

Developing a Guideline for the Management of Barite in Soil

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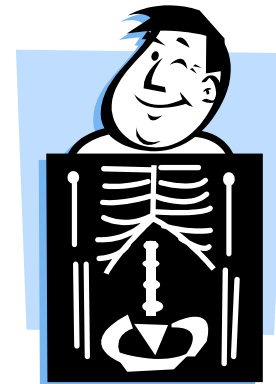
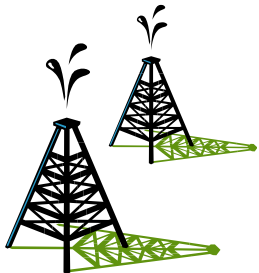
Overview

- Background
- Technical Steering Committee
- Scientific Basis
- Guideline Application
- Regulatory Implementation



Properties and Uses of Barite

- Properties:
 - Barium sulphate BaSO_4
 - Heavy – density = 4.5 g/cm^3
 - Largely insoluble and inert
- Uses
 - Oilfield Drilling mud
 - Medical x-rays



Current Barium Guidelines

- Alberta
 - Tier 1: 600 mg/kg
- CCME Soil Quality Guidelines:
 - Agricultural: 750 mg/kg
 - Residential/Parkland: 500 mg/kg
 - Commercial: 2,000 mg/kg
 - Industrial: 2,000 mg/kg



Need for a Barite Guideline



- Many Sumps with Ba > 750 mg/kg
- Majority of Barium is Likely Barite
- Barite Largely Insoluble and Inert
- Wasting Contaminated Landfill Space?

Technical Steering Committee

- Regulators

- Gordon Dinwoodie – Alberta
- Todd Hann – Saskatchewan

- Industry

- Chris Meloche – Chevron
- Phil Langille – Talisman

- Consultants

- Miles Tindal – Axiom

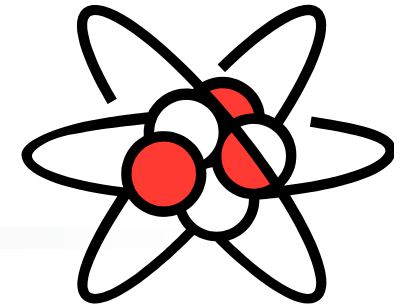


Funding Acknowledgements

- Funding
 - CAPP/SEPAC Broad Industry Initiative
 - AENV
 - Newpark Environmental Services



Scientific Basis



- CCME/AENV Protocol
 - What level of barite is safe?
- Special Challenges
 - Is my barium in the form of barite?
 - Will it stay as barite?



CCME/AENV Protocol

- 5 Standard Land Uses
- Exposure Pathways
 - Human soil ingestion
 - Plants and invertebrates
 - Wildlife soil ingestion



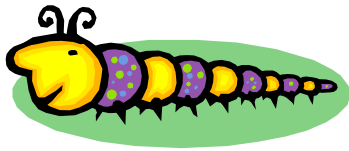
Human Soil Ingestion

- Is Barite Toxic?
 - Acute
 - Chronic data gap
 - Use tox data from soluble barium compounds
- Soil Ingestion Guideline
 - 3,200 mg/kg (agricultural/residential)
 - 11,000 mg/kg (commercial)
 - 41,000 mg/kg (industrial)



Plants and Invertebrates

■ Barite Toxicity



○ Invertebrates

- Can survive in pure barite



○ Plants

- Can survive in pure barite (growth reduced)
- NOEC for plants is 180,000 mg/kg (as Ba)

○ Guideline: 180,000 mg/kg (all land uses)

Wildlife Soil Ingestion



- Based on Small Rodent
- Uses Rat Toxicity Data for BaCl_2
- Guideline:
 - 3,300 mg/kg (natural area/agricultural)

Scientific Basis

- CCME/AENV Protocol
 - What level of barite is safe?
- Special Challenges
 - Is my barium in the form of barite?
 - Will it stay as barite?



Is My Barium in the Form of Barite?

- No Commercial Analysis for Barite
- Extractable/Available Barium
 - Analytical method developed by ETL
- More Plant/Invertebrate Tox Tests
 - Barium acetate - source of available Ba.



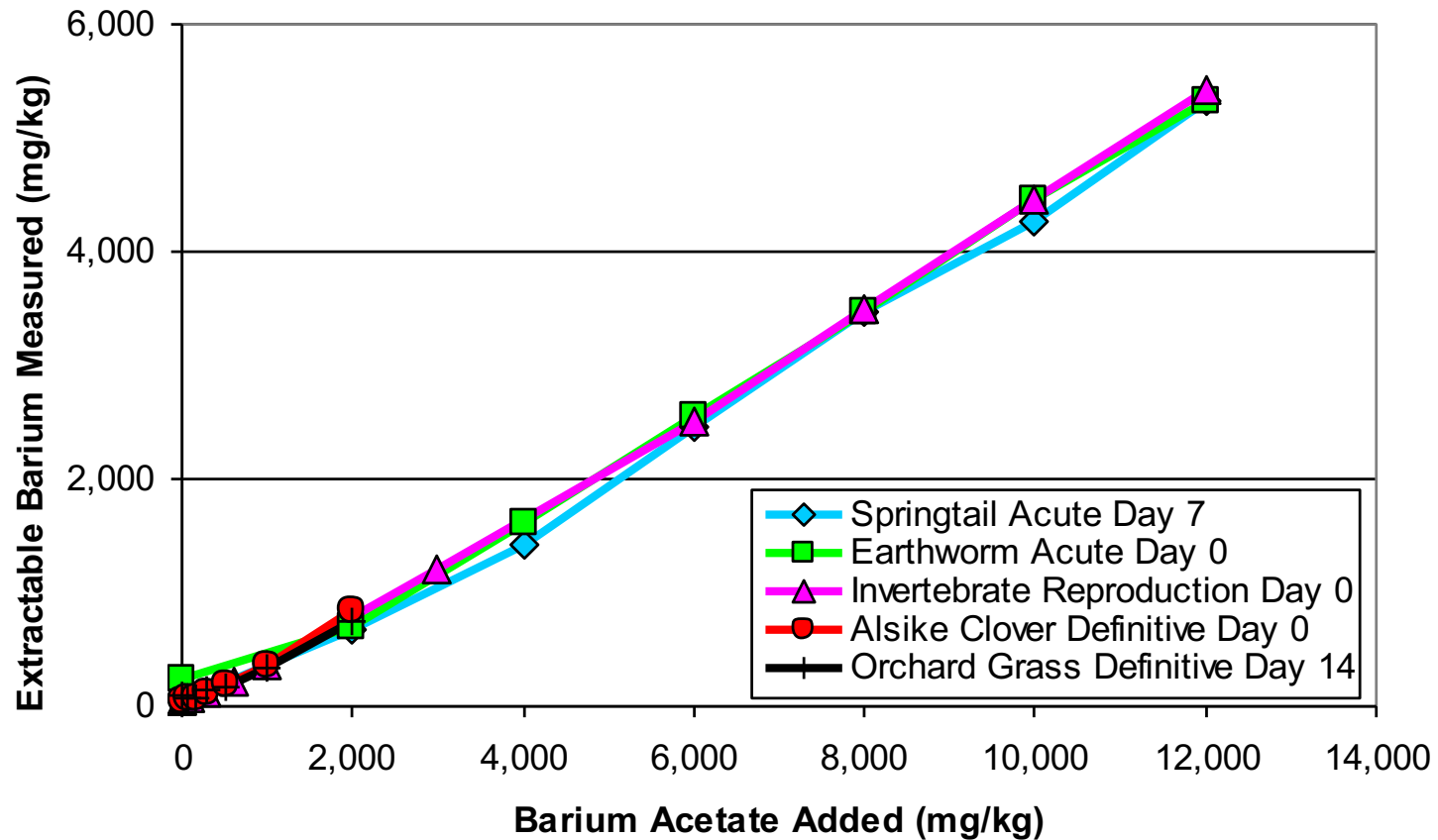
Analytical Method



- Extractable Barium Method
 - Developed by ETL
 - John Ashworth and Warren Greig
 - Summary:
 - Calcium chloride extraction
 - ICP analysis
 - Expressed as mg ExBa/kg dry soil
 - Contact ETL for details or analysis



Correlation of Total and Extractable Barium



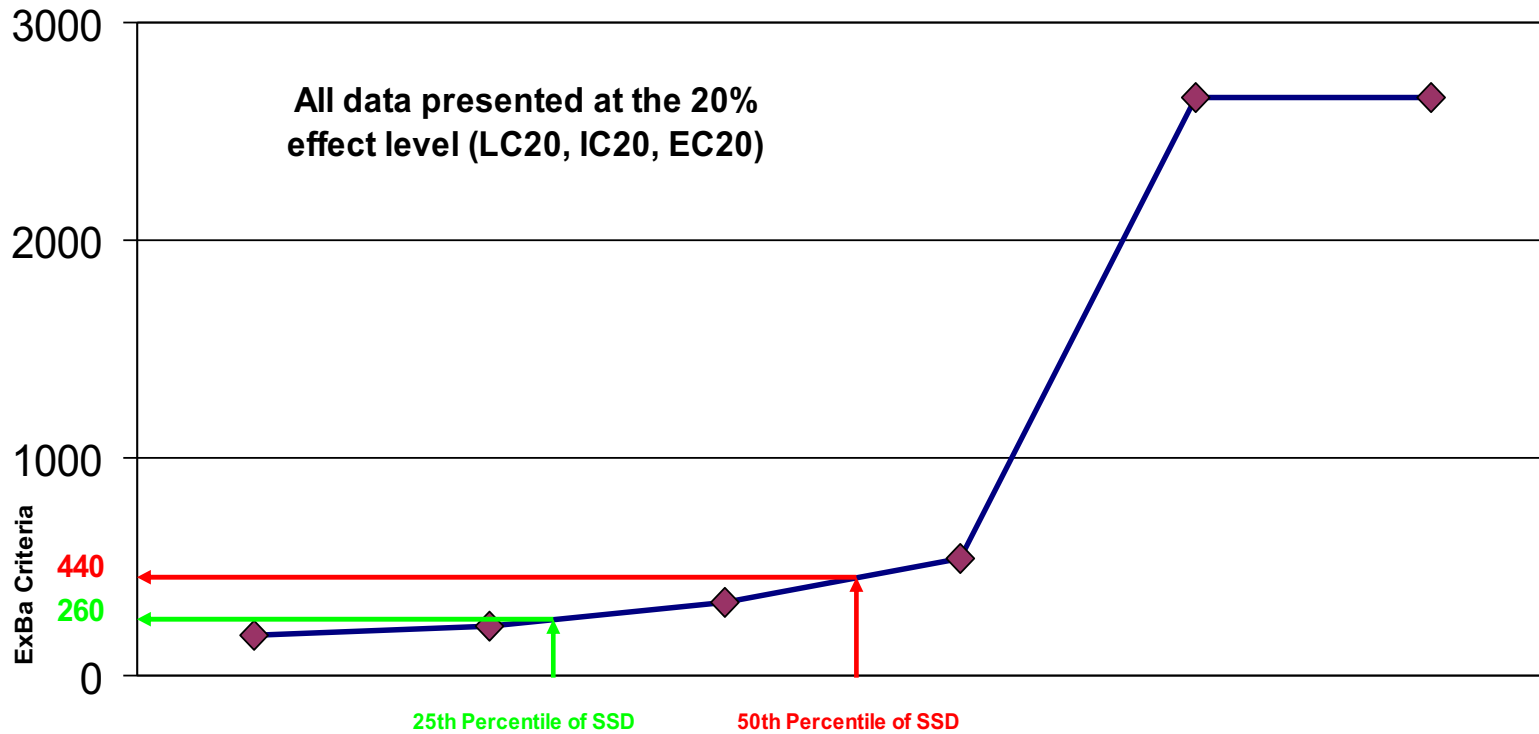
Barium Acetate Toxicity Test

- Plants and Invertebrates
 - Toxic response correlated with extractable barium
 - Result:
 - 260 mg/kg (natural area, ag, res)
 - 440 mg/kg (com/ind)



Species Sensitivity Distribution

Extractable Barium Concentration (mg/kg)

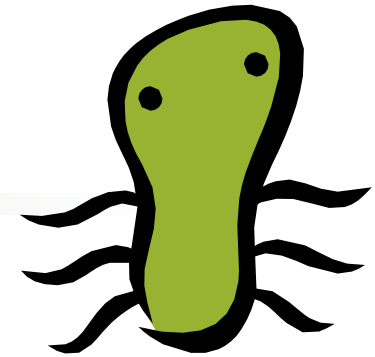


Will it Stay as Barite?

- Microbial Mobilization?
- Mobilization by Salts?

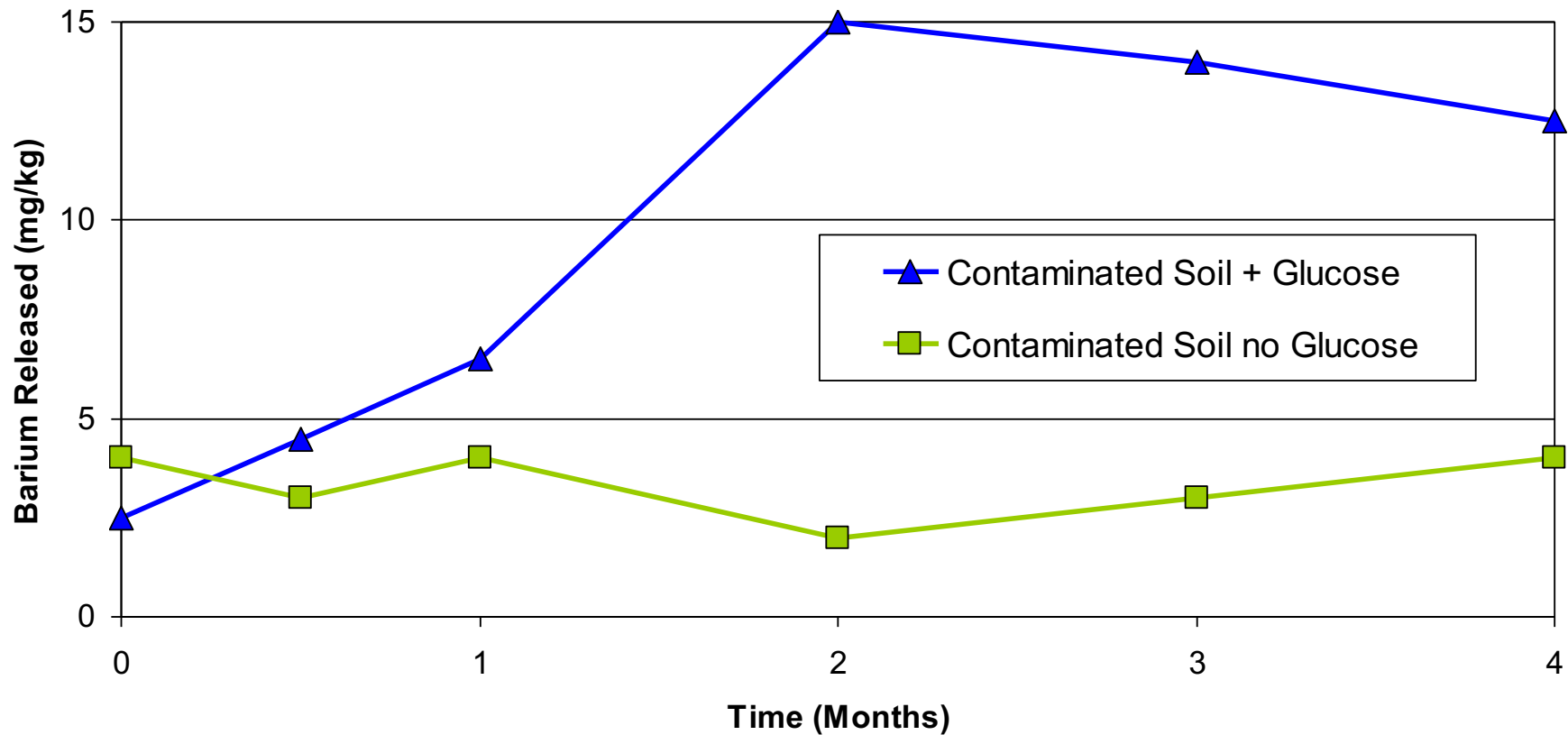
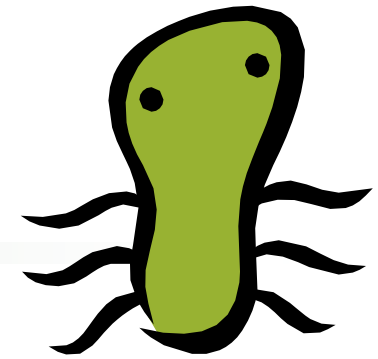


Microbial Mobilization?

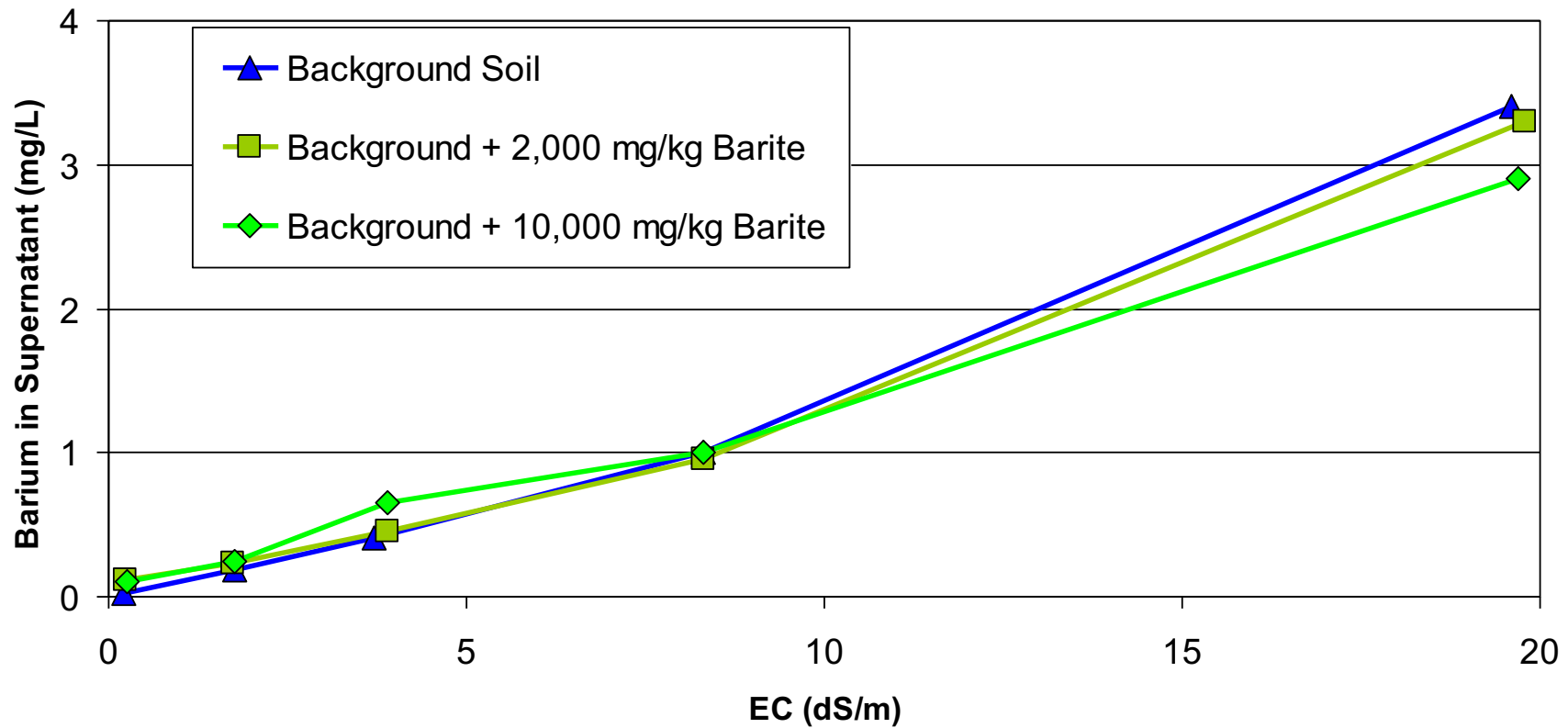
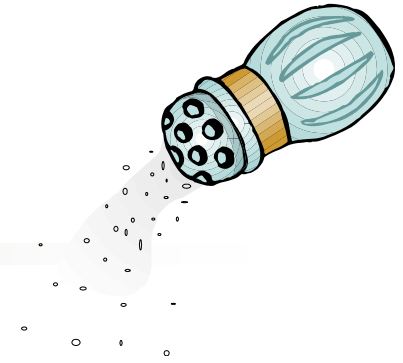


- Can Bacteria Release Barium from Barite?
- 9 Month Research Program at U of A

Microbial Mobilization?



Mobilization by Salts?



Guideline Application

- Determine Maximum **Extractable Ba**
- Compare with **ExBa** Guideline:
 - 260 mg/kg (natural area, ag, res)
 - 440 mg/kg (com/ind)
- If **ExBa** Below Guideline:
 - Site is “Barite Site”
 - Barite guidelines can be applied



Applying The Barite Guideline

- For “Barite Site”:
 - Apply Guidelines for **Total Ba**:
 - 3,300 mg/kg (natural area)
 - 3,200 mg/kg (agricultural)
 - 3,200 mg/kg (residential)
 - 11,000 mg/kg (commercial)
 - 41,000 mg/kg (industrial)
- If not “Barite Site”
 - Apply CCME barium guidelines



Data Gap



- Mammalian Toxicity
 - Affects human and wildlife soil ingestion
 - No chronic barite study
 - BaCl_2 data probably over-estimate risk
 - But chronic studies are expensive . . .

Regulatory Implementation

- AENV Website

- <http://www3.gov.ab.ca/env/>
- Draft document expected soon

- Axiom Website

- <http://www.axiomenvironmental.ca>
- Link to the draft document once posted

