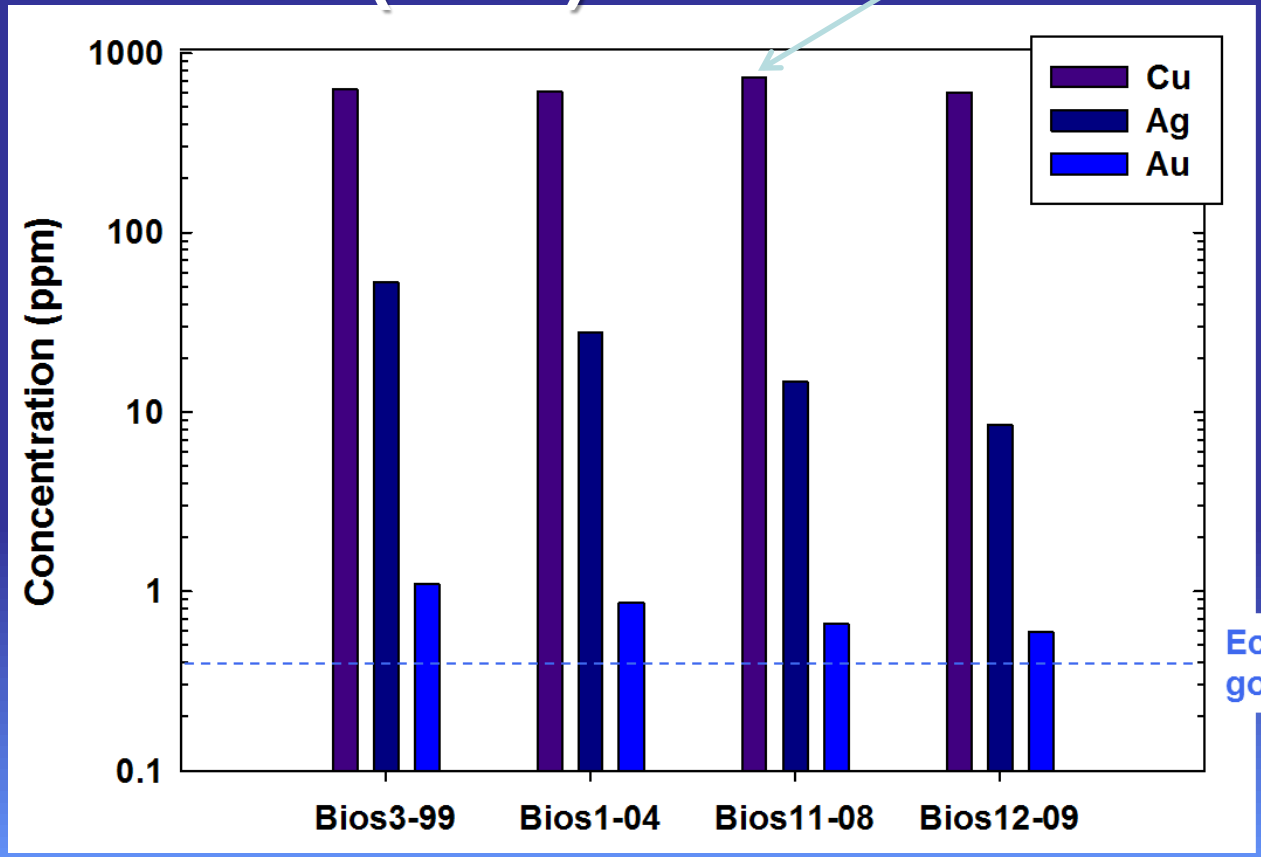
*Yager et al. (2013); http://pubs.usgs.gov/sir/2013/5065/

Biosolids from a Metropolitan Wastewater District

Reanalyzed selected biosolids samples for gold and silver (and other minor elements)

Copper porphyry deposits typically contain 5,000 to 10,000 ppm Cu

Biosolids (Total)



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Biosolids from a Metropolitan Wastewater District

Performed cyanide leach of selected biosolids samples

- ✓ Cyanide leaching is a dominant mining method used to extract gold and other metals from ore

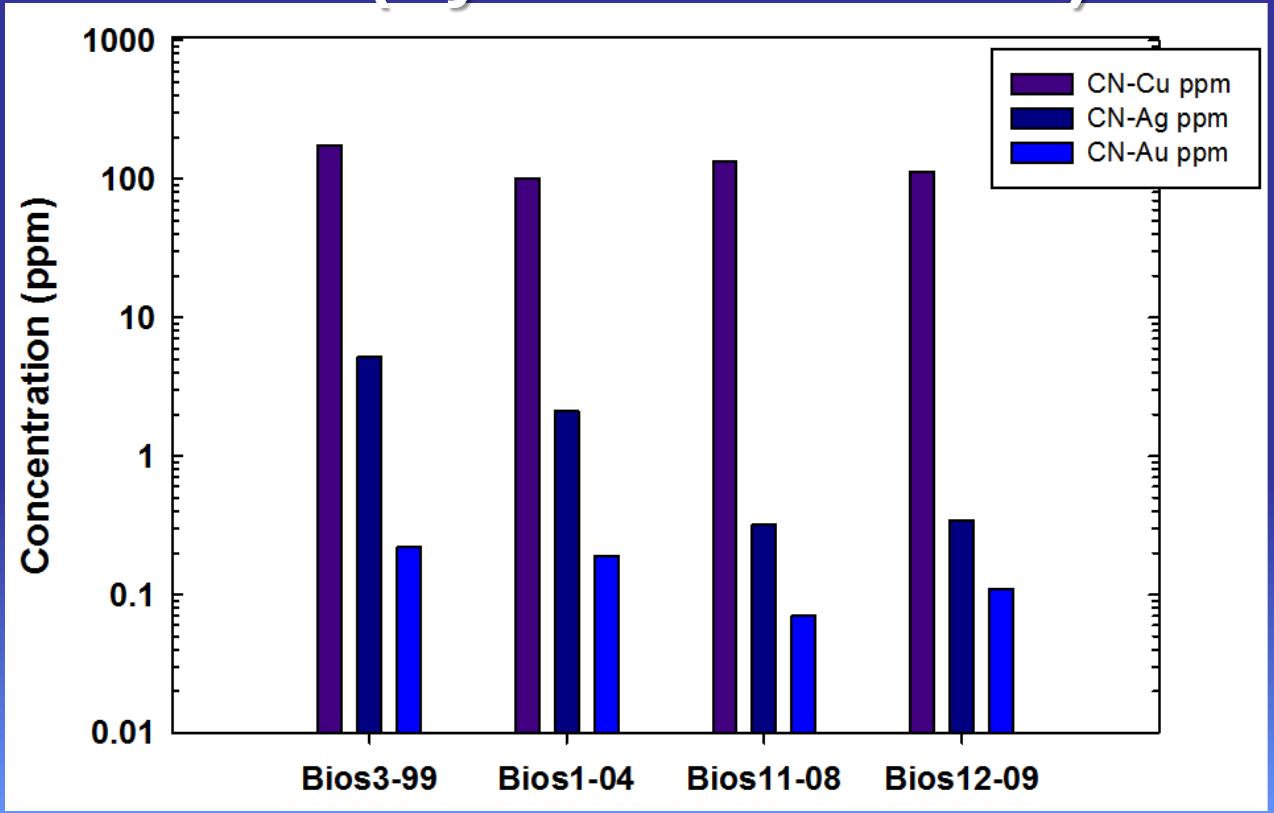
Appreciable concentrations of gold, silver and copper are leachable by sodium cyanide

Cu = 17-28% of total

Ag = 2-10% of total

Au = 11-22% of total

Biosolids (Cyanide Leachable)



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Summary

- Waste streams can contain a variety of metals that may represent untapped resources for recovery
- Metal recovery from mining influenced water (and associated sludge)
  - ✓ Can use economic geology knowledge to help identify best candidates for metal recovery
- Metal recovery from municipal biosolids
  - ✓ Existing mining methods, such as cyanide leaching, may be adapted to recover gold, silver, copper, and other metals
  - ✓ Once metals are recovered, biosolids still have fertilizer potential (with added benefit of decreased concentrations of regulated metals)

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Summary, cont.

- For any type of waste stream, the economic and technical feasibility of metal recovery needs to be evaluated on a case-by-case basis
- Even if metal recovery is not economically viable, metal recovery could offset treatment and disposal costs as well as reduce long-term liability

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A Plea for Samples

- Need waste stream samples for characterization, especially mining wastes
- USGS is a non-regulatory, science-based agency
- Build partnerships
- Contact Kathy Smith ksmith@usgs.gov

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Acknowledgements

Funding through the U.S. Geological Survey
Mineral Resources Program

Jim Budahn, INAA analyses

Thank you !

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