Providing a scientific basis for evaluating and predicting inorganic and organic contaminant bioaccessibility in soils found at contaminated sites in Canada.

BioAccessibility Research Canada (BARC)

Strategic Research Planning Workshop on Bioaccessibility/Bioavailability in Contaminated Site Assessment

October 11-12, 2007

Hawthorn Hall A,
Delta Toronto Airport West,
5444 Dixie Road, Mississauga, ON

C.N.T.C.
R.C.C.T.
Canadian Network of Toxicology Centres
Réseau canadian des centres de toxicologie
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Health Canada Santé Canada

Table of Contents **Page**

1. Introduction

In December 2006 Health Canada sponsored a workshop to seek an industry perspective on how to move forward with soil bioaccessibility /bioavailability research in Canada. The workshop identified a strong need for a review and comparison of soil bioaccessibility methods which have been developed independently over the years and are being used by Canadian laboratories for risk assessment purposes.

To address this need Bioaccessibility Research Canada (BARC) is conducting an initial round robin study that will compare soil bioaccessibility data provided by Canadian laboratories using commonly sourced materials. The intent of this round robin is not to validate, certify nor rate individual laboratories for conducting soil bioaccessibility assays but to better understand the variability between methods used by laboratories across Canada. The ultimate goal of this and future activities of BARC is to advance the science of soil bioaccessibility in Canada and improve confidence in the use of bioaccessibility data for human health risk assessment.

The round robin exercise will require a coordinated effort by the organizing group and the participating laboratories. A primary focus of the October 11-12 strategic workshop was to solicit input and gain consensus on the technical and logistical components for the initial round robin. Another item on the agenda (Annex A) for the workshop was to initiate discussions around the collection and preparation of one or more Canadian reference soils that would be useful for generating risk assessment data for contaminated sites. The agenda for the workshop also included a discussion around a three to five year action plan for addressing research gaps pertaining to bioaccessibility/bioavailability of organic and inorganic soil contaminants as identified in the Health Canada workshop on December 5-6, 2006 (*in vitro and in vivo* approaches).

The workshop was co-chaired by Dr. Ken Reimer from the Royal Military College (RMC) of Canada and Dr. Beverly Hale from University of Guelph, Ontario, Canada. Logistical support was provided by the Canadian Network of Toxicology Centres(CNTC) and Environmental Sciences Group (ESG), Royal Military College. Workshop participants included representatives from the government, university, and industry communities and the private sector and are listed in Annex B of the document. This report serves as a record of the proceedings which are summarized in section 2.0.

2. Proceedings

Day One

Dr. Ken Reimer opened the workshop by welcoming the participants. This was followed by a review of the workshop agenda and an invitation to participants to introduce themselves and describe their preferred bioaccessibility method. Dr. Beverly Hale reviewed the charge questions and outcomes from the December 2006 Health Canada sponsored workshop and how the outcomes relate to the objectives set out for this workshop especially in regards to BARC's projected research activities in the next five years.

Joanna Wragg, research scientist with the British Geological Survey began the session with a presentation entitled "Overview of Barge Round Robin Experiences – Objectives, Outcomes and Lessons Learned" (presentation attached). The presentation described three self-funded round robin studies that were carried out by the Bioaccessibility Research Group of Europe (BARGE). Dr. Wragg described the logistical and technical challenges that were encountered by BARGE and suggested strategies for avoiding them in future round robins. Dr. Wragg discussed how variation due to methods was introduced through differences in pH, separation techniques, use of different types and quality of reagents and simulated stomach contents. She then went on to explain how the experience led to the development of the unified BARGE Method.

Dr. Wragg followed her presentation of the Barge round robin experiences with a presentation of a strawman plan for the BARC initial round robin. The strawman plan provided a framework for addressing the technical, logistical and analytical aspects of the upcoming round robin (presentation attached).

There was considerable discussion following the presentation about the purpose of the BARC round robin and what this means for the technical and analytical approach that will be adopted. Bruce Conard asked the question "is the purpose to examine variability between methods or variability between the whole process?" He suggested that to get at the true interlab variability samples should be split to allow extraction and analysis in house as well as extraction in house and analysis at a central lab. Pat Rasmussen echoed the need to understand interlab variability by allowing labs to use their own methods. However it would be okay to control variables such as reagent age which will not artificially alter variability between methods.

Mark Richardson commented that from a regulatory perspective both the percent variability in the extraction phase and the percent variability in analytical procedures are important. He went on to say that the use of different methods is acceptable as long as regulators have information about the range in variability among labs in Canada. For this round robin exercise Health Canada will not know the methods and labs that generate the data points – they will only be given the range of variability among labs in Canada. This information will be helpful for determining how to interpret and use results for risk assessment purposes.

Nick Basta proposed that a unified method may not be the best way to go because a single method may not be suitable for all elements and soil types. Steve Siciliano expressed the idea that analytical uncertainty will always exist and therefore a decision

needs to be made regarding what level of uncertainty is acceptable and what are the performance criteria that all labs must demonstrate. Rather than develop a standardized method the outcome of the round robin should be to reach a performance standard.

Chris Ollson raised the issue of limitations with respect to costs and time. BARC has a limited budget and a limited amount of time within which to conduct the initial round robin. The scope should be kept small for now knowing that BARC will be building on this initiative in future round robins. He suggested a tiered approach in which the first round robin would establish the variability between the different labs. Round robin # 2 would examine the variability of the same method between labs and round robin #3 would employ a spiked solution such as spiked cat chow to compare lab results to TRV's that are commonly referenced by risk assessors.

There was significant discussion around what and how many reference soils to use. Should the soil have *in vivo* data attached to it and how important is certification? Should more than one soil be used to address confounding factors such as high versus low organic matter content? Two possible soils for the round robin are NIST 2710 and NIST 2711. They can easily be accessed and are available in large enough quantities. However, it was pointed out that both are mining soils and mining is only one issue that risk assessors must confront. For example, NIST soils are not appropriate for testing animal models and pesticides. After much discussion it was decided that for the purposes of this initial round robin one reference soil will be sufficient. The NIST soil of choice will be the one that has the mineral content of most interest to Canadian labs

The day concluded with the request that everyone reflect on the ideas that were discussed on Day 1 and to keep in mind the goal to finalize the plan for the round robin on Day 2. Labs participating in the round robin were also asked to prepare a slide of their bioaccessibility method for presentation to the group during the afternoon session of Day 2.

Day Two

The first part of the morning session was spent re-examining the strawman proposal for the round robin and making sure that all of the ideas discussed on day one were well captured (presentation attached). There was strong consensus among the workshop participants that the plan developed by the group was doable and would accomplish the goal of ascertaining interlab variability.

This discussion was followed by a presentation by Beverly Hale who put forward a strawman of a research proposal for addressing research gaps in bioaccessibility/bioavailability methods (presentation attached). The research that is being proposed is a multilab study with three themes (*in vivo*, tier1/tier2, and PCF). The objective of the *in vivo* theme is to demonstrate whether *in vitro* estimates are conservative. The objective of the tier1/tier2 theme is to estimate the *in vitro* bioaccessibility of metals in media used to establish TRV's that are in use and link these estimates with *in vivo* data. Lastly, the objective of PCF theme is to explore the sources of variability among media due to potentially confounding factors such as TOC/DOC, amorphous Fe oxides, CEC, P, grain size, mineralogy, and speciation.

Funding for this project could potentially come from an NSERC Collaborative and Development Grant or an NSERC Strategic Program Grant. It was suggested that NSERC grant funds could be supplemented with graduate industrial scholarships. For all of these funding options the involvement of commercial labs will be critical for obtaining industry support for the project and to ensure the transfer of new technology to commercial labs. Technology transfer is also an important criteria for NSERC strategic funding.

An outcome of this discussion was the establishment of a subcommittee to define the funding strategy and further develop the research proposal. The subcommittee will be chaired by Ken Reimer from ESG and consist of Mike Dutton from CVRD INCO, Guy Gilron from Teck Cominco Ltd., Dr Bev Hale from University of Guelph and director of MITHE-RN[1], Pat Rasmussen from Health Canada, and Steven Siciliano from University of Saskatchewan. Mike Dutton offered to champion investments by industry.

The latter part of the morning session was a facilitated discussion around the question of what should a Canadian reference soil look like? This discussion was led by Andy Rencz, a geologist with NRCan. There was agreement that whatever is decided in regards to choosing a reference soil there must be lots of it. The soil must be available in sufficient quantities to allow the building of a database over time. The soil must also have a mineral content in appropriate concentrations that is of interest to Canadian labs and that supports research on different sources of contaminants including mining sites, brownfields, and agricultural lands. The characteristics of the soil that will be important to consider include organic matter content, horizons, particle size fraction, cation exchange capacity, mineralogy, trace elements, major elements, oxides, and absorbency. It will also be important to consider which properties are correlated and to separate out the inter-correlations.

Ken Reimer proposed that the discussion on reference soils should be continued via the BARC newsletter. A dialogue and a subcommittee will be set up through the newsletter with the aim of creating a profile for 2 or 3 standardized soils that would address the risk assessment needs of Canadian labs.

There are several different tests for determining bioaccessibility of metals and metalloids in contaminated soils and many different modifications of each test. In the afternoon session individual labs presented their SOPS to the group which provided some insight into the range of methods employed by labs across Canada. The methods were divided into three subgroups (physiologically based-batch, physiologically based-dynamic, and extraction based-batch). Within the physiologically based-batch group there were four labs and four different methods used (IVG, PBET, UBM, and CaCo-2). Within the physiologically based-dynamic group there was one lab and the method used was the shime method. Lastly within the extraction based - batch group there were five labs and two methods (TOY, SBRC).

1. Network name changed to Metals in the Human Environment Strategic Network (MITHE-SN) in November 2007

Annex A: Agenda

Bioaccessibility Research Canada (BARC) Strategic Research Planning Workshop on Bioaccessibility/Bioavailability in Contaminated Site Assessment

October 11-12, 2007; Start time is 12:45 p.m.

Hawthorn Hall A, Delta Toronto Airport West, 5444 Dixie Road, Mississauga,

Workshop Facilitators: Ken Reimer and Beverley Hale

Day I (Oct. 11)

12:30 p.m.	Registration and coffee
12:45 p.m.	Chair Opening Remarks (Beverly Hale /Ken Reimer)
12:55 p.m.	Summary of workshop objectives (review of charge questions and outcomes from the December 2006 workshop) (Hale and Reimer)
1:20 p.m.	Introduction of participants and bioaccessibility methods (Reimer)
2:30 p.m.	Overview of BARGE round robin experience - objectives, outcomes, and lessons learned (Joanna Wragg)
3:00 p.m.	Coffee break
3:15 p.m.	Presentation of strawman plan for BARC Round Robin (Reimer/Wragg/ Iris Koch)
3: 45 p.m.	Open discussion of technical aspects of round robin (Q&A facilitated by Reimer)
4:45 p.m.	Synthesis of day 1 (Reimer)
	Dinner on own

Day II (Oct. 12)

	Breakfast on own
8:30 a.m.	Confirmation of plans (technical and logistical arrangements) for the initial BARC round robin (Facilitated by Reimer)
9:30 a.m.	Discussion on the collection and preparation of standard soils (Facilitated Andy Renzc, NRCan)
10:30 a.m.	Coffee break
10:45 a.m.	Discussion on the mechanisms and a schedule for accessing, collecting and preparing soils (Facilitated by Reimer/Hale)
12:00 p.m.	Cold buffet lunch in meeting room
12:45 p.m.	Review and enhancement of plan to address bioaccessibility/bioavailability research gaps and strawman of research grant proposal (Hale)
2:15 p.m.	Coffee break
2:30 p.m.	Presentation and discussion of action plan to develop a research grant proposal and to secure funding partnerships (Hale)
4:00 p.m.	Synthesis of workshop (Reimer)
4:30 p.m.	Workshop conclusion

Note: To access the Dec. 5-6/06 Proceedings from the Workshop on Bioaccessibility/Bioavailability in Contaminated Site Assessment – an Industry Perspective, go to http://www.cntc.ca

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Annex C: Presentations

Barge Round Robin Experience: Objectives, Outcomes, and Lessons Learned
Dr. Joanna Wragg, British Geological Survey

Overview of BARGE round robin experiences –

objectives, outcomes, and lessons learned

Dr Joanna Wragg

Round Robin Experiences

- 3 self funded round robin studies
  - Oomen *et al.,* 2002
  - Van de Wiele et al., 2007
  - Current BARGE Round Robin - UBM

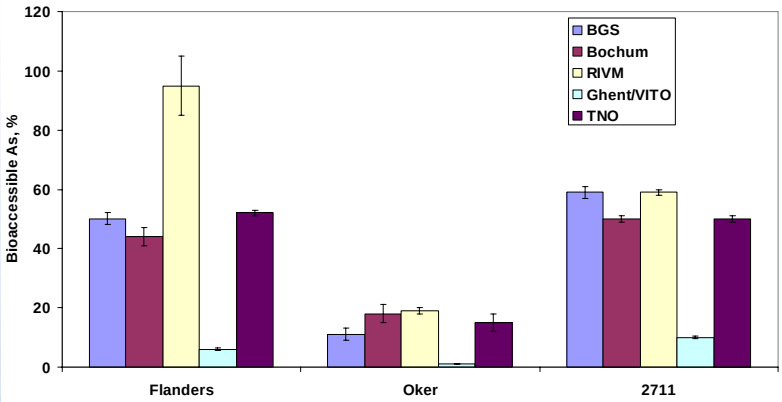
Objectives

- Oomen et al., 2002
  - To determine the extent to which in vitro bioaccessibility is method dependent
- Van de Wiele et al.,2007
  - To assess the bioaccessibility of soil-bound lead under simulated fasted and fed conditions
- BARGE UBM
  - The validation of a standardized method using in vivo tested soils

Oomen et al., 2002

- Comparison of five in vitro digestion models to study the bioaccessibility of soil contaminants, *Environmental Science & Technology,* **36** (15)**,** 3326-3334
  - RIVM, BGS, Ghent, Bochum, TNO
    - Each laboratory undertook their own totals and bioaccessibility analysis
      - RIVM in vitro, SBRC, SHIME, German DIN and Dynamic TIM bioaccessibility methods
      - Different methods of total digest (different acid digest)
      - ICP-AES and ICP-MS
  - Oker 11, Flanders soil and NIST 2711
    - As, Cd, Pb

Oomen et al., 2002 (2)



•Overestimation of uncertainties if data taken at face value

•Variation in pH, soil:solution ratio, separation technique, measurement of total element concentrations……

Van de Wiele et al., 2007

- Comparison of 5 in vitro digestion models: Lead bioaccessibility in the human gastrointestinal tract, *Journal of Environmental Science and Health, Part A*, 42 (9) 1203-1212

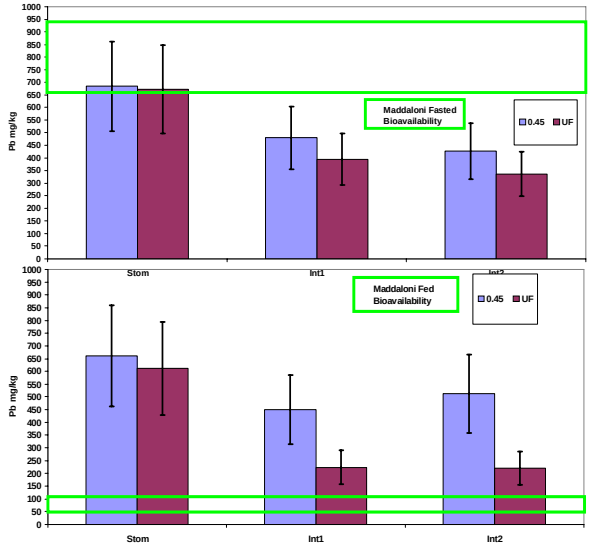
- TIM, BGS PBET, RIVM, SHIME, DIN
  - Maddaloni in-vivo Bunker Hill soil, Pb
  - Fed and Fasted state
  - **1 lab for analysis (Flemish Institute of Technical research (VITO))**

Van de Wiele et al., 2007 (2)

- FED STATE
  - Maddaloni standard breakfast – TNO
  - Infant formula - BGS (Cow & Gate); RIVM, (Macaroni based)
  - Whole milk powder – DIN
  - Nutrilon - SHIME
- Separation
  - Centrifugation
  - 0.45um filtration
  - Ultrafiltration

BARGE

Van de Wiele et al., 2007 (3)

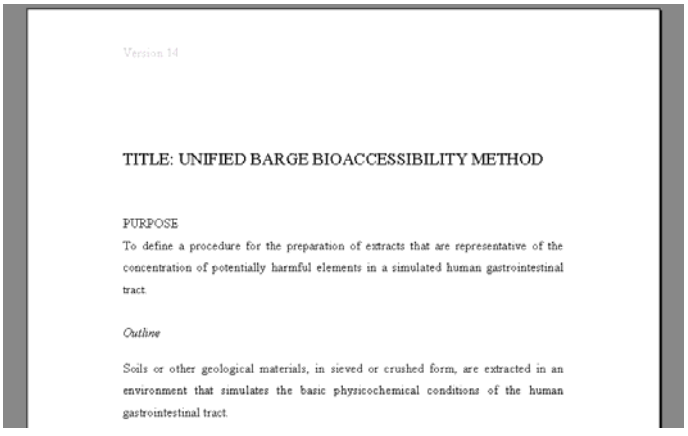


Current BARGE Initiative

- **Unified Bioaccessibility Method**
- 1 standardized methodology
- Provide a physiologically based, robust and reproducible method
  - Simulated fluids
    - Based on RIVM method –
      - adjusted for new pH regime and buffering capacity of materials encountered in each member country
  - pH
    - Stomach 1.2 ± 0.5
    - Intestine 6.3 ± 0.5
  - Residence times
    - Stomach 1 hour
    - Intestine 4 hours
  - Separation Step
    - Centrifugation @ 3000G for 5 minutes

Unified Bioaccessibility Method

- R & D carried out prior to finalization of method parameters
  - to ensure the method is robust enough for all soil conditions encountered across member countries



Version 14

TITLE: UNIFIED BARGE BIOACCESSIBILITY METHOD

PURPOSE

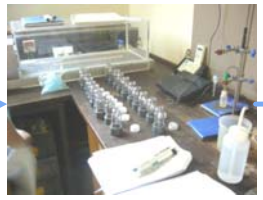
To define a procedure for the preparation of extracts that are representative of the concentration of potentially harmful elements in a simulated human gastrointestinal tract.

Outline

Soils or other geological materials, in sieved or crushed form, are extracted in an environment that simulates the basic physicochemical conditions of the human gastrointestinal tract.

Unified Bioaccessibility Method (3)

Stomach and Intestine reagents are prepared according to the protocol

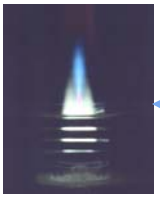


Soil samples are weighed into centrifuge tubes

Soils are extracted with gastric and intestine solutions in a water bath at 37^0 C

Samples are Centrifuged

Decanted samples are diluted and preserved in 0.1 M HNO_3

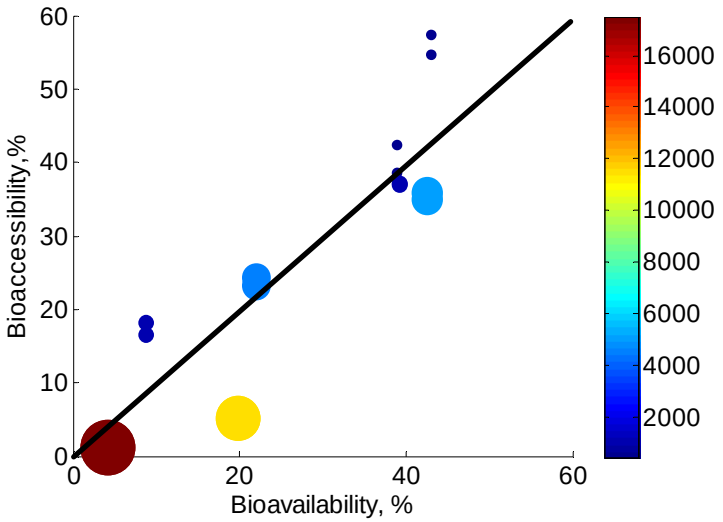


Samples are analysed by ICP-AES

Unified Bioaccessibility Method (2)

- Validation trial
  - Address issues of uncertainty
  - 7 International research laboratories
    - BGS, Ghent, RIVM, INERIS, RMC, Ohio state, DHI
  - c.20 soils with in-vivo swine data for As, Cd and or Pb
  - NIST Reference soils, BGS guidance soil, spiking tests, blanks, duplicates
  - 1 laboratory – all analysis (BGS)
  - Current status – data processing and statistical analysis

Stomach As



Lessons Learned

Planning (1)

- Prepare Well
- Have written procedures
  - Decide on the fundamental principles in a group situation, i.e. fed or fasted, soils, elements
    - Minor issues can be resolved by email etc
- Obtain agreements between all parties
- Communicate with the people carrying out the RR
- Communicate with the analytical laboratory
- Ensure that all parties understand each process – DON'T ASSUME
- Prepare for all possibilities/problems

Lesson Learned (2)

Planning (2)

- Have a good experimental design
  - Make any final decisions before instructions go to the labs
    - Different labs will interpret the same instructions in different ways!!
    - Don't keep adding on, this will confuse!!
- Include a small trial by the analytical lab
  - extra $ but it will iron out some of the bugs
- If possible analyze for as many major and trace elements as you can
  - more information is better than less

Lessons Learned (3)

TECHNICAL (1)

- Standardization
  - Grade/Supplier of reagents and consumables if possible
  - Analysis techniques
- QA/QC
  - Consider Blanks, Spikes and duplicates carefully
- Sample preservation/Storage/Transport
  - Consider how these will be addressed before the RR begins

Lessons Learned (4)

TECHNICAL (2)

- Sample Analysis
  - Use of 1 analytical laboratory (1 instrumental method) will reduce the associated uncertainty
  - Communicate the aims and objectives of the RR with the analytical Laboratory
  - Ensure all R&D associated with the measurement is complete prior to the start of the RR

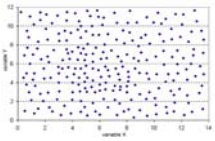
Lessons Learned (5)

Data Handling

- Discuss the protocol at the start of the RR
  - Remember the RR aims?
- Make one person/institute responsible
- Send out QA returns to each lab to confirm their data
- Use a recognised statistics protocol for data comparison
- Reporting units for the data?

Conclusions

- Before you start
  - Think carefully about the question you want to answer
    - This will effect
      - The design of your experiment
      - The cost of the experiment



What is the cause of the scatter

-pH?

-Filtration?

-Soil:solution ratio?

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Strawman Plan for the initial BARC Round Robin

Joanna Wragg, British Geological Survey and Iris Koch, Environmental Sciences Group, RMC with Input from Members of BARC

Strawman Plan for the BARC Round Robin

October 2007

Outline

- Technical Aspects
- Logistical Aspects
- Analytical Aspects
- Reporting and Data Manipulation Aspects

Aim of RR

- Key objective: determine the variation between methods among participating labs
- Get everyone discussing bioaccessibility and how to incorporate it into risk assessment

Technical Aspects

- **Methods and conditions to include in the RR**
  - Those currently run as standard in the lab/asked for by the client -agreed
- **Elements of interest**
  - As, Cd, Ni, Pb plus….As and Pb as a minimum plus whatever else the labs routinely do?
- **Soils of interest**
  - NIST 2710 and 2711 – Agreed to use one of these

NIST 2710

Table 1. Certified Values

Element	Mass Fraction (%)			Element	Mass Fraction (mg/kg)		
Aluminum	6.44	±	0.08	Antimony	38.4	±	3
Calcium	1.25	±	0.03	Arsenic	626	±	38
Iron	3.38	±	0.10	Barium	707	±	51
Magnesium	0.853	±	0.042	Cadmium	21.8	±	0.2
Manganese	1.01	±	0.04	Copper	2950	±	130
Phosphorus	0.106	±	0.015	Lead	5532	±	80
Potassium	2.11	±	0.11	Mercury	32.6	±	1.8
Silicon	28.97	±	0.18	Nickel	14.3	±	1.0
Sodium	1.14	±	0.06	Silver	35.3	±	1.5
Sulfur	0.240	±	0.006	Vanadium	76.6	±	2.3
Titanium	0.283	±	0.010	Zinc	6952	±	91

Non-certified
Cr 39 mg/kg
Co 10 mg/kg

NIST 2711

Table 1. Certified Values

Element	Mass Fraction (%)			Element	Mass Fraction (µg/g)		
Aluminum	6.53	±	0.09	Antimony	19.4	±	1.8
Calcium	2.88	±	0.08	Arsenic	105	±	8
Iron	2.89	±	0.06	Barium	726	±	38
Magnesium	1.05	±	0.03	Cadmium	41.70	±	0.25
Phosphorus	0.086	±	0.007	Copper	114	±	2
Potassium	2.45	±	0.08	Lead	1162	±	31
Silicon	30.44	±	0.19	Manganese	638	±	28
Sodium	1.14	±	0.03	Mercury	6.25	±	0.19
Sulfur	0.042	±	0.001	Nickel	20.6	±	1.1
Titanium	0.306	±	0.023	Selenium	1.52	±	0.14
				Silver	4.63	±	0.39
				Strontium	245.3	±	0.7
				Thallium	2.47	±	0.15
				Vanadium	81.6	±	2.9
				Zinc	350.4	±	4.8

Non-certified
Cr 47 mg/kg
Co 10 mg/kg

Technical Aspects (2)

- **Number of replicates to provide sufficient information?**
  - For each extraction phase 5 or 6 replicates would provide a more robust data set
- **What and how many spiking solutions to include**
  - Mixed spikes for blanks only (to check extraction efficiency) and we need to identify at what concentration
  - 3 spikes for each phase are recommended
  - ESG will ship spike solution

Technical Aspects (3)

- Number of extraction blanks to include
  - 3 blanks for each phase should give us a good reading across Canadian labs
  - It may not be possible for everyone to run blanks at that same time as their samples.
- Use of a standard grade/supplier of reagents and consumables
  - Confirm: use what you currently use or same grade?
  - Do what you do normally but send documentation for reagents
  - Will consider one source of pancreatin for all labs using it

Technical Aspects (4)

- Sample preservation prior to shipping
  - Agreed to use an environmental grade of HNO3
  - 0.1M HNO3 in a sample to preservation reagent ratio of 1:10? (depending on the concentration in the soil)
  - Labs will Archive residual samples for future phases
- Use of a standard labelling system
  - Provided by RMC
- Storage of samples prior to shipping
  - Refrigerate at 0-8°C
  - TDG requirements for test samples

Logistical Aspects

- **Sample transportation options**
  - Overnight shipping
- **Benefits of sample preservation prior transportation**
  - This will halt the growing of bugs, if there is a delay in transportation of samples
  - Carried out by the BARGE group
  - Beneficial for those labs with the furthest to distance to transport
  - If one lab carries out preservation, all labs should – the data is less likely to be skewed
- **Communication with the Analytical Laboratory**
  - The analytical lab should nominate one staff member to deal with all aspects of the work
  - All communication regarding expected shipping date etc should be through the nominated staff member

Analytical Aspects

- **Importance of using an external laboratory**
  - Helps to remove any bias, and therefore reduce the uncertainty in the data
- **Digestion of samples prior to analysis**
  - Agreed to drop digestion step
  - matrix matching is a consideration if contributing labs do it – dilution may negate the need for this.

Analytical Aspects (2)

- **Digestion method**
  - Not using
  - **Delay between sample receipt and analysis**
  - preservation will account for any delays in shipping
    - With good communication the lab can schedule timely analysis

Data Manipulation/Reporting

- **Data reported by the analytical laboratory**
  - As mg l^{-1} to one central group/person to reduce issues with uncertainty – Iris Koch
- **Information required by the centrally responsible group**
  - Method information and a spreadsheet supplying technical details such as weights and volumes etc for each sample
  - Each lab must provide a list of elements that the lab can report on (i.e. what they normally test).

Data Manipulation / Reporting (2)

- **Data manipulation**
  - ONE person should calculate the bioaccessibility data for each contributing lab
  - Each contributing lab receives a 'QA return' for checking purposes
- **Data investigation**
  - Use a recognised statistics programme
  - ISO 5725-2 (this is what BARGE are currently using)
  - Compile all of the data according to the ISO procedure
  - Report total metal analysis for reference soil
  - Report bioaccessibility as a %age of total

Strawman Proposal for an NSERC Collaborative and Research Development (CRD) Grant

Dr. Bev Hale, University of Guelph

NSERC Collaborative Research and Development Grant:

- -well-defined projects
- -apply anytime
- -up to 5 years, more typically 2-3 years
- Funding formula:
- Partner $$ = ½ NSERC $$ + Partner In-Kind = ½ NSERC $$
- > $200k/year from NSERC requires a site visit
- > $150k/year from NSERC requires Selection Committee, which meets Mar, June, Sept, Dec

NSERC Strategic Project Grant:

- -early-stage project
- -target area: "Healthy Environments and Ecosystems", objective of which is "determine better and more effective ways to manage wastes and remediate contaminated soil and groundwater"
- -between 1 and 3 years
- -apply April 15 2008, outcome October 2008
- Funding formula – not strictly prescribed, but approximately:
- Partner $$ = 1/3 or ¼ NSERC $$, with Partner In-Kind less critical

Title: "Validation of in vitro estimates of Soil Contaminant Bioaccessibility: A Framework for Inclusion in Site Specific Risk Assessment for Selected Metals (and HOCs)"

- Numerous Investigators
- Three "Themes":
  - In vivo
  - Tier I / Tier II
  - Potential Confounding Factors (PCFs)

In vivo – the objective of this theme is to demonstrate whether in vitro estimates are conservative; correlation possible

- Juvenile swine would be first choice of animal model
- Eight separate feeding studies
- Media: NIST 2710, Federal contaminated site, three partner soils, three TRV media, dust
- Ten animals in each of two groups (study soil, control soil), per separate study
- Two – three week feeding study
- Endpoints - ????
- Cost guess: $20,000 x 8 = $160,000

Tier I/Tier II – the objective is to systematically estimate in vitro bioaccessibility of metals in media used to establish TRVs that are in use, and link those estimates with in vivo data

- As, Cu, Ni, (Pb,) Cd, Cr…others? (How many of these have a single medium that was used for the TRV?)
- In vitro method(s) need to be chosen

PCFs – the objective of this is to explore the sources of variability among media

- TOC/DOC
- amorphous Fe oxides
- CEC
- P
- grain size
- total metals including mineralogy (speciation)
- source of contamination

Need to collect a large variety of soils, small amounts of each OR artificial soils with varied properties and constant metal concentrations

Surface complexation models and BLM

One method of in vitro

Budget for three years (or, do we compress this into two years, for 2/3 of the total cost?)

- $160,000 for in vivo studies
- $50,000 for Tier I/Tier II studies
- $150,000 for PCF studies
- Sub-total: $360,000
- $90,000 unallocated
- Total: $450,000

- Per Year:
- Cash: $50,000 from partners, $100,000 from NSERC