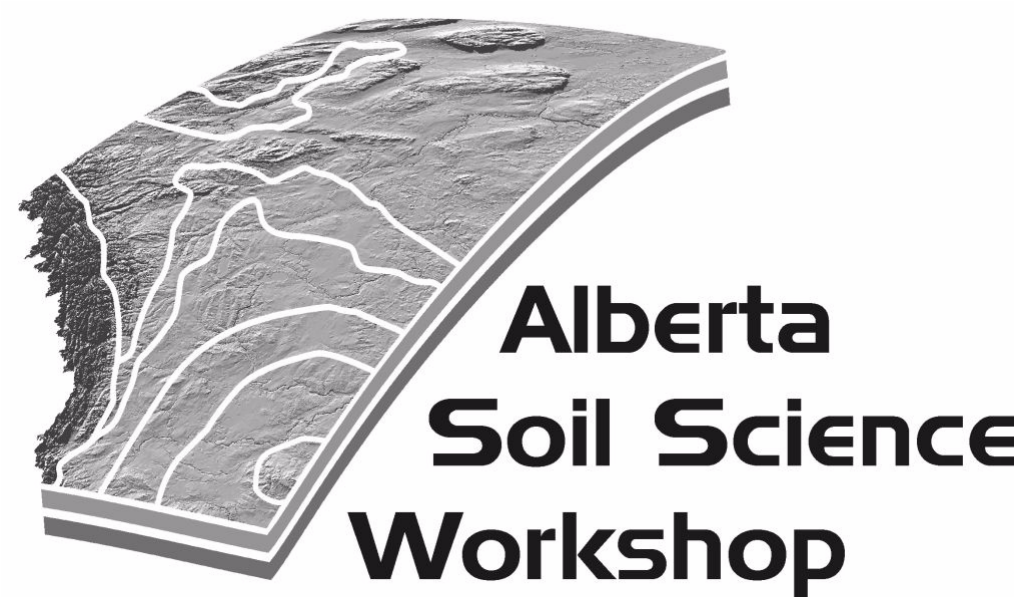
Program and Abstracts for the 46th Annual Alberta Soil Science Workshop



Workshop Theme:

AN EARTH SCIENCES PERSPECTIVE OF SOILS

February 17-19, 2009

Mayfield Inn and Suites
16615 - 109th Avenue
Edmonton, AB T5P 4K8
Tel.: 780-484-0821 or
Toll-free: 800-661-9804
www.mayfieldinnedmonton.com

www.soilsworkshop.ab.ca

Organizing Committee for the 2009 Alberta Soil Science Workshop

Past Co-Chairs:	Grace van Melle City of Calgary	Myron Flexhaug EBA Engineering Consultants Ltd., Calgary
Chair:	Scott Chang Dept. Renewable Resources, Univ. of Alberta, Edmonton	
Treasurer:	Benjamin Ellert Agriculture & Agri-Food Canada Research Centre, Lethbridge	
Secretary:	Sylvia Chan-Remillard Golder Associates Ltd./ HydroQual Laboratories Ltd., Calgary	

Chairpersons for Technical Groups:

Soil Fertility:	Len Kryzanowski Alberta Agriculture and Rural Development, Edmonton.	
Soil Conservation:	Jason Cathcart Alberta Agriculture and Rural Development, Edmonton	
Reclamation:	Chi Chen Alberta Environment, Edmonton	Claudia Gomez Matrix Solutions Inc., Calgary
Forest, Riparian & Wetland Soils	Cindy Shaw Northern Forestry Centre, Canadian Forest Service	

Sponsorship Acknowledgments

We are grateful to all the sponsors who have generously contributed to the 2009 Alberta Soil Science Workshop. Please consider sponsorship of future workshops to support professional soil science in Alberta, and to enhance the visibility of your organization among this community. The sponsors for the 2009 Workshop include:

1) Agrium Inc; 2) Agriculture and Agri-Food Canada - Lethbridge Research Centre; 3) ALS Laboratory Group, Analytical Chemistry & Testing Services; 4) Canadian Association of Petroleum Producers; 5) Department of Renewable Resources, University of Alberta; 6) EBA Engineering Consultants Ltd; 7) Faculty of Agricultural, Life and Environmental Sciences, University of Alberta; 8) Ivey International Inc; 9) Matrix Solutions Inc; 10) Paragon Soil and Environmental Consulting Inc; 11) University of Alberta (Research Services Office); 12) Varian Canada, Inc; 13) Western Ag Innovations; 14) Wiebe Environmental Services Inc. (WES Inc.); 15) HydroQual Laboratories Ltd, Golder Associates Ltd.

Please see the last page of this program brochure for logos for sponsors.

Program for the 46th Annual Alberta Soil Science Workshop

Tuesday, February 17, 2009 – Evening

7:00-10:00 pm	Registration (**Hallway outside the Pallisades Ballroom**) **Wine and Cheese Reception**, and Poster Set-Up (**Pallisades Ballroom**)

Wednesday, February 18, 2009 – Morning

7:00 am-4:00 pm	**Registration: Hallway outside the Pallisades Ballroom** **Coffee, tea and bread loaf served from 7:30 am**
Plenary Session	**Pallisades Ballroom**
Theme	**"An Earth Sciences Perspective of Soils"**
8:00-8:05 am	**Introduction, Chair** Scott Chang Dept. Renewable Resources, Univ. of Alberta, Edmonton
8:05-8:55 am	**Bedrock to soil: Case studies from Earth's weathering engine** Dr. Sue Brantley, Professor and Director, Earth and Environmental Systems Institute. The Pennsylvania State University
8:55-9:45 am	**Pedological Knowledge: What it is and why it matters** Mr. Scott Smith, Manager, Soil Data Section of the National Land and Water Information Service, Pacific Agri-Food Research Centre, ,Agriculture and Agri-Food Canada, Summerland, BC
9:45-10:00 am	Coffee and Refreshments**. Coffee sponsored by Western Ag Innovations** Poster Viewing, **Pallisades Ballroom**
10:00-10:50 am	**Minerals, Water And Air In Soil Microstructure And Their Relevance To Functional Ecosystems** Dr. Joselito M. Arocena, Professor and Canada Research Chair in Soil and Environmental Sciences, University of Northern British Columbia
10:50-11:40 am	**Soil Planet: Designing the Smithsonian Exhibition *Dig It! The Secrets of Soil*** Dr. Patrick Megonigal, Senior Scientist and Curator, Smithsonian Environmental Research Center, Edgewater, MD
11:40-12:00 am	**Panel Discussion** All Speakers
12:00-12:30 am	Poster Viewing, **Pallisades Ballroom**; Authors Present
12:30-1:30 pm	Lunch – **Pallisades Ballroom**

Wednesday, February 18, 2009 – Afternoon

VOLUNTEER SESSIONS

Time	Session 1, Pallisades Ballroom	Session 2, Logan Ballroom
1:30 – 1:35 pm	**Introduction** Chair: Dr. Sylvia Chan-Remillard Golder Associates Ltd./ HydroQual Laboratories Ltd.	**Introduction** Chair: Dr. Benjamin Ellert, AAFC- Lethbridge, AB
1:35 – 1:55 pm	**Restoration of minerotrophic peatlands: Carbon exchange at naturally revegetated patches** Maria Strack, Jordanna Branham Department of Geography, University of Calgary, Calgary	**Movement and volatilization losses of nitrogen fertilizers on boreal forest-floor substrates** Victor Lieffers, Natalia Startsev and Simon Landhäusser Dept. of Renewable Resources, Univ. of Alberta
1:55 – 2:15 pm	**Proposed Classification System For Anthropogenic Soils In Alberta: Anthroposol Order** L. A. Leskiw, M.A. Naeth, D.S. Chanasyk Paragon Soil and Environmental Consulting and Department of Renewable Resources, University of Alberta	**Assessment Of Polymer-Coated Urea Fertilizer Versus The Uncoated Form For Grain Production In Northern Alberta** Y. K. Soon, C. A. Grant, N. Lupwayi and R. Azooz Agriculture & AgriFood Canada, Beaverlodge AB and Brandon, MB
2:15 – 2:35 pm	**Eco-Soil Contact Guidelines for Remediation of Tebuthiuron on a Native Prairie Site** Natasha Harckham, Alfred Burk, Gladys Stephenson, Bob Corbet, Kathryn Bessie EBA Engineering Consultants Ltd., EnCana Corporation, Stantec Consulting Ltd., Access Analytical Laboratories, EBA Engineering Consultants Ltd.	**Aspen regeneration on log decking areas as influenced by season and duration of log storage** Kevin Renkema, Vic Lieffers and Simon Landhausser Department of Renewable Resources, University of Alberta * Student presentation
2:35-2:55 pm	**Smooth Brome Reaction To Ammonium And Potassium** Peggy A. Desserud, Dr. M. Anne Naeth Department of Renewable Resources University of Alberta **Student Competition	**Nitrogen Release From Grain Legume Residues And Green Manure** N. Z. Lupwayi1 and Y. K. Soon Agriculture & Agri-Food Canada, Beaverlodge, Alberta
2:55-3:15 pm	Coffee and Refreshments. **Coffee break sponsored by Matrix Solutions** Poster Viewing, **Pallisades Ballroom**, Authors Present	

Wednesday, February 18, 2009 – Afternoon, after Coffee & Refreshments

VOLUNTEER SESSIONS

Time	Session 1, Pallisades Ballroom	Session 2, Logan Ballroom
3:15 – 3:35 pm	**Nanotechnology in the Environment – Beneficial Applications and Unintended Consequences** S. Chan-Remillard, S. Goudey, L. Kapustka HydroQual Laboratories Ltd. and Golder Associates Ltd., and LK Consultancy. Calgary	**Seasonal response of $\delta^{13}C$ and $\delta^{15}N$ in cattle hair to long term stocking rates on a Rough Fescue grassland** Chunli Li, Xiying Hao, Mônica Benke and Walter Willms AAFC - Lethbridge
3:35 – 3:55 pm	**Integrated Bioremediation of Contaminated Sites: Present Scenario and Future Prospects** M. Tahir Rashid Ecoventure Inc. 7105-104 Street, Edmonton	**Peat bubbles: quantifying subsurface carbon gas storage in northern peatlands** J. Ben Hale, Maria Strack University of Calgary, Calgary ****Student Competition**
3:55 – 4:15 pm	**Barium in Soil: Total and Fusion Methods** D. Lintott Bodycote Testing Group, 7217 Roper Rd., Edmonton	**Warming and N addition effects on soil respiration in a desert steppe in Inner Mongolia** Yang Lin, Zhen Wang, Guodong Han, Mengli Zhao, Scott X. Chang University of Alberta, Edmonton, and Inner Mongolia Agricultural University, Hohhot, China ****Student Competition**
4:15 – 4:35 pm	**Biotreatability Testing for Soil and Groundwater Contaminants: Monitoring with DNA Profiling** A. L. Douglas, L. Oosterbroek, L. L. R. Marques, and J. S. Goudey HydroQual Laboratories Ltd., Calgary	**Alberta's Meteorological Station Network: Data Quality Control Procedures and Data Accessibility** Ralph Wright, Daniel Itenfisu, and Mei Yin Alberta Agriculture and Rural Development, Edmonton
4:35 – 5:30 pm	Poster Viewing, **Pallisades Ballroom**; Authors Present	

Wednesday, February 18, 2009 – Evening

5:30-6:30 pm Free time for relaxing and socializing

6:30-8:30 pm Banquet – **Pallisades Ballroom**

After Dinner Speaker:

Mr. John Acorn, Faculty Service Officer, Department of Renewable Resources, U of A

"**Deep Alberta"**

Acorn is an internationally known scientist, author and broadcaster whose career has been marked with creativity and a passion for science. The host and creative force behind the popular TV series Acorn, the Nature Nut, he has educated and entertained audiences worldwide. In 2008 he received the prestigious NSERC Michael Smith Award for Science Promotion, amongst many other awards he has received over the years.

Thursday, February 19, 2009 – Morning

7:30-10:00 am Registration: **Hallway outside the Pallisades Ballroom**
Coffee, tea and bread loaf served from 7:30 am, sponsored by CAPP (Canadian Association of Petroleum Producers)

TECHNICAL SESSIONS

Time	Soil and Land Reclamation Pallisades Ballroom	Soil Conservation Logan Ballroom
7:55 – 8:00 am	**Introduction** Co-Chairs: Chi Chen, Alberta Environment, Edmonton, AB Claudia Gomez Matrix Solutions Inc.	**Introduction** Chair: Jason Cathcart Alberta Agriculture and Rural Development, Edmonton, AB
8:00 – 8:20 am	**Environmental Site Assessment Repository (ESAR): A new land information system** G. Byrtus[1], J. Legarie[1], C. Chen[1], R. Orthner[1], K. Barrie[2] and B. Warner[2] [1] Alberta Environment, Edmonton [2] WayTo Integration and Consulting, Calgary	**Tittle TBD** Karen Haugen Kozyra Climate Change Central, Edmonton
8:20 – 8:40 am	**Update on the Reclamation Criteria Advisory Group** N. Page Alberta Environment, Edmonton.	**Generating Carbon Offsets From Management That Increases Soil Carbon Sequestration** Sheilah Nolan , Karen Haugen-Kozyra, Rob Dunn, John Zylstra Alberta Agriculture and Rural Development in Edmonton, Lethbridge and Fairview and Climate Change Central, Edmonton
8:40 – 9:00 am	**Peat Mineral Mix vs. Forest Floor Mineral Mix: Reclamation Substrate Matters** D. Mackenzie and S. Quideau Dept. of Renewable Resources, University of Alberta, Edmonton	**Long-Term, Trans-Canada Decay Of Crop Residues** B.H. Ellert, H.H. Janzen , and E.G. Gregorich Agriculture & Agri-Food Canada, Research Branch, Lethbridge Research Centre, and Eastern Cereal & Oilseed Res. Ctr., Central Experimental Farm, Ottawa
9:00 – 9:20 am	**Applicability of Engineered Biological Soil Treatment in the Context of a Tier II Remediation Approach.** P. Gingras Biogenie S.R.D.C. Inc. Sherwood Park	**Modelling economic and environmental effects of BMPs in watersheds** Andrzej T. Jedrych, Richard Heikkila, Ali Saleh, Edward Osei, and Oscar Gallego Alberta Agriculture and Rural Development, Edmonton, Alberta, and Texas Institute for Applied Environmental Research (TIAER), Tarleton State University, Stephenville, TX
9:20 – 9:40 am	**Strategies and techniques utilized for a soil remedial program at an active compressor station – A contractor's perspective** Tony. Ciarla HAZCO Environmental Services, Calgary	**Enhancing AGRASID for SWAT** J.A. Brierley and M.D. Bock Agriculture and Agri-Food Canada, Edmonton
9:40 – 10:05 am	Coffee and Refreshments**. Coffee break sponsored by ALS Environmental Labs.** Poster Viewing, **Pallisades Ballroom**, Authors Present	

Thursday, February 19, 2009 – Morning, after Coffee & Refreshments

TECHNICAL SESSIONS

Time	Soil Fertility Pallisades Ballroom	Forest, Riparian and Wetland Soils Logan Ballroom
10:05 - 10:10 am	**Introduction** Chair: Len Kryzanowski, Alberta Agriculture and Rural Development, Edmonton, AB	**Introduction** Chair: Ms. Cindy Shaw, Canadian Forest Service, Edmonton, AB
10:10 – 10:30 am	**Evaluating Nitrogen Fertilizer Sources for Winter Wheat.** Tom Jensen Northern Great Plains Director, International Plant Nutrition Institute (IPNI), Saskatoon	**Influence of permafrost on greenhouse gas dynamics in forests and peatlands along the McKenzie Valley, NWT** Jagtar Bhatti, Natalia Startsev and Michael Whiticar Canadian Forest Service, Edmonton and University of Victoria, Victoria, BC
10:30 – 10:50 am	**Simulation of Ammonia Losses from Manure Land Application with a Wind Tunnel** Guoliang Qu, Atta Atia, Ki Au, Len Kryzanowski, Lawrence Papworth, Ike Edeogu, and Darry Slingerland Alberta Agriculture and Rural Development, Edmonton and Lethbridge	**Wastewater And Biosolids For Enhanced Woody Biomass Crop Production** Richard Krygier Canadian Forest Service
10:50 – 11:10 am	**Influence of Feeding Dry Distillers Grains with Solubles on the Nutrient Content of Cattle Manure.** Rob Dunn, Wally Sawchuk, Sheilah Nolan and Gerald Ontkean Alberta Agriculture and Rural Development, Ag Centre, Lethbridge and Edmonton	**Carbon Balance In Hybrid Poplar Plantations In North Central Alberta, Canada** C. Arevalo, J. Bhatti1 and S.X. Chang University of Alberta and Canadian Forest Service, Edmonton * Student presentation
11:10 – 11:30 am	**Using the *ECOSYS* Mathematical Model to Simulate Topographic Effects on Spatial Variability of Nitrous Oxide Emissions from an Agricultural Soil.** K. Metivier, R.F. Grant and E. Pattey Department of Renewable Resources, University of Alberta, Edmonton and Eastern Cereal and Oilseed Research Centre, Agriculture and Agri-Food Canada, Ottawa	**Soil Respiration In A Hybrid Poplar Plantation Located In Central Alberta** David T Price, Alberto Orchansky, Carmela Arevalo, Paul Jassal and Barb Thomas Natural Resources Canada, Edmonton; Consultant, Edmonton; University of Alberta; University of British Columbia; Alberta-Pacific Forest Industries
11:30 – 11:50 am	**Development of a Nitrous Oxide Emission Reduction Protocol** R. Janzen, D. Beever, R. Dowbenko, C. Graham, K. Haugen-Kozyra, T. Jensen and L. Kryzanowski ClimateCHECK, Ottawa, Agrium, Calgary, Canadian Fertilizer Institute, Ottawa, Climate Change Central,	**Quantifying The Role Of Soil In Forest Carbon Offsets Estimated Using The Carbon Budget Model Of The Canadian Forest Sector (CBM-CFS3)** B.N. Simpson, C.H. Shaw and W.A. Kurz Canadian Forest Service, Edmonton and Victoria

	Edmonton, International Plant Nutrition Institute, Saskatoon, and Alberta Agriculture and Rural Development, Edmonton	
11:50 am	Technical Sessions Completed	
11:50 am -1:00 pm	Lunch – **Pallisades Ballroom** **Student Awards – Pallisades Ballroom** **Business Meeting and Closing Remarks – Pallisades Ballroom**	

Tuesday, Wednesday & Thursday, February 17-19, 2009 – Poster Presentations

Poster Session, Pallisades Ballroom

Authors Present: 11:40 – 12:00 am on Wednesday, February 18, 2009
2:25-2:45 pm on Wednesday, February 18, 2009
4:05-5:30 pm on Wednesday, February 18, 2009
Posters may be removed after 10:05 am on Thursday, February 19, 2009

Poster Numbers:

1. **Long-Term Effects Of Tillage And Legume Crops On Crop Productivity And Nitrogen Use Efficiency**
   Y. K. Soon, N. Lupwayi and R. Azooz,
   Agriculture & AgriFood Canada, Beaverlodge, AB

2. **PRS™-probes Determine Soil Nutrient Supply Rates in Organic and Conventional Snap Bean Rotation Experiments**
   J. Owen, S. Leblanc, S. A. E Fillmore, Elaine Qualtiere, Rebekka Rieder
   Agriculture and Agri-Food Canada, New Brunswick and Nova Scotia, and Western Ag Innovations, Saskatoon

3. **Responses Of Soil Greenhouse Gas Emissions To Climate Change And Defoliation In An Alberta Native Grassland**
   B. Attaeian, S.X. Chang and J.F. Cahill
   Dept. of Renewable Resources, U of A and Dept. of Biological Sciences, U of A

   * Student presentation

4. **Preventing Nutrient Deficiencies in Organic Crop Production with Proper Management Practices and Amendments**
   S. S. Malhi, S. A. Brandt, R. P. Zentner, J. D. Knight, K. S. Gill, T. S. Sahota and J. J. Schoenau
   Agriculture and Agri-Food Canada, Department of Soil Science, University of Saskatchewan, Smoky Applied Research and Demonstration Association, Fahler, Alberta, and Thunder Bay Agricultural Research Station, Ontario

5. **Relationship between topsoil capping depth and subsurface water quality for reclamation of a phosphogypsum stack in central Alberta**
   Jackson, M.E., M.A. Naeth, D.S. Chanasyk and C.K. Nichol
   Dept. of Renewable Resources-U of A

* Student presentation

6. **Effects Of Land-Use History And Incubation Temperature On N_2O And CO_2 Fluxes: A Comparison Between Chinese And Canadian Soils**
M. Lang, S.X. Chang, Z.C. Cai
Department of Renewable Resources, University of Alberta and Institute of Soil Science, Chinese Academy of Sciences, Nanjing, China

* Student presentation

7. **The Alberta Soils Tour In 2008**
R. Jason Cathcart
Alberta Agriculture and Rural Development, Edmonton

8. **Veracity of commercial standards used to measure greenhouse gas concentrations**
B.H. Ellert, E.M. Nakonechny and P.R. Rochette
Agriculture and Agri-Food Canada, Lethbridge and Ottawa

9. **Sulphate adsorption and its relationships with forest soil properties in the Athabasca oil sands region**
Kangho Jung, Yong Sik Ok, and Scott X. Chang
University of Alberta, Edmonton and Kangwon National University, Chuncheon, Korea

* Student presentation

10. **Evaluation of a Substrate and Vegetation Cover System for Reclaimed Phosphogypsum Stacks at Fort Saskatchewan, Alberta**
I.L. Hallin, M.A. Naeth and D.S. Chanasyk
University of Alberta, Edmonton

SPONSORS FOR THE 2009 ALBERTA SOIL SCIENCE WORKSHOP

Research Services Office

ABSTRACTS OF THE 46TH ALBERTA SOIL SCIENCE WORKSHOP

PLENARY SESSION: Wednesday, February 18, 2009

BEDROCK TO SOIL: CASE STUDIES FROM EARTH'S WEATHERING ENGINE

S. Brantley[1]
Earth & Environmental Systems Institute, Penn State Univ., 2217 EES Building, University Park, PA 16802

[1]Corresponding Author: brantley@eesi.psu.edu

ABSTRACT

Scientists working to understand the coupled chemical, biological, physical, and geological processes operating together at the earth's surface in the zone that supports life have defined this integrated system as the Critical Zone (CZ). Our understanding of this zone has advanced significantly over the last hundred years. Further advance now requires scientists to cross disciplines and scales of time and space to integrate understanding of processes in the CZ from the mineral-organism-water interface to the globe. Despite the extreme heterogeneities that are manifest in the CZ, patterns are observed at all scales and can be explained using new computational and analytical tools, new interdisciplinary approaches, and growing networks of sites and people. By choosing examples of soils developed on ridgetops and terraces where fluid movement can be conceptualized as one-dimensional downward while earth material moves upward, regolith development can be investigated using chemical models. Where such profiles develop on bedrock rather than on alluvium, the rate of opening of porosity and permeability is often rate-controlling and difficult to predict. Current models are not capable of incorporating all the biological, physical, and chemical processes within soils but many soil patterns that are commonly observed can be understood in terms of simple models now available.

PEDOLOGICAL KNOWLEDGE: WHAT IT IS AND WHY IT MATTERS

Scott Smith
Pacific Agri-Food Research Centre, Agriculture and Agri-Food Canada,
Summerland, BC

ABSTRACT

Pedological knowledge is the scientific knowledge we possess about soil formation and function at both site and landscape levels. It most importantly includes knowledge of the soil-landscape relation. Without this understanding, it is difficult to meet the data input requirements that fuel modern process modelling. The traditional role of soil survey maps, databases and taxonomies as the organizational framework for pedological knowledge is examined in light of emerging digital mapping technologies that will affect the future creation, storage, and utilization of soil data. The current state of national soil data holdings and pedological knowledge in Canada and elsewhere is reviewed. An initiative to produce a new gridded soil attribute map of the world (Globalsoilmap.net) is described that will test our capacities to define the soil-landscape relations needed to produce spatially-explicit soil attribute information at remarkably high resolution.

MINERALS, WATER AND AIR IN SOIL MICROSTRUCTURE AND THEIR RELEVANCE TO FUNCTIONAL ECOSYSTEMS

J.M. Arocena
University of Northern British Columbia
3333 University Way, Prince George BC V2N4Z9 e-mail: arocenaj@unbc.ca

ABSTRACT

Soils constitute the skin of the earth. This approximately one-meter thick layer of minerals and rock fragments is less than 0.003% of the thickness of earth's crust yet supports humanity since its existence. Each soil has a range of structures that reflect unique arrangements of minerals and organic matter to store and regulate movement of liquids and gases. Soil scientists especially pedologists have been using the presence of structure to differentiate soils from non-soil materials in addition to the contents of soil organic matter. The establishment of functional ecosystems often starts with the intimate mixing of organic matter and minerals into soil aggregates (i.e., granular microstructure). I will use the formation of granular soil microstructure to demonstrate the integration of earth and life sciences to understand the ecosystem functions of the soils. We observed aggregated (or granular) structure in incipient soils, regardless of pioneer plant species in degraded landscapes resulting from hundreds of years of mineral extractions in southeast Spain. The presentation will stress that degraded landscapes (e.g., mine tailings) should be regarded as initial soil parent materials and accelerated establishment of functional ecosystem should commence with amendments conducive to the formation of granular structure typically found on surface of productive soil.

SOIL PLANET: DESIGNING THE SMITHSONIAN EXHIBITION *DIG IT! THE SECRETS OF SOIL*

J. Patrick Megonigal
Smithsonian Environmental Research Center, Edgewater, MD 21037

ABSTRACT

There is an enormous gap in perceptions about the importance of soil resources between the general public and scientists, impeding the discovery and adoption of new approaches to soil management. An unusually ambitious attempt to educate the general public about soils opened in July 2008 at the Smithsonian's National Museum of Natural History in Washington DC, USA. *Dig It! The Secrets of Soil* is a 460 square-meter exhibition that reveals the complex world of soil and how these hidden ecosystems support life on Earth. It was designed to explore the full breadth of soil science, and to address the implications of human impacts on soil resources. The exhibit is rich in audiovisual and interactive components. Testing suggests it is very successful at accomplishing the primary goal, which was to inspire people about the importance of understanding and conserving soil resources in ecosystems as diverse as forests, wetlands and agriculture. Educators can find teaching resources based on the exhibit at www.forces.si.edu/soils. The exhibit will travel across North America for 4 years after it closes on January 3rd, 2010.

ABSTRACTS OF THE 46TH ALBERTA SOIL SCIENCE WORKSHOP

VOLUNTEER SESSION 1: Wednesday, February 18, 2009

RESTORATION OF MINEROTROPHIC PEATLANDS: CARBON EXCHANGE AT NATURALLY REVEGETATED PATCHES

Maria Strack, Jordanna Branham
Department of Geography, University of Calgary, Calgary, AB

ABSTRACT

In Canada horticultural peat extraction has contributed to drainage and extraction of over 12 000 ha of peatlands. While restoration of *Sphagnum* peatlands is relatively well established, in practice peat is often extracted to a depth that exposes deeper minerotrophic (fen) peat layers resulting in soil chemistry that is less suitable for re-establishment of *Sphagnum* moss. In these situations restoration of plant species characteristic of minerotrophic peatlands is desirable with the goal of returning the site to a carbon accumulating ecosystem. As methods for North American fen restoration are developed, it is necessary to understand the role that naturally recolonizing plant communities play in carbon exchange. To address this question CO_2 and CH_4 exchange were determined for six types of revegetated patches at an abandoned (previously extracted) minerotrophic peatland in southeastern Quebec. Carbon gas fluxes were compared to those measured on bare peat and in a neighbouring undisturbed fen. CH_4 fluxes were generally low, even from the natural fen. The highest CH_4 fluxes were often measured from patches revegetated by *Eriophorum spissum*. Vegetated patches with abundant biomass (e.g. *Scirpus atrocinctus, Carex aquatilis, Eriophorum spissum*) were two to three times as productive as plots in the natural peatland. However, ecosystem respiration at these sites was also high, limiting net ecosystem CO_2 uptake. Despite this, many revegetated patches were net sinks for carbon over the growing season. Moreover, previous research as shown that tall vascular species (such as *Scirpus* spp.) can act as nurse plants improving the success of moss reintroduction, suggesting that the maintenance of revegetated patches is likely to assist in achieving restoration goals.

PROPOSED CLASSIFICATION SYSTEM FOR ANTHROPOGENIC SOILS IN ALBERTA: ANTHROPOSOL ORDER

L. A. Leskiw[1], M.A. Naeth[2], D.S. Chanasyk[2]
1. Paragon Soil and Environmental Consulting
2. Department of Renewable Resources, University of Alberta

ABSTRACT

As Alberta continually develops its natural resources, a growing area of land is being disturbed and reclaimed in an attempt to emulate natural soils with a target goal of equivalent land capability. The need for a consistent soil classification system of these human made soils is apparent. Part of the difficulty in accurately describing the characteristics of these reclaimed soils is the broad use of terms that are not clearly defined, such as cover soil and overburden. A classification system for Anthropogenic soils in Alberta will aid in the much needed standardization of terms used across the province and will allow professionals to efficiently communicate regarding these altered soils. The proposed system is similar to the Canadian System of Soil Classification in format and characterization of principal categories. The Anthropogenic Order is divided into: Great Groups that reflect different topsoil characteristics, Subgroups that distinguish subsoil layers, and Subgroup Modifiers that identify important soil characteristics.

ECO-SOIL CONTACT GUIDELINES FOR REMEDIATION OF TEBUTHIURON ON A NATIVE PRAIRIE SITE

Natasha Harckham[1]
EBA Engineering Consultants Ltd. #115, 200 Rivercrest Drive SE, Calgary, AB T2C 2X5
Alfred Burk,
EnCana Corporation. 2900, 421 7th Avenue SW, PO Box 2850, Calgary, AB T2P 2S5
Gladys Stephenson,
Stantec Consulting Ltd. 361 Southgate Drive, Guelph, ON N1G 3M5

Bob Corbet,
Access Analytical Laboratories Inc. #3, 2215 27th Avenue NE, Calgary, AB T2E 7M4

Kathryn Bessie
EBA Engineering Consultants Ltd. #115, 200 Rivercrest Drive SE, Calgary, AB T2C 2X5

[1]Corresponding author: nharckham@eba.ca

ABSTRACT

EBA Engineering Consultants Ltd. (EBA) managed the remediation of a decommissioned facility in a native prairie setting near Brooks, Alberta. Tebuthiuron, a sterilant, was identified as a soil contaminant of concern at this site. The 2008 Alberta Tier 1 Soil Remediation Guideline for Tebuthiuron does not consider the eco-soil contact exposure pathway; therefore, it should not be used in situations where the receptors of concern are soil invertebrates and/or vegetation. A literature review identified limited data that could be used to establish eco-contact guidelines. Reviewed studies were not based on native prairie plant species and/or soil invertebrates; therefore, a site-specific ecotoxicity assessment was conducted at Stantec Consulting Ltd. (Stantec) (Guelph, Ontario). Access Analytical Laboratories Inc. (Access) provided analytical services (LC/MS with a method detection limit of 0.00016 mg/kg). Stantec, using Environment Canada methods, tested the following ecologically relevant species for this site: two invertebrate species, springtail (*Folsomia candida*) and earthworm (*Eisenia Andrei*); and four plant species, blue grama (*Bouteloua gracilis*), western wheatgrass (*Pascopyrum smithii*), durum wheat (*Triticum durum*) (to compare to existing literature) and silver sage (*Artemis cana*), a predominant species at the site. Analysis of the distribution of species sensitivities using the ranked IC25s (inhibiting concentrations for a 25% effect) for all species and the 25th percentile was used to derive a threshold effect concentration (TEC) for agricultural land. The TEC derived for Tebuthiuron in soil was 0.046 mg/kg. However, to ensure that the site-specific guideline was protective of the most sensitive ecological receptors at this site, the endpoints for plant species only were used to establish the proposed guideline of 0.020 mg/kg.

SMOOTH BROME REACTION TO AMMONIUM AND POTASSIUM

Peggy A. Desserud, M. Anne Naeth
Department of Renewable Resources, University of Alberta

ABSTRACT

A large area of native grassland in central Alberta, the Rumsey Natural Area, is being invaded by smooth brome (*Bromus inermis*), in aspen stands and ephemeral wetlands. In a field experiment, straw was rototilled into the topsoil on a newly reclaimed natural gas well site at three rates: 1 kg/m^2, 500 g/m^2 and none (control). Smooth brome was seeded in 2007 and assessed in 2008. The results showed a negative response of the brome to the high straw treatment in the first 3 months of growth. Brome leaf biomass and length in the high straw treatment were significantly lower than those in the control. This trend was opposite to the soil water trend, where soil water was greatest in the high straw treatment and lowest in the control, making the growth reaction surprising since brome prefers high moisture. The high straw strips averaged 1.5 times the concentration of potassium (K) and 1.3 times the concentration of ammonium (NH_4). The experiment was repeated under greenhouse controlled conditions with similar results. This research has raised the question of whether potassium and ammonium, through negative effects on the growth of smooth brome, would have potential in controlling smooth brome in native grasslands.

NANOTECHNOLOGY IN THE ENVIRONMENT – BENEFICIAL APPLICATIONS AND UNINTENDED CONSEQUENCES

S. Chan-Remillard[1],
HydroQual Laboratories Ltd. and Golder Associates Ltd. #4, 6125 – 12th Street S.E., Calgary, Alberta. Canada. T2H 2K1.
Alberta Ingenuity Industry R&D Associate. Alberta Ingenuity Fund. Suite 2410, Manulife Place, 10180 – 101 Street. Edmonton, Alberta. Canada.

S. Goudey
HydroQual Laboratories Ltd. and Golder Associates Ltd. #4, 6125 – 12th Street S.E., Calgary, Alberta. Canada. T2H 2K1.

L. Kapustka
LK Consultancy. 8 Coach Gate Place SW. Calgary, Alberta. Canada. T3H 1G2

Corresponding author: sylvia_chanremillard@golder.com.

ABSTRACT

Nanotechnology is a rapidly emerging science with potential applications enveloping virtually every realm of science and technology. It is projected that freshwater will be a scarce resource in the 21st century. Although many technologies are available for water remediation and purification they are neither cost effective or time efficient. Nanotechnology has the potential to address these issues. The use of Nanotechnology may have long-term impacts on quality, availability, and viability and to enhance capabilities to detect very low concentrations of biological and chemical contaminants within water systems. However, besides the advances that may be achieved with nanotechnology the added responsibility to ensure that technologies we introduce in the resolution of one problem do not inadvertently create another must also receive equal consideration. Currently the health impact of nanotechnology on the environmental are very ill defined. The movement of nanoscale particles through water systems will also impact surrounding terrestrial environments. Studies are beginning to demonstrate that some nanoscale particles may have toxic effects on the environment. We examined the toxic effects of a series of nanoscale particles, which may potentially be used in soil and water remediation or will ultimately end up in the environment via waste streams, on different water and terrestrial receptors. The results of this study and different applications of nanoscale particles will be discussed.

INTEGRATED BIOREMEDIATION OF CONTAMINATED SITES: PRESENT SCENARIO AND FUTURE PROSPECTS

M. Tahir Rashid
Ecoventure Inc. 7105-104 Street, Edmonton Alberta, Canada T6E 4B7

ABSTRACT

The conventional techniques used for remediation have been to dig up contaminated soil and remove it to a landfill, which in fact is the shifting of contaminants to other locations or isolation on site. Better approaches are needed to completely destroy the pollutants or transform them to innocuous substances at acceptable cost and bioremediation is one of them. Bioremediation is performed through bioaugmentation and biostimulation and superiority of one on the other is still debatable as both have their advantages and disadvantages. Bioremediation of soil-bound contaminants relies on their availability to degrading microorganisms, optimal physical and chemical conditions for their catabolic activity which is often achieved by homogenization of the contaminated matrix. Mechanical treatment of soil for the stimulation of bioremediation is energy inefficient, since it moves the entire soil matrix just to facilitate the encountering of microbes and pollutants. Although the bioremediation technologies continue to advance but their acceptability as viable conventional technologies is only possible through knowledge management in the light of practical field experience. In this paper, an integrated approach of bioremediation will be discussed and methods and mechanisms will be presented that are capable of dispersing microbes in soil without the need of physical disturbance.

BARIUM IN SOIL: TOTAL AND FUSION METHODS

D. Lintott
Bodycote Testing Group, 7217 Roper Rd., Edmonton AB, T6B 3J4

ABSTRACT

Barite is used extensively in drilling in the upstream oil and gas industry, is non-toxic, insoluble and immobile in soil. However, soluble forms of barium are highly toxic. Both Alberta Environment and the BC MOE have developed criteria for barite. Since there are currently no analytical methods for quantifying barite directly, the regulatory standards include limits for both total barium and soluble ($CaCl_2$ extractable) barium.

Total barium refers to barium analyzed by one of the "standard acid" methods for measuring metals in soils (EPA3050, BCSALM). Because methods are performance-based, labs are able to incorporate modifications to the test procedures which may have significant implications on the accuracy and reproducibility of the metal content measured. As a result, it is anticipated that AENV will be revising the AENV Tier 1 criteria for barium in 2009 to include total barium measured by more aggressive techniques such as fusion.

This study examined the effectiveness of acid digestion/ICP and fusion methods to accurately detect "total barium" in soil. We will discuss the dependency of metal recovery on modifications

to acid digestion techniques, such as sample size, digestion temperature and acid strength. Additionally, potential techniques for quantifying barite directly in soil will be presented.

BIOTREATABILITY TESTING FOR SOIL AND GROUNDWATER CONTAMINANTS: MONITORING WITH DNA PROFILING

A. L. Douglas, L. Oosterbroek, L. L. R. Marques, and J. S. Goudey
HydroQual Laboratories Ltd., #4 6125-12th Street SE, Calgary, AB T2H 2K1

ABSTRACT

The remediation of contaminants in soils occurs naturally by abiotic and biotic mechanisms. Several factors influence the rate of biotic clean up, including: the presence of microbial communities capable of metabolizing a contaminant; the speed at which the contaminant is metabolized; and if remediation be enhanced by additional compounds. Treatments can include the introduction of nutrients to enhance microbial growth or chemicals that increase contaminant bioavailability. Because some treatments drastically affect soil health and microbial populations, we monitor bacterial, archaeal, and fungal communities by DNA profiling. The effectiveness of a treatment is typically monitored by the detection of the contaminant and/or its breakdown products; however, DNA technologies allow us to quickly and cost-effectively monitor general and specific microbial populations and provide a powerful tool for evaluating the bioremediation potential of a site.

Bench-scale biotreatability tests were performed for a number of sites contaminated with hydrocarbons or chlorinated hydrocarbons for 30 – 180 days. We found that some treatments drastically reduced the diversity of bacteria while others increased it. Increased diversity roughly correlated to greater contaminant degradation. We hope that microbial profiling will facilitate the design of better and more targeted remediation without any of the negative impacts on soil microbial ecosystems.

VOLUNTEER SESSION 2: Wednesday, February 18, 2009

MOVEMENT AND VOLATILIZATION LOSSES OF NITROGEN FERTILIZERS ON BOREAL FOREST-FLOOR SUBSTRATES

Victor Lieffers, Natalia Startsev and Simon Landhäusser
Dept. of Renewable Resources, University of Alberta, Edmonton, T6G 2H1

Victor.lieffers@ualberta.ca

ABSTRACT

In boreal forests, thick organic substrates blanket mineral soil and these substrate have first contact with applied fertilizer. In this study urea or NH_4NO_3 fertilizers were applied on feathermoss or aspen litter substrates to determine the rates of uptake, volatilization, and eventually the ability of these substrates to release this nitrogen. Substrates were kept moist for 28 days after which they were watered to leach soluble N. After this leaching, substrates retained 20% of the added N. However, in terms of N content in the leachate, only 17% was recovered in urea treatment compared to 69.5% in the NH_4NO_3, regardless of substrate type. This difference was due to gaseous loss of N from urea-treated samples, reaching as high as 64% of total applied N. In contrast, after NH_4NO_3 fertilization only 11% of the total N was lost. Feathermoss and aspen substrates had similar rates of buffering of the excess OH^- resulting from the hydrolysis of urea, but the feathermoss started at pH of 5.0 vs. 6.8 for the aspen substrate. After 28 days, the pH was still elevated in the leachate from both substrates treated with urea. Thus, the feathermoss had less potential for urea volatilization than the aspen substrates and as a result more of the N was still available to be leached out. Because of the large capacity of organic substrates to hold water and dissolved nutrients, coupled with only a moderate buffering capacity, there is considerable risk of N-loss following fertilization of organic substrates with urea.

ASSESSMENT OF POLYMER-COATED UREA FERTILIZER VERSUS THE UNCOATED FORM FOR GRAIN PRODUCTION IN NORTHERN ALBERTA

Y. K. Soon[1],
Agriculture & AgriFood Canada, Beaverlodge Research Farm, P. O. Box 29, Beaverlodge, Alberta T0H 0C0

C. A. Grant,
Agriculture & AgriFood Canada, Brandon Research Centre, P. O. Box 1000A, Brandon, Manitoba R7A 5Y3

N. Lupwayi and R. Azooz
Agriculture & AgriFood Canada, Beaverlodge Research Farm, P. O. Box 29, Beaverlodge, Alberta T0H 0C0

[1] Corresponding author: soony@agr.gc.ca

ABSTRACT

A field study was conducted from 2004 to 2007 on a Dark Gray Luvisol in Beaverlodge, Alberta, as part of a larger study across Canada, on the efficiency of polymer-coated urea fertilizer as a source of N for grain production compared with uncoated urea fertilizer. Nine treatments compared were: uncoated urea (UU) at rates of 0, 0.5X, 1X and 1.5X, coated urea (CU) at 0.5X and 1X, both applied as side bands in the spring, and UU and CU applied in late fall at 1X. The 9th treatment was UU at 1X with N split between seeding and post-tillering (or post-bolting for canola). The base rate, 1X, was 50-60 kg N ha^{-1} depending on the year, and approximated rates commonly used on commercial fields. Barley was grown in 2004 and 2007, canola in 2005 and wheat in 2006. Grain production and shoot N uptake at maturity increased almost linearly with N rate applied, except that in 2006, due to a dry year, there were no significant differences in wheat yield. Split application of UU resulted in the highest yields in two of the four years. Fall application of UU and CU resulted in lower yields compared with equivalent rate of spring-applied UU in 2007, the year which produced the most difference in crop response to fertilizer N. Also, in that year, spring-applied CU outperformed equivalent UU. The only other instance in which CU outperformed UU was in 2004 with 30 kg N ha^{-1} applied in the spring. It is concluded that normally in northern Alberta there is little advantage in the use of CU compared with UU. Split application of UU can be beneficial under certain conditions.

ASPEN REGENERATION ON LOG DECKING AREAS AS INFLUENCED BY SEASON AND DURATION OF LOG STORAGE

K. Renkema[1], V. Lieffers, S. Landhäusser
Centre for Enhanced Forest Management, Dept. of Renewable Resources, 4-42 Earth Sciences Building, University of Alberta, Edmonton, AB T6G 2E3, Canada.

[1]Corresponding author: renkema@ualberta.ca

ABSTRACT

The objective of our study was to assess aspen regeneration on decking areas as affected by the season of log deck building and duration of log storage as well as, root wounding, soil compaction, and slash depth. Log deck building and storage in a summer harvest decreased aspen regeneration by one half and increased the portion of dead roots by 35% compared to building and storing logs for a similar after a fall harvest. Duration of log deck storage after a fall harvest had little effect on aspen regeneration; storage for one year or one month resulted in similar suckering densities and proportions of dead roots. Suckering density and height growth were decreased with increasing depth of the consolidated and interwoven slash found on decking areas. In this study root wounding and soil compaction had a weaker impact on regeneration.

For best management practices, log storage during summer logging operations should be avoided; especially if the log decks are to be maintained over the growing period when suckering would normally occur. In addition, remediation treatments to promote suckering on decking areas should include the removal of the mat of slash.

NITROGEN RELEASE FROM GRAIN LEGUME RESIDUES AND GREEN MANURE

N. Z. Lupwayi[1] and Y. K. Soon
Agriculture & Agri-Food Canada, Box 29, Beaverlodge, Alberta T0H 0C0

[1]Corresponding author: lupwayin@agr.gc.ca

ABSTRACT

The rotational benefits of grain legume crops include N contribution to nonlegume crops grown in rotation with them. However, their N contribution is supposedly less than that of legume green manures (GMs) because most of the N in grain legumes is removed with seed at harvest. Using a litterbag method under zero tillage system at Beaverlodge, Alberta, we quantified N released from residues of two pea varieties (Camry, a semi-leafless variety, and 4010, a taller forage pea variety), faba bean grown for seed, faba bean GM and chickling vetch (variety AC Greenfix) GM in 2007-2008. Legume straw (residue) yields, which were inversely related to grain yields, were in the order: faba bean > 4010 pea > Camry pea. The N contained in these residues was in the order: faba bean (215 kg N ha^{-1}) > 4010 pea and GMs (90-125 kg N ha^{-1}) > Camry pea (40 kg N ha^{-1}). The percentage of residue N released in the first 14-22 weeks of residue placement was in the order: GMs (approx. 70%) > faba bean (approx. 40%) > 4010 and Camry peas (approx. 15%), and the amounts of N released were in the order: faba bean and GMs (approx. 60-80 kg N ha^{-1}) > 4010 and Camry peas (approx. 10-20 kg N ha^{-1}). Therefore, faba bean grown for seed released the most N because it accumulated (fixed) more N than GMs due to its longer growth period, and little of that N was removed with the grain because its grain yield was lower than pea yield. The N harvest index, i.e., the percentage of legume N that was contained in the seed, was in the order: Camry pea (75%) > 4010 pea (51%) > faba bean (30%).

SEASONAL RESPONSE OF $\delta^{13}C$ AND $\delta^{15}N$ IN CATTLE HAIR TO LONG TERM STOCKING RATES ON A ROUGH FESCUE GRASSLAND

Chunli Li, Xiying Hao*, Mônica Benke and Walter Willms
Agriculture and Agri-Food Canada, Lethbridge Research Centre. 5403 1st Ave. S. Lethbridge, Alberta, Canada, T1J 4B1.

*Corresponding author: haoxy@agr.gc.ca

ABSTRACT

This study investigates the seasonal response of $\delta^{13}C$ and $\delta^{15}N$ levels in cattle hair to long term stocking rates on a Rough Fescue (*Festuca campestris* Rydb.) grassland near Stavely, Alberta Canada. The grassland was grazed by cattle from May 15 to Oct 15 each year since 1949. The stocking rates were 1.2, 2.4 and 4.8 animal unit month (AUM) ha^{-1} for light grazing (LG); moderate grazing (MG) and heavy grazing (HG), respectively. Tail hair samples were collected from cows (>2 yr) and calves (<1 yr) for each treatment at the end of the grazing season in 2007 (except treatment LG) and 2008. Hair samples were washed and sectioned to 2.3 cm length. Each section represents the growth in one month with the section closest to skin indicating the one-month hair growth prior to sample collection. A total of 5 sections, representing hair growth from May 15 to Oct. 15, were analyzed for $\delta^{13}C$ and $\delta^{15}N$ levels. In 2007, $\delta^{13}C$ increased ($P<0.05$) over the grazing season for all treatments for both cows and calves. The $\delta^{13}C$ levels in cow hair were higher ($P<0.05$) than in calf hair for all treatments and months. The $\delta^{15}N$ levels were affected ($P<0.05$) by grazing only for the periods between mid-June to mid-July and mid-September to mid-October. The $\delta^{15}N$ levels in hair for all cows and calves decreased ($P<0.05$) over the grazing season both in MG and HG treatments and cow or calf $\delta^{15}N$ also decreased ($P<0.05$) over the grazing season for all treatments. Higher ($P<0.05$) $\delta^{15}N$ levels were detected in cow hair than in calf hair in any month. In 2008, the $\delta^{13}C$ levels in cow or calf hair over the grazing season showed similar patterns as in 2007. The $\delta^{13}C$ levels in cow hair were higher ($P<0.05$) than in calf hair, but the differences were significant for only several periods. The $\delta^{13}C$ levels in calf hair decreased as grazing intensity increased in most of months, however, the cow $\delta^{13}C$ in most of months were not affected ($P>0.05$) by grazing. The $\delta^{13}C$ levels in cow hair were higher ($P<0.05$) than in calf hair especially in the HG treatment. The $\delta^{15}N$ levels in cow hair were lower ($P<0.05$) than in calf hair for all treatments and months. The responses to $\delta^{13}C$ and $\delta^{15}N$ in cattle hair samples seemed to reflect changes in vegetation over the growing season as well as vegetation differences among grazing treatments.

PEAT BUBBLES: QUANTIFYING SUBSURFACE CARBON GAS STORAGE IN NORTHERN PEATLANDS

J. Ben Hale, Maria Strack

Department of Geography, University of Calgary, Calgary, Alberta

ABSTRACT

Many recent studies have revealed the importance of entrapped gas bubbles in peat soils for influencing hydrology, ecology and carbon biogeochemistry in peatland ecosystems. However, there are still relatively few studies that have quantified the size of both the dissolved and bubble subsurface CH_4 and CO_2 pools and fewer still that have investigated how the size of these pools vary across and between peatlands. We collected depth profiles of pore water and entrapped gas within the upper 1 m of peat at four Canadian peatlands. At each study site, samples were collected at triplicate dry hummock and wet hollow microtopographic locations. CH_4 and CO_2 content of the resulting samples were determined. The four study sites included a treed moderate-rich fen, two poor fens and an ombrotrophic bog. The degree of microtographic development also varied between the study sites.

Entrapped gas bubbles were found at all peatlands and microforms. For CH_4, the bubble phase dominated the subsurface stock, whereas for CO_2 the dissolved phase was more substantial. Subsurface carbon gas stocks varied between peatland types and microforms. There were consistently higher volumes of entrapped gas bubbles at hummocks compared to hollows. This is most likely linked to differences in peat structure between the microforms with hummocks consisting of denser, often woody peat that appears to be more conducive to trapping bubbles. Also, since CH_4 is an important bubble component, it is likely that aerenchymatic vegetation present at hollows enhances CH_4 release and maintains lower bubble stock at this microform.

WARMING AND N ADDITION EFFECTS ON SOIL RESPIRATION IN A DESERT STEPPE IN INNER MONGOLIA

Yang Lin[1,*], Zhen Wang[2,*], Guodong Han[2], Mengli Zhao[2], Scott X. Chang[1]

[1] Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada

[2] College of Ecology and Environmental Science, Inner Mongolia Agricultural University, Hohhot, China

[*] These two authors contributed equally to this work

ABSTRACT

Global changes may profoundly affect C dynamics in terrestrial ecosystems. We studied the responses of soil respiration (SR) to simulated warming and increased N deposition over three years in a desert steppe at Siziwang Banner, Inner Mongolia, China. The research site was moderately grazed before the experiment was initiated. We used a split-plot design with warming as the main-plot effect and N addition as the sub-plot effect. There were twelve 4×4 m main plots, half of which were randomly chosen to be heated by an infrared heater located 2.5 m above the soil surface. A "dummy" heater was used for each un-warmed plot. Each main plot was divided into two sub-plots and N was added in one of the randomly selected sub-plots as NH_4NO_3 at 35 kg N ha^{-1} yr^{-1}. The SR was measured once or twice a month by a Li-Cor 6400 connected to a soil respiration chamber. The warming treatment significantly increased temperature at the soil surface by 1-2 °C in each summer of the three-year study. The effect of warming on SR in the first two years varied seasonally from significant negative effect to no effect; however, there was no warming effect on SR throughout the third growing season. The disappearance of warming effects on SR in year three may have indicated the limited long-term warming effect, or simply the inter-annual variation of the response of SR to warming. Significant effect of N addition on SR was observed only at one of the sampling dates in the third growing season, suggesting that other factors might have constrained the responses of SR to N addition. Correlation analyses indicated that soil water availability potentially limited the response of SR to N addition.

ALBERTA'S METEOROLOGICAL STATION NETWORK: DATA QUALITY CONTROL PROCEDURES AND DATA ACCESSIBILITY

Ralph Wright[1], Daniel Itenfisu, and Mei Yin
Technology and Innovation Branch, Alberta Agriculture and Rural Development
Edmonton, Alberta T6H, 5T6

[1]Corresponding Author: Ralph.wright@gov.ab.ca

ABSTRACT

Climate is one of the main drivers of soil formation process. Advances in science and computer technology has lead to the development of a host of complex models that are capable of simulating various pedogenic process, carbon sequestration, plant growth, water supply, climate change etc. At the heart of these models lies the requirement that weather data of sufficient density and quality is readily available to make meaningful and accurate predictions. Alberta Agriculture with its partners has recognized the need for quality weather data of sufficient density and since 2002 has expanded Alberta's near-real-time (NRT) Meteorological Network by approximately 123 stations. Moreover, it has developed a state of the art quality assurance and quality control (QAQC) program that provides hourly and daily, NRT meteorological data for a wide range of uses. This paper describes the elements measured in Alberta's principal NRT metrological networks and the QAQC process that monitors data quality, fills erroneous or missing data and attaches quality flags to each record. This process gives users access to high grade continuous time series data from all meteorological elements measured across Alberta's meteorological network.

ABSTRACTS OF THE 46TH ALBERTA SOIL SCIENCE WORKSHOP

Thursday, February 19, 2009
TECHNICAL SESSIONS: SOIL AND LAND RECLAMATION

ENVIRONMENTAL SITE ASSESSMENT REPOSITORY (ESAR): A NEW LAND INFORMATION SYSTEM

Gary Byrtus[1], Jamie Legarie and Chi Chen
Alberta Environment, Land Policy Section, 10th Floor, 9820-106 St., Edmonton, AB, T5K 2J6

Rick Orthner
Alberta Environment, Integrated Information Solution Branch, 12th Floor, 9820-106 St., Edmonton, AB T5K 2J6

Ken Barrie and Brent Warner
WayTo Integration and Consulting, #305, 11979-40 St. S.E., Calgary, AB T2Z 4M3

[1]corresponding author: gary.byrtus@gov.ab.ca

ABSTRACT

The Environmental Site Assessment Repository (ESAR) is an integrated information system that will enable web based reporting and information distribution, with a focus on environmentally assessed sites (contaminated, remediated, reclaimed and potential development sites). Phase 1 of the system is a document delivery system that integrates Alberta Environment's environmental site assessment document storage system (Documentum) with Service Alberta's SPIN2 system to provide spatial and non-spatial searches for environmental site assessments and other scientific or technical information on properties of interest. This web based application enables users to search the system, and view or download documents directly to their computer. Previously, access to these documents required a FOIP request, resulting in a paper document search in regional offices, taking 1-6 weeks to complete. The ESAR project was only able to move forward following routine disclosure regulatory implementation, the ESA imaging project, and a Memorandum of Understanding for information sharing between Alberta Environment and Service Alberta.

UPDATE ON THE RECLAMATION CRITERIA ADVISORY GROUP

Natasha Page,
Alberta Environment

ABSTRACT

The Reclamation Criteria Advisory Group (RCAG), established in 2005, is a multi-stakeholder group chaired by Alberta Environment. RCAG's mandate is to review and provide recommendations for upgrading the 1995 Update of the Reclamation Criteria for Wellsites and Associated Facilities. This review of reclamation criteria is intended to include improvements in reclamation practices, scientific developments and recommendations for improving the former criteria.

The RCAG began with an assessment of the 1995 Criteria to identify and retain the aspects that worked and improve those that did not. This culminated in the creation of the draft *2009 Reclamation Criteria* document. The intent of the 2009 Criteria is to measure appropriate parameters and evaluate whether land function and operability is comparable to the surrounding area or an appropriate reference. In 2008, practitioners assessed 115 reclaimed cultivated, grassland, and forested sites using the methodology outlined in the draft criteria. The RCAG is currently working through their data and feedback to better understand how to update reclamation criteria for wellsites and associated facilities.

PEAT MINERAL MIX VS. FOREST FLOOR MINERAL MIX: RECLAMATION SUBSTRATE MATTERS

Derek Mackenzie[1] and Sylvie Quideau
Department of Renewable Resources, University of Alberta, Edmonton, AB T6G 2E3

[1]Corresponding author

ABSTRACT

Land reclamation is limited by the types of materials available within the geographic area occupied by the industrial activity. Re-establishing healthy ecosystems on reclaimed land is largely dictated by the type of surface soil material available. In the Athabasca oils sands region (AOSR), surface soil materials that are selectively salvaged and stockpiled for later use fall into two main categories which are a peat mineral mixture (PMM) and an upland forest floor mineral mixture (FFM). These two substrates exist in different quantities because peatlands occupy approximately 70% of the landscape, with upland forests making up the remainder. Preliminary evidence suggests that sites reclaimed with FFM have better natural regeneration, as well as N dynamics more similar to recently disturbed ecosystems. The purpose of this study was to compare the two substrates in a series of laboratory incubations designed to examine microbial community dynamics and nutrient release. FFM consistently had greater microbial activity in terms of basal and substrate induced respiration. Phospholipid fatty acid analysis (PLFA) and

^{13}C PLFA analysis also revealed significant differences between the two substrate types. Finally, fertilizer additions and N mineralization rate constant data suggest that a combination of the two substrates may be the optimal solution for establishing high microbial activity and N mineralization without the addition of fertilizer.

APPLICABILITY OF ENGINEERED BIOLOGICAL SOIL TREATMENT IN THE CONTEXT OF A TIER II REMEDIATION APPROACH

Philippe Gingras, P.Eng
Project Manager – Biogenie S.R.D.C. Inc.
pgingras@biogenie-env.com

ABSTRACT

Biological treatment of contaminated soil has been employed for more than 20 years and is now a well proven technology to address soil contaminated with organic compounds, from petroleum and non-petroleum sources. This presentation will discuss the typical performance and limitations of the technology, and will emphasize on its applicability and the flexibility that it provides in the context of a Tier II soil remediation approach.

STRATEGIES AND TECHNIQUES UTILIZED FOR A SOIL REMEDIAL PROGRAM AT AN ACTIVE COMPRESSOR STATION – A CONTRACTOR'S PERSPECTIVE

Tony Ciarla
Hazco Environmental Services, #103, 3355 – 114th Avenue SE, Calgary, AB T2Z 0K7

ABSTRACT

A case study on the challenges encountered by HAZCO during the decommissioning, demolition, and soil remedial work at an active gas compressor station. The facility lands have a complex network of aboveground and underground pipelines that are both active and inactive, thus further complicating the project. The timetable required that the contractor manage multiple tasks simultaneously and ensure that demolition and remedial work did not interfere with the operation of the facility. The presentation will focus on the specialized techniques employed by the contractor to facilitate the excavation, transport, and disposal of soil impacted with PCBs, Hg, Hydrocarbons, and other materials impacted by natural occurring radioactive materials (NORM).

Thursday, February 19, 2009
TECHNICAL SESSIONS: SOIL CONSERVATION

TITLE : TBD

Karen Haugen-Kozyra,
Climate Change Central, 930, 10303 Jasper Avenue, Edmonton, AB T5J 3N6

An abstract was not available at time of printing.

GENERATING CARBON OFFSETS FROM MANAGEMENT THAT INCREASES SOIL CARBON SEQUESTRATION

Sheilah Nolan[1],
Alberta Agriculture and Rural Development, #206, 7000 – 113 St. Edmonton, AB T6H 5T6

Karen Haugen-Kozyra,
Climate Change Central, 930, 10303 Jasper Avenue, Edmonton, AB T5J 3N6

Rob Dunn,
Alberta Agriculture and Rural Development, Ag Centre, #100, 5401 1 Ave S, Lethbridge T1J 4V6

John Zylstra
Alberta Agriculture and Rural Development, Provincial Bldg, 10209 109 St., Fairview T0H 1L0

[1]Corresponding author: sheilah.nolan@gov.ab.ca

ABSTRACT

Alberta's recent Climate Change and Emissions Management Amendment Act requires companies that emit more than 100,000 tonnes of carbon dioxide equivalents (C02e) annually to reduce their emission intensity by 12 %. If unable to meet this requirement, companies may purchase carbon offsets generated by government approved ISO 14064-2 compliant protocols. Science-based protocols have been used to create agricultural carbon offsets in Alberta, based on management practices that either remove or reduce greenhouse gases (GHG). A series of possible new protocols to sequester soil carbon are being developed, including reduced summerfallow, conversion from annual to perennial crops, improvements to pasture and range, and straw retention. These possible new protocols build on an approved Tillage System Management protocol, using coefficients developed for the National Inventory Report on GHG sources and Sinks in Canada to account for increases in soil carbon and reductions in emissions such as nitrous oxide. Requirements for the identification of baseline management practices,

additionality to business-as-usual conditions, and the potential for reversal are addressed on a protocol- and site-specific basis.

LONG-TERM, TRANS-CANADA DECAY OF CROP RESIDUES

B.H. Ellert[1] and H.H. Janzen ,
Agriculture & Agri-Food Canada, Research Branch, Lethbridge Research Centre, 5403 1st Avenue South, Lethbridge AB T1J 4B1

E.G. Gregorich
Eastern Cereal & Oilseed Res. Ctr., Central Experimental Farm, Ottawa K1A 0C6

[1] Corresponding author: ellertb@agr.gc.ca

ABSTRACT

The long-term decomposition and stabilization of crop residues returned to soil determines whether soil organic carbon accumulates and persists in agroecosystems or is decomposed back to CO_2 and released to the atmosphere. The long-term (2 to 20 year) decomposition and stabilization of crop residues in soils constitutes a major gap in our understanding of carbon and nitrogen cycling in agroecosystems. In many biogeochemical models, assumptions about long-term decomposition are largely unverified. Many of the data available for long-term crop residue decomposition are studies conducted from before 1970 when radiocarbon-enriched materials were used. To address these gaps, we implemented a long-term, trans-Canada decay study to measure the decomposition (10 to 20 years) of barley (*Hordeum vulgare*) residues at ten sites across Canada's agricultural region. The barley residues were uniformly and highly enriched with the stable ^{13}C isotope so that small amounts can be distinguished from background soil carbon. In this presentation we will discuss the rationale for the study, explain how the ^{13}C-labelled crop residues were produced, and show how the decomposition study was implemented and will be maintained. Because the study was initiated in the fall of 2007, we will present results on soil respiration (CO_2 emissions) which reflect the early stages of crop residue decomposition.

MODELLING ECONOMIC AND ENVIRONMENTAL EFFECTS OF BMPs IN WATERSHEDS

Andrzej T. Jedrych[1] and Richard Heikkila,
Alberta Agriculture and Rural Development, #206, 7000-113 Street, Edmonton, Alberta, T6H 5T6

Ali Saleh, Edward Osei, and Oscar Gallego
Texas Institute for Applied Environmental Research (TIAER), P.O. Box T-0410, Tarleton State University, Stephenville, TX 76402 U.S.A.

[1] Corresponding author: andy.jedrych@gov.ab.ca

ABSTRACT

Monitoring the effects of implementing beneficial management practices (BMPs) is expensive and time consuming. A limited number of modeling systems have been developed to assess simultaneously the economic and environmental effects of BMPs at farm and watershed scales. The Alberta Agriculture and Rural Development's (ARD's) Nutrient BMP Evaluation Project selected the Comprehensive Economic and Environmental Optimization Tool (CEEOT) model developed by Texas Institute of Applied Environmental Research (TIAER) for ongoing BMP assessments. The CEEOT model consists of the Farm-level Economic Model (FEM) and two environmental simulation models: Agricultural Policy Environmental eXtender (APEX) and Soil and Water Assessment Tool (SWAT). The unique integration of these three models has enabled effective assessment of BMPs in various watersheds in the United States.

The objective of the study is to implement the modeling system for two study watersheds in Alberta and to develop a protocol for rapid assessments in other watersheds in the province. The two study watersheds are Whelp Creek Sub-watershed near Lacombe and Indianfarm Creek Watershed near Pincher Creek. A protocol has been established for CEEOT application in the two watersheds and input databases have been developed. Initial CEEOT simulation results are not available due to the existing data gaps in the input database. Extensive model calibration efforts will continue into 2009 and 2010.

ENHANCING AGRASID FOR SWAT

J.A. Brierley and M.D. Bock
Agriculture and Agri-Food Canada, #206, 7000 – 113 St. Edmonton, AB T6H 5T6

[1] Corresponding author: tony.brierley@gov.ab.ca

ABSTRACT

Alberta Agriculture and Rural Development staff and partners are assessing the environmental and economic effectiveness of nutrient beneficial management practices (BMPs), through in-field monitoring and computer modeling in two watersheds in central and south-west Alberta. AGRASID (Agricultural Region of Alberta Soil Inventory Database) is the principal source of soil landscape information for the allocation of representative soil types to hydrologic response units (HRUs). HRUs are the basic landscape unit for environmental analysis using the SWAT (Soil Water Assessment Tool) model. Relative to the other sources of SWAT input data, such as sub 1/4 section land cover data and a detailed hydrology layer, the spatial resolution of AGRASID is too "coarse". Therefore AAFC personnel were asked to "densify" or improve the spatial representation of soil landscape data within these two watersheds. This presentation describes the methodology, including the utilization of LiDAR and landscape segmentation products which was employed to create more detailed soil landscape maps for these study areas.

Thursday, February 19, 2009
TECHNICAL SESSIONS: SOIL FERTILITY

EVALUATING NITROGEN FERTILIZER SOURCES FOR WINTER WHEAT

Tom Jensen[1]
Northern Great Plains Director, International Plant Nutrition Institute (IPNI)
102 - 411 Downey Rd., Saskatoon, SK S7N 4L8

[1]Corresponding author: tjensen@ipni.net

ABSTRACT

Ammonium nitrate (AN) was the recommended nitrogen (N) source for winter wheat fields usually applied in early Spring. However, with the general removal of AN from the retail market in Canada the most available source of dry fertilizer is urea (46-0-0). Under Spring conditions where the surface applied urea is not moved sufficiently into the soil with a timely rain after application there can be unwanted losses through ammonia (NH_3) volatilization due to urease activity in surface residues and soil. A study was conducted to compare applications of AN to applications of urea, urea treated with Agrotain, urea treated with Agrotain plus DCD nitrification inhibitor (Super Urea), and ESN, applied as side-banded at planting (September), or top-dressed in the Spring (mid-April). Most of the alternate N sources provided similar yields to spring broadcast AN, except fall banded AN, and Spring surface applied ESN. Different features of some of the N fertilizer sources make them better suited to certain times of application.

SIMULATION OF AMMONIA LOSSES FROM MANURE LAND APPLICATION WITH A WIND TUNNEL

Guoliang Qu[1]
Environmental Stewardship Division, Alberta Agriculture and Rural Development, 306 J.G. O'Donoghue Building, 7000-113 Street, Edmonton, Alberta, Canada T6H 5T6

Atta Atia
Environmental Stewardship Division, Alberta Agriculture and Rural Development, 306 J.G. O'Donoghue Building, 7000-113 Street, Edmonton, Alberta, Canada T6H 5T6

Ki Au
Irrigation and Farm Water Division, Alberta Agriculture and Rural Development, A016 Agriculture Centre, 100, 5401 - 1 Avenue S, Lethbridge, Alberta, Canada T1J 4V6

Len Kryzanowski
Environmental Stewardship Division, Alberta Agriculture and Rural Development, 306 J.G. O'Donoghue Building, 7000-113 Street, Edmonton, Alberta, Canada T6H 5T6

Lawrence Papworth
Environmental Stewardship Division, Alberta Agriculture and Rural Development, 3000 College Drive South, Lethbridge, Alberta, Canada T1K 1L6

Ike Edeogu
Environmental Stewardship Division, Alberta Agriculture and Rural Development, 306 J.G. O'Donoghue Building, 7000-113 Street, Edmonton, Alberta, Canada T6H 5T6

Darryl Slingerland
Environmental Stewardship Division, Alberta Agriculture and Rural Development, 3000 College Drive South, Lethbridge, Alberta, Canada T1K 1L6

[1]Corresponding author: gq@ualberta.ca

ABSTRACT

A wind tunnel and accessory facilities were developed to simulate ammonia losses from manure land applications under different environmental conditions. The wind tunnel consists of a stabilizer, a 7-meter long tunnel, a control chamber, and an extraction fan. The 7-meter tunnel accommodates two 2.44m x 1.22m x 0.23m soil trays. Different manure applicators were developed to apply manure to the trays at different manure application rates and depths. Nine pairs of sample tubing and Pitot tubes were evenly installed on the lateral section of the tunnel downwind to take air samples and measure wind speed. Ammonia in the air samples emitted from the soil was trapped with the solution of 0.1 molar HCL. Colorimetric method was used to determine the ammonia concentration of the HCL solution.

INFLUENCE OF FEEDING DRY DISTILLERS GRAINS WITH SOLUBLES ON THE NUTRIENT CONTENT OF CATTLE MANURE

Rob Dunn[1],
Alberta Agriculture and Rural Development, Ag Centre, #100, 5401 – 1 Ave S, Lethbridge T1J 4V6

Wally Sawchuk,
Alberta Agriculture and Rural Development, Ag Centre, #100, 5401 – 1 Ave S, Lethbridge T1J 4V6

Sheilah Nolan,
Alberta Agriculture and Rural Development, 206, 7000 – 113 St. Edmonton, AB T6H 5T6

Gerald Ontkean,
Alberta Agriculture and Rural Development, Ag Centre, #100, 5401 – 1 Ave S, Lethbridge T1J 4V6

[1]Corresponding author: rob.dunn@gov.ab.ca

ABSTRACT

Corn or wheat dry distillers grains with solubles (DDGS) are considered a suitable and valuable feedstuff for livestock, with relatively high crude protein and phosphorus (P) concentrations. DDGS is the main by-product of the grain ethanol fermentation industry with nutrient concentrations often three times that of the parent grain. In Alberta, DDGS are used in high-energy feedlot cattle diets replacing a portion of the grain. This trend is expected to continue into the foreseeable future. Research has shown that increasing cattle dietary protein and P intake, irrespective of source can significantly increase excretion of nitrogen (N) and P, although ammonia losses often reduce the final manure N content. This has been confirmed through DDGS cattle feeding studies where increased dietary levels of DDGS have been linked to higher N and P excretion. This effect is influenced by cattle type (dairy versus beef) and growth stage (background versus finishing) due to differing requirements for dietary protein or P. Manure P content trends higher as DDGS levels increase while manure N content varies because of the potential for high ammonium-N losses during storage and handling. Depending on DDGS feeding levels and cattle type, current manure application rates may rapidly build soil P levels, increasing the risk for P runoff from affected fields.

USING THE *ECOSYS* MATHEMATICAL MODEL TO SIMULATE TOPOGRAPHIC EFFECTS ON SPATIAL VARIABILITY OF NITROUS OXIDE EMISSIONS FROM AN AGRICULTURAL SOIL

K. Metivier[1],
Department of Renewable Resources, University of Alberta, Edmonton, AB T6G 2E3, Canada

R.F. Grant,
Department of Renewable Resources, University of Alberta, Edmonton, AB T6G 2E3, Canada

E. Pattey
Eastern Cereal and Oilseed Research Centre, Agriculture and Agri-Food Canada, Ottawa, ON K1A 0C6, Canada

[1]Corresponding Author: metivier@ualberta.ca

ABSTRACT

Large spatial variability of nitrous oxide (N_2O) complicates calculation of its emission factors (EFs). *Ecosys*, a process-based, three dimensional mathematical model was used for our research because it captures the large spatial and temporal variability of N_2O emissions by simulating the complex hypotheses for these fluxes at different spatial scales. We simulated emissions using *ecosys* at scales of meter, fetch and field, using a digital elevation model (DEM) to represent topography. Modeled and measured results at meter (chambers) and fetch (micrometeorological flux towers) scales were compared. Coefficients of spatial variation amongst four chamber replicates (2 x 3 m grid) were 28 to 195%, indicating that spatial variation of N_2O occurs at a very small spatial scale. Modeled EF assumed for 112 kg N ha^{-1} was larger in the lower topographic field area (0.3%) than that of the higher (0.1%). EFs were comparatively low because nitrification of fertilizer N occurred in slightly cooler soil temperatures compared to long-term normals. These results show the importance of the use of *ecosys* model which has hourly time-step and uses input from DEMs, to fully capture the large spatial and temporal variability of N_2O at different spatial scales even in seemingly flat (0.2% slope) landscapes.

DEVELOPMENT OF A NITROUS OXIDE EMISSION REDUCTION PROTOCOL

R. Janzen[1]
ClimateCHECK, 325 Dalhousie St, Suite 204, Ottawa, K1N 7G2

D. Beever and R. Dowbenko
Agrium, 13131 Lake Fraser Drive SE, Calgary, T2J 7E8

C. Graham
Canadian Fertilizer Institute, 350 Sparks St., Ottawa, K1R 7S8

K. Haugen-Kozyra
Climate Change Central, Suite 1560, 10303 Jasper Ave, Edmonton, T5J 3X6

T. Jensen
International Plant Nutrition Institute, 102, 411 Downey Rd., Saskatoon, S7N 4L8

L. Kryzanowski
Alberta Agriculture and Rural Development, 306, 7000 - 113 St, Edmonton, T6H 5T6

[1]Corresponding author: rj@climate-check.com

ABSTRACT

Climate Change Central, in collaboration with the Canadian Fertilizer Institute, has engaged ClimateCHECK to compile and coordinate scientific information concerning the greenhouse gas emission reductions associated with best management practices ("**BMPs**") to decrease emission of nitrous oxide from management of nitrogen ("**N**") in the Canadian Prairies.

To date, extensive consultation with science researchers and technical experts has provided the framework of the Nitrous Oxide Emission Reduction Protocol ("**NERP**"). The NERP is designed to quantify GHG emission reductions associated with BMPs to manage N fertilizer in the Canadian prairies. The quantification approach of the NERP is based on the methods used in the National Inventory Report, prepared to meet Canada's Kyoto commitments and validated by the IPCC. The operational framework of the NERP is based on a comprehensive N management plan supporting the performance areas described in the stewardship model of the Canadian Fertilizer Institute — Right Product @ Right Rate, Right Time, Right Place™. The NERP is developed according to the ISO 14064-2 standard, which meets the requirements of the Alberta Offsets System, and which is compatible with the stated intentions of Canada's Offsets System and the California Climate Action Registry.

Thursday, February 19, 2009
TECHNICAL SESSIONS: FOREST, RIPARIAN AND WETLAND SOILS

INFLUENCE OF PERMAFROST ON GREENHOUSE GAS DYNAMICS IN FORESTS AND PEATLANDS ALONG THE MCKENZIE VALLEY, NWT

Jagtar Bhatti, Natalia Startsev and
Canadian Forest Service, Northern Forestry Centre, 5320 122 St Edmonton, AB

Michael Whiticar
School of Earth and Ocean Sciences, University of Victoria, Victoria, BC

ABSTRACT

Soils in northern permafrost regions are vulnerable to thaw in response to climate warming. The northern regions of Canada have undergone the greatest increase in annual temperature over the last 30 years as compared with rest of Canada. These soils also contain large amounts of organic carbon(C) and as the permafrost thaws the thickness of the active layer exposed to decomposition increases. Consequently, thawing of permafrost soils could increase GHG (carbon dioxide (CO_2) and methane (CH_4)) emissions to the atmosphere.

This study was initiated to evaluate source-sink relationships of CO_2 and CH_4 across a climatic gradient of forest-peatland transition sites, and to identify climatic and biological factors that affect CO_2 and CH_4 assimilation/released in northern ecosystems. Sites were located in the low boreal, high boreal, low subarctic and high subarctic ecoregions throughout the Mackenzie Valley in the vicinity of Fort McMurray, Fort Simpson, Norman Wells, and Inuvik, respectively.

The methane release/consumption distribution pattern within the study area is intricate and highly variable, and varies with the local hydrology including depth-to-water and corresponding vegetation cover. Early results show that significant surface methane production occurred only in the submerged parts of the soil profile. Contradictory to initial expectations, the greatest methane production reached a maximum during the warmest months and did not take place during the spring thaw. Carbon dioxide emissions and net ecosystem exchange (NEE) decreased across the climatic gradient from south to north and were mainly affected by soil temperature and presence of permafrost. Landscape position affected soil respiration rate, which was significantly greater in upland areas compared to peatland, and surface assimilation rate that accounted for over half of NEE in the peatland and less than a quarter in the upland.

Initial results from this study indicated CO_2 and CH_4 emissions from soil are likely to increase from regions, or landscape positions, where permafrost thaws.

WASTEWATER AND BIOSOLIDS FOR ENHANCED WOODY BIOMASS PRODUCTION

Richard F. Krygier
Natural Resources Canada, Canadian Fibre Wood Fibre Centre, Northern Forestry Centre, Canadian Forest Service, 5320 122 Street, Edmonton, Alberta

phone: 780 435 7286, email: rkrygier@nrcan.gc.ca

ABSTRACT

At Whitecourt, Alberta, a short rotation coppice (SRC) willow plantation is being grown with and without irrigation using treated municipal sewage wastewater. This project is part of a nation-wide Canadian Biomass Innovation Network study, led by Natural Resources Canada, Canadian Forest Service, that is investigating growing of SRC willow as a bioenergy feedstock. The Whitecourt site was chosen because of its accessibility for demonstration purposes, its proximity to a wastewater treatment facility, and the fact that a potential end user of the wood fibre produced (a waste-wood fired power plant) is located in the community. Five willow clones are being monitored for their performance with and without irrigation. Growth, survival, biomass yield, insect and disease issues, and soil chemistry are being monitored. The use of wastewater for irrigation offers the opportunity to increase yields of willow biomass by augmenting low rainfall in western Canada, to reduce environmental impacts of waste water disposal and to decrease the need for manufactured fertilizers. This has the potential to reduce operating costs and improve the net carbon budget of plantations. Other uses of SRC willow include site reclamation, riparian buffers, phytoremediation, and nutrient cycling and management. The presentation will outline the project purpose, objectives, and results to-date, and present the additional opportunity of applying municipal sewage biosolids to SRIC plantations.

CARBON BALANCE IN HYBRID POPLAR PLANTATIONS IN NORTH CENTRAL ALBERTA, CANADA

C. Arevalo,
Dept. of Renewable Resources, University of Alberta,
442 Earth Sciences Bldg., Edmonton AB T6H 4M5

J. Bhatti[1] and
Northern Forestry Centre, Canadian Forest Service,
5320-122nd St., Edmonton AB T6H 3S5

S.X. Chang
Dept. of Renewable Resources, University of Alberta,
442 Earth Sciences Bldg., Edmonton AB T6H 4M5

[1]Corresponding author: JBhatti@NRCan.gc.ca

ABSTRACT

Planting fast-growing hybrid poplars is perceived as a strategy to offset anthropogenic greenhouse gas emissions; however, the net carbon (C) benefits of such plantations are unclear, particularly as they are expected to be C sources during the initial years following establishment. A full analysis of the global C contribution of short rotation woody crop (SRWC) systems is needed before the efficacy of these systems can be clarified. In this study, we compared the C balance in hybrid poplar plantations (2- and 9-year old in 2006 and re-measured in 2008 when they became 4- and 11-year old) with an adjacent agricultural cropping system in north central Alberta, Canada. Overall, we found no significant differences in soil C storage between the hybrid poplar plantations and the agricultural system, although a decline (4 Mg ha-1) of soil C storage during the first two years of plantation establishment and then an increase thereafter was observed. Above- and belowground tree biomass production increased with age, reaching 7 Mg C ha-1 yr-1 in the 11-year old plantation. The rate of C loss, via soil respiration, decreased from 5 to <1 Mg C ha-1 yr-1as the plantations got older. Annual C balance calculations indicated that these plantations were initially large sources of C. As cultivation ceased and trees grew bigger, the plantation became a C sink by year 4, and by year 9 the plantation fully recovered soil C lost in the early plantation establishment phase. Our data show that growing hybrid poplars on rotations less than 4 years would result in C loss but would otherwise sequester significant quantities of C if the rotation is longer than 9 years.

SOIL RESPIRATION IN A HYBRID POPLAR PLANTATION LOCATED IN CENTRAL ALBERTA

David T Price[1], Alberto Orchansky[2],Carmela Arevalo[3], Paul Jassal[4] and Barb Thomas[5]

[1] Natural Resources Canada, Edmonton
[2] Consultant, Edmonton
[3] University of Alberta
[4] University of British Columbia
[5] Alberta-Pacific Forest Industries Inc.

ABSTRACT

There is considerable interest in exploiting carbon (C) sequestration benefits of tree plantations established on marginal agricultural lands to mitigate Canada's greenhouse gas (GHG) emissions from production and consumption of fossil fuels. In Alberta, plantations of fast growing hybrid poplars have been established by Alberta-Pacific Forest Industries Inc. (Al-Pac) on land leased from farmers within a 200 km radius of the Al-Pac mill (located near Athabasca, AB). An experiment was set up at a farm near Ashmont, AB to measure the C balance of an operational-scale poplar plantation over several years from planting in June 2005.

Here we focus on the measurement and modeling of soil respiration (R_s) rates from the plantation taking account of seasonal variations in climate and spatial variability in soil conditions. Soil CO_2 concentrations were measured continuously using Vaisala solid state CO_2 probes at a single location over the period July 2005 to November 2008 (ontinuing into 2009). During each growing season, net CO_2 flux (or ecosystem exchange, NEE) at the site was measured independently using eddy covariance (EC) while R_s was measured periodically at multiple locations using a field portable infra-red gas analyzer (IRGA). The time series of soil CO_2 concentrations was used to estimate year-round rates of R_s which compared favorably with those measured using the portable IRGA and are consistent with the EC measurements of NEE.

During 2005, the site was a C source with high R_s attributed to the decomposition of residues from previous agricultural crops and dead weeds. Since then, the trees have grown rapidly, while Rs has increased slowly, thereby causing site C balance to shift from a net source in 2005 and 2006 to a small sink in 2008. These results suggest the trees invested a surprisingly large portion of annual C uptake in root activity in the first four years of stand growth, presumably fine root production and turnover.

QUANTIFYING THE ROLE OF SOIL IN FOREST CARBON OFFSETS ESTIMATED USING THE CARBON BUDGET MODEL OF THE CANADIAN FOREST SECTOR (CBM-CFS3)

B.N. Simpson, C.H. Shaw
Northern Forestry Centre, Canadian Forest Service, 5320 122 Street, Edmonton, Alberta email: bsimpson@nrcan.gc.ca

W.A. Kurz
Pacific Forestry Centre, Canadian Forest Service, Victoria, BC

ABSTRACT

Models, alone or in combination with direct measurement, will be used to estimate carbon (C) offsets in the forest sector. However, data on dead organic matter (DOM) and soil C is limited. Forest C models, like the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3), that are capable of simulating disturbances, stand dynamics, and decay processes are able to predict carbon stock and stock changes for DOM and soil C pools. We provide an overview of model features needed to meet the reporting requirements of existing and developing guidelines for international reporting and potential domestic reporting in the United States and Canada. The CBM-CFS3 is described, and three simple hypothetical project scenarios in the CBM-CFS3 were used to illustrate how a forest C offset can be estimated. In all three scenarios, the magnitude of the offset was primarily determined by the impact of periodic major disturbances (e.g., fire, harvesting) on biomass and DOM pools. The impact of soil C on the offset in the year of a disturbance was relatively small, but the contribution of mineral soil C to total emissions in the long period of time between disturbances was as high as 30% and always exceeded the *de minimis* criterion of the United States Department of Energy's 1605(b) Program for monitoring.

ABSTRACTS OF THE 46TH ALBERTA SOIL SCIENCE WORKSHOP

POSTER SESSION

LONG-TERM EFFECTS OF TILLAGE AND LEGUME CROPS ON CROP PRODUCTIVITY AND NITROGEN USE EFFICIENCY

Y. K. Soon[1], N. Lupwayi and R. Azooz
Agriculture & AgriFood Canada, Beaverlodge Research Farm, P. O. Box 29, Beaverlodge, Alberta T0H 0C0

[1] Corresponding author: soony@agr.gc.ca

ABSTRACT

Rotational legume crops typically benefit the sequent crops by increasing crop production and reducing the need for fertilizer N, thus improving N use efficiency (NUE). However, few studies have assessed the long-term NUE of tillage and legume crops. Data from a 12-yr study (1993-2004) in northern Alberta are presented here to address the paucity of such information. Four crop rotations, field pea-wheat-canola-wheat, red clover green manure-wheat-canola-wheat, summer fallow-wheat-canola-wheat, and continuous wheat (CW), managed under conventional tillage (CT) or no-till (NT), were compared. Fertilizer N input was determined according to soil test conducted in the fall. Productivity across all rotations was measured as photosynthate (glucose) production in the grain, and NUE was defined as photosynthate production per unit of fertilizer N input. The field pea rotation had the highest productivity throughout the study, followed by continuous wheat. The red clover and the fallow rotations produced no grain in one of four years, and so resulted in a lower productivity. Fertilizer N input was, initially, higher under NT than CT, but by the third rotation cycle, the difference became insignificant. NUE was lowest with CW, similar between the pea and red clover rotations, and initially lower under NT than CT. NUE varied between rotation cycles for the fallow rotation, but was relatively constant for the pea rotation. The pea rotation resulted in high productivity and NUE over 12 years compared to other rotations.

PRS™-PROBES DETERMINE SOIL NUTRIENT SUPPLY RATES IN ORGANIC AND CONVENTIONAL SNAP BEAN ROTATION EXPERIMENTS

J. Owen [1]
Agriculture and Agri-Food Canada, Atlantic Food and Horticulture Research Center, P.O. Box 2069, Bouchtouche, New Brunswick, E4S 2J2

S. Leblanc
Agriculture and Agri-Food Canada, Atlantic Food and Horticulture Research Center, P.O. Box 2069, Bouchtouche, New Brunswick, E4S 2J2

S. A. E Fillmore
Agriculture and Agri-Food Canada, AFHRC, Kentville, Nova Scotia, B4N 1J5

Elaine Qualtiere
Western Ag Innovations, #3-411 Downey Road, Saskatoon, Saskatchewan, S7N 4L8

Rebekka Rieder
Western Ag Innovations, #3-411 Downey Road, Saskatoon, Saskatchewan, S7N 4L8

[1]Corresponding author: owenj@agr.gc.ca

ABSTRACT

There is little information to guide organic growers on the timeline of bioavailable nutrients during the growing season for organic vegetables. Organic snap bean cropping systems contain dynamic nutrient cycling due to additions of compost and disturbance of soil though mechanical weeding. PRS™-probes have the ability to functionally measure soil nutrient dynamics and were chosen to access the nutrient fluxes in an organic cropping system. The experimental design included continuous snap beans and a fully phased snap beans/fall rye rotation, in the context of two, three, and four years. Treatments consisted of combinations of fertilizer (1x compost, 3x compost, and chemical fertilizer) and weed control (mechanical weeding/herbicide). Results showed that available NH_4-N was not affected by weeding treatment, but NO_3-N was repeatedly lower in mechanically weeded plots relative to plots treated with herbicide. Overall PRS™-probes showed that applying 3x compost increased P, Ca and K supplies but other gains in nutrients were minimal relative to the 1x rate. Therefore, no real advantage warrants the cost of amending at greater than the 1x rate of compost.

RESPONSES OF SOIL GREENHOUSE GASE EMISSIONS TO CLIMATE CHANGE AND DEFOLIATION IN AN ALBERTA NATIVE GRASSLAND

B. Attaeian*, S.X. Chang,
Dept. of Renewable Resources, University of Alberta, Edmonton, Alberta, T6G 2E3

J.F. Cahill
Dept. of Biological Sciences, University of Alberta, Edmonton, Alberta, T6G 2E9

ABSTRACT

Air temperature has risen about 1.2°C over the last 50 years in the Prairie Provinces of Canada, and there is consensus that increases in atmospheric greenhouse gas concentrations have been responsible for much of this increase in air temperature. Grazed landscapes particularly grass-dominated ecosystems may serve as a net carbon sink, mitigating some effects of climate change. However, grazed ecosystems are themselves vulnerable to the effect of climate change, and overgrazing. Overgrazing may increase soil greenhouse gas emissions and create a positive feedback to climate change. We investigated climate change and grazing intensity's effect on soil greenhouse gas (CO_2, CH_4 and N_2O) emissions in an Alberta native grassland ecosystem. We used a completely randomized block design with three factors: precipitation (ambient or ±70% ambient), warming (ambient or warmed) and defoliation (control, low and high intensities of defoliation) crossed in a factorial design. Greenhouse gas emissions were monitored during two growing seasons in 2007 and 2008 using static gas chambers. The result showed that +70% precipitation increased CO_2 emissions and warming increased soil CH_4 and N_2O emissions. Defoliation did not influence soil greenhouse gas emissions. Our results show that warming and increased precipitation may decrease carbon sequestration potential of the studied grassland ecosystem and provide a potential positive feedback to climate change.

PREVENTING NUTRIENT DEFICIENCIES IN ORGANIC CROP PRODUCTION WITH PROPER MANAGEMENT PRACTICES AND AMENDMENTS

S. S. Malhi[1], S. A. Brandt[2], R. P. Zentner[3], J. D. Knight[4], K. S. Gill[5], T. S. Sahota[6] and J. J. Schoenau[4]

[1]Agriculture and Agri-Food Canada, P.O. Box 1240, Melfort, SK, Canada S0E 1A0; [2]Agriculture and Agri-Food Canada, Scott, SK, Canada; [3]Agriculture and Agri-Food Canada, Swift Current, SK, Canada; [4]Department of Soil Science, University of Saskatchewan, Saskatoon, SK, Canada; [5]Smoky Applied Research and Demonstration Association, Fahler, Alberta, Canada; and [6]Thunder Bay Agricultural Research Station, Thunder Bay, Ontario, Canada

ABSTRACT

Synthetic fertilizers/chemicals are not applied to increase yield in organic farming. Nitrogen deficiency in organic crops can be corrected by growing N-fixing legumes in rotations, but if soils are deficient in available P, K, S or other nutrients, only alternative is to use external nutrient sources. Field experiments are underway to determine the influence of management practices and amendments on crop yield. In a study established in 1995, crop yields for organic system were 30-40% lower than conventional system with high inputs. But, lower input costs plus price premiums for organic produce normally resulted in favourable economic performance and energy efficiency. In the organic system, amount of P removed in crop exceeded that of P replaced and this can be a major yield limiting factor. In amendments experiments, there was small effect of granular rock phosphate fertilizer and/or *Penicillium bilaiae* in increasing soil P level and crop yield in the application year. Other findings suggested the use of legume crops in the rotation, green manure, compost manure, alfalfa pellets, wood ash or gypsum to improve

nutrient availability and yield. In conclusion, integrated use of management practices and amendments has the potential to increase sustainability of organic crop production.

RELATIONSHIP BETWEEN TOPSOIL CAPPING DEPTH AND SUBSURFACE WATER QUALITY FOR RECLAMATION OF A PHOSPHOGYPSUM STACK IN CENTRAL ALBERTA

Jackson, M.E., M.A. Naeth, D.S. Chanasyk and C.K. Nichol.
Dept. of Renewable Resources, University of Alberta, Edmonton, Alberta

ABSTRACT

Phosphogypsum (PG) is an acidic by product generated from the production of phosphorus fertilizers. It is commonly stacked in large piles around the world including Alberta, Canada. This research involves reclamation of phosphogypsum stacks in central Alberta. Current legislation requires a 1 m topsoil cap overlying PG. With an annual precipitation of 400 to 500 mm, it was hypothesized this cap depth could be reduced. The research focused on the effect of soil cap depth on hydrologic, vegetation and radiation variables. Experimental plots with varying depths of topsoil (0, 8, 15, 30, 46 and 91 cm) were constructed and seeded with one of five grasses in spring 2007. Results showing the relationship between topsoil depth and subsurface water quality will be presented.

EFFECTS OF LAND-USE HISTORY AND INCUBATION TEMPERATURE ON N_2O AND CO_2 FLUXES: A COMPARISON BETWEEN CHINESE AND CANADIAN SOILS

M. Lang,
Department of Renewable Resources, University of Alberta, Edmonton, Alberta. T6G 2E3, Canada and State Key Laboratory of Soil and Sustainable Agriculture, Institute of Soil Science, Chinese Academy of Sciences, Nanjing 210008, China

S.X. Chang[1],
Department of Renewable Resources, University of Alberta, Edmonton, Alberta. T6G 2E3, Canada

Z.C. Cai[1]
State Key Laboratory of Soil and Sustainable Agriculture, Institute of Soil Science, Chinese Academy of Sciences, Nanjing 210008, China

[1]Corresponding author: Scott.Chang@afhe.ualberta.ca and zccai@issas.ac.cn

ABSTRACT

The potential for nitrification and thus N_2O emissions can be affected by land-use history and temperature**.** The effects of land-use type (forest vs. grassland) and temperature (10 vs. 15°C) on nitrification and microbial release of N_2O and CO_2 were investigated under aerobic conditions (at 60% water holding capacity) in a laboratory incubation experiment. Ammonium sulfate was added at 30 mg N kg^{-1} to both forest and grassland soils collected from China and Canada. The results indicated that land-use type had significant effects on nitrification and the fluxes of N_2O and CO_2, and pH showed a positive correlation ($P<0.05$) with nitrification rate. The release of N_2O and CO_2 was much higher from forest than from grassland soils, with the highest release rate from the Canadian forest soil. Dissolved organic C concentrations were positively ($P<0.05$) related to the rate of N_2O and CO_2 fluxes, suggesting that soil DOC is a good surrogate indicator of microbial available organic C substrate for supporting microbial activities. The rate of N_2O flux was strongly influenced by incubation temperature, with rates higher at 15 than at 10°C incubation, the same pronounced effect was also found for CO_2 emission from forest soils with high DOC concentrations, indicating that low temperature limited microbial activity and reduced the rate of N_2O and CO_2 fluxes.

THE ALBERTA SOILS TOUR IN 2008

R. Jason Cathcart

Alberta Agriculture and Rural Development, J.G. O'Donoghue Bldg. 206, 7000 - 133 Street, Edmonton, AB T6H 5T6

ABSTRACT

With over 40 participants on board, the Alberta Soils Tour set out from the Lacombe Research Station early on July 22 on a cross-country journey through west central Alberta. The tour visited Alberta Agriculture's Beneficial Management Practices Evaluation Project at Whelp Creek, several up-stream oil site reclamation projects, and took an informative tour of a number of land use issues surrounding Sylvan Lake and Red Deer County. Along the route, participants passed over, stopped, and discussed a number of different soils and geographic features of this unique region of Alberta, before spending a great evening in Rocky Mountain House. On July 23, the tour headed north from Rocky Mountain House, along the Cowboy Trail towards Drayton Valley, and then east along Secondary Highway 616 as it weaved its way back towards Highway 2. Along the way the tour continued to look at the soils and interesting landscapes of the area, in addition to visiting Premier Horticulture's peat extraction bog, area woodlots and the University of Alberta's famous Breton Plots and Bentley Preserve. Entering Leduc County, participants listened to both a discussion of the clubroot issue in this region and the municipal responsibilities and activities of Leduc County with respect to its soil-infilling program. The tour arrived safely back at the Lacombe Research Station.

VERACITY OF COMMERCIAL STANDARDS USED TO MEASURE GREENHOUSE GAS CONCENTRATIONS

B.H. Ellert[1*], E.M. Nakonechny[1] and P.R. Rochette[2]
Agriculture & Agri-Food Canada, Research Branch,
[1] Lethbridge Research Centre, 5403 1st Avenue South, Lethbridge AB T1J 4B1
[2] Soils and Crops Research and Development Centre, Québec QC G1V 2J3

[*]Corresponding author: ellertb@agr.gc.ca

ABSTRACT

Concern about increasing concentrations of greenhouse gases in the atmosphere has spurred research into the influence of terrestrial ecosystems on the atmosphere, and how management might affect emissions. Of particular concern are soil N_2O emissions that enhance radiative forcing and eventually catalyze O_3 destruction in the stratosphere. Inventories of soil N_2O emissions are crucial to assess the contribution of terrestrial ecosystems relative to various other industrial and residential sources. Such inventories ultimately are based on measurements of [N_2O] in environmental gas samples, and these measurements typically are calibrated against pressurized cylinders of gas mixtures from commercial suppliers. An error in the concentration assigned to the calibration gas leads directly to errors in flux estimates and ultimately in emission inventories. Thus, the primary goals of this study were to check for consistency among commercial standards used to calibrate N_2O analyses and to place several laboratories on a common, internationally-accepted measurement scale. We obtained five "NOAA cylinders" with N_2O concentrations verified by the US National Oceanic & Atmospheric Administration's (NOAA) Earths Systems Research lab in Boulder CO, and compared them with 56 cylinders from commercial sources used in 15 university and government research laboratories. Generally there was close agreement between analyses performed in the various participating labs and the central lab. Of 46 commercial cylinders with [N_2O] ranging from 0.250 to 16.0 ppmv, 22 had commercially-assigned values that differed appreciably from those determined by cross-calibration against the NOAA cylinders. That is, for these 22 cylinders the absolute values of the differences between the commercially-assigned and the NOAA-calibrated values ranged from 14.9 to 88.6% of the NOAA-calibrated value. The differences were less than 4.0% for only 22 cylinders. This exercise raised serious concerns about the use of commercially-prepared gas mixtures to calibrate N_2O analyses for measuring emissions from soil.

SULPHATE ADSORPTION AND ITS RELATIONSHIPS WITH FOREST SOIL PROPERTIES IN THE ATHABASCA OIL SANDS REGION

Kangho Jung[1], Yong Sik Ok[2], and Scott X. Chang[1]

[1]Department of Renewable Resources, University of Alberta, Edmonton, AB T6G 2E3
[2]Department of Biological Environment, Kangwon National University, Chuncheon 200-701, Korea

ABSTRACT

Soil acidification poses a great environmental risk in the Athabasca oil sands region (AOSR) due to increased acidic fallout such as SO_2. Sulphate adsorption by soil particles can potentially mitigate soil acidification via delaying leaching of base cations that could accompany sulphate ions. The objectives of this study were to assess sulphate adsorption capacities of some forest soils in AOSR and to determine relationships between sulphate adsorption and soil properties. Lake 287 and Lake 185 as two representative watersheds with contrasting hydrological regimes were selected in AOSR and twenty seven soil samples representing different horizons and soil types were collected. Results indicated that the Freundlich model fitted well for most soils to described sulphate adsorption and an unified adsorption variable (k_u) derived from the Freundlich model performed well for comparing sulphate adsorption capacities among different soils. The soils in Lake 287 had higher sulphate adsorption capacities than soils in Lake 185. The Ae horizon adsorbed less sulphate than the B horizons. The increase in solution pH with sulphate addition indicated that hydroxyl ion was released. Sulphate adsorption was highly correlated ($r = 0.9798$, $p < 0.001$) with k_u. Soil pH in 1 M NaF solution (pH_{NaF}) measured with a 1:40 (w:v) ratio of soil to extractant was also positively correlated ($r = 0.7004$, $p<0.05$) with sulphate adsorption. Our results showed that both k_u and pH_{NaF} could be used as indicators to compare sulphate adsorption among different soils without having to conduct a more time-consuming conventional adsorption isotherm experiment.

EVALUATION OF A SUBSTRATE AND VEGETATION COVER SYSTEM FOR RECLAIMED PHOSPHOGYPSUM STACKS AT FORT SASKATCHEWAN, ALBERTA

I.L. Hallin, M.A. Naeth and D.S. Chanasyk

ABSTRACT

Phosphogypsum (PG), a byproduct of the phosphate fertilizer industry, was produced and stored at the Agrium Fort Saskatchewan facility from 1965 to 1991. Upon decommissioning, 15 cm of topsoil and a non native seed mix were applied to the outer slopes as a reclamation cover system. Successful reclamation of PG stacks is achieved when the cover system provides an impermeable barrier between PG and the surrounding environment. Physical, chemical and hydrologic evaluations of the cover system confirm that it is providing a suitable substrate for

plants, preventing trace elements within the PG pore spaces from reaching the surrounding environment via diffusion or plant uptake, and in general preventing water from percolating through to the PG. Sites with dense vegetation cover and highly compacted PG at the substrate/PG interface were most successful.

NOTES

NOTES

SPONSORS FOR THE
2009 ALBERTA SOIL SCIENCE WORKSHOP

Agrium

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

eba

VARIAN

Ivey-sol® Surfactant Technology
"TODAY'S ENVIRONMENTAL SOLUTIONS FOR A BETTER TOMORROW" ®
1-800-246-2744 • www.iveyinternational.com

CAPP
CANADIAN ASSOCIATION
OF PETROLEUM PRODUCERS

PARAGON
soil & environmental consulting

HydroQual
Laboratories Ltd.

ALS
ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

WES

FACULTY OF
AGRICULTURAL, LIFE & ENVIRONMENTAL SCIENCES
UNIVERSITY OF ALBERTA

WESTERN AG INNOVATIONS

RENEWABLE RESOURCES

UNIVERSITY OF ALBERTA
Research Services Office

Agriculture and Agri-Food Canada
Lethbridge Research Centre

Agriculture et Agroalimentaire Canada
Centre de recherches de Lethbridge