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North American Soil Geochemical Landscapes Project

Canadian Initiative - Workshop II

Looking Forward to 2008

February 27th – 28th 2008
Ottawa, Ontario

Canada

Workshop II
Statement of Purpose

The purpose of the North American Soil Geochemical Landscape Project is to build a soil geochemical database that is useful to a wide range of users in the field of environment and health. This workshop is a step towards achieving this goal by:

- Reviewing accomplishments and lessons learned from 2007 to make a "best plan" for new work in 2008 and beyond
- Identifying opportunities to expand the sampling
- Developing partnerships to promote data application
- Developing ideas for new Canadian projects that will respond to users' needs.

Contents

- Introduction
- Workshop agenda
- Participant list
- Add-on research activities
- Proposed sampling surveys for 2008
- Overview of field and laboratory procedures

Introduction

The North American Soil Geochemical Landscapes Project is a tri-national initiative between the United States, Canada and Mexico and the first multi-national, multi-agency collaboration of its kind for this continent. It was established to develop a useful set of geochemical data for North America generated using a consistent set of protocols. The Project is designed to show the following: 1) systematic regional variations in chemistry and microbiology at a 40 km sample spacing (i.e. more than 10,000 samples for North America, including more than 6100 for Canada); 2) regional natural-occurring differences, thereby defining natural regional background levels and controls; and 3) regional variation from anthropogenic sources, thereby identifying human impacts on the soil landscape. From the start the Project goal is to have a common understanding and focus and to have outcomes related to government decision-marking.
The Project had a tremendously successful first year. Through co-operative efforts with provincial and territorial agencies sampling was completed in the Maritimes and at some sites in northern Yukon Territory and northern Northwest Territories. We are now evaluating the activities from 2006 and 2007, analyzing the samples collected, and looking forward to the 2008 field season. We have organized Workshop II to achieve the following:

1) Outline the accomplishments and lessons learned from the first year's activities related to both "core" sample collection and add-on research. Review a "best plan" for new work.

2) Obtain feedback from present partners in add-on research. Learn how they will benefit from having a set of consistent geochemical data for Canada. Ask how they can add more to the tri-national project in 2008 and beyond.

3) Determine from present or potential data users what types of geochemical and related information are needed. Look for ways to work together with users more effectively. Determine how to best use the resultant survey data to address their specific problems. Establish priorities for identifying future survey areas.

4) Plan for the 2008 field season and beyond. At present the activities proposed for 2008 are a trans-Canada sampling swath and test surveys for protocol development in peatland and permafrost terranes. Learn where and for what reasons other groups are undertaking major field surveys. Explore possibilities for combining resources and expertise to help answer their questions and meet their needs.

This booklet includes the following documents: a workshop schedule, a participant list, brief descriptions of some add-on research activities, a flow chart showing procedures for sample handling and analysis, and information on proposed surveys for 2008.

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NORTH AMERCAN SOIL GEOCHEMICAL LANDSCAPE PROJECT

Canadian Initiative - Workshop II
Looking Forward to 2008

DRAFT WORKSHOP AGENDA, FEB 27-28, 2008

FEBRUARY 27 AFTERNOON

WELCOME AND INTRODUCTION

12:30	Registration and coffee at Sala San Marco, 215 Preston Street.	
13:00	Welcoming remarks	D. Boerner (NRCan)
13:10	Remarks on Workshop II purpose and objectives	A. Rencz

WHAT WE DID IN THE FIELD IN 2007

13:20	Canadian and Mexican field surveys from 2007	A. Rencz
13:30	United States field surveys from 2007	L. Woodruff (USGS)
13:40	Insights from summer field acquisitions: Comments from and a question and answer session with participants from Canadian "core" sampling surveys	A. Rencz Participants: P. Friske (NRCan-GSC), T. Goodwin (NSDNR), T. Pronk (NBDNR), M. Parkhill (NBDNR), K. Ford (NRCan-GSC)

WHAT WE ARE DOING IN THE LABORATORY

14:10	Introduction to the session	A. Rencz
14:15	Why are consistent protocols important? What is in a number? What are the standard reference materials?	R. Klassen (NRCan-GSC)
14:35	COFFEE	

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14:50	Scheme for sample preparation	M. McCurdy (NRCan-GSC)
15:00	Protocols manual	I. Kettles/P. Friske (NRCan-GSC)
15:10	Aqua regia tests	R. Garrett/E. Grunsky/ P. Friske (NRCan-GSC)
15:20	Group discussion	

WHAT WE ARE DOING WITH THE DATA

16:00	Data: framework, analysis and presentation	E. Grunsky/R. Garrett (NRCan-GSC)
16:20	Presentation of new data from "core" analyses	E. Grunsky/R. Friske/R. Garrett/ R. Klassen (NRCan-GSC)
16:45	Group discussion	

END OF DAY 1

17:15	Summary and plans for Day 2	A. Rencz
17:30	POSTERS/ BAR and SNACKS (Sala San Marco)	
18:30	DINNER (self-funded at Allegro Restaurant, 422 Preston Street)	

FEBRUARY 28 MORNING

INTRODUCTION TO DAY 2

8:15	COFFEE	
8:45	Opening remarks	A. Rencz

ADD-ON RESEARCH – HOW THESE EFFORTS ADD TO THE TRI-NATIONAL

9:00	Soil gas radon studies	K. Ford (NRCan-GSC)/J. Chen (HC-RPB)
9:10	Studies of the organic layer (0-30 cm)	R. Mroz (EC)
9:20	Biomethods for assessing soil toxicity	R. Scroggins (EC-BMD)
9:30	Studies of bioaccessiblity and selected organic components	S. Hall (HC)/K. McKendry (HC)

9:40	Stream water and sediment sampling survey	R. McNeil (NRCan-GSC)
9:50	Group discussion	
10:15	COFFEE	

WORKING WITH DATA USERS AND PROVIDERS MORE EFFECTIVELY

10:30	Introduction to session	A. Rencz
10:40	Remarks by participants followed by a round table discussion	S. Hall (HC), G. Russo (NRCan-CFS), D. Kroetsch/S. Smith (AAFC), C. Allaway (EC), and others to be arranged.
12:00	Group discussion with questions from the floor	
12:30	LUNCH (served in-house)	

FEBRUARY 28 AFTERNOON

MOVING FORWARD WITH THE CANADIAN INITIATIVE IN 2008 AND BEYOND

13:15	Introduction to the session:	A. Rencz
13:20	Proposed sampling surveys for 2008 and data products	A. Rencz
13:30	What is happening in the provinces and territories? Are there other opportunities for collaboration?	R. Lett (British Columbia), J. Campbell (Saskatchewan), H. Groom (Manitoba), R. Kelly (Ontario), S. Cairns (Northwest Territories), and others to be arranged
14:30	Group discussion	

WALKING OUT WITH A ROAD MAP

15:00	Summary of sessions	A. Rencz
15:15	Group discussion: Building an action plan for 2008	
16:15	END	

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Participant List

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Participant List

Last Name	First Name	Organization	Location	Email
Allaway	Chris	Environment Canada-National Guidelines and Standards Office	Ottawa, ON	chris.allaway@ec.gc.ca
Béchard	Geneviève	Natural Resources Canada - Geological Survey of Canada	Ottawa, ON	Genevieve.Bechard@nrcan-rncan.gc.ca
Cairns	Scott	Northwest Territories Geoscience Office	Yellowknife, NT	Scott_Cairns@gov.nt.ca
Campbell	Janet	Saskatchewan Energy and Resources - Northern Geological Survey	Regina, SK	jcampbell@ir.gov.sk.ca
Chen	Jing	Health Canada	Ottawa, ON	jing_chen@hc-sc.gc.ca
Couillard	Yves	Environment Canada	Gatineau, QC	yves.couillard@ec.gc.ca
Ellert	Benjamin H.	Agriculture and Agri-Foods Canada	Ottawa, ON	Ellert@agr.gc.ca
Ford	Ken	Natural Resources Canada - Geological Survey of Canada	Ottawa, ON	ken.ford@nrcan-rncan.gc.ca
Friske	Peter	Natural Resources Canada - Geological Survey of Canada	Ottawa, ON	Peter.Friske@nrcan-rncan.gc.ca
Garrett	Robert	Natural Resources Canada - Geological Survey of Canada	Ottawa, ON	Robert.Garrett@nrcan-rncan.gc.ca
Geng	Xiaoyuan	Agriculture and Agri-Foods Canada	Ottawa, ON	gengx@agr.gc.ca
Goodwin	Terry A.	Nova Scotia Department of Natural Resources	Halifax, NS	goodwita@gov.ns.ca
Groom	Heather	Manitoba Geological Survey	Winnipeg, MB	hgroom@gov.mb.ca
Grunsky	Eric	Natural Resources Canada - Geological Survey of Canada	Ottawa, ON	Eric.Grunsky@nrcan-rncan.gc.ca
Hall	Sarah	Health Canada	Ottawa, ON	sarah_hall@hc-sc.gc.ca
Jains	Pritam	Saskatchewan Ministry of Environment - Environmental Monitoring Branch	Regina. SK	pritam.jain@gov.sk.ca
Johnson	John	Ontario Ministry of Natural Resources	Sault Ste. Marie, ON	John.A.Johnson@ontario.ca
Kelly	Ross	Ontario Geological Survey	Sudbury, ON	ross.kelly@ontario.ca

Kettles	Inez	Natural Resources Canada - Geological Survey of Canada	Ottawa, ON	Inez.Kettles@nrcan.gc.ca
Klassen	Rod	Natural Resources Canada - Geological Survey of Canada	Ottawa, ON	klassen@nrcan.gc.ca
Kozak	Leonard	Agriculture and Agri-Foods Canada	Ottawa, ON	kozakl@agr.gc.ca
Kroetsch	David	Agriculture and Agri-Foods Canada	Ottawa, ON	kroetschd@agr.gc.ca
Laframboise	Richard	Natural Resources Canada - Geological Survey of Canada	Ottawa, ON	rilaframb@nrcan-rncan.gc.ca
Lalonde	Ginette	Natural Resources Canada - Geological Survey of Canada	Ottawa, ON	ginette.lalonde@nrcan-rncan.gc.ca
Lett	Ray	British Columbia Geological Survey	Victoria, BC	Ray.Lett@gov.bc.ca
McKendry	Karen	Heath Canada	Ottawa, ON	karen_mckendry@hc-sc.gc.ca
McNeil	Rick	Natural Resources Canada - Geological Survey of Canada	Ottawa, ON	RickJ.McNeil@nrcan-rncan.gc.ca
Mroz	Rita	Environment Canada	Dartmouth, NS	rita.mroz@ec.gc.ca
Parkhill	Michael	New Brunswick Department of Natural Resources	Fredericton, NB	Michael.Parkhill@gnb.ca
Princz	Juliska	Environment Canada - Biological Methods Division	Ottawa, ON	Juliska.princz@ec.gc.ca
Pronk	Toon	New Brunswick Department of Natural Resources	Fredericton, NB	Toon.pronk@gnb.ca
Rencz	Andy	Natural Resources Canada - Geological Survey of Canada	Ottawa, ON	Andy.Rencz@nrcan-rncan.gc.ca
Russo	Glenda	Natural Resources Canada - Canadian Forest Service	Ottawa, ON	grusso@nrcan.gc.ca
Scroggins	Rick	Environment Canada	Ottawa, ON	rick.scroggins@ec.gc.ca
Smith	Scott	Agriculture and Agri-Foods Canada	Summerlands, BC	smithcas@agr.gc.ca
Woodruff	Laurel	United States Geological Survey	Mounds View, MN	woodruff@usgs.gov

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Add-On Research Activities from 2007

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STUDIES OF NATURAL RADIOACTIVITY RELATED TO THE SOIL GEOCHEMICAL LANDSCAPES PROJECT

K. Ford
Natural Resources Canada-Geological Survey of Canada, Ottawa, Canada
J. Chen
Health Canada – Radiation Protection Bureau, Ottawa, Canada

Radon is a naturally-occurring hazard and the second leading cause of lung cancer. In 2007 Health Canada lowered the threshold limit of exposure in Canadian homes and buildings above which there is a recommended need for remediation. This change is part of a new radon strategy for Canada and includes new approaches for achieving compliance with the guideline. In 2007 Natural Resources Canada, through the Geological Survey of Canada, entered into a partnership with Health Canada - Radiation Protection Bureau with the end goal of producing a map of radon prone areas in Canada to guide risk management. The map will be used to delineate those areas where there is increased health risk from radon and, hence, require follow-up testing.

The partnership supports new airborne gamma ray spectrometry where there are gaps in the existing coverage and provides for soil gas radon and in-situ gamma ray spectrometry surveys under the auspices of the North American Soil Geochemical Landscapes Project. Variations in soil gas radon concentrations have been used to delineate radon prone areas as have airborne gamma ray spectrometry data along with bedrock and surficial geology information. In 2007, as part of the NASGLP, three projects involving in-situ measurements of soil gas radon and gamma ray spectrometry (in particular K, U, Th) were undertaken in the following areas:

1) Maritime provinces. Through co-operative efforts with partners from the provincial surveys, data were collected at the "core" NASGLP sites in the Maritimes. In addition, laboratory gamma ray spectrometry measurements were made on A-, B-, and C-horizon splits of core samples from the Maritimes in the Gamma-ray Spectrometry Standards Laboratory at GSC.
2) Ottawa area. At two sites at the Ottawa Experimental Farm, field measurements of soil gas radon and gamma ray spectrometry were made at regular intervals over summer 2007 to test for seasonal variation. Data and samples were also collected at additional sites in the Ottawa area to provide a larger set of ground data for test purposes.
3) Southern Ontario. Measurements were made along a transect between Ottawa and Sarnia.

The data obtained to date from the 2007 surveys is currently being compiled and interpreted. In each case, data from the in-situ surveys will be compared to data from existing regional airborne gamma ray spectrometry surveys and the NASGLP and other geochemical sampling surveys and also the best available information on bedrock and surficial geology. The aim is to develop methodology for identifying areas with high risk potential for radon through the use of these proxy data.

BIOLOGICAL METHOD DIVISION – THE DERIVATION OF SOIL TOXICITY TEST METHODS

Rick Scroggins and Juliska Princz
Environment Canada

The Biological Methods Division (BMD) in the Environmental Science and Technology Centre of Environment Canada has a mandate to conduct research and develop standardized soil, sediment, and aquatic toxicity test methods. The BMD includes two soil testing laboratories, the Soil Toxicology Laboratory and the Soil Biotechnology Laboratory, where the derivation and standardization of soil toxicity test method research takes place on-site. The development of scientifically-sound toxicity test methods requires the cooperation with many researchers (e.g., National Research Council (NRC), Natural Resources Canada (NRCan) and Agriculture and Agri-food Canada (AAFC)) for the selection of ecologically-relevant test species, test systems, and soil (reference and contaminated) with which to assess the applicability of the test methods and species. Among the on-going research projects, the BMD has been evaluating the use of boreal forest plant and soil invertebrate species, as well as microbial community effects for the development of a series of standardized soil toxicity test methods for the assessment of soil pollutants. The type of soil pollutants associated with these forested regions includes hydrocarbon and brine-impacted sites from the oil and gas industry, and metal contamination from smelting operations. As part of the method development process, it is crucial to examine the applicability of the tests and species to a variety of undisturbed reference soils; this also helps to establish performance data for the development of test validity criteria. The reference soils are collected using bulk collection methods (separated by horizons) and soil cores, and involve physical and chemical characterization of the soils, the soil horizons, and any ecological information that can be derived from the area of collection. The collaboration with other departmental colleagues and projects, such as the Tri-National Initiative, provide the opportunity for the selection of reference sites across Canada to support diverse research objectives. For example, past reference locations that have been characterized by the BMD can be provided for inclusion in the Tri-National Initiative. Information derived from new sites can be collectively shared (e.g., performance data, ecological information) and available to researchers beyond the scope of the BMD's and the Tri-National Initiative's objectives.

Prepared: January 31, 2008

THE AQUA REGIA DIGESTION STUDY*

To Aqua Regia or not ….. that is the question

Robert G. Garrett, Eric C. Grunsky, Peter B.F. Friske and Martin McCurdy
Geological Survey of Canada, Ottawa, Ontario

Currently a variety of different analytical protocols are employed by environmental agencies in North America. There are no consistent national or international protocols, though many require use of an Aqua Regia, or a relatively similar, digestion procedure. In order to determine whether an Aqua Regia, or some other hot acid, digestion would be used to determine near-total metal and metalloid levels in soil materials from the Tri-National survey an experiment was undertaken to compare five different digestion protocols, Aqua Regia, Lefort (reverse Aqua Regia), 1:1 HCl-HNO_3, 1:1:1 HCl-HNO_3-H_20, and the HNO_3-H_2O_2 variant of US-EPA 3050. Eight control reference materials, two each of soils, tills, stream sediments and lake sediments, were analysed in triplicate. Both the digestion steps and final ICP-OES and -MS determinations were undertaken following randomization so any systematic temporal or other variability would be distributed as random 'noise'. The data from this experimental design was subjected to an Analysis of Variance to determine which analytical protocols yielded similar data to each other. The ANOVA results indicate that the HNO_3-H_2O_2 variant of US-EPA 3050 generally extracts significantly less metals and metalloids than Aqua Regia and the Aqua Regia-like digestions. Notable exceptions are Hf, Nb, Th and Zr. For the remaining four analytical protocols, Aqua Regia and three HCl-HNO_3 variants, the results are very similar, if not identical. Even when results are statistically ($p<0.05$) different between some protocols, an inspection of the data indicates that these differences are likely not significant in a geochemical/engineering context. Considering the vast amounts of Aqua Regia and US-EPA Aqua Regia variant data that are extant in North America and internationally, and the fact that the Aqua Regia-like variants extract very similar results for most elements, it is recommended that the North American Soil Geochemical Landscapes Project, the Tri-National, employs the US-EPA 3050B Aqua Regia variant digestion. This procedure used a 4:1 HCl-HNO_3 mix rather than the 3:1 of "classical" Aqua Regia. The Geological Survey of Canada is preparing a protocol document defining the procedures to be used for Tri-National analyses. These include the choices of 1 g (<63 µm) or 10 g (<2 mm) aliquots and a 1:12.5 solid:reagent ratio.

*This write-up was revised on March 11, 2008 and differs from the version mailed out to participants on February 22, 2008, and included in the booklet handed out at the Workshop II meeting on February 27, 2008.

DEVELOPMENT OF A BACKGROUND SOIL CHEMISTRY/TOXICOLOGY DATABASE FOR THE ATLANTIC REGION AND THE NORTH AMERICAN SOIL GEOCHEMICAL LANDSCAPES PROJECT (NASGLP)

Rita Mroz[1], Gerry McCormick[1], Kok-Leng Tay[1], Ken Doe[2], Paula Jackman[2], Terry Goodwin[3], Toon Pronk[4], Michael Parkhill[5]

1. Environment Canada, Atlantic Region, 45 Alderney Dr., Dartmouth NS, B2Y 2N6
2. Environment Canada, Atlantic Laboratory for Environmental Testing, Moncton, NB, E1A 3E9
3. Nova Scotia Department of Natural Resources, P.O. Box 698, Halifax, NS B3J 2T9
4. New Brunswick Department of Natural Resources, Fredericton, NB E3B 5H1
5. New Brunswick Department of Natural Resources Bathurst, NB E2A 3Z1

The need for baseline soil geochemical data to effectively assess and manage natural resources and the risk of environmental hazards is well recognized. One particular application of such data is to compliment the ecological and human health risk assessment processes. While other jurisdictions have established background soil data, at present, there is limited data on the background soil chemistry for the Atlantic Region. Environment Canada-Atlantic (EC-Atlantic), in partnership with other stakeholders, has undertaken the development of a background soil conditions for the region. In addition to standard chemical analyses, the sampling protocols also include subjecting a portion of the soils to several soil toxicity tests which provides a biological aspect to the chemical data interpretation. Samples have been collected throughout the Atlantic Region over the past 4 years and the resulting data is being collated in a GIS-based database. A key purpose of this research is provide risk assessors with additional data in which to incorporate into their risk calculations, further strengthening the scientific validity of the risk assessment process.

The North American Soil Geochemical Landscapes Project (NASGLP) is a tri-national initiative between US, Canada and Mexico designed to understand the amount and origin of variation in soil geochemistry and to establish a consistent methodology for determining these characteristics. For Canada, this project is being lead by Natural Resources Canada with in-kind support being provided by EC-Atlantic, Health Canada, Agriculture Canada and several provincial departments of natural resources. EC-Atlantic has partnered with NASGLP in order to exchange protocols and data, allow comparisons between the sampling protocols at each site (discrete sample vs. composite samples, horizon-based sampling vs. integrated 0-30 cm sampling, etc.) and optimize sampling efforts between the two projects. NASGLP sampling occurred in between June and September 2007 resulting in the collection of approximately 175 samples from Nova Scotia and New Brunswick. These samples are to be analyzed for metals, polycyclic aromatic hydrocarbons (PAHs), total organic carbon, pH, and grain size. In addition, bulk soil samples were collected at 30 sites for the purposes of toxicological testing. Chemical and toxicological results are pending.

STUDIES OF BIOACCESSIBILITY AND SELECTED ORGANIC COMPOUNDS RELATED TO THE NORTH AMERICAN SOIL GEOCHEMICAL LANDSCAPES PROJECT

Karen McKendry and Sarah Hall
Health Canada
Contaminated Sites Division
Ottawa, ON

The Contaminated Sites Division (CSD) of Health Canada plays a key role in both the development of soil quality guidelines and as an expert support department on issues related to federal contaminated sites. As such, CSD, through a long standing relationship with the Geological Survey of Canada, relies on the GSC for accurate data and interpreted information on background soil concentrations for a variety of elements. Through this agreement, and in particular through the efforts of the Tri-National project, CSD is also able to foster collaborative research related to risk assessment. The Tri National project, in using a robust sampling design and methodology, offers the opportunity to further explore the country wide variability of a variety of known contaminants. Using tri-national data, CSD is able to move forward on the delivering more informed soil guidelines, improve its calculations of estimated daily intakes, explore spatial variability of contaminants, complete risk assessments, and conduct detailed research on bioavailability and some specific contaminants of concern. This presentation will discuss those four uses and highlight recent research results using perchlorates as an example.

DRAINAGE BASIN GEOCHEMISTRY PROJECT

R.J. McNeil, P.W.B. Friske, M.W. McCurdy
Natural Resources Canada, Geological Survey of Canada
Ottawa, Canada K1A 0E8

The geochemical analysis of stream sediment and water within the NASGLP was initiated to fulfill two main objectives: 1) generate systematic baseline geochemical data for drainage basins across Canada and 2) provide data to facilitate the study of the relationship between the geochemistry of the soils and that of stream sediment and stream water within the same drainage basin.

The developmental phase of the Drainage Basin Geochemistry Project was conducted throughout New Brunswick during the fall of 2007. A GSC field crew visited 30 sites where stream sediment and a stream water samples were collected for lab analysis and also multiple field variables were measured in-situ. The stream site locations were selected within the same drainage basin and downstream from the previously sampled NASGLP soil sample sites. The drainage sites were selected within drainage basins with an areal extent of <100 km^2, generally first or small second order streams.

Water variables measured in-situ included the following: pH, conductivity, temperature, dissolved oxygen, colour, turbidity and total discharge. Laboratory analyses undertaken on water samples were as follows: ICP-MS for trace elements, ICP-ES for major elements, ion chromatography for anions, alkalinity, dissolved organics and mercury. Stream sediment samples are analyzed by ICP-MS and INAA for more than 50 variables.

This project will continue in the summer of 2008 as part of NASGLP with additional funding from Environment Canada's Clean Air Regulatory Agenda (CARA) program.

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Proposed Sampling Surveys for 2008

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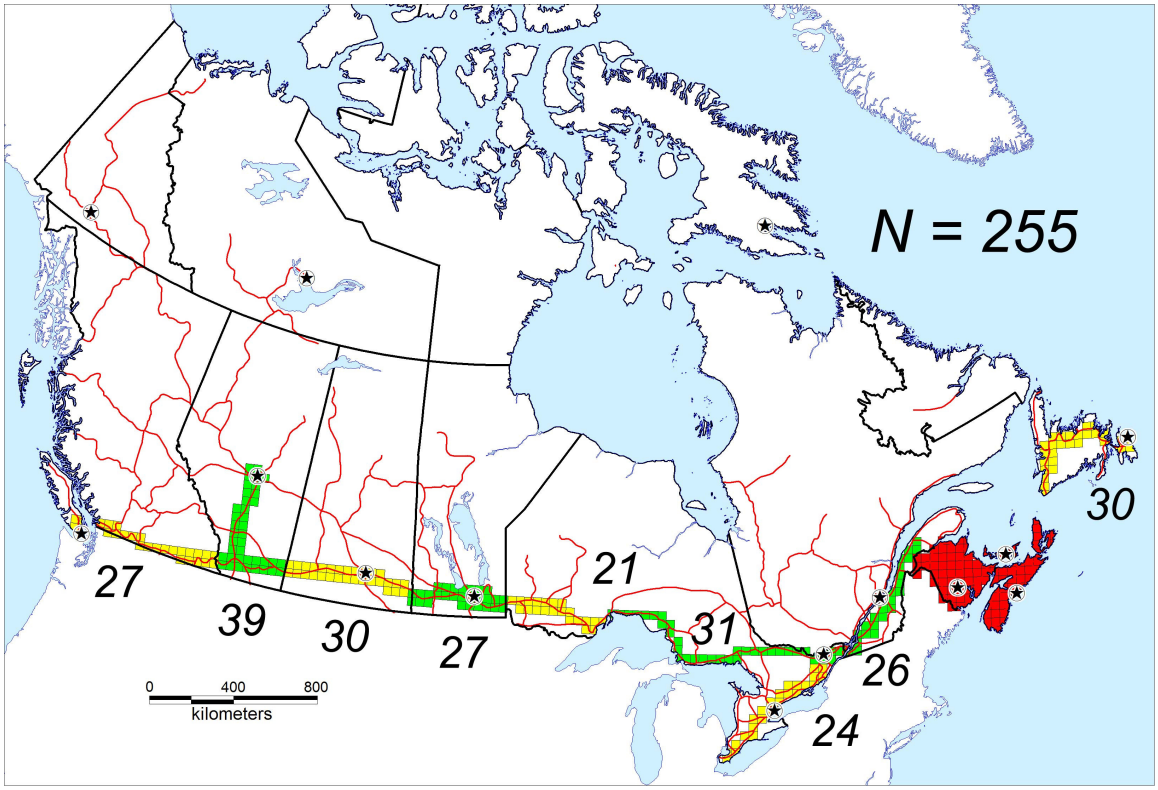
PROPOSED TRANS-CANADA SAMPLING "SWATH"

The sampling "swath" is two 40 km grid cells wide and follows the Trans Canada highway, excluding the part through the Maritimes where sampling is completed. Samples would be collected at 255 primary tri-national sites as shown below. The count for Ontario includes an offshoot from the main transect along Highway 401 and in Alberta there is another offshoot between Calgary and Edmonton.

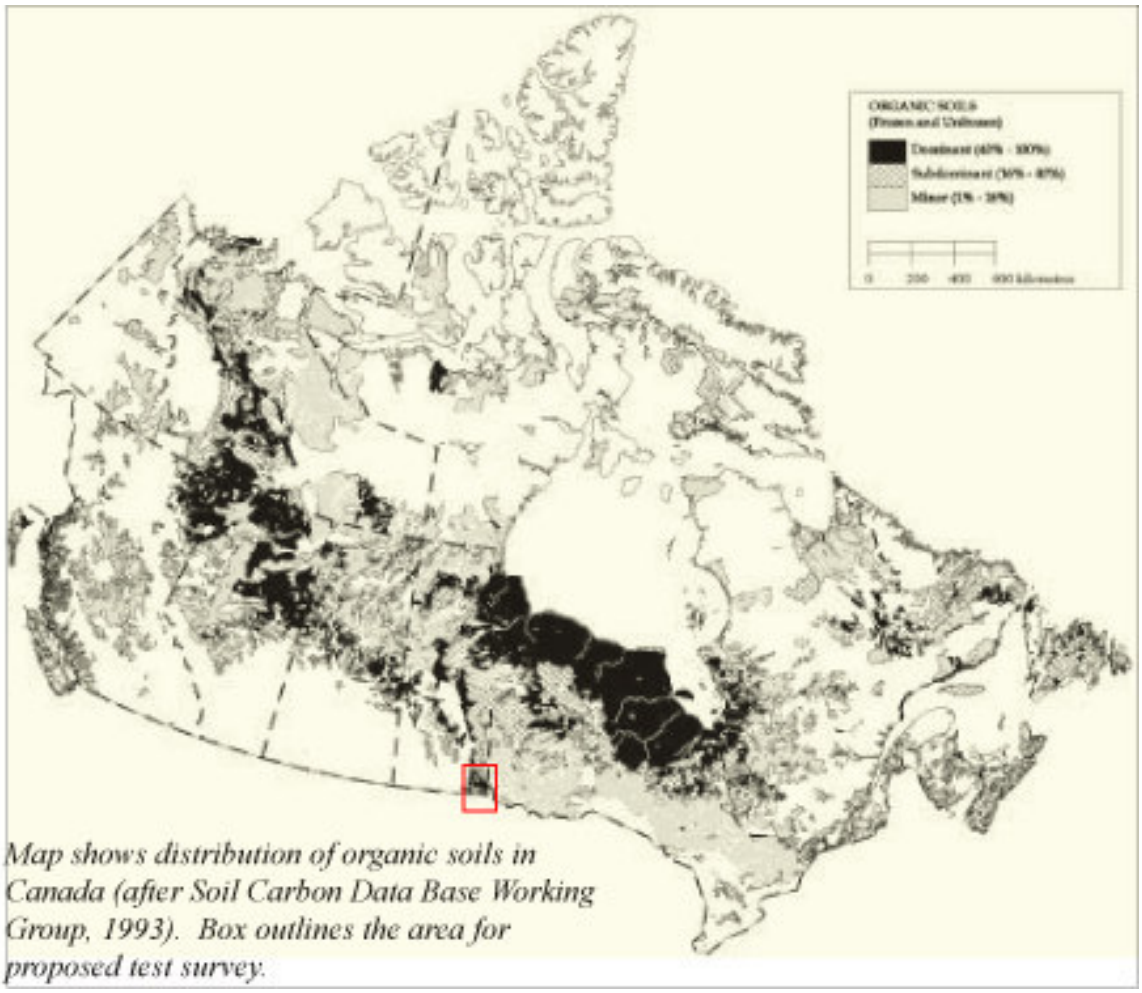
The proposed sampling is an important step towards generating a consistent set of soil geochemical data for the most populated regions of Canada. Data from the new survey combined with data from the Maritimes would provide a first set of national-scale data. These data are needed to develop collaborative efforts with federal and provincial agencies working on issues related to environment and human health protection.



PEATLAND SURVEY FOR PROTOCOL DEVELOPMENT

Organic soils cover 1.23 x 106 km2, or 14 % of the soil area (excluding water, bedrock and glaciers) of Canada. As a result there will be an estimated 840 tri-national sites located in peatlands. The composition of organic soils reflects the decomposition state and types of vegetation that characterize the accumulation layer. Within the uppermost metre of organic soils sudden changes in each are common. Further work is needed to determine what layers or intervals in organic soils should be sampled and how.

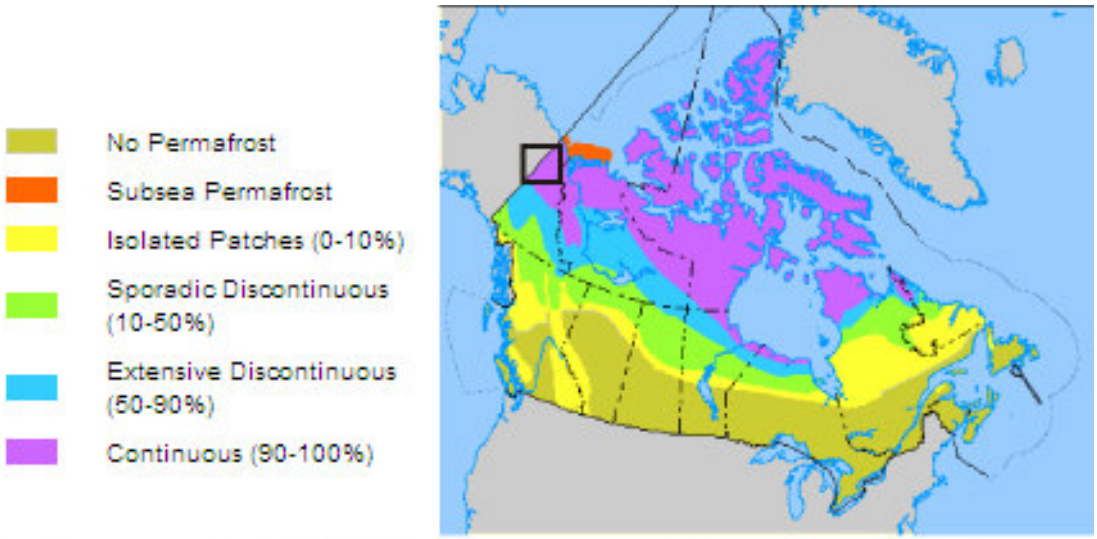
There is a large peatland area that straddles the Canada-United States border covering parts of southeastern Manitoba, northwestern Ontario and northern Minnesota. This area would be ideal for developing organic protocols in a joint effort with our counterparts from the United States Geological Survey.



Map shows distribution of organic soils in Canada (after Soil Carbon Data Base Working Group, 1993). Box outlines the area for proposed test survey.

SURVEY IN PERMAFROST ATEAS FOR PROTOCOL DEVELOPMENT

An estimated 42% of the Canada landmass is underlain directly by permafrost (Geological Survey of Canada, Current Research 1997-E, pl 109-115). Based on this estimate, there will be more than 2500 tri-national sites in permafrost-bearing areas. In addition, there are strong interrelationships between the distribution of peatlands and permafrost because of the insulating properties of peat and the poor drainage conditions in peatland. Sampling frozen soils and, in many cases, frozen organic soils is challenging. Additional work is needed to develop tri-national protocols for sampling permafrost-affected soils. An effort will be made to co-ordinate protocol development work in the Yukon or northern Northwest Territories with similar work being undertaken in Alaska.



Map shows permafrost distribution in Canada (from Atlas of Canada website: http://atlas.nrcan.gc.ca/site/english/maps/environment/land/permafrost). A possible area for the proposed study is outlined .

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Overview of Field and Laboratory Protocols

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Overview of Sampling and Laboratory Protocols from 2007

Intervals or horizons for sampling at the "core" sites
0-5 cm "public health" layer and A-, B -, C-horizons

Size fractions of samples to be analyzed
<2.00 mm fraction for all analyses; <0.063 mm for selected analyses (carbon, 4-acid, and aqua regia**)**

"Core" determinations on tri-national soil samples

- ICP-MS/ES analysis (42 elements) after aqua regia digestion (0-5 cm , A, B, C)
- ICP-MS/ES analysis (42 elements) after 4-acid near total digestion (0-5 cm , A, B, C)
- ICP-MS/ES analysis after water leach (0-5 cm and C)
- Carbon – Organic and inorganic content (0-5 cm , A, B, C)
- pH (0-5 cm , A, B, C)
- Munsell colour (0-5 cm , A, B, C)
- Particle size analysis
- Loss-on-ignition (0-5 cm, A, B, C)
- Moisture content (0-5 cm, A, B, C)
- Bulk density (0-5 cm , A, B, C)
- Electrical conductivity (0-5 cm , A, B, C)
- Cation exchange capacity (CEC) (to be arranged)

"Add-on" determinations on splits from core tri-national samples

- N, P (0-5 cm, A, B,C)
- Gastric leach procedures followed by ICP-MS/ES or AAS (A and C; <0.063 mm only)
- Perchlorates (A and C)
- Biological methods for determining soil toxicity (A and C)
- X-ray diffraction (A, B, C)
- Radiometric test (laboratory testing)

"Add-on" determinations on additional samples collected at tri-national or other sites

- Radon analysis (tri-national site)
- Radiometric tests (tri-national site)
- Anthrax (to be arranged)
- Studies on the 0-30 cm interval (tri-national site)
- Stream waters and sediments analysis
- Collaborative sample and data collection for National Forest Inventory