

Elements



Volume 26, Number 2

July 2008

THE NEWSLETTER OF THE CANADIAN GEOPHYSICAL UNION

IN THIS ISSUE

Canadian Associations-AGU Joint Assembly 2009 Announcement ___1
Call for Nominations: J. Tuzo Wilson Medal, Young Scientist & Meritorious Service Awards ___1-3
CGU-CGRG Joint Meeting 2008 ___3 J. Tuzo Wilson Medal ___5 Young Scientist Award ___8
Meritorious Service Award ___9 HS Section News ___9 Best Student Paper Awards ___10
Canadian Associations-AGU Joint Assembly 2009 Flyer ___20-21 Financial Report ___22
Officers of the CGU Executive Committee ___23

LE BULLETIN DE L'UNION GÉOPHYSIQUE CANADIENNE

JOINT ASSEMBLY 2009

AGU / GAC / MAC / CGU / IAH-CNC

May 23-27, 2009, Toronto Convention Centre, Toronto, Ontario

Ideas and suggestions are solicited for themes, symposia, joint sessions, short courses and field trips for our full participation in the Joint Assembly 2009. Co-sponsored symposia, workshops and sessions are expected in most areas of the geophysical sciences.

Proposals for technical sessions may now be made online at

<http://www.agu.org/meetings/ja09/>

Canadian proposals may be made via one of AGU's regular sections with a US partner, or may be made in the Canadian Associations section on the pull-down menu at this website. The deadline for receipt of session proposals is November 1, 2008.

Commercial and educational exhibits are always welcome!

CGU 2009 LAC Chair: Spiros Pagiatakis, York University, spiros@yorku.ca

CGU 2009 SPC Chair: Rod Blais, University of Calgary, blais@ucalgary.ca

IAH-CNC Program: Christopher Munro, Ont. Gov't. christopher.munro@ontario.ca

IAH-CNC Program: Dave Rudolph, Univ. of Waterloo drudolph@sciborg.waterloo.ca

JA 2009 & CGU Websites:

<http://www.jointassembly2009.ca>

<http://www.ucalgary.ca/~cguconf>

J. Tuzo Wilson Medal – Call for Nominations

The Executive of the CGU solicits nominations for the J. Tuzo Wilson Medal – 2009. The Union makes this award annually to recognize outstanding contributions to Canadian geophysics. Factors taken into account in the selection process include excellence in scientific and/or technological research, instrument development, industrial applications and/or teaching.

If you would like to nominate a candidate, please contact Dr. Hugh Geiger, Chair of the CGU Awards Committee, Talisman Energy, Calgary AB (Email: HGEIGER@talisman-energy.com). At a minimum, the nomination should be supported by letters of recommendation from colleagues, a brief biographical sketch and a Curriculum Vitae. Nominations should be

submitted by February 28, 2009. Additional details concerning the nomination process can be obtained from the Chair of the CGU Awards Committee.

L'exécutif de l'UGC vous invite à suggérer des candidats pour la médaille J. Tuzo Wilson – 2009. L'Union décerne la médaille chaque année "en reconnaissance d'une contribution remarquable à la géophysique canadienne". En choisissant parmi les candidats, on considère les accomplissements en recherches scientifique ou technologiques, aux développements d'instruments, aux applications industrielles et/ou à l'enseignement.

Si vous désirez suggérer un candidat pour cette médaille, s.v.p. contacter Dr. Hugh Geiger, Président du Comité des Prix d'Excellence, Talisman Energy (Email: HGEIGER@talisman-energy.com). Les nominations doivent être supportées de lettres de recommandation de collègues, d'un bref sommaire biographique et d'un Curriculum Vitae. Les nominations doivent être soumises avant le 28 février, 2009. Des détails additionnels concernant le processus de nomination peuvent être obtenus en communiquant avec le Président du Comité des Prix d'Excellence de l'UGC.

Past Wilson Medallists

1978	J. Tuzo Wilson
1979	Roy O. Lindseth

1980	Larry W. Morley
1981	George D. Garland
1982	Jack A. Jacobs
1983	D. Ian Gough
1984	Ted Irving
1985	Harold O. Seigel
1986	Michael Rochester
1987	David Strangway
1988	Ernie Kanasewich
1989	Leonard S. Collett
1990	Gordon F. West
1991	Thomas Krogh
1992	R. Don Russell
1993	Alan E. Beck
1994	Michael J. Berry
1995	Charlotte Keen
1996	Petr Vaníček
1997	Chris Beaumont
1998	Ron M. Clowes
1999	David Dunlop
2000	Don Gray
2001	Roy Hyndman
2002	Doug Smylie
2003	Garry K.C. Clarke
2004	W.R. (Dick) Peltier
2005	Ted Evans
2006	Alan Jones
2007	Herb Dragert
2008	Ming-ko (Hok) Woo

CGU Young Scientist Award – Call for Nominations

The Executive of the CGU solicits nominations for the CGU Young Scientist Award – 2009. The CGU Young Scientist Awards recognize outstanding research contributions by young scientists who are members of the CGU. Both the quality and impact of research are considered. To be eligible for the award, the recipient must be within 10 years of obtaining their first Ph.D. or equivalent degree. The awards are made by the CGU Executive on the recommendations of a special committee struck for this purpose. The selection committee seeks formal written nominations from the membership, plus letters of support and a current curriculum vitae. Nominations for the CGU Young Scientist Awards may be submitted by CGU members at any time.

If you would like to nominate a candidate, please contact Dr. Hugh Geiger, Chair of the CGU Awards Committee, Talisman Energy, Calgary AB (Email: HGEIGER@talisman-energy.com). The nomination should be supported by three letters of recommendation from colleagues. Nominations should be submitted by February 28, 2009. Additional details concerning the nomination process can be obtained from the Chair of the CGU Awards Committee.

L'exécutif de l'UGC vous invite à suggérer des candidats pour le prix pour Jeune Scientifique de l'UGC – 2009. Les Prix pour Jeunes Scientifiques de l'UGC reconnaissent les contributions exceptionnelles de jeunes scientifiques qui sont membres de l'UGC. La qualité et l'impact de la recherche sont considérés. Pour être éligible pour le prix, le scientifique doit avoir obtenu son premier Ph.D. ou degré équivalent au cours des dix dernières années. Les prix sont accordés par l'Exécutif de l'UGC sur recommandations d'un comité spécial à cette fin. Le comité de sélection sollicite des nominations formelles par écrit des membres de l'UGC, accompagnées de lettres d'appui et d'un curriculum vitae à jour. Des nominations pour les Prix pour Jeunes Scientifiques de l'UGC peuvent être soumis en tout temps par les membres de l'UGC.

Si vous désirez suggérer un candidat pour cette médaille, s.v.p. contacter Dr. Hugh Geiger, Président du Comité des Prix d'Excellence, Talisman Energy, Calgary AB (Email: HGEIGER@talisman-energy.com). Les nominations doivent être supportées de trois lettres de recommandation de collègues. Les nominations doivent être soumises avant le 28 février, 2009. Des détails

additionnels concernant le processus de nomination peuvent être obtenus en communiquant avec le Président du Comité des Prix d'Excellence de l'UGC.

Past Winners

2005 Shawn J. Marshall, J. Michael Waddington
2006 No winner
2007 No winner
2008 Brian Branfireun, Scott Lamoureux

CGU Meritorious Service Award – Call for Nominations

The Executive of the CGU solicits nominations for the CGU Meritorious Service Award – 2009. The CGU Meritorious Service Award recognizes extraordinary and unselfish contributions to the operation and management of the Canadian Geophysical Union by a member of the CGU. All members of the CGU are eligible for this award, although the award is not normally given to someone who has received another major award (e.g. the J. Tuzo Wilson Medal). Nominations for the CGU Meritorious Service Award may be submitted by CGU members at any time. The award is made by the CGU Executive based on recommendations from the CGU Awards Committee, and is based on lifetime contributions to CGU activities.

If you would like to nominate a candidate, please contact Dr. Hugh Geiger, Chair of the CGU Awards Committee, Talisman Energy, Calgary AB (Email: HGEIGER@talisman-energy.com). The nomination should be supported by three letters of recommendation from colleagues. Nominations should be submitted by February 28, 2009. Additional details concerning the nomination process can be obtained from the Chair of the CGU Awards Committee.

L'exécutif de l'UGC vous invite à suggérer des candidats pour le Prix pour Service Méritoire de l'UGC – 2009. Le Prix pour Service Méritoire de l'UGC reconnaît les contributions extraordinaires et désintéressées à l'opération et à l'administration de l'Union Géophysique

Canadienne par un membre de l'UGC. Tous les membres de l'UGC sont éligibles pour ce prix, sauf que normalement, ce prix n'est pas donné à quelqu'un qui a reçu un autre prix important tel que la Médaille Tuzo Wilson. Des nominations pour le Prix pour Service Méritoire de l'UGC peuvent être soumises en tout temps par les membres de l'UGC. Le Prix est accordé par l'Exécutif de l'UGC sur recommandations du Comité des Prix de l'UGC, pour l'ensemble des contributions d'un membre aux activités de l'UGC.

Si vous désirez suggérer un candidat pour cette médaille, s.v.p. contacter Dr. Hugh Geiger, Président du Comité des Prix d'Excellence, Talisman Energy, Calgary AB (Email: HGEIGER@talisman-energy.com). Les nominations doivent être supportées de trois lettres de recommandation de collègues. Les nominations doivent être soumises avant le 28 février, 2009. Des détails additionnels concernant le processus de nomination peuvent être obtenus en communiquant avec le Président du Comité des Prix d'Excellence de l'UGC.

Past Winners

2004 Ron Kurtz
2005 Ted Glenn
2006 J.A. Rod Blais
2007 Ed Krebes
2008 Patrick Wu

CGU-CGRG 2008 Joint Annual Meeting

Rod Blais

The 34th Annual Scientific Meeting of the Canadian Geophysical Union (CGU) was held jointly with the Annual Meeting of the Canadian Geomorphology Research Group (CGRG) at the Banff Park Lodge, in Banff, AB, on May 11-14, 2008. Some 245 CGU members (including 117 students) and 28 CGRG members (including 8 students) participated in the four-day meeting under the inspiring theme “*Canadian Geophysical Sciences: Present and Future*”.

The joint CGU-CGRG Meeting started with a Plenary Presidential Session on Sunday evening with the following Invited Speakers:

- G. Kaser: Changing Mountain Glaciers: What Do They Tell Us?
- E.A. Johnson: Biogeoscience: How an Ecologist Became Interested in the Geosciences.
- W. M. Moon: Polarimetric SAR Imaging of Earth's Surface Processes and Geophysical Applications.

The inaugural Woo Lecture in Hydrology was given by

- D. Kane: Reflections on Forty Years of Arctic Hydrology Research

in a special session on Monday afternoon.

Other technical sessions included:

- Biogeoscience (Coupling of ecosystem and geomorphic processes)
- Continental Erosion and Physics of Sediment Transport
- Ecohydrology (I and II)
- Geocomputations and the New Cyberinfrastructure (I and II)
- Geodesy and Geodynamics (I and II)
- General Hydrology (I and II)
- Hydrologic and cryospheric processes in mountain and polar regions (I, II and III)
- Imaging the Earth
- IPY (International Polar Year)
- Landslides and Rock Avalanches
- Mountain to Lowland Rivers: Dynamics and Stability
- Multiscale Landscape Evolution and Glacial Geomorphology (I and II)
- Permafrost and Geophysics
- Planetary and Space Sciences
- POLARIS
- Sediment Transport in Fluids (I and II)
- Solid Earth

with three stand-alone poster sessions on Monday, Tuesday and Wednesday afternoons. More details on these sessions will be included on the 2008 CGU Archival CD. Furthermore, on Wednesday morning, a Geoid Workshop was conducted by M. Veronneau as in previous years.

The organization of this joint Meeting was somewhat different from CGU Annual Meetings in previous years. First, a Scientific Program Committee (SPC) and a Local Arrangement Committee (LAC) were set up to share the workload and improve the experience for the participants. The SPC consisted of

- i) Rod Blais, Chair of SPC
- ii) Spiros Pagiatakis, Vice President of CGU
- iii) Brian Branfireun, Vice President of Hydrology Section
- iv) Joe Henton, Vice President of Geodesy Section
- v) Philip McCausland, GAC/Geophysics Division
- vi) John Pomeroy, CGU President (ex officio)
- vii) Yves Michaud, CGRG President (ex officio)

- viii) Peter Ashmore, joint CGRG-CGU-HS Sessions
- ix) Steve Wolfe, CGRG Technical Program
- x) Ed Krebs, CGU-CGRG Technical Program
- xi) Hugh Geiger, CGU Awards

and the LAC consisted of

- i) Rod Blais, Chair of LAC
- ii) Kathy Young, CGU Treasurer
- iii) Jim Buttle, CGU-HS Representative
- iv) Marcelo Santos, CGU-GS Representative
- v) Philip McCausland, GAC/Geophysics Representative
- vi) John Pomeroy, CGU President (ex officio)
- vii) Yves Michaud, CGRG President (ex officio)
- viii) Patrick Wu, Conference Webmaster
- ix) Masaki Hayashi, CGU Secretary
- x) Margaret-Anne Stroh, Conference Services (ex officio)

This year, in addition to the formalization of the SPC and LAC in accordance with the decisions of the CGU Executive, more work was expected of the Conveners and Chairs for the technical sessions. With the ever increasing numbers of submitted abstracts and sessions, the Conveners were asked to decide on the contents of their sessions and their priorities in scheduling the presentations. In the near future, a number of steps will be automated using web services but the inputs from the Conveners and Chairs will remain most important for the success of the Meeting. Furthermore, the poster sessions were scheduled for the late afternoons with open bar services nearby to encourage discussions and socializing.

A successful fieldtrip on Sunday, May 11th, led by Dr. Shawn Marshall, to the Columbia Icefield had 21 participants, including three from CGRG. This fieldtrip has always been a popular one in previous years and this year was somewhat special with the CGRG participation.

Based on the comments received from numerous participants, the joint Meeting was very successful. The changes in the organization of the technical and social programs have generally been well received. The new venue at the Banff Park Lodge also got high marks from my co-organizers and a large number of the participants. Thanks again for all the contributions and great collaboration of our new SPC and LAC members, and further comments and suggestions are always greatly appreciated.

The 2008 CGU J. Tuzo Wilson Medallist: Ming-ko (Hok) Woo

Citation, by Nigel Roulet

Professor Ming-ko (Hok) Woo received his BA in Geography and Geology (1964) and his M.A. in Geomorphology (1967) from the University of Hong Kong. He then came to Canada to pursue a PhD in geomorphology in the Department of Geography at the University of British Columbia under the supervision of Professor Olav Slaymaker. It was during his PhD research that he began to study snow hydrology. Hok received his Doctorate of Philosophy in 1972 and that same year began his academic career as an Assistant Professor in the Department of Geography at McMaster University in Hamilton Ontario. He was promoted to Associate Professor in 1978 and became a Full Professor in 1983. He remained at McMaster University for his entire academic career. In 1993 he also became an associate member of McMaster's Department of Civil Engineering.

Throughout his career Professor Woo has received many awards and honours. In 1992 he received the Award for Scholarly Distinction in Geography from the Canadian Association of Geographers. The following year (1993) he was elected a Fellow of the Royal Canadian Geographical Society and a Fellow of the Arctic Institute of North America. In 1996 he was honoured with the President's Service Award in the Society of Wetland Scientists. He has been a pillar of the Canadian hydrological science community. He has served as the President and Vice President of the Hydrology Section of the Canadian Geophysical Union. He was a Vice Chairman, International Geographical Union, Commission/Study Group on Water Sustainability, committee member of the Canadian National Committee for International Association of Hydrological Sciences, Canadian National Committee for the World Climate Research Program, Committee on Hydrology, Geographical Society of China, and International Geographical Union Study Group on Regional Hydrology Responses to Global Warming. He has also served as a chief delegate for the Canadian delegation to the International Hydrological Program Northern Research Basin Symposia. Most recently he was the lead investigator on the Global Energy and Water Experiment (GEWEX) Canadian Mackenzie GEWEX Study (MAGS) research network. Professor Woo has also served on the editorial boards of a number of scientific journals including *Nordic Hydrology*, *Physical Geography*, *Journal of the Society of Wetland Scientists*, *Canadian Geographer*, and *Géographie Physique et Quaternaire*.

Professor Woo's has contributed to integrating three main areas of hydrology: the hydrology of cold regions, the hydrology of wetland ecosystems, and stochastic and statistical hydrology. In addition he has

made a significant contribution in applying hydrology and fluvial geomorphology in developing areas. His research has focused on understanding the principles of catchment, hillslope, and wetland hydrology and applying basic scientific knowledge to the assessment of potential changes in hydrological systems by environmental stressors such as climate variability and change, and human modification to the landscape. Throughout his career he has combined empirical, experimental and observational studies with both deterministic and stochastic modelling.

A quick review of Professor Woo's publication record indicates that he has produced a large quantity of high quality papers. He has published over 170 papers in refereed journals and conference proceedings. His main outlets have been the premier journals in hydrology such as Water Resources Research; Journal of Hydrology; Hydrological Processes; and the Hydrological Sciences Journal; and journals more focused on cold regions science such as Permafrost and Periglacial Processes; Arctic, Antarctic and Alpine Research; Nordic Hydrology; Cold Regions Science and Technology; Journal of Cold Regions Engineering; and the Journal of Glaciology. His work also appears frequently in journals that are read regularly across fields such as Geophysical Research Letters; Climate Change; Bulletin of the American Meteorological Society; The Canadian Journal of Earth Sciences; Mitigations and Adaptation Strategies for Global Change; and Wetlands. Unlike many of his fellow physical geographers, Professor Woo has published in physical geography journals such as Physical Geography; Progress in Physical Geography; Applied Geography; Catena; Annals of the American Association of Geographers; and the Canadian Geographer, to ensure a strong and viable discipline.

In his publishing one could say he has come somewhat full circle with receiving this award in Banff, Alberta. His first peer-review paper "A numerical simulation model of snow storage in small coastal basins in southwestern British Columbia" appeared in the 1972 Proceedings of the International Symposia on the Role of Snow and Ice in Hydrology, *International Association of Hydrological Sciences Publication* 107, 992-1003, a symposium held in Banff. There is no question that Hok is best known for his work in cold regions and permafrost hydrology. A quick search using the key words of snow, cold regions and permafrost hydrology reveals the author M-K Woo at the very front of the list. This body of work spanned whole catchment hydrological balances and hillslope runoff processes to detailed process studies on how water percolation through layered snowcovers, over winter water loss in soils, and basal ice production.

However Professor Woo was not unidimensional in his exploration of hydrological systems. He is equally well known for his work on wetland and peatland hydrology where he studied runoff production and water balance in wetlands stretching from the high arctic to the cool temperate region. He examined the hydrology of prairie potholes, or sloughs as they are known in western Canada. This work led to several seminal review papers, co-authored with Dr. Thomas Winter of the United States Geological Survey. He also made a major contribution in the literature on hydrological connectivity in complex landscapes such as the Canadian Shield where he and his students developed the concept now referred to as “fill and spill” runoff generation.

Hok also worked in some of the more applied aspects of hydrology. In the mid 1990s he studied water use in Nigeria as a Principal Investigator of a Canadian International Development Agency (CIDA) sponsored project. In the late 1980s he led a project on soil erosion and land management in the granitic areas of Guangdong Province China for the International Development Research Centre (IDRC), Canada.

In conjunction with his empirical studies, Professor Woo always had a ‘foot’ in hydrological modelling. His modelling comprised two approaches. He was interested in how one can characterize hydrological regimes and how they change with time and/or environmental conditions. With the few brave students who would follow his interest in statistical hydrology (most of his students were empiricist) he studied flow regimes in Ontario and other geographical regions, developing and expanding the basic statistical tools for analyses. He has also made contributions to deterministic modelling, particularly on the modelling of snowmelt, snowmelt infiltration into cold snow, and how permafrost and the presence of organic soils in permafrost settings alter the hydrology. This work culminated in his recent challenge to the climate modelling community to recognize the critical role the thermal properties of organic soils in the predictions of changes in active layer thickness due to climate change. Through his activities in the Mackenzie GEWEX Study, Professor Woo has been involved in hydrological modelling studies of larger river basins such as the Liard Basin.

Aside for Professor Don Gray, a former Tuzo Wilson Medal winner, it would be difficult to find another Canadian hydrologist that has played such an important role in the training of the current generation of Canadian catchment and process hydrologists. Many of his PhD students have gone on to distinguished careers as research hydrologists in universities and/or government research centres. He has supervised over 16 M.Sc. and 12 PhD students. One needs to look no further than the book of

abstracts for the present meeting of the CGU. Thirty-four oral and poster presenters can trace their academic lineage back to Professor Woo. At this meeting are six of his academic children. They in turn have generated at this meeting 13 academic grandchildren, 11 great grandchildren, and 4 great, great grandchildren. This importance as a giant on whose shoulders a considerable amount of Canadian environmental hydrology rests has led some to suggest we need to identify Woo as a unique species of hydrologist by the name *Frigo aqua homo canadensis* MKW var.

It is appropriate to complete this citation with some of the praise his colleagues in the hydrological sciences have given him. Professor Woo went to the University of Alaska on his first sabbatical to collaborate with the famous permafrost hydrologist, Professor Douglas Kane. Doug writes “... Professor Woo has had an excellent academic career in the field of hydrology, he has amassed a significant volume of scientific contributions in the area of northern hydrology, and he has produced numerous graduate students that will carry on his legacy. The Tuzo Wilson medal of the CGU would be a fitting reward for a dedicated, tireless researcher and promoter of high latitude hydrologic knowledge.” Dr. Tom Winter of the USGS writes “... It seems that every paper was of yet another type of wetland system that took yet another innovative approach to develop understanding of that system. Not only is Dr. Woo an innovative thinker, the field and analytical methods he used also were innovative, and remarkably thorough ...” and “It is unquestioned that Dr. Woo is a first-rate scientist, but he is also a first-rate human being ...”. Finally Dr. Larry Hinzman from the University of Alaska, representing a generation of younger northern hydrologists states “Dr. Woo is a shining star in the international hydrology research community. His energy and insight have propelled him through a career as a prolific researcher and valued collaborator. He is a dynamic scientist with the energy and character to inspire his colleagues and students.”

As a former student of yours, a fellow hydrological scientist, and a friend it was with a pleasure and with great pride I was given this opportunity to present the 2008 CGU J Tuzo Wilson Medal citation. I can think of no more appropriate and deserving recipient. We all thank you for contributions to scientific hydrology as one of its most enthusiastic builders, support, intellectual contributor, and myth slayer. May you continue to slay myths.

Nigel Roulet
James McGill Professor of Geography
McGill University, Montreal

Acceptance, by Ming-ko (Hok) Woo

Mr. President, Professor Roulet, dear colleagues and guests.

This is the 100th year after Dr. John Tuzo Wilson was born, and the thirty-first year since the Tuzo Wilson Medals was awarded to distinguished recipients, with Dr. Wilson himself being the first in 1978. I stand humble, grateful and honoured for being conferred this most prestigious award of the Union.

Applied hydrology is as ancient as the Egyptian pharaohs or the Chinese emperors of many dynasties past. However, scientific hydrology as we understand it is only decades old. This relative youthfulness parallels geophysics in general, considering that Tuzo Wilson had to take geology and physics separately as an undergraduate, and he graduated in 1930. In the 1960s, government scientists played a major role in hydrologic and hydrology-related research through institutions such as the National Research Council, Meteorological Branch, which became the Meteorological Service, the Geographical Branch and the Glaciology Division, or the Alberta Research Council. In universities, hydrology was taught mainly in professional schools like Engineering, Agriculture and Forestry, but hydrology was only peripheral to other academic departments. It was against this background that I arrived from the crowded tropical metropolis of Hong Kong to the then peaceful and quiet city of Vancouver.

I received my undergraduate degree from the University of Hong Kong in Geography and Geology, and my Masters degree in Geomorphology. Imagine my fascination with the first snowfall in 1967. I was quickly attracted to the hydrology of snow and since then, I have pursued cold region hydrology for forty years. At the time of my doctoral study, numerical modeling and data analyses gained popularity and importance as researchers were given a powerful tool called the digital computer. The impossible decks of computer cards had always the first priority to be protected against the incessant winter rain that followed me to the Computing Centre of the University of British Columbia. That was an exciting time for physical hydrology in Canada, with many hydrologic unknowns yearning to be explored. One defining moment was the delivery of a Seminar Series by a group of experts, culminating in the publication of a book edited by Donald M. Gray, another Medalist, entitled "Handbook on the Principles of Hydrology." It was published in 1970, yet remains a classic text for hydrologic students and practitioners today.

Fieldwork features prominently in Canadian hydrology. I was encouraged and greatly facilitated by my colleagues at McMaster University to conduct field research. The vast and varied land of Canada and its endowment of water resources offer unlimited prospects for hydrologic process investigations. I often recall with

excitement the intoxicating scent of the damp forest air of the rain-soaked West Coast, the tormenting attacks of insects as one splashes and slogs through the swamps, the fast approach of a thunderstorm that blotches the open prairie sky, the fearful breakup and forceful rafting of the tumultuous river ice, the serenity of gauging placid streams that thread through the permafrost tundra or the rendering of snowmobile tracks across endless stretches of pristine Arctic snow. All these are the bonus that comes with fieldwork. The main satisfaction for me was to glean a better understanding of various hydrologic processes that operate under the influence of low temperatures.

Climate change comes with a pressing need for hydrologic prediction and monitoring, usually on a large-basin or regional scale. This provides an impetus for further advancement in statistical hydrology and hydrologic modelling, for data augmentation both from remote sensing platforms and from ground-based networks. There are much needed research collaborations across disciplinary boundaries. In the past decade, I was fortunate to have worked with atmospheric, earth and hydrologic scientists and engineers on the Mackenzie GEWEX Study. This and other partnership programmes are healthy moves towards linking physical hydrology with other branches of science.

My academic life has been a wonderful voyage in hydrology, be it field studies of physical processes, model application and statistical analyses of data, collaborative investigations of trans-disciplinary problems, or education of the next generations. For fifteen years, scientific hydrology has been an integral part of the Canadian Geophysical Union. We now have a vibrant forum for the practicing hydrologist and a nurturing environment for hydrologists in training. Hydrologic training has been expanding over the years, and training is a two-way flow whereby the teachers also learn from the students, as I have thus been benefited.

I take this opportunity to thank my former students and research associates for the many stimulating discussions and arguments we had. Together with my colleagues and collaborators in various research projects, they gave me inspirations and broadened my knowledge. I acknowledge the support for my research in Canada and overseas by various agencies, and I particularly mention these two: the Natural Sciences and Engineering Research Council for its unwavering support through a rigorous adjudication system, and the Polar Continental Shelf Project that enables many university researchers to make scientific discoveries in remote corners of the Northern domain. With this Medal, I pay tribute to my family, my former students and research associates, and my colleagues who give a warm human face to the cold science. Thank you all for the indulgence.

The 2008 CGU Young Scientist Award Winners: Brian Branfireun & Scott Lamoureux

Citation for B. Branfireun, by J.M. Waddington

It is my great honour to introduce one of the 2008 CGU Young Scientist Award winners, Dr. Brian Branfireun.

Brian is an ecohydrologist who has a contagious commitment to the cause of his research on one of the most devastating pollutants in our environment – mercury.

With a foundation of catchment hydrology in temperate and boreal ecosystems, he has also developed into an internationally respected biogeochemist. He has been highly involved in an international collaboration (METAALICUS) to assess atmospheric loading of mercury from a truly interdisciplinary approach that showed how rapidly mercury signals move through watersheds and show up in fish populations. Over the past few years he has expanded his research on mercury dynamics to also explore mercury in urban environments, atmospheric mercury deposition to ecosystems, ecosystem mercury dynamics in a sub-tropical setting, and the impacts of commercial mining on mercury export to ecosystems.

The importance and breadth and interdisciplinary nature of his research in mercury in the environment is evident in a high citation rate, numerous publications in a number of top-rate journals, an

exceptional record of independent funding, and his involvement as an expert advisor on various national and international panels dealing with mercury issues.

Brian is extremely dedicated to his students and to the Canadian hydrological community. He is an exceptionally diligent supervisor with a sense of equity and fairness that is unanimously respected by his past and present students. He is also an executive member on the CGU-HS board.

Here is a quote from a fellow CGU-HS member. “Brian is one of the brightest scientists I know. He is enthusiastic, determined and funny. He is easy to work with, has a vision and clarity of understanding, and is ambitious.

Yes he is certainly ambitious. In addition to his research, he travels greatly with his wife Marnie and together they are greatly dedicated to their love of dog sports. How does he do it? Well for those that don’t know Brian, he is a compulsive tinkerer. There is usually something in pieces at the Branfireun house. The latest project was one that was closely coupled to the requirements of Brian’s professional life - a commercial-sized espresso machine.

Congratulations Brian.

Acceptance, by Scott Lamoureux

It is a tremendous honour to receive the CGU Young Scientist Award. The mere fact that I am still considered “young” is remarkable, but to have my research efforts recognized by my peers is a deeply gratifying experience. Of course, like all researchers, my efforts have been shaped by the exceptional efforts of the people around me. Mentorship as a graduate student by John England and Martin Sharp laid the foundation for my research career- “keep your stick on the ice, Scientist.” Colleagues at Queen’s and elsewhere have been incredibly supportive and generous with their efforts and resources to help me achieve my goals, particularly my departmental collaborators Bob Gilbert, Melissa Lafrenière and Paul Treitz. But the core of my efforts has been supported by a group of graduate and undergraduate students that have

worked tirelessly and with great humour to collect samples, fix another datalogger, or to run seemingly endless laboratory analyses. They have challenged my efforts and inspired me with their questions, insights and scientific creativity. Perhaps more importantly, they have fearlessly challenged me with criticism and pushed me to take forks in the road that have been deeply rewarding and fruitful. Finally, but most importantly, my wife Linda has suffered with my fieldwork for nearly twenty years with grace and patience, and my children Mac and Brenna have accepted my absences, unexpected laboratory trips, and apparently random road stops to look at sediments and rivers, but have made me feel like I have not missed anything. They have always reminded me why science and research is so important.

The 2008 CGU Meritorious Service Award Winner: Patrick Wu

Citation, by Rod Blais

I am very pleased to announce the recipient of the 2008 CGU Meritorious Service Award, Dr. Patrick Pak-Cheuk Wu. Dr. Patrick Wu, or Patrick, has been a member of CGU since 1991 and has contributed greatly to the organization of CGU Annual meetings since 1993. However before describing his contributions to CGU, I would like to present his brief biography.

Patrick was born in Hong Kong and attended Pickering College, in Newmarket, ON, from 1969 to 1971, and the University of Toronto from 1971 to 1982. He obtained a B.Sc. in 1975, an M.Sc. in 1978 and a Ph.D. in 1982 with Dr. R. Peltier as Supervisor. After a brief PDF stay at the University of Toronto, he went to work as an Exploration Geophysicist for some four years. Then he joined the University of Calgary as a PDF in Geomatics Engineering and later on, as a faculty member in Geology and Geophysics (now Geoscience). He has been a full Professor in Geophysics since 2002. He has published numerous papers in geophysics and

geodynamics and edited a book entitled 'Dynamics of the Ice Age Earth – A Modern Perspective' in 1998. He is also Associate Editor of the Journal of Geodynamics. His research interests are mainly in Global Geophysics, Geodesy and Geodynamics, and more specifically in ice age geodynamics and related climate changes.

We have been fortunate to have Patrick as a very active member of our Calgary CGU Organizing Committees since 1993. He has developed our conference website www.ucalgary.ca/~cguconf from the beginning when HTML was not very well known, and has upgraded and maintained it ever since. Every year, we send our requests to Patrick and things get done whether Patrick is on campus or in Hong Kong or Vienna ...

His contributions towards the success of our CGU Annual Meetings for over 15 years clearly make him most deserving for the CGU Meritorious Service Award and am very happy to see Patrick receive the Award.

Acceptance, by Patrick Wu

Thank you. It is my privilege and pleasure to serve CGU. I'd like to thank Rod Blais, Ed Krebs, Masaki Hayashi, Margaret-Anne Stroh and all present and past CGU

Executives for their help during all these years. If you like the new look of the CGU web page, the credit should go to Mei Jun for her new design!



HYDROLOGY SECTION NEWS

CGU-HS Northern Research Basins Committee (28 March 2008)

Chair and Canadian Chief Delegate: Kathy L. Young, Geography Department,
York University

One of the main activities of the CGU-HS Northern Basins Committee during the last year was participation at the 16th NRB Symposium and Workshop held in Petrozavodsk, Russia, 27-Aug. to 2-Sept. 2007. The

general theme of the 16th meeting was **Time-space changes in the northern hydrological systems: features, consequences, prediction**. As outlined in the NRB Mandate and the Canadian NRB terms of

Reference, the Canadian participation in the NRB is limited to 10 delegates appointed by the Canadian Chief Delegate (and approved by the CGU-HS Executive) to represent Canadian interest in the hydrology of northern areas. The Canadian Chief Delegate to the 17th meeting was Kathy Young. Chris Spence, who took over the Deputy Chief Delegate position from Philip Marsh was unfortunately not able to attend.

Canadian delegates are invited based on past experience and in order to represent various aspects of Canadian northern hydrology. While nine delegates initially indicated that they would attend, due to last minute federal government budget constraints and visa issues, only five Canadian delegates attended. Participants included Hok Woo (permafrost modelling), Kathy Young (high arctic environments), Richard Janowicz (operational water resources and the Wolf Creek research watershed), Melissa Lafreniere (cold regions hydrology and biogeochemistry) and Anna Abnizova (subarctic, high arctic wetland hydrology). Other participants attending the meeting included delegates from the USA, Denmark, Finland, Japan and Russia. Plenary sessions included papers on Climate Change Impacts on Hydrological Processes; Snow & Ice, Regional Hydrology and Hydrologic Methods & Investigations. Limited task force reports (PUB, Thermal Regime of Lakes) were presented during the workshop. All delegates appreciated the kind hospitality of the Russians and enjoyed a rafting trip down the Shuga River, a boat trip on Lake Onego and a cultural side-trip to Kizhi Island. However, the attending NRB group was disappointed that no delegates from Sweden, Norway and Iceland attended and a letter was circulated by Doug Kane (USA Chief Delegate) urging a greater participation in 2009. As in other years, Canadian participants were invited to submit their paper to the refereed journal *Nordic Hydrology* (to be renamed

Hydrologic Research) for a special edition.

Canada will be hosting the 17th NRB meeting **August 12-18, 2009**. The symposium/workshop will be held on an expedition ship which will travel from Iqaluit to Pangnirtung and then onto Kuujuaq. The conference theme is **Managing Hydrological Uncertainty in High Latitude Environments**. Achievements from the IPY will also be communicated and there will be a special session on Hydrology and Ocean Interactions. Plans are underway to hold a Public Workshop/Open House in Pangnirtung where a discussion on critical water issues, both local and global will be held. An organizing team as been formed (Kathy Young, Chris Spence, William Quinton, Richard Janowicz Sean Carey, Melissa Lafreniere, Anna Abnizova and Laura Brown) and fund-raising has commenced. An application was recently submitted to the IPY Government of Canada Program-Training, Communications and Outreach. Support for the conference has recently come from INAC-NWT, CGU & CGU-HS, Yukon Government, Environment Canada, University of Wilfrid Laurier, Carleton University, Queen's University and York University. A preliminary announcement of the meeting circulated early October 2007, and a formal call for papers will occur in early September 2008.

Canada has taken back responsibility for the main NRB websites and NRB listserv and is actively trying to rejuvenate the Northern Research Basins working group. Laura Brown has updated these web sites: <http://www.canadiannrp.com> and <http://www.northernresearchbasins.com>. Information about the 17th NRB can be found on these websites or contact Kathy Young for more details: klyoung@yorku.ca.

CGU-CGRG 2008 Best Student Paper Award Winners

A number of awards were presented in recognition of outstanding performance in scientific research and presentation by students. Each of the awards comes with a monetary prize. The awards were announced and presented at the Awards Banquet at the recent CGU-CGRG Annual Meeting in Banff, Alberta. To be considered for an award the student must be the first author and presenter of the paper. The winners are

listed below, and the extended abstracts for the D.M. Gray and Campbell Scientific Awards appear below.

The CGU component of the Organizing Committee of the Congress and the CGU Executive Committee would like to sincerely thank all the judges of the student papers for their careful evaluations of the student presentations.

CGU Best Student Paper Award (all fields of geophysics – oral presentation)

Winner: J.M. Shea (University of British Columbia).
Glacier melt model sensitivity to climatic forcings (co-author: R.D. Moore).

Runner-up: J.T. Gardner (University of Western Ontario).
Confluence evolution and river bed deposit geometry in a braided river model (co-author: P.E. Ashmore).

Runner-up: C. Alexandrakis (University of Western Ontario). Study of the Earth's outermost core using empirical transfer functions (co-author: D.W. Eaton).

Chevron Canada Outstanding Student Paper in Seismology (oral or poster presentation)

Winner: C. Alexandrakis (University of Western Ontario). Study of the Earth's outermost core using empirical transfer functions (co-author: D.W. Eaton).

Runner-up: M. Villemaire (GEOTOP UQÀM-McGill, Université du Québec à Montréal). Travel-time tomography of the Abitibi-Grenville region, eastern Canada (co-author: F. Darbyshire).

Runner-up: S. Hippchen (University of Victoria).
Thermal models of the Sumatra subduction zone: implications for the megathrust seismogenic zone (co-author: R.D. Hyndman).

Shell Canada Outstanding Student Poster Paper

Winner: J. Leach (University of British Columbia).
Stream energy exchange processes with special reference to stream-subsurface interactions (co-author: R.D. Moore).

Runner-up: M.C. Richardson (University of Toronto).
Concentration-flux-discharge relationships in forested peatland catchments: implications for watershed mercury sensitivity (co-author: B.A. Branfireun).

Runner-up: F. Forouhdeh (University of Western Ontario). Seismic Anisotropy beneath Hudson Bay: Constraints from Shear-Wave Splitting

Analysis (co-authors: D.W. Eaton, K.F. Tiampo).

D.M. Gray Award for Best Student Paper in Hydrology (oral presentation)

Winner: G. Lilbæk (University of Saskatchewan).
Enhanced Infiltration Reduces Ion Load in Infiltration Excess Water during Snowmelt (co-author: J.W. Pomeroy).

Campbell Scientific Award for Best Student Poster in Hydrology

Winner: H. Dugan (Queen's University). The contribution of unusual active layer thaw in the hydrological and sediment yield response to rainfall events in a small High Arctic Watershed (co-authors: S.F. Lamoureux, M.J. Lafrenière, T. Lewis).

Geodesy Award for Best Student Paper in Geodetic Research & Education (oral presentation)

Winner: P. Vergados (York University). Ionospheric Corrections for the estimation of Bending Angles derived from COSMIC mission Excess Phase Delays (co-authors: S. Pagiatakis, M. G. Shepherd).

Runner-up: R. Kingdon (University of New Brunswick).
A forward modelling approach for estimation of 3D density effects on geoidal heights (co-authors : P. Vanicek, M. Santos).

CGRG Best Student Paper Awards (Olav Slaymaker Awards)

Winner (Best Oral Presentation) : A.E. Zimmermann (University of British Columbia). Step-pool stability experiments (co-authors : M. Church & M.A. Hassan).

Winner (Best Poster Presentation) : E. Stephani (University of Alaska). Preservation of the Alaska Highway (co-authors : D. Fortier, R. Walsh, Y. Shur).

Enhanced Infiltration Reduces Ion Load in Infiltration Excess Water during Snowmelt

Gro Lilbæk* and John W. Pomeroy

Centre for Hydrology, University of Saskatchewan,

117 Science Place, Saskatoon, Saskatchewan, S7N 5C8, Canada. *g.lilbaek@usask.ca

ABSTRACT

Meltwater ion concentration and infiltration rate into frozen soil both decline rapidly as snowmelt progress. The temporal association between them is highly non-linear and a covariance term must be added in order to use time-averaged values of snowmelt ion concentration and infiltration rate to calculate chemical infiltration. The covariance is labelled *enhanced infiltration* and represents the additional ion load that infiltrates due to the timing of high meltwater concentration and infiltration rate. Previous assessment of the impact of enhanced infiltration has been theoretical, thus, experiments were carried out to examine whether enhanced infiltration to frozen soil can be recognized in controlled laboratory settings and to what extent its impact varies with soil moisture. Three experiments were carried out: one with dry soil (0%), one with saturated soil (100%), and one with unsaturated soil (85%). Chloride solution was added to the surface of frozen soil columns; the concentration decreased exponentially over time to simulate snow meltwater. Infiltration excess water was collected and chloride concentration and volume were determined. Ion load infiltrating the frozen soil was dictated by mass conservation. Results showed that infiltrating ion load increases with decreasing soil moisture; however, the impact of enhanced infiltration increased considerably with increasing soil moisture. Normalized enhanced infiltration showed that 250% more ion load may infiltrate during saturated conditions than if calculated from time-averaged ion concentration and infiltration rate; only 131% more infiltrated during the dry conditions and 149% during unsaturated. Reduction in infiltration excess ion load due to enhanced infiltration increased slightly (2–5%) over time; being greatest for the dry soil (45%) and least for the saturated soil (6%). The importance of timing between high ion concentration and high infiltration rate was best illustrated in the unsaturated experiment which showed greatest inter-column variation in enhanced ion infiltration and impact hereof.

INTRODUCTION

The flow pathway of snowmelt ions is important for determining the aquatic or terrestrial sink for these ions and the timing of ion delivery to water bodies (Lilbæk and Pomeroy, 2007). Using Zhao and Gray's (1997) parametric relationship for the cumulative mass of water that infiltrates into frozen soil, F [kg m⁻²], and Stein *et al.*'s (1986) expression for meltwater ion concentration, $C_i(t)$ [meq m⁻³], Lilbæk and Pomeroy (2007) showed that the temporal association between infiltration rate, $f(t)$ [kg s⁻¹ m⁻²], and meltwater ion concentration, $C(t)$, is highly non-linear even though both decline rapidly with time. Cumulative infiltration of snowmelt ions is enhanced by initially higher ion concentration in meltwater and infiltration rate. However, time averaged ion concentration, \bar{C}_i , and infiltration, \bar{f}/ρ , where ρ [kg m⁻³] is the solution's density, are far easier and more reliable to estimate than are concentrations and infiltration rates at any one time. Thus, in order to reliably calculate the cumulative ion load infiltrating a frozen soil, F_i [meq m⁻²], the covariance between the instantaneous values of $C_i(t)$ and $f(t)$ has to be added to the mean terms:

$$F_i = \int_0^t C_i(t) \cdot \frac{f(t)}{\rho} dt = \frac{\bar{C}_i \cdot \bar{f} \cdot t}{\rho} + cov[C_i(t), f(t)] = \frac{\bar{C}_i \cdot F}{\rho} + cov[C_i(t), f(t)] \quad (1)$$

This covariance term is labelled *enhanced infiltration* and represents the additional load of ion that infiltrates during snowmelt due to the combination of initially rapid infiltration rate and

higher ion concentration in meltwater (Lilbæk and Pomeroy, 2007). Its magnitude was found to be governed by initial snow water equivalent [kg m^{-2}], average melt rate [$\text{kg s}^{-1} \text{m}^{-2}$], and the meltwater ion concentration factor, CF [$(\text{meq m}^{-3}) (\text{meq m}^{-3})^{-1}$].

The objective of this paper is to examine whether enhanced infiltration can be identified in a controlled laboratory experiment. It is hypothesised that initial soil saturation will influence enhanced infiltration. Thus, soil columns with different initial soil moisture contents were used. It was assumed that solutions released to the soil surface were conservative, fully mixed within each time step, and that mass and energy were conserved.

METHODOLOGY

The experimental setup consisted of 0.46 m long frozen soil column with a surface area of 0.004 m^2 (Figure 1A). Each column consisted of an acrylonitrile butadiene styrene (ABS) pipe with a 1 mm mesh at the base. The columns were filled with 30 mm of coarse quartz sand ($\sim 2 \text{ mm}$) to prevent the overlying soil from exiting the column, $\sim 0.32 \text{ m}$ of homogenized, dried, and grinded loamy soil collected at a forested site in the Marmot Creek Basin, Kananaskis Valley, AB, and $\sim 0.11 \text{ m}$ of an in-situ soil sample from the same field site. The columns were placed on top of $\sim 70 \text{ mm}$ of sand to allow air escaping freely during the infiltration experiments.

Type-E thermocouples were placed at the interface between the in-situ soil sample and the homogenized soil and one towards the base of the column ($\sim 0.34 \text{ m}$). Temperatures were averaged and recorded every hour by a Campbell Scientific Canada 21X datalogger.

Frozen soil conditions were maintained by circulating coolant through copper pipe, coiled tightly around the ABS pipe, and connected to a temperature controlled refrigerated bath (RTE-DD8, Neslab). Filter sand was used to fill the voids between the coils. Duct insulation was wrapped around the outside of each column for further insulation.

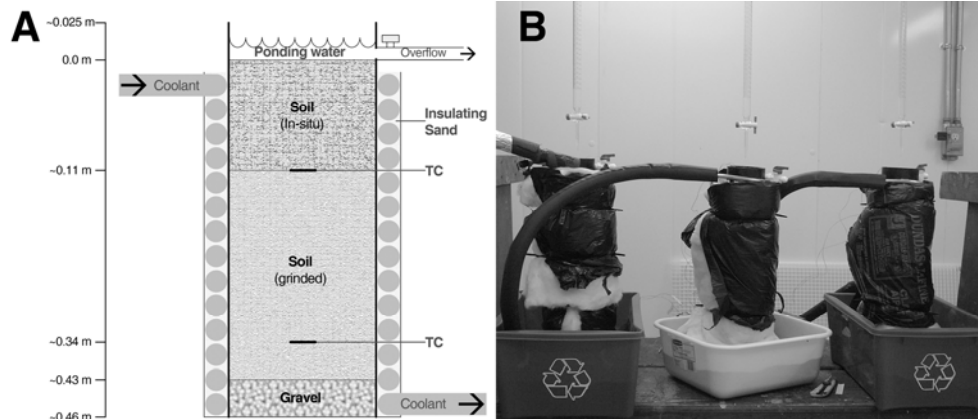


Figure 1: A) Schematic drawing of soil column setup (not to scale). B) Three columns set up in coldroom with burettes over top.

Experiments were carried out in a temperature controlled cryospheric environmental laboratory containing a dual refrigerating system (Heatcraft, BZ series). Soil columns were allowed to freeze at -2°C ($\pm 2^\circ \text{C}$) for a minimum of 12 hours where after the room temperature was increased and the experiment was initiated; average temperature during experiments was $+1.6^\circ \text{C}$ ($\pm 1.2^\circ \text{C}$). All materials were cleaned thoroughly prior to each experiment with deionized distilled water and plastic gloves were worn at all times to prevent contamination.

Three experiments were carried out differing with respect to initial average soil saturation, S_I [$\text{mm}^3 \text{mm}^{-3}$]. S_I was estimated from average volumetric soil moisture, θ [$\text{mm}^3 \text{mm}^{-3}$], and average soil porosity, ϕ ($S_I = \theta / \phi$). S_I was 0% in experiment 1 (dry conditions), 100% in

experiment 2 (saturated conditions), and 85% in experiment 3 (unsaturated conditions). Each experiment was conducted simultaneously on three soil columns (Figure 1B).

Chloride solution was added to the soil surface at rates varying between 0.001 and 0.020 $\text{kg s}^{-1} \text{m}^{-2}$ using 100 ml burettes; the average rate was 0.010 $\text{kg s}^{-1} \text{m}^{-2}$. Chloride concentration decreased exponentially from ~ 82000 to ~ 4000 meq m^{-3} over the experimental period to simulate natural changes in meltwater ion concentration. An overflow valve prevented $> \sim 10$ mm ponding.

Infiltration excess water was collected using a syringe at increasing time intervals. Total experimental time was 12 hours. Samples were stored at 5 °C for ~ 24 hours until analysed using an Orion 290A meter with an Orion chloride combination electrode (9617B). Detection sensitivity of the electrode was found to be 3 mV over 10 readings. Triplicate readings were done on all water samples, allowing < 1.5 mV differences between readings. Calibration curves had correlation coefficients of 0.99.

RESULTS

A summary of experimental setup is given for each soil column in Table I. Major differences between experiments were due to the initial soil saturation. Differences in average porosity ($< 0.04 \text{ g cm}^{-3}$), dry bulk density (< 0.2), room temperature (0.1 °C), and average precipitation rates ($< 0.003 \text{ kg s}^{-1} \text{m}^{-2}$) were considered minor. Greatest inter-column variability was observed in average soil temperature ranging between -0.7 and -1.4 °C with standard deviations ranging between 0.4 and 1.2 °C.

Table I: Summary of experimental setup for each soil column.

Experiment	1: Dry			2: Saturated			3: Unsaturated		
Column #	1	2	3	4	5	6	7	8	9
Soil saturation, ave. (S_i , $\text{mm}^3 \text{mm}^{-3}$)	0.00	0.00	0.00	1.00	0.99	1.00	0.88	0.86	0.84
Soil porosity, ϕ	0.45	0.46	0.46	0.42	0.42	0.42	0.41	0.44	0.41
Dry bulk density (g cm^{-3})	1.5	1.4	1.4	1.5	1.5	1.5	1.6	1.5	1.6
Soil temperature, ave. (°C \pm stdev)	-1.4 ± 1.1	-0.9 ± 0.8	-0.9 ± 0.8	-0.9 ± 0.9	-0.7 ± 0.4	-0.8 ± 0.5	-1.2 ± 1.2	-0.9 ± 0.6	-0.8 ± 0.6
Precipitation rate, ave. ($\text{kg s}^{-1} \text{m}^{-2}$)	0.011	0.010	0.011	0.009	0.008	0.010	0.009	0.009	0.010

Ponding occurred after approximately two hours in experiment 1 (0%), where as it occurred instantaneously in experiment 2 (100%). In experiment 3 (85%), ponding took place almost instantaneously for column 7 and 9 and after 25 minutes for column 8. The mass of water added to the soil surface, P [kg m^{-2}], and the mass of collected infiltration excess water, R [kg m^{-2}], were recorded throughout the experiment. Mass of infiltrated water, F , was estimated from $F = P - R$. Greatest F was observed for the dry soil with an average of 119.7 $\text{kg s}^{-1} \text{m}^{-2}$ (Table II); average F was $\sim 25.2 \text{ kg s}^{-1} \text{m}^{-2}$ for the unsaturated soil and $8.7 \text{ kg s}^{-1} \text{m}^{-2}$ for the saturated.

Table II: Summary of infiltration results for each soil column.

Experiment	1: Dry			2: Saturated			3: Unsaturated		
Column #	1	2	3	4	5	6	7	8	9
Precipitation Cl^- concentration, ave. (meq m^{-3})	21873	22822	19831	24587	23472	22874	23967	23472	24069
Precipitation Cl^- concentration, ave. (ppm)	777	810	704	873	833	812	851	833	854
Cumulative mass infiltrating, F ($\text{kg s}^{-1} \text{m}^{-2}$)	119.7	119.3	120.0	12.2	6.3	7.7	19.4	39.6	16.7
Cumulative ion load infiltrating, F_i (meq m^{-2})	5953	6189	5643	1172	478	600	870	2375	1174
If no covariance (meq m^{-2})	2625	2721	2387	310	143	167	477	931	406
Normalized enhanced infiltration, NEI	1.27	1.27	1.37	2.90	2.21	2.42	0.82	1.56	1.92
Normalized infiltration excess ion load, NR_i	0.55	0.53	0.56	0.90	0.96	0.96	0.95	0.81	0.92

Chloride concentrations in P and R confirmed conservative behaviour of the solution; average differences between concentrations were $<10\%$, which was assumed to be a result of instability in electrode readings. The ion load infiltrating the frozen soil, F_i , was dictated by conservation of mass, $F_i = P_i - R_i$, where P_i and R_i are the ion load in respectively precipitation and infiltration excess water. Greatest F_i was observed for the dry soil with an average of 5928 meq m^{-2} and lowest for the saturated soil with an average of 750 meq m^{-2} (Figure 2A). F_i for the unsaturated soil ranged between 870 and 2375 meq m^{-2} with an average of 1473 meq m^{-2} .

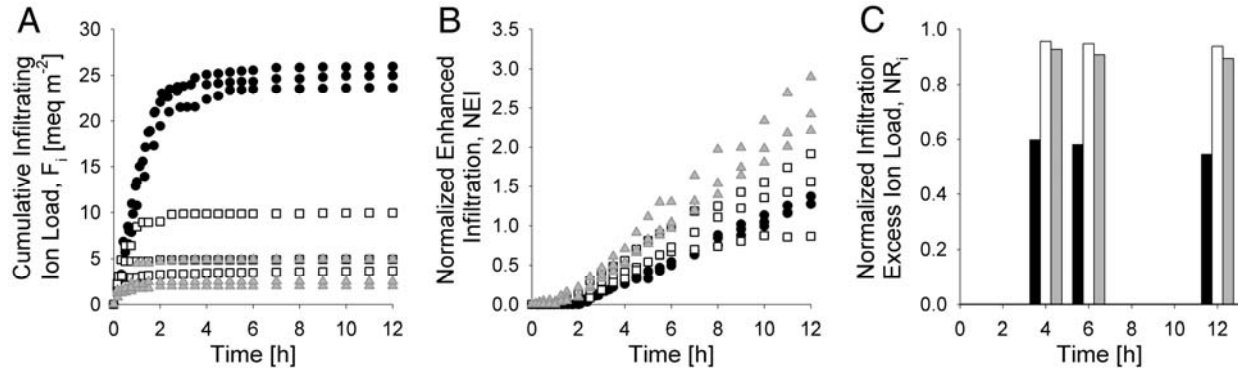


Figure 2: A) Cumulative ion load infiltrating, F_i , for each soil column. B) Variation with time in normalized enhanced infiltration, NEI , for each soil column. C) Variation in average normalized infiltration excess ion load, NR_i , after 4, 6, and 12 hours for each experiment type.

To assess the magnitude of enhanced infiltration, the normalized enhanced infiltration, NEI [$(\text{meq m}^{-2}) (\text{meq m}^{-2})^{-1}$], was calculated for each column. NEI is defined as the ratio between the cumulative enhanced infiltration and cumulative ion infiltration estimated from time-averaged ion concentration and cumulative infiltration (no covariance) (Lilbæk and Pomeroy, 2007):

$$NEI = \frac{\text{cov}[C_i(t), f(t)]}{\left(\frac{\overline{C_i \cdot F}}{\rho}\right)} = \frac{F_i - \left(\frac{\overline{C_i \cdot F}}{\rho}\right)}{\left(\frac{\overline{C_i \cdot F}}{\rho}\right)} \quad (2)$$

Greatest NEI were obtained for the saturated soil with an average of 2.50 (Table II) indicating that on average 2.5 times more ion load infiltrated than if calculated from time-averaged ion concentration and cumulative infiltration (no covariance). Average NEI was 1.31 for the dry soil and 1.45 for the unsaturated soil. Figure 2B shows how NEI increased with infiltration time; fastest for the saturated soil columns and slowest for the dry soil columns. Column 7 (unsaturated soil) changed slope after approximately 6 h and ended up with the lowest cumulative NEI (0.82).

The impact of enhanced infiltration on infiltration excess ion load, R_i [meq m^{-2}] was assessed by the normalized infiltration excess ion load, NR_i [$(\text{meq m}^{-2}) (\text{meq m}^{-2})^{-1}$]. NR_i is the ratio between R_i and the difference between P_i and F_i due only to time-averaged ion concentration and cumulative infiltration (no covariance) (Lilbæk and Pomeroy, 2007):

$$NR_i = \frac{R_i}{P_i - \left(\frac{\overline{C_i \cdot F}}{\rho}\right)} = \frac{P_i - F_i}{P_i - (F_i - \text{Cov}(C_i(t), f(t)))} = \frac{R_i}{R_i + \text{Cov}(C_i(t), f(t))} \quad (3)$$

After the initial third of the experimental period the ion load in the infiltration excess water was reduced due to enhanced infiltration ($I-NR_i$) by an average of 40% in experiment 1, 4% in experiment 2, and 7% in experiment 3 (Figure 2c); increasing slightly (2-5%) over the rest of the period. The variations in total R_i in-between columns were 3% in experiment 1, 6% in experiment 2, and 14% in experiment 3.

DISCUSSION AND CONCLUSION

Three experiments were conducted to assess whether enhanced infiltration to frozen soil can be recognized in controlled laboratory settings in addition to its magnitude. Each experiment differed with respect to initial soil saturation and was carried out simultaneously on three soil columns. Differences in porosities, average room and soil temperatures, and average precipitation rates were minor (Table I). The results show that enhanced infiltration takes place once partitioning of meltwater added to a frozen surface occurs.

From the three experiments it was demonstrated that F_i increases with decreasing initial soil moisture (Table II); general ranking order was dry >> unsaturated > saturated soil conditions. However, the impact of enhanced infiltration increases with increasing initial soil moisture content. Greatest NEI (2.90) was calculated for column 4 (saturated soil) with >50% difference to the other saturated columns. This was a result of F being twice that of the other columns most likely as a result of a higher soil temperature at the beginning of the experiment. On average, NEI in the saturated experiment was close to twice that of the other experiments with 250% more ion load infiltrating compared to only 131% when the soil was initially dry and 145% when the soil was unsaturated. NEI ranked the experiments saturated >> unsaturated > dry soil conditions. The reduction in R_i due to enhanced infiltration ($I-NR_i$) was most pronounced for the dry soil with 44-47%; ranking order was dry >> unsaturated > saturated soil conditions.

The unsaturated soil experiment showed the most inter-column variability in infiltration results. F for column 8 (39.6 kg m^{-2}) was twice that of column 7 and 9 resulting in the greatest F_i (2375 meq m^{-2}). Nevertheless, did column 9 have a F_i (1174 meq m^{-2}) half of that for column 8 with less than half the F . Lowest F_i was obtained by column 7 even though it had a higher F than column 9 illustrating the importance of timing between high $C_i(t)$ and $f(t)$.

In conclusion, enhanced ion infiltration takes place during infiltration of meltwater into frozen soil. This is due to initially higher infiltration rates and initially enriched ion concentrations in meltwater. Laboratory experiments with frozen soil showed that enhanced infiltration was greatest for saturated and near-saturated soils, but that even infiltration into dry soil may result in enhanced infiltration. The results also show that synchronicity between the timing of high ion concentration and infiltration rate greatly influence enhanced infiltration and therefore the flow path of snowpack ions during the melt and spring runoff periods. Future work will focus on examining whether enhanced infiltration can be identified in the field.

REFERENCES

- Lilbæk, G. and Pomeroy, JW. 2007. Modeling enhanced infiltration of snowmelt ions into frozen soil. *Hydrological Processes* **21**: 2641-2649. DOI: 10.1002/hyp.6788 and 10.1002/hyp.6905.
- Stein J, Jones HG, Roberge J, and Sochanska W. 1986. The prediction of both runoff quality and quantity by the use of an integrated snowmelt model. *IAHS Publication* **155**: 347-358.
- Zhao LT and Gray DM. 1997. A parametric expression for estimating infiltration into frozen soils. *Hydrological Processes* **11** (13): 1761-1775.

The Contribution of Unusual Active Layer Thaw in the Hydrological and Sediment Yield Response to Rainfall Events in a Small High Arctic Watershed

H. Dugan¹, S.F. Lamoureux, M.J. Lafrenière & T. Lewis

Department of Geography, Queen's University, Kingston, ON K7L 3N6

¹Email: 4hd2@queensu.ca

Introduction

In cold regions, the importance of antecedent mechanisms in producing flood flows from hydrometeorological events is extremely important, yet has received little study. To date, there has not been a documented summer precipitation event with a peak discharge or total sediment yield that exceeds the snowmelt discharge or sediment yield from the nival period in the High Arctic (Hardy et al., 1996). Although there are records of rain events creating substantial suspended sediment pulses in High Arctic catchments (Church, 1972; Cogley and McCann, 1976), low summer rainfall intensities rarely exceed infiltration capacity and active layer storage (Lewkowicz and Kokelj, 2002). With little vegetation, frozen or saturated bare ground inhibits infiltration, creating high runoff ratios (Church, 1972). If rainfall is capable of creating high intensity discharges, the suspended sediment concentration is usually much higher than snowmelt discharges of equivalent magnitudes (Woo and McCann, 1994).

This study reports the hydrological impact of two precipitation events in a small High Arctic watershed during the summer of 2007. High resolution soil and sediment transport records reveal the important role of antecedent controls on rainfall response during late summer. This study adds to existing literature at a site where river generation is sustained by winter snowpack melt, and initial SWE has previously been demonstrated as the most important climatological factor controlling seasonal sediment delivery (Cockburn and Lamoureux, 2007).

Study Site

Cape Bounty (74°55'N, 109°35'W) is a small coastal headland situated on the south-central coast of Melville Island, in the Canadian High Arctic. The non-glacierized catchment (7.9 km²) is composed of hilly terrain and lowlands ranging from 5-100 m asl, and is underlain by continuous permafrost. Classified as a polar desert, the region experiences mean July temperatures of 3-5°C and less than 125 mm of annual precipitation, with 60% falling as snowfall (Maxwell, 1981). Snowmelt is initiated in mid-June and typically wanes after several weeks.

Methodology

Meteorological: A meteorological station was established in the northwest corner of the catchment to record summer temperature at one-hour intervals with an Onset Hobo H8 logger ($\pm 0.7^\circ\text{C}$ accuracy), and precipitation with a Davis Industrial tipping bucket gauge (0.2 mm tip).

Hydrological: The West river (unofficial name) station recorded stage, electrical conductivity, turbidity and water temperature. A stilling well housed a HOBO U20-001-01 water level logger ($\pm 0.5^\circ\text{C}$ temperature accuracy, ± 0.5 cm stage accuracy), and a boom held a Global Water WQ301f, electrical conductivity sensor (accuracy $\pm 5\mu\text{S/cm}$), and an Analite 9000 turbidity probe (0-3000 NTU, accuracy $\pm 2\%$) 50 cm from the bank. A discharge rating curve was generated from daily depth/velocity and stage measurements between June 13 – July 23.

Soil Moisture and Temperature: Soil monitoring stations were equipped with either YSI 44033 thermistors (accuracy $\pm 0.2^\circ\text{C}$) or Onset TMC1/TMC6 temperature sensors (accuracy

$\pm 0.4^{\circ}\text{C}$). All stations included a Decagon ECH₂O gravimetric soil moisture sensor (accuracy $\pm 3\%$) that integrated the upper 10 cm and were logged with either an Onset Hobo H8 or U12 four channel datalogger at two hour intervals. Gravimetric soil samples intended for moisture calibration were destroyed during transport to the laboratory.

Results

At Cape Bounty, total summer precipitation was 29.6 mm, with 9.2 mm and 10.8 mm falling on June 30 and July 21, respectively (Fig. 1a). July temperatures averaged 9.5°C , and reached a record maximum of 21°C on July 13.

The seasonal hydrograph had three distinct phases (Fig. 1b): 1) A nival period (June 10–26), characterised by moderate discharge with a strong diurnal trend; 2) two, high-flow, short-duration episodes with a peak flow of 2.1 m/s; the result of two precipitation events with run-off ratios of 0.73 and 0.74, respectively; and 3) a baseflow period between and subsequent to the precipitation events. Suspended sediment concentrations broadly paralleled discharge (Fig. 1c), and the highest seasonal sediment flux (1700 mg/l) occurred during the second precipitation event. Sediment load that resulted from both events represented 35% of the seasonal sediment transport, and compares to 29% of the seasonal sediment transport over the 16-day nival period.

As inferred from the maximum voltage signals at each site, soils became saturated during the two rainfall events (Fig. 2). Prior to the rainfall events, soil moisture at both stations was similar. Hence, while landscape processes were different, antecedent soil moisture was indistinguishable prior to the two events.

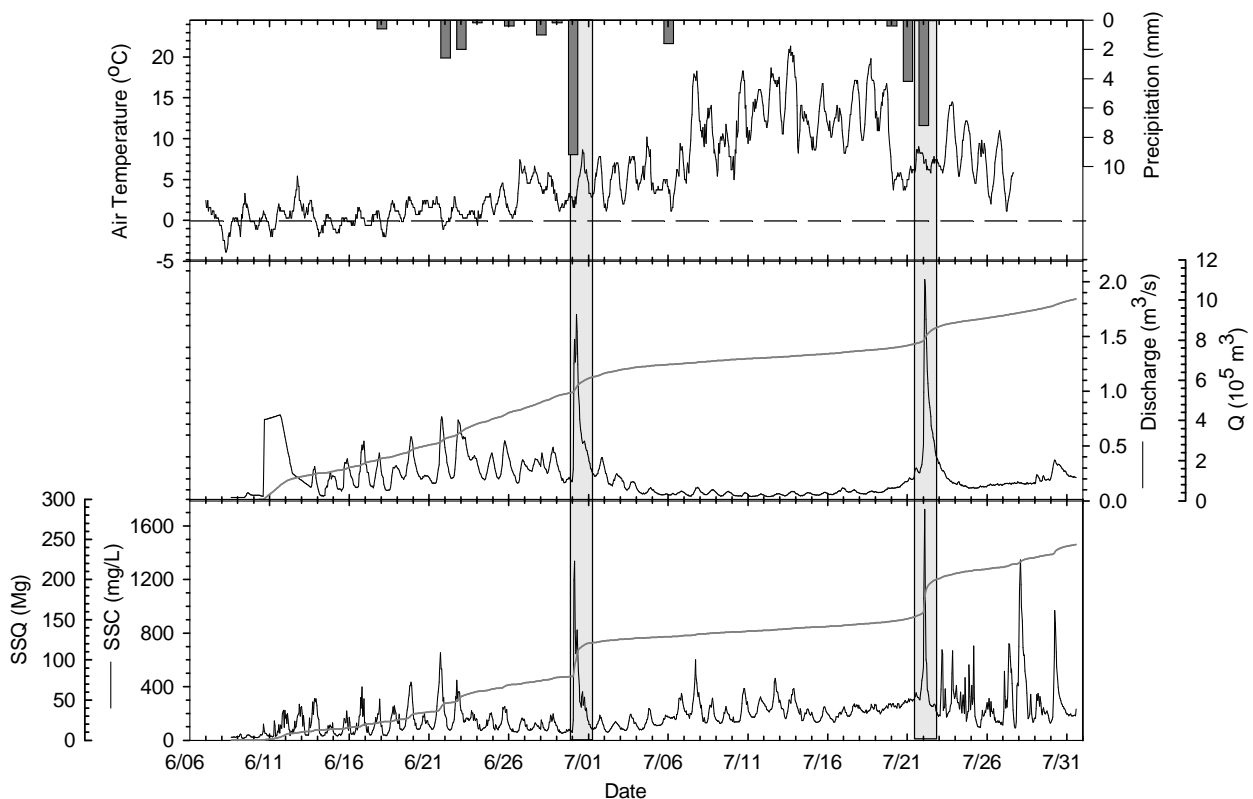


FIGURE 1. Hydrometeorological properties of West River, 2007. Vertical grey bars denote two intense precipitation events. A) Hourly air temperature and daily precipitation. B) Hourly average discharge and cumulative seasonal discharge. C) Hourly suspended sediment concentrations and seasonal sediment yield.

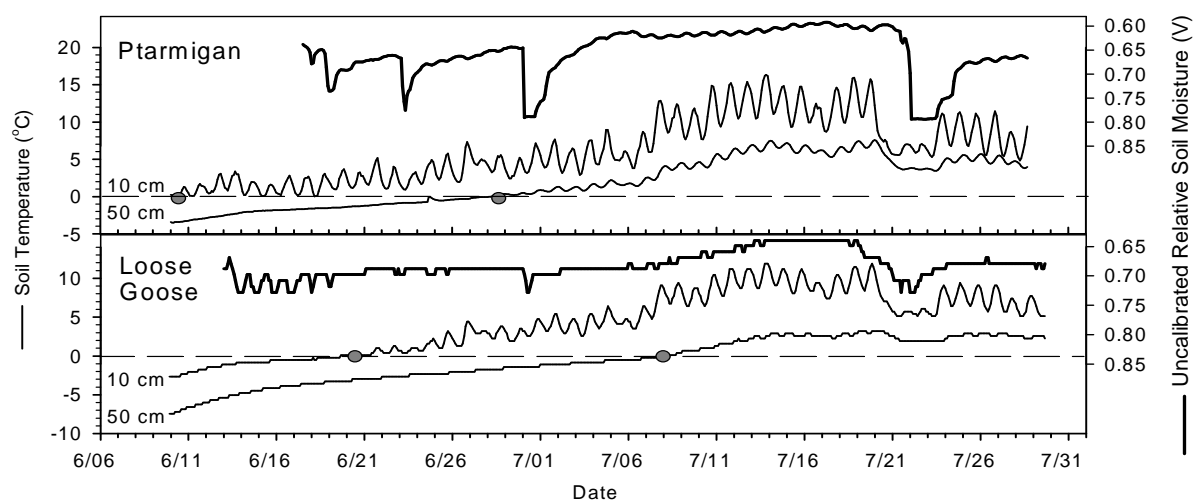


FIGURE 2. Soil moisture and temperature conditions at soil stations Ptarmigan and Loose Goose. Grey dots represent when 0°C was reached at 10 cm and 50 cm depth. Maximum moisture voltages infer saturated conditions.

Discussion

For the first time in five years of monitoring, initial SWE in 2007 was not the most important factor in total suspended sediment transfer at Cape Bounty. This was due to the combination of a prolonged, low-magnitude nival flood, and two high-intensity precipitation events. The rain events were able to yield high energy discharge because of antecedent high soil moisture characteristics across the landscape. Prior to both events, soils were saturated; although the saturation emanated from different hydrological processes. The first rain event occurred immediately following the nival period and snowmelt directly contributed to soil saturation. Under typical conditions, the second event would be expected to be ineffective at sediment mobilization due to the large soil water storage capacity typical after snowpack exhaustion (Lewkowicz and Kokelj, 2002). In 2007, exceptional summer temperatures resulted in early and deep permafrost thaw, and led to ground ice melt. This ground ice melt saturated the landscape and primed the system for a substantial rainfall response.

With Arctic temperatures expected to increase in the future, these results demonstrate the hydrological and geomorphic interaction and importance of temperature, permafrost thaw and resultant soil moisture as factors in runoff response to rainfall.

References

- Church, M. 1972, 'Baffin Island sandurs: a study of Arctic fluvial processes', Geological Survey of Canada Bulletin. 216, 208.
- Cockburn, J.M.H., and Lamoureux, S.F. 2007, 'Hydroclimate controls over seasonal sediment yield in two adjacent High Arctic watersheds', Hydrological Processes. DOI: 10.1002/hyp.6798
- Cogley, J.G., and McCann, S.B. 1976, 'An exceptional storm and its effects in the Canadian High Arctic', Arctic and Alpine Research. 8, 105-110.
- Hardy, D.R., Bradley, R.S., and Zolitschka, B. 1996, 'The climatic signal in varved sediments from Lake C2, northern Ellesmere Island, Canada', Journal of Paleolimnology. 16, 227-238.
- Lewkowicz, A.G., and Kokelj, S.V. 2002, 'Slope sediment yield in arid lowland continuous permafrost environments, Canadian Arctic Archipelago', Catena. 46, 261-283.
- Maxwell, J.B. 1981, 'Climatic regions of the Canadian Arctic Islands', Arctic. 34, 225-240.
- Woo, M., and McCann, S.B. 1994, 'Climatic variability, climatic change, runoff, and suspended sediment regimes in Northern Canada', Physical Geography. 15, 201-226.



JOINT ASSEMBLY 2009

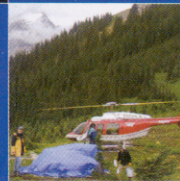
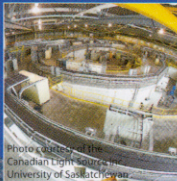
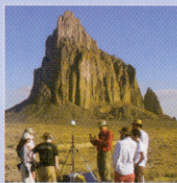
JOINT ASSEMBLY 2009

A major continental event

The Joint Assembly (JA) will be a meeting jointly organized by the American Geophysical Union (AGU) and Canadian geoscience associations, including the Geological Association of Canada (GAC[®]), Mineralogical Association of Canada (MAC), Canadian Geophysical Union (CGU), and International Association of Hydrogeologists-Canadian National Chapter (IAH-CNC). The meeting will last for four full days, one day longer than the usual GAC[®]-MAC annual meeting.

Metro-Toronto Convention Centre
Saturday 23rd May to Wednesday 27th
May, 2009

www.jointassembly2009.ca



Photographed at the
Canadian Light Source
University of Saskatchewan

Technical Program

This will be an opportunity to engage in geoscience on a continent-wide scale.

Start to think big.

Suggestions for themes and symposia are invited.

Contact Grant Henderson at henders@geology.utoronto.ca

Members of AGU may also propose sessions through the AGU website at www.agu.org

Field Trips

A variety of education trips will be offered to introduce earth scientists to the geology of central Canada

We will also be offering a geology and wine tour to the Niagara area

Suggestions for additional field trips should be made to Nick Eyles at eyles@utsc.utoronto.ca

Social and Cultural Events

Visit some of Toronto's special places:

The Royal Ontario Museum

The Ontario Science Centre

Exhibits

A large technical trade show will accompany the convention.

Contact Nicole Januszczyk for initial details at

Nicole.Januszczyk@ca.debeersgroup.com

Registration

Registration will commence in December 2008.

Registration for the conference, for housing and for all related events will be carried out online through the website of the American Geophysical Union. Details will be announced later.

Local Organizing Committee:

Contact persons:

Andrew Miall, U of T (Chair and GAC[®] representative)

Email: miall@geology.utoronto.ca, phone: 416-978-8841

Grant Henderson, U of T

Email: henders@geology.utoronto.ca, phone: 416-978-6041

(Co-Chair, MAC representative, Technical Program Co-Chair with AGU)



Canadian Geophysical Union

Statement of Cash Receipts and Disbursements (2007)

Receipts	2007	2006	2005	2004
Memberships				
-Canadian Association of Physicists	90.00	—	195.00	210.00
-Geological Association of Canada	1057.00	1,215.00	1,299.00	1,299.00
-Memberships Direct	2819.00	2,934.00	3,420.00	3,242.00
Annual Meeting	10400.00	—	9,551.00	16,163.00
Annual Meeting (previous year)	15066.49	—	702.00	10,640.00
CGU Conference Support	—	1,160.00	—	—
Bank Interest	2968.12	1,025.00	350.00	1,288.00
GSC Grant (Student Support)	4500.00	4,000.00	4,000.00	4,000.00
Miscellaneous	0.00	100.00	1,509.00	231.00
TOTAL RECEIPTS	36,900.61	10,434.00	21,026.00	37,073.00

Disbursements				
Newsletter	2919.56	2,081.00	5,622.00	810.00
Prize for Best Student Papers/Poster	500.00	2,000.00	2,000.00	2,000.00
Student travel	—	—	5,375.00	4,225.00
Student travel (previous year)	5,025.00	—	—	—
Annual Meeting Charges	15148.76	8,864.00	6,690.00	1,709.00
Annual Meeting Charges (previous year)	5,560.00	—	—	—
CGU Executive Meetings	969.94	1,483.00	219.00	43.00
CGU-HS Student Conferences	—	—	—	572.00
Miscellaneous	5667.57	30.00	348.00	453.00
Membership in Can. Geoscience Council	—	—	—	—
Bank Charges	140.92	—	10.00	32.00
J. Tuzo Wilson Medal	—	—	—	—
Seismix 2004 Student Support	—	—	—	3,000.00
PAGSE Membership	300.00	600.00	—	300.00
GAC Geophysics Division Award	300.00	—	—	300.00
Accountant, Lawyer Fees	—	—	6,484.00	—
Secretariat	5821.65	2,500.00	5,893.00	3,400.00
TOTAL DISBURSEMENTS	42,353.40	17,558.00	32,642.00	16,844.00

Income less expenses	-5,452.79	-7,124.00	-11,616.00	20,229.00
-----------------------------	------------------	------------------	-------------------	------------------

Statement of ASSETS	31-Dec-07	31-Dec-06	31-Dec-05	31-Dec-04
Savings account	— closed	29,511.00	76,885.00	76,446.00
Chequing account	18,767.37	22,109.00	3,992.00	16,552.00
Guaranteed income certificate	97,952.25	70,635.00	48,500.00	48,190.00
Credit with Canadian Ass'n of Physicists	535.47	241.00	241.00	46.00
Cash on hand	-23.00	-23.00	-23.00	-23.00
Total: Canadian Dollars	117,232.09	122,473.00	129,596.00	141,211.00

OFFICERS OF THE CGU EXECUTIVE COMMITTEE

PRESIDENT: John Pomeroy, University of Saskatchewan

Telephone: (306) 966-1426

Fax: (306) 966-1428

Email: john.pomeroy@usask.ca

VICE-PRESIDENT: Spiros Pagiatakis, York University

Telephone: (416) 736-2100 ext.20644

Fax: (416) 736-5516

Email: spiros@yorku.ca

SECRETARY: Masaki Hayashi, University of Calgary

Telephone: (403) 220-2794

Fax: (403) 284-0074

Email: cgu@ucalgary.ca

TREASURER: Kathy Young, York University

Telephone: (416) 736-5107 ext.22371

Fax: +001 (416) 736-5988

Email: klyoung@yorku.ca

PAST PRESIDENT: Gary Jarvis, York University

Telephone: (416) 736-5245

Fax: (416) 736-5817

Email: jarvis@yorku.ca

HYDROLOGY SECTION PRESIDENT: Jim Buttle, Trent University

Telephone: (705) 748-1011 ext.7475

Fax: (705) 748-1205

Email: jbuttle@trentu.ca

GEODESY SECTION PRESIDENT: Marcelo Santos, University of New Brunswick

Telephone: (506) 453-4671

Fax: (506) 453-4943

Email: msantos@unb.ca

AWARDS COMMITTEE CHAIR: Hugh Geiger, Talisman Energy, Calgary

Telephone: (403) 237-1234

Fax: (403) 237-1902

Email: HGEIGER@talisman-energy.com

SCIENTIFIC MEETINGS COORDINATOR: Rod Blais, University of Calgary

Telephone: (403) 220-7379

Fax: (403) 284-1980

Email: blais@ucalgary.ca

NEWSLETTER EDITOR: Ed Krebs, University of Calgary

Telephone: (403) 220-5028

Fax: (403) 284-0074

Email: krebes@ucalgary.ca

GAC GEOPHYSICS DIVISION CHAIR: Philip McCausland, University of Western Ontario

Telephone: (519) 661-2111 x87985

Fax: (519) 661-3198

Email: pmccausl@uwo.ca

CGU WEB SITE ADDRESS : <http://www.cgu-ugc.ca>

Editor's Note: ELEMENTS, the newsletter for the Canadian Geophysical Union, is published and distributed to all CGU members twice each year; one Summer issue and one Winter issue. We welcome submissions from members regarding meeting announcements or summaries, awards, division news, etc. Advertisements for employment opportunities in geophysics will be included for a nominal charge (contact the Editor). Notices of post-doctoral fellowship positions available will be included free of charge.

Submissions should be sent to the Editor:

Prof. E.S. Krebs, Dept. of Geoscience, University of Calgary, Calgary, Alberta, Canada,
T2N 1N4. Telephone: (403) 220-5028; Fax: (403) 284-0074; Email: krebes@ucalgary.ca.

Electronic submission is encouraged.



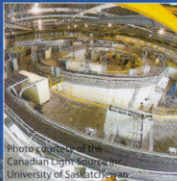
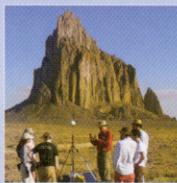
JOINT ASSEMBLY 2009

A major continental event

The Joint Assembly (JA) will be a meeting jointly organized by the American Geophysical Union (AGU) and Canadian geoscience associations, including the Geological Association of Canada (GAC[®]), Mineralogical Association of Canada (MAC), Canadian Geophysical Union (CGU), and International Association of Hydrogeologists-Canadian National Chapter (IAH-CNC). The meeting will last for four full days, one day longer than the usual GAC[®]-MAC annual meeting.

Metro-Toronto Convention Centre
Saturday 23rd May to Wednesday 27th
May, 2009

www.jointassembly2009.ca



Photographed at the
Canadian Light Source
University of Saskatchewan