

Updating the Barite Soil Quality Guideline to Reflect Bioavailability

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Overview

- The Alberta Barite SQG – Refresher
- Barium Toxicity Updates
- Bioavailability and Bioaccessibility
- Ongoing Updates to Barite SQG



Project Funding

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 - CAPP/SEPAC Broad Industry Initiative



Project Team

- Regulators
 - Gordon Dinwoodie – Alberta
- Industry
 - Chris Meloche – Husky
- Consultants/Academics
 - Miles Tindal – Axiom
 - Yvette Lowney – Exponent (Colorado)
 - Matt Dodd – Royal Roads University



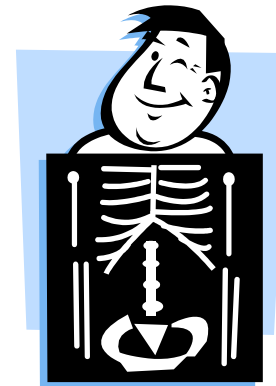
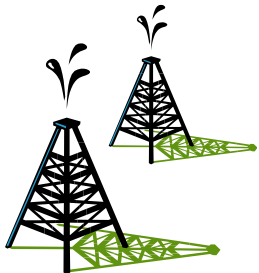
The 2004 Alberta Barite SQG

- Refresher



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



Previous 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



Extractable Barium Method



- Extractable Barium Analytical 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



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



Barium Guidelines for “Barite Sites”

Pathway	Nat. Area	Ag/Res	Com	Ind
Human Soil Ingestion	---	3,200	11,000	180,000
Off-Site Migration Check	---	---	---	41,000
Eco Soil Contact	180,000	180,000	180,000	180,000
Wildlife Soil Ingestion	3,300	3,300	---	---
Overall Guideline	3,300	3,200	11,000	41,000



Applying The Barite Guideline

- If not “Barite Site”
 - Apply CCME barium guidelines



Data Gap



- Mammalian Toxicity/Bioavailability
 - Affects human and wildlife soil ingestion
 - No chronic barite study
 - Soluble Ba toxicity data probably over-estimate risk

Human Toxicity Update

- **Current Guideline:**
 - RfD = 0.07 mg/kg-bw/day (USEPA, 1999)
 - SQG = 3,200 mg/kg
- **Updated USEPA (2005a) Guidance:**
 - RfD = 0.2 mg/kg-bw/day
 - SQG = 9,000 mg/kg



Wildlife Toxicity Update

- Existing Wildlife TRV:
 - 15 mg/kg-bw/day
- New USEPA Guidance on TRV:
 - 51.8 mg/kg-bw/day
- Effect on SQG:
 - Existing: 3,300 mg/kg
 - Potential new: 11,000 mg/kg



Bioavailability and Bioaccessibility

- Total Concentration
 - in Soil
- Bioaccessible Fraction
 - in stomach/intestine
- Bioavailable Fraction
 - Absorbed into body



Measuring Bioaccessibility

- “Physiologically-Based Extraction Tests” (PBETs)
- Extraction Mimics Conditions in Mammalian Stomach/Intestine:
 - pH, Temperature, Enzymes, Agitation, Residence Time
- Bioaccessible Fraction is Conservative Estimate of Bioavailable Fraction



Potential Applications

- Refining Soil Quality Guidelines
- Cost-Effective Estimation of Bioavailability in Risk Assessment



Potential Concerns (Health Canada)

- Effect of Grain Size
- Effect of Dilution Ratio



Barite Bioaccessibility Study

- Objective:
 - Bioavailability Correction for Barite SQG
 - Human soil ingestion
 - Wildlife (small rodent) soil ingestion

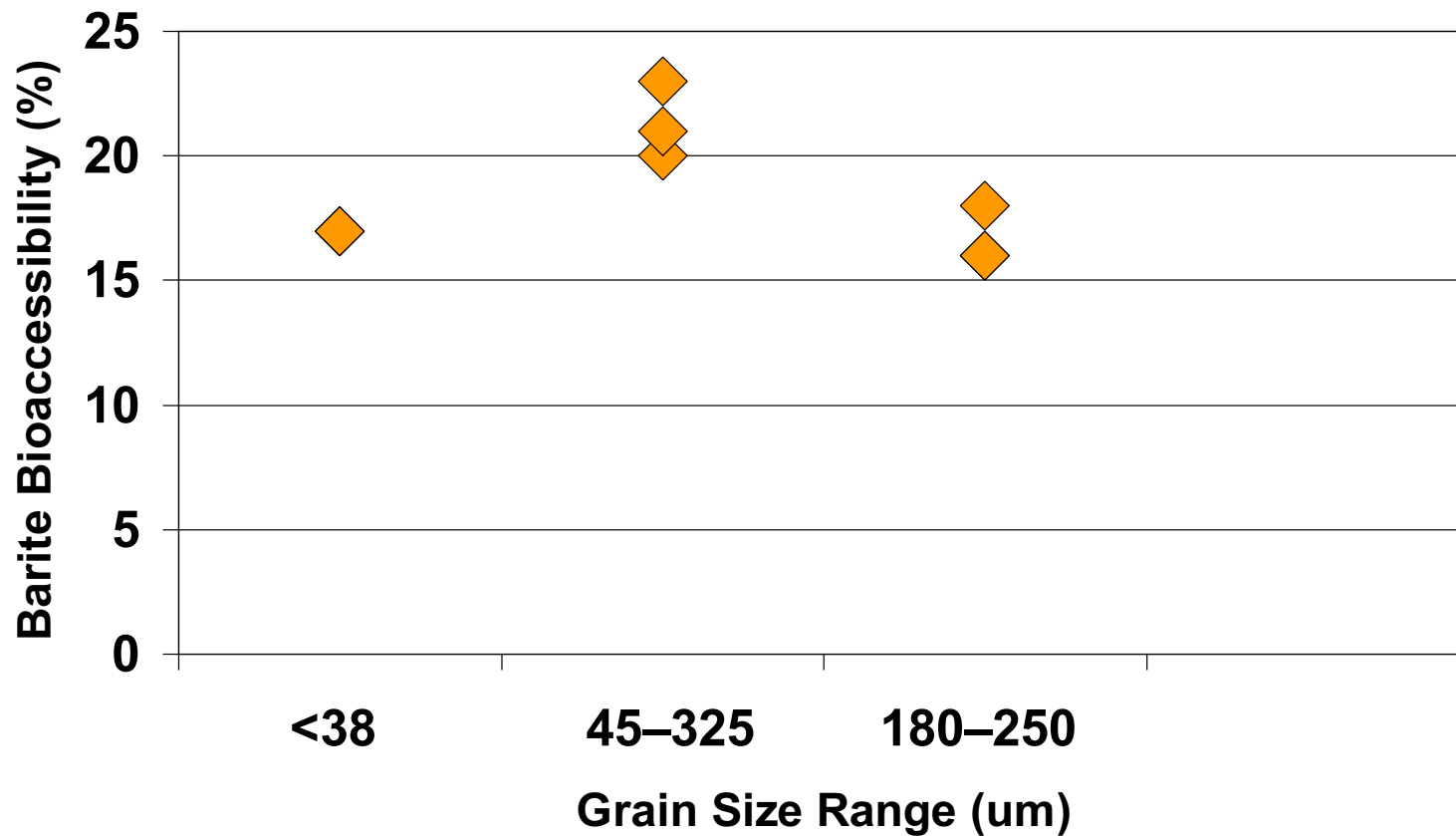


Barite Study Design

- Phase 1
 - Effect of grain size (pure barite)
- Phase 2
 - Effect of dilution ratio (pure barite)
- Phase 3
 - Tests with barite-contaminated field soils



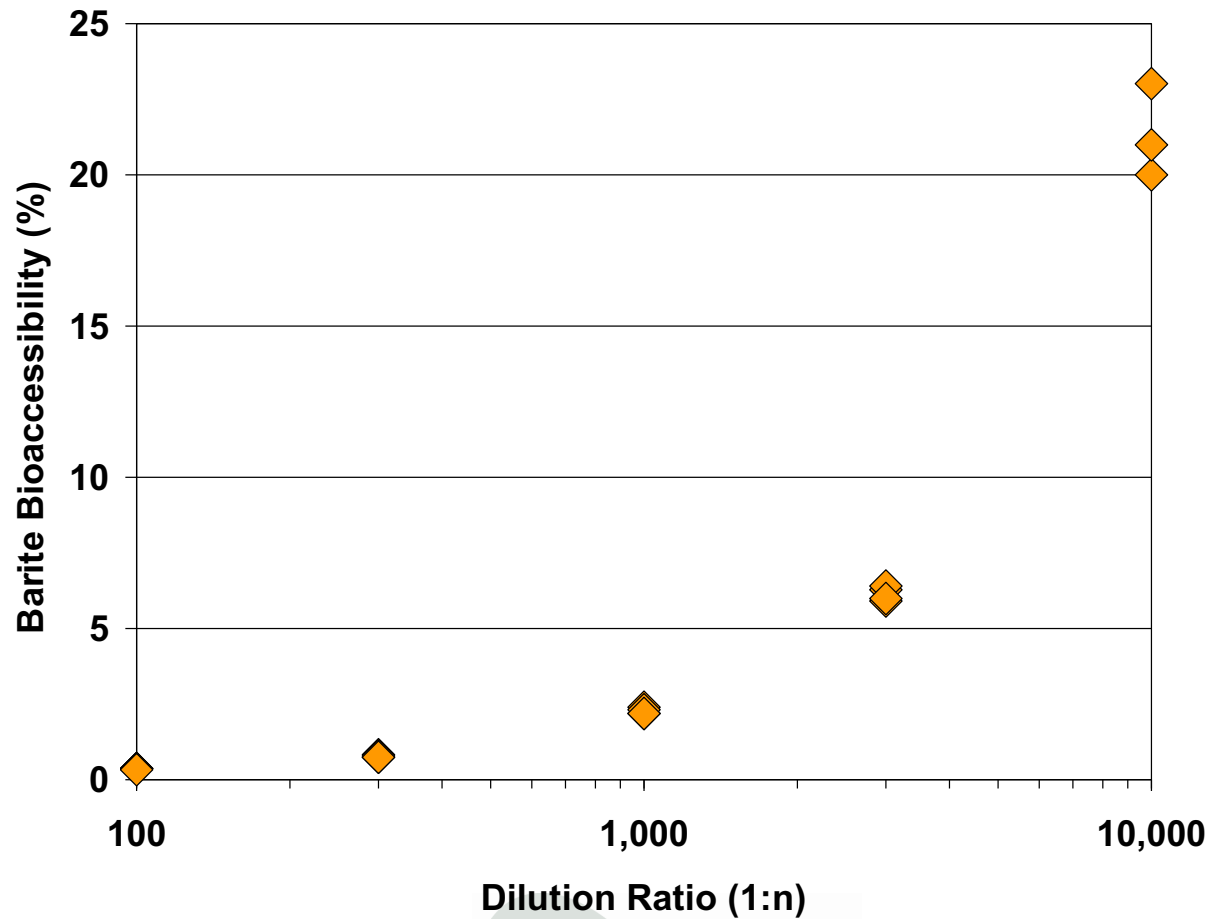
Phase 1 - Effect of Grain Size



All data for 1:10,000 Dilution
Ratio with Pure Barite



Phase 2 - Effect of Dilution Ratio



All data for 45-325 μ m
Fraction of Pure Barite



Phase 3 - Field Samples

- Phase 3 is Currently Underway
- 5 Site Samples from Soil Treatment Projects
 - Total Barium 2,500-6,900 mg/kg
 - Extractable barium < 60 mg/kg
- Data Expected Spring/Summer 2006



Next Steps

- Complete Phase 3 Testing
- Analyze Results
 - Recalculate guidelines if necessary
- Submit Revised Report to AENV for Consideration

