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THE NEWSLETTER OF THE CANADIAN GEOPHYSICAL UNION

IN THIS ISSUE

LE BULLETIN DE L'UNION GÉOPHYSIQUE CANADIENNE

President's Column

As the incoming President of the CGU, I would like to begin this column by thanking my predecessor, Phil Marsh, for his dedication and leadership for the past two years. During Phil's term as President, the CGU negotiated the terms of a number of agreements with other societies. These include a highly successful Joint Assembly of the CGU/AGU which was held in May 2004, in Montreal. Ongoing discussions with the Canadian Society of Soil Science (CSSS) and the Canadian Meteorological and Oceanographic Society (CMOS) have led to agreements to hold a joint CGU/CSSS meeting in Banff next year (May 2006) and a joint CGU/CMOS meeting in St. John's the following year (May 2007). The CGU has negotiated a memorandum of understanding with the Canadian Geomorphology Research Group (CGRG), with respect to affiliated memberships, and will be inviting them to join us at our scientific meeting in Banff in May 2008. The CGU has also renegotiated the CGU - NRC partnership in support of Canada's affiliation with the International Union of Geodesy and Geophysics (IUGG). It has been a busy two years and much of the work landed on the desk of Phil Marsh. I will count on Phil's experience and sage advice during the next two years as he continues on the CGU Executive Committee as Past President.

I would also like to acknowledge the contributions of two longstanding members of the CGU Executive Committee who have now rotated off the Executive. Dave Eaton served the CGU for 9 years: as Secretary (1996-99), Vice-President (1999-2001), President (2001-03) and Past President (2003-05). Ted Glenn served as the Awards Committee Chair for 13 years and was awarded the CGU Meritorious Service Award at the Banff meeting in May 2005 in recognition of his service. In addition, Spyros Beltaos has completed his term on the Executive Committee as the Hydrology Section President. Although we will miss these three at CGU Executive Committee meetings, we know we can count on their help when needed.

New members of the Executive Committee include John Pomeroy as Vice-President, Hugh Geiger as Awards Committee Chair and Lawrence Martz as Hydrology Section President. I would like to formally welcome them. The continued success of the CGU depends on the talents, time and efforts of such volunteers. I encourage all members of the CGU to think about becoming involved in the organization and planning of CGU events.

The Banff Centre - problems in paradise.

Scientifically, the Annual Meeting held in Banff in May 2005 was a great success. However, financially we had a minor (and almost a major) disaster. Until 2005 all meeting rooms in the Max Bell Building have been free of charge to the CGU as long as we booked and guaranteed a certain minimum number of bedrooms with meal plans on site at the Banff Centre. In 2005 for the first time ever we failed to meet our guaranteed room bookings - by about 50 room-nights. The consequences were two-fold: we became liable for rental fees for the meeting rooms (in excess of $8,000) and we had to pay over $6,000 for the unused bedrooms. Fortunately, after a number of meetings between the CGU Executive and the Banff Centre management, the Banff Centre agreed to

waive the meeting rooms rental fees and only charge us for the unused bedrooms. Since we normally make a profit of between $5,000 and $10,000 on the annual meeting (which funds other activities such as *Elements*, student awards and invited speakers) a penalty of over $14,000 would have been a serious financial blow. Even the $6,000 penalty we paid for the empty rooms is significant and we do not want to repeat this experience.

The number of registrants at the 2005 meeting was similar to previous years when we filled our bedroom quotas well before the meeting dates. However, in 2005 many more attendees elected to stay off site at hotels in Banff. We think this may be due to the high price tag of $198 per night for accommodation on site at the Banff Centre. In 2005 the majority of the bedrooms assigned by the Banff Centre to CGU members were "deluxe" rather than "standard" and the compulsory meal package included supper at the Banff Centre. To lower accommodation costs for the 2006 meeting the Banff Centre has agreed to assign mainly standard rooms and to take the lunch and supper meals out of the meal package. [We will include the cost of lunch in the meeting registration fee for all attendees.] This will reduce the cost per room to $143 per person (single occupancy) or $81 per person (double occupancy), including breakfast(s). The CGU has committed to 400 room-nights at the Banff Centre for the 2006 meeting. We encourage you to stay on site if at all possible. If we fail to meet our guaranteed bedroom booking again we will have to look for an alternate meeting site in Banff, or elsewhere.

<u>End of the NSERC Reallocations Exercise(?)</u>

On June 18, 2005, I attended a meeting in Calgary of the Council of Presidents of Geoscience Societies and Organizations. Representatives of about 15 groups attended. NSERC was also represented. The focus of the meeting was the issue of replacing the existing Canadian Geoscience Council (CGC) with a more effective and more credible umbrella organization. Externally such an organization could assume an advisory role to Government. Internally the functions of such an organization would be to provide communication and coordination among the various societies and to link together, somewhat, the Canadian Earth Science community which in the view of some is fragmented and without a clear sense of future direction. [This view has been reinforced by successive failures of the Earth Sciences in the NSERC reallocation exercises.] Recommendations for a complete restructuring and replacement of the CGC were being forwarded to the CGC. Developments in this area will be reported in future issues of Elements.

One of the most surprising events of the meeting occurred towards the end of the day when the NSERC representative indicated that Reallocation Exercises, in their present form, would not be held in future. They were to be replaced with new strategic thrusts at the 'discovery level'. Details were not yet available. Thus, while it is still desirable to establish common themes and a vision of the future for Canadian Geoscience, this new development may reduce the sense of urgency on a national level. Rather than relying on *ad hoc* committees, a new umbrella organization in the Earth Sciences could take the lead in establishing unifying themes and future directions.

- Gary Jarvis

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J. Tuzo Wilson Medal – Call for Nominations

The Executive of the CGU solicits nominations for the J. Tuzo Wilson Medal – 2006. 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, Geology and Geophysics Dept., University of Calgary, Calgary AB, T2N 1N4 (Email: geiger@ucalgary.ca, Fax: 403-284-0074). 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, 2006. 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 – 2006. L'Union décerne la médaille chaque année "en reconnaissance d'une contribution remarquable à la géophysique canadienne". En choisissant parmi les candidats, on considére 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, Geology and Geophysics Dept., University of Calgary, Calgary AB, T2N 1N4 (Email: geiger@ucalgary.ca, Fax: 403-284-0074). Les

nominations doivent être supportées de lettres de recommandation de colléques, d'un bref sommaire biographique et d'un Curriculum Vitae. Les nominations doivent être soumises avant le 28 février, 2006. 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

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CGU Young Scientist Award – Call for Nominations

The Executive of the CGU solicits nominations for the CGU Young Scientist Award – 2006. 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, Geology and Geophysics Dept., University of Calgary, Calgary AB, T2N 1N4 (Email: geiger@ucalgary.ca, Fax: 403-284-0074). The nomination should be supported by three letters of recommendation from colleagues. Nominations should be submitted by February 28, 2006. 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 – 2006. 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 recommendations 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, Geology and Geophysics Dept., University of Calgary, Calgary AB, T2N 1N4 (Email: geiger@ucalgary.ca, Fax: 403-284-0074). Les nominations doivent être supportées de trois lettres de recommandation de colléques. Les nominations doivent être soumises avant le 28 février, 2006. 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

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CGU Meritorious Service Award – Call for Nominations

The Executive of the CGU solicits nominations for the CGU Meritorious Service Award – 2006. 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, Geology and Geophysics Dept., University of Calgary, Calgary AB, T2N 1N4 (Email: geiger@ucalgary.ca, Fax: 403-284-0074). The nomination should be supported by three letters of recommendation from colleagues. Nominations should be submitted by February 28, 2006. 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 – 2006. Le Prix pour Service Méritoire de l'UGC reconnait 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 recu 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 recommendations 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, Geology and Geophysics Dept., University of Calgary, Calgary AB, T2N 1N4 (Email: geiger@ucalgary.ca, Fax: 403-284-0074). Les nominations doivent être supportées de trois lettres de recommandation de colléques. Les nominations doivent être soumises avant le 28 février, 2006. 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

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CGU 2005 ANNUAL SCIENTIFIC MEETING, 8-11 MAY, Banff, Alberta

HIGHLIGHTS AND SESSION SUMMARIES

The 31st annual scientific meeting of the Canadian Geophysical Union took place at the Banff Centre, in Banff, Alberta, in the period 8-11 May 2005. There were over 200 registered participants. All enjoyed an excellent technical program consisting of 194 oral and poster presentations, as well as a number of social activities (e.g., the icebreaker, barbeque, and the annual awards banquet). Notable events were the awarding of the J. Tuzo Wilson Medal to Ted Evans of the University of Alberta, the Young Scientist Awards to Shawn Marshall and J. Michael Waddington, and the Meritorious Service Award to Ted Glenn. The citation and acceptance speeches for the Wilson Medal, and the citation speeches for the Young Scientist and Meritorious Service Awards, as well as some of the session summaries, follow.

The 2005 CGU J. Tuzo Wilson Medallist: Michael E. (Ted) Evans

Citation by David Dunlop

It is my great pleasure to cite Ted Evans of the University of Alberta as the 2005 J. Tuzo Wilson Medallist, for his outstanding contributions to research in rock magnetism, paleomagnetism and paleoclimatology.

Over his career, Ted has consistently published research that is ahead of its time. It addresses vital issues in how rocks record a stable memory of the ancient magnetic field, the strength and direction of that field on

time scales from modern to Precambrian, and how the magnetic record can be applied to continental drift, stratigraphic correlation, and variations in global climate.

Ted's recent very successful book, *Environmental Magnetism* (coauthored by Friedrich Heller of ETH Zürich), will be the standard text for a long time to come. To summarize such a vast field, drawing on intimate knowledge of widely disparate disciplines, in an authoritative yet engaging fashion is a signal accomplishment.

Ted is also a lively presence at meetings. Prof. Andrew Roberts of the Southampton Oceanography Centre writes: "Ted has remarkable breadth as a scientist, which is rooted in his background in physics and applying physics to a wide range of problems in the earth sciences, in his deep understanding of a broad literature, and in his innate curiosity. I can't remember having ever been in an audience where Ted has not asked probing questions of a speaker regardless of the topic under discussion."

Ted began his research with Mike McElhinny in the late 1960s, showing that the early Precambrian geomagnetic field was as strong as today's field and that the core dynamo was therefore in operation early in Earth history. His celebrated work with Mike Wayman in the 1970s on the microscopic origin of stable magnetic memory in volcanic and plutonic rocks, is a landmark. Evans and Wayman were the first to examine microtextures in magnetic minerals by electron microscopy and to quantify the contribution of single-domain grains to paleomagnetic stability. Their work has never been surpassed and is still being cited today.

Prof. Subir Banerjee of the University of Minnesota says of that early work: "He and I debated the paleointensity value he had found for 2.6 Ga Precambrian gabbros of southern Africa. The dipole moment of 13×10^{22} Am^2 was unexpectedly high, and as the magnetic minerals postulated as the carriers of magnetization were so small that they could not be observed optically, there was considerable doubt about their existence. Ted addressed the problem by both modeling theoretically the size of the single-domain magnetite particles and using transmission electron microscopy to observe the needles directly. This combined theoretical/experimental approach became a hallmark of Ted's later work and is a great example to us, his colleagues, of how to solve a problem."

Three spectacular firsts in other areas of rock and paleomagnetism were his test of the dipolar nature of the geomagnetic field throughout the Phanerozoic (1976), his documentation (1975, with D. K. Bingham) of the details of a middle Proterozoic reversal of the Earth's field, still the oldest well documented record of a polarity transition, and a demonstration (1974, with A. G. Thomlinson) that the magnetic polarity of unoriented dredged oceanic basalts can be determined by reference to present-field overprints in the rock, allowing them to be used to test the Vine-Matthews-Morley hypothesis of seafloor spreading. All these papers were published in *Nature* and attracted much attention.

Paleomagnetism of the Precambrian of western Canada was a theme for much of Ted's work in the 1970s. His meticulous work on the Belt-Purcell Supergroup of Alberta has stood the test of time, including a recent revisiting in a major paper in GSA Bulletin that added results from Montana but did not change Ted's interpretation of the magnetic stratigraphy or of the time interval over which the Belt-Purcell was deposited. In a series of studies of the Coronation geosyncline of Great Slave Lake, Ted and his colleagues discovered the pervasive middle Proterozoic "Coronation overprint", which is used to this day as a tracer of remagnetization and inferred fluid pathways in the western Shield.

Dr. Ted Irving of the Pacific Geoscience Centre adds: "In this work, several sequences showed rotations of 40 to 90° relative to each other. These are now known to be associated with large transcurrent fault systems that affected the Western Shield during its final consolidation. Field-based structural geology provided much lower estimates of such rotations, but these geophysically based estimates are the true measure. Ted's work showed that processes in Proterozoic orogenic belts were comparable to those in Phanerozoic orogenic belts, where such large rotations are widespread."

In the 1980s, Ted turned his attention to paleosecular variation and magnetostratigraphy, the latter as an aid to stratigraphic correlation in the famous Red Deer Valley sections in Alberta. He also began work on archeomagnetism as a dating tool in archeology, working actively on Mediterranean sites from classical antiquity.

It is Ted's work in the 1990s, which he continues actively to the present, on the magnetic record in loess and paleosol sequences in China, Siberia and elsewhere for which he is best known by the current generation of geomagnetists and paleoclimatologists. He and his collaborators have shown how the magnetic record can be related to paleotemperature and precipitation and can even record Heinrich events half a globe away. The importance of these studies to concerns about global climate change cannot be overemphasized.

Of this work, Prof. Friedrich Heller writes: "Very early, Ted took the influence of sedimentary processes on the rock magnetic properties into consideration and realized first that Milankovitch cyclicities were driving the magnetic properties of Chinese loess, one of the most important archives of Quaternary paleoclimate." Prof. Nat Rutter of the University of Alberta says: "Ted Evans has not only helped us establish the stratigraphy and chronology of the Chinese Loess Plateau using paleomagnetic methods, but has gone far beyond this by offering insight and explanations on the origin of

magnetic susceptibility and how it can be applied (or not applied) to climate change."

I will close by again quoting Ted Irving: "Evans' work, over 35 years, has been consistently sound, his observations reliable, his analysis careful yet not unnecessarily elaborate, and his interpretations remarkably durable. He is quiet and modest, telling you about his work in an understated way. When the papers come to be written, however, you realize just how deeply he has thought about what he is doing."

Ted Evans is a Canadian star in international geophysics and a most worthy recipient of the 2005 J. Tuzo Wilson medal.

Acceptance by Ted Evans

Mr. President, Ladies and Gentlemen,

Thank you, David, for those very generous words. I am overwhelmed.

Once I had floated back to earth after hearing the news of this award, I began to compile a list of all the people who have helped me along the way. But it soon became clear that merely to read out such a list I would have to detain the audience for several hours! I will therefore focus on a number of key individuals without whose guidance and help I certainly would not be standing before you now.

At the outset I was extremely fortunate to be introduced to geophysics by Don Griffiths and Roy King at Birmingham University, England. Without their dedicated teaching, encouragement and goodwill it is doubtful if I would ever have progressed to graduate work in the first place. Then I had the great good fortune to be shepherded through my doctoral dissertation by Mike McElhinny, first at UCRN (in what was then Southern Rhodesia, now Zimbabwe) and subsequently at ANU (Canberra, Australia). Not only did Mike hand me on a plate a rich research project, nurture me during my scientific infancy, put up with my foibles and compensate for my failings, he did it all with an enviable lightness of touch; always serious about the science but unfailingly with good humour. In those years I also learned a great deal from many discussions (in the lab/in the field/over a beer) with Jim Briden, Andrew Brock, Dai Jones and Tony Gifford at UCRN and with Francois Chamalaun at ANU.

I am especially indebted to Ian Gough, who gave me my first job in Canada and who has been such an excellent colleague and friend ever since. One of the first graduate courses I taught (Plate Tectonics – very avant-garde at the time) was given jointly with Ian. Thanks to his breadth and depth of geophysical knowledge, I learned more than the students! In my very first summer at the University of Alberta (1969), Ian was instrumental in setting up my initiation (under the expert guidance of Walter Fahrig) into the fascination and rewards of the Great Canadian North. Continued effort in the Precambrian of western Canada, to which David alluded, was only made possible by the unstinting counsel of Ted Irving and Paul Hoffman and by the enthusiastic collaboration of Earl McMurry, Doug Bingham and Gerry Hoye. It was very much a team effort, aided throughout by the support of Jack Jacobs, Ernie Kanasewich and George Cumming. In parallel with the macroscopic properties involved in classical palaeomagnetism, I had the good luck to become interested in the microscopic (even nanoscopic, if the word is permissible). Here I quickly made an important discovery – Mike Wayman. Mike's mastery of the electron microscope, stemming from his background as a metallurgist, was absolutely essential in the search for tiny iron oxide particles in rocks and the extremely stable magnetism they carry. Subsequently, Paul Davis brought his experimental skills and firm grasp of theory to this endeavour.

In more recent years, I have benefited enormously from several joint projects involving much younger geological, even archaeological, targets. In the latter category, I cannot adequately convey what a thrill and privilege it was to be given free access to the celebrated site of Pompeii at the very start of a series of investigations in which Marianne Mareschal played a central role. Her lively mind and indomitable spirit were an unfailing source of joy. Closer to home, Jack Lerbekmo introduced me to the Cretaceous magnetostratigraphy of Alberta and its significance to the demise of the dinosaurs and the nature of the so-called "tiny wiggles" seen in the oceanic magnetic stripes. In the new field of magnetoclimatology, I have had the amazing good fortune to be able to work with Nat Rutter and Friedrich Heller on the best natural archives available, most notably in China. Moving into such a complex, inter-disciplinary subject, I could not have wished for better tutelage. Nat's comprehensive knowledge of Quaternary environments in the four corners of the globe provided a sure and steady guiding hand. Friedrich's wide experience in all matters magnetic and his great generosity have underpinned most of my efforts in this area.

Finally, I wish to express my heartfelt thanks to the committee and to all those who supported my nomination and – once again – to you, David. How much I've enjoyed our friendship and discussions over the years,

including one concerned with the weighty issue of turning 30!

Let me close by sharing with you recollections of my first meeting with Professor Wilson. Actually, the verb to meet is entirely inadequate in Tuzo's case. It felt more like an encounter with a cosmic force. He swept into UCRN one day as I was beavering away on my Ph.D. and demanded to know how many types of fault there are. Without waiting for a reply, he informed us that he had just discovered a new kind. He then produced a sort of origami version of sea-floor spreading and proceeded to explain the nature of transform faults. All this was very new in those days and his performance was completely mesmerizing. It was pure magic. I half expected him to pull a rabbit out of a hat! But over the years, it is his infectious enthusiasm that stays in my mind. What an inspiration…and what an honour to receive the medal named after such a great Canadian.

Thank you all.

Left: Gary Jarvis, CGU President (left) presenting the Wilson medal to Ted Evans.
Middle: Ted Evans ***Right:*** Ted Evans and David Dunlop.

The 2005 CGU Young Scientist Award Winners: Shawn J. Marshall and J. Michael Waddington

Citation for Shawn Marshall by Garry K. C. Clarke

Dr. Shawn Marshall, currently an Associate Professor in the Department of Geography, University of Calgary, is not only one of Canada's leading young geoscientists, he is clearly one of Canada's leading young scientists. Among the many high points of his short professional career are receipt of the Governor General's Gold Medal for his doctoral thesis at UBC, the NSERC national doctoral prize, his appointment as a scholar of the Canadian Institute of Advanced Research and his selection by the Partnership Group for Science and Engineering as one of the top young scientists and engineers in Canada.

Shawn's scientific expertise is in glaciology and his approach is both broad and deep, combining attention to complex details with the sweeping vision of an Earth system scientist. He brings to his work the ability to formulate sharp scientific questions, outstanding talent in computational physics, a gift for clear expression and a command of climate science. He has come far since completing his doctorate but will go very much farther because of his capacity for growth and his appetite for collaboration.

Shawn's published work is internationally regarded as defining the state-of-the-art in cryoshperic science. His collaborations with world leading Quaternary and climate scientists like Peter Clark (Oregon State), Kurt Cuffey (Berkeley), Helgi Bjornsson (U Iceland), Jonathan Overpeck (U Arizona) and Giff Miller (Colorado) have arisen because these individuals wanted to work with the best person. That person is Shawn Marshall.

Citation for J. Michael Waddington by Brian Branfireun

Dr. Mike Waddington, currently an Associate Professor in the School of Geography and Geology, McMaster University, is a young scientist with an exceptional ability to consistently conceive and execute first rate, policy-relevant science; a firm commitment to

the mentorship of students; and a contagious collegial and collaborative spirit.

Mike is recognized internationally as an expert in peatland ecohydrology with a focus on methane dynamics. Over time, this research focus has evolved into an incredibly productive line of inquiry concerning the dynamics of restoring peatland ecosystems, with research sites in Quebec and New Brunswick. Together with his students and colleagues as part of the Peatland Ecology Research Group (PERG), Mike has published 18 papers from his PERG research program alone since 2000. This is an astounding level of productivity for an experimental field based researcher, and a testament to the progress that their research has made in this field. Mike and his PERG collaborators were recently awarded the Synergy Award for Innovation from NSERC and the Conference Board of Canada, that recognizes outstanding achievements of university-industry collaboration.

Mike is an exceptional mentor to his students. Mike sets high standards, but he practices what he preaches though his tireless efforts reviewing the work of his students, developing experiments with them in the laboratory, and working those long days in the field. This formula pays off in the form of the recruitment of the absolutely top students who bring with them incredible dedication, productivity and originality.

Mike has a spirit of discovery and a constant level of enthusiasm for his research that most of us hope to muster only occasionally. He is an unfailing collaborator who places the highest value on his friendships and research partnerships, which for him are one and the same. Mike lives by his motto of 'doing fun research with friends' which is clearly a recipe for success.

Left: Gary Jarvis, CGU President, presenting the Young Scientist Award to Shawn Marshall.
Right: Gary Jarvis presenting the Young Scientist Award to J. Michael Waddington.

The 2005 CGU Meritorious Service Award Winner: Ted Glenn

Citation

Ted Glenn became the CGU Awards Chairman in 1992, following previous holders of the office from Chevron Canada Resources. Ted contiunued to perform the duties of Awards Chairman after he retired from Chevron a few years ago. He served the CGU in the position until 2004, for 13 years under 7 CGU presidents! Ted found it extremely rewarding to have been part of the CGU in a period when it increased the number of awards, embraced new sections and expanded its reach in the scientific community. It has been a dynamic period and he credits the various persons in the CGU leadership over those 13 years for the growth of the CGU.

Ted wishes to thank the CGU for presenting him with this award. Working for the CGU was in itself a reward that he will cherish. He is still a member of the CGU and will work with its leadership in the future whenever there may be some need for "volunteers". Ted regrets not being here at the awards dinner since he attended so many and participated in the handing out of awards to many deserving students over the years. All the best to the winners in 2005!

The 2005 CGU Annual Meeting, Banff, 8-11 May: Some Session Summaries

Gravity and Geocomputations (Conveners: R. Blais and N. Sneeuw)

This new session started with an overview of High Performance Computing (HPC) in Canada and the Long Range Plan (LRP) for the next decade, by R. Blais. Consortia in HPC include ACEnet in Atlantic Canada, RQCHP and CLUMEQ in Québec, HPCVL and SHARCNET in Ontario and WESTGRID in Western Canada. This LRP document for HPC is available from www.c3.ca, and it is imperative for the Earth sciences to have more prominence in the LRP for HPC in Canada. An invited speaker, Dr. Nikolaos Pavlis from Raytheon Inc., Washington, D.C., discussed the current status and future challenges of very high degree geopotential modeling. El-Habiby then presented results on the evaluation of geodetic integrals using wavelet transforms. Soofi then discussed parallel computations of spherical harmonic transforms. Blais then presented some research results on multiresolution analysis and synthesis using Fourier and Gabor transforms. Van der Wal then discussed the effect of uncertainty in ice load history on glacial isostatic adjustment observables in North America. Mutulu also had a poster presentation on the implementation of HDF-EOS data in spatio-temporal environmental modeling. In summary, this new session has significantly improved the geodesy section profile and plans are already in place for a more comprehensive session in geocomputations next year.

Tectonics and Seismology I-II (Conveners: Drs. M.A. Soofi and P. Wu)

The Tectonics and Seismology sessions were held on Monday, May 9, 2005. Both, morning and afternoon, sessions were well attended and had significant number of student contributions. Out of the total of nineteen oral presentations eight were student contributions and two of these received awards. Congratulations to S.K. Miong for receiving the Chevron Canada Outstanding Student Paper in Seismology and P.J. Thompson for receiving the CGU Best Student Paper Award.

The topics covered in the sessions were quite diverse and included various aspects of global tectonics, seismicity and mantle dynamics. Four presentations were on the seismicity and crustal structure of Western Canada and associated subduction zone. The presentation by Dash et al. used a 3D P-wave model to estimate the seismic structure and depth of the Georgia Basin. Dragger et al. reported on the observed episodic slip that is accompanied by distinct low-frequency tremors along the Northern Cascadia margin (ETS events). While Thompson et al. (best student paper award) discussed an algorithm that can quantitatively characterize the level of these ETS tremors from a collection of seismic waveform data. A.F. McNeill discussed the 3D modeling of post-critical reflections.

In the second half of the morning session five papers were presented and the majority were on geophysical investigations of the crust in various parts of Canada. Tiampo et al. analyzed the eigen-pattern of historic seismicity data for the characterization of the fault systems and earthquake predictions. He et al. investigated the effect of heat flow on a mud mound offshore Vancouver Island. Darbyshire & Snyder used surface wave recorded by POLARIS stations to study the shear wave structure of the upper mantle and showed that the lithosphere is 200-260 km thick in northeastern Ontario but decreases to the south and west. The resistivity structure in Manitoba, as identified by the POLARIS magnetotelluric (MT) survey, was discussed in Gowan et al and presented by Ferguson. Soofi & Wu discussed the style and extent of crustal deformation in Alaska due to collision with the Yakutat terrane and showed that high-strength inhomogeneities may be required to explain the observed crustal thickening.

The first half of the afternoon session included papers on plate subduction, mantle flow, stress distribution in the crust, and structure of ocean ridges. Miong & Frederiksen (best student paper award) used the shear wave splitting observed by FEDNOR and CNSN stations in the Superior Province to study the preferred orientation of mantle fabric and lithospheric thickness. Biard et al. discussed the effect of pre-existing structures on the orientation and distribution of stresses in the crust. Using 3D models of mantle convection, Jarvis & Lowman investigated the factors affecting the rate of descend of a slab in to the mantle and explained why some slabs resisted at mid-mantle depths for 150 My while others descended to the base of the mantle in much less time. Ghias & Jarvis used mantle convection with internal heating to confirm that reversal in the direction of mantle flow is geodynamically possible. Based on vertical component body and surface waves at regional and teleseismic distances, Gu et al. discussed the variation of temperature and size of the partial melt along the East Pacific Rise.

The second half of the afternoon session had five presentations on the topics of mantle heat flow and propagation of seismic waves. Costin et al. (presented by

Butler) discussed the effect of core potassium on the thermal history of the earth and age of the inner core using a asymmetric model with parameterized core cooling. Sinha & Butler discussed the thermally insulating effects of continents on mantle heat flow and thermal evolution. They found modest effects due to the self-regulating effects of temperature-dependent mantle viscosity on mantle temperature. C.J. Thomson discussed the advantages of using pseudo-differential-operator (PSDO) in solving wide-angle one-way wave equation. Baig et al. presented a new technique to determine the compressional and shear properties of the crust and upper mantle using Green's function. Geiger et al. discussed the use of Rayleigh wavefield extrapolators for data acquired on an irregular topography.

The Mackenzie GEWEX Study (MAGS) – Advances in Hydrological Science
(Conveners: Ming-ko Woo and Peter di Cenzo)

The Mackenzie GEWEX Study (MAGS) was initiated in 1994 and is nearing its successful completion. The 2005 CGU provided an excellent forum for presentation of integrative results to the broad community of Canadian geophysicists. Although MAGS is a collaborative investigation with participation from both the hydrological and atmospheric communities, this session focussed on the hydrological perspective. MAGS research, as reinforced by the presentations, places emphasis on aspects of cold region hydrology.

This session started with six invited overview presentations on how MAGS has contributed to advancements in hydrological science. L.W. Martz (speaker) and W.R. Rouse summarized MAGS hydrological achievements which include: enhanced understanding of a wide range of hydrological processes important in cold regions; a suite of numerical process models; coupling of hydrological models to atmospheric models; improved representation of hydrological processes in land surface schemes; compilation of a legacy database of process observations and measurements; improved modelling and assessment of global energy and water cycles; and application of results to resource management and social policy. J.W. Pomeroy (speaker) and P. Marsh focused on advances made in understanding snow processes: Arctic blowing snow; forest snow interception and sublimation; snowmelt energetics in open and forests; advection as a source of snowmelt energy; snowmelt variability and effect on snowcover depletion and runoff; and realistic snow algorithms for cold regions hydrological and atmospheric modelling. F. Hicks (speaker) and S. Beltaos presented an overview of advances in river ice science during MAGS. In addition to improving knowledge on thermal and mechanical ice-breakup processes, several studies show that: remote sensing by satellite can be used effectively to determine river ice characteristics; we can expect severe reduction in ice jam flood frequency in response to changing climate; and a neuro-fuzzy logic model can accurately predict the timing and magnitude of ice jams and related flooding, and is now being used as an operational tool by the community of Fort McMurray along Athabasca River. S.K. Carey (speaker) and M.K. Woo provided an overview of work done by various MAGS investigators to gain better understanding of runoff processes and modelling in cold regions (including permafrost slope runoff generation; runoff generation in Canadian Shield; vegetation/ecozone controls on runoff; landscape-scale controls; channel processes). W.R. Rouse and W.M. Schertzer (speaker) provided cases of dynamic climate-lake interactions in a cold environment. Some examples are the sensitivity of lake ice thickness and longevity to air temperature and snow overburden; the enhancement of lakes to annual evaporation – the larger the lakes, the greater the effects; the ability of large northern lakes to evaporate significantly during stable atmospheric conditions, feeding water vapour into the atmosphere through pulses that have variable time scales. E.D. Soulis, A. Pietroniro and F. Seglenieks (speaker) described WATCLASS, the distributed hydrologic modelling system developed for MAGS in which vertical water energy budgets are calculated by routines from the Canadian Land Surface Scheme (CLASS) and lateral flows are calculated using algorithms from WATFLOOD. Current modelling work focuses upon coupling WATCLASS with the Canadian Regional Climate Model (CRCM) and with the Canadian NWP system. The major contributions of the integrated modelling include: closing the basin scale water budget; integration of micro-scale physics to large domains; GRU-based routing strategy for mesoscale to macroscale; and calibration strategies for large basins.

Following the invited presentations, four "case-studies" were presented. E. Kerkoven (speaker) and T.Y. Gan showed that the land surface model ISBA can better simulate hydrologic processes in the Athabasca basin by adding statistical representation of sub-grid variability. C. Spence spoke on hydrological processes in a lake dominated Canadian Shield drainage system in which lake size relative to contributing area is important in the transfer of water downstream. A.M. Way (speaker) E.H. Atallah and J.R. Gyakum presented preliminary results from a new initiative on Great Bear Lake, showing that the lake can influence both local and regional climate. The session concluded with B. Davison, S. Pohl (speaker), P. Marsh, A. Pietroniro and P. Dornes who indicated that the incorporation of topographic effects on incident solar radiation and snow drift can considerably

improve the prediction by WATCLASS of the spatial variability of snow cover in high latitudes.

A major aspect of MAGS as discussed during the session is the application of scientific results to benefit economic activities (hydroelectric) and the communities (traditional livelihood; spring flood forecasting). Through partnerships with stakeholders, MAGS provides results that offer a scientific basis for planning, policy making and improved resource management.

For information on MAGS, please contact MAGS Secretariat (GEWEX.MAGS@ec.gc.ca) or visit http://www.usask.ca/geography/MAGS/

Glacier Change in Western Canada (Conveners : S. Boon and D. Smith)

The inaugural 'Glacier Change' session was a success, despite having been scheduled concurrently with the 'Hydrology: Cold/Snow' session. Scott Munro (UofT) began by speaking briefly on behalf of Mike Demuth (GSC), who was unable to attend. He focused on Mike's interest in the GSC-university partnership program to maintain glacier monitoring stations in Western Canada, as well as the collaborative opportunities in the international GLIMS program. Scott Munro was the second speaker, discussing 'Temperature trends in the Peyto Glacier weather station record'. He noted a decrease in maximum temperature and an increase in minimum temperature over the 11-year period of the record. Dan Moore (UBC) then spoke about 'Summer stream temperature dynamics in snow- and glacier-fed catchments'. He studied temperature differences between snow- and glacier-fed catchments, and determined that deterministic – rather than empirical – techniques are required to more accurately quantify these differences and their causes. Joe Shea (UBC) was fourth, with 'Atmospheric flow indices, temperature, precipitation, and glacier mass-balance in the Canadian Rocky Mountains'. He used atmospheric flow indices to successfully model annual glacier mass balance at several glaciers in the Canadian Rocky Mountains. The final speaker before the coffee break was our invited speaker, Dan Fagre (USGS). He discussed studies of glacier retreat in Glacier National Park, Montana. The phenomenal rate of retreat has been examined with remote sensing and dendrochronology, and the current installation of a mass balance network. Dan's humorous and informative talk was an excellent introduction to the rest of the session, which covered in more detail some of the techniques he discussed.

Posters were viewed during the break. Dave Lewis' (UVic) poster, 'Late Holocene glacier activity at Forrest Kerr Glacier, Andrei Icefield, northern British Columbia Coast Mountains', showed early results of dendroglaciological studies that indicate that glaciers in the north and south Coast region experienced similar phases of glacier advance. Chris DeBeer's (UofA) poster, 'Recent glacier retreat within the Canadian Rockies and Coast Mountains', was an overview of his MSc research, in which he plans to use a combination of remote sensing techniques, ground-truthed data, and climate records to examine glacier change in the area.

After the break, Roger Wheate (UNBC) presented 'Glacier extent changes in northern, central and southern British Columbia using Landsat TM, DEMs and historic map vectors'. Roger's studies of glacier extent changes at various locations in British Columbia show that glacier retreat increases further south, and the rate of change has increased over the past decade. Sarah Boon (UVic) then presented 'Glacier-climate relationships in the North Coast Mountains of BC', an overview of her research to use tree rings to create proxy glacier mass balance records for the area, and link these to climate indices such as the PDO. Brian Luckman (UWO) presented 'Glaciers, tree-rings and environmental change in the Canadian Rockies', giving an overview of his group's dendrochronological research in the Canadian Rockies, including creation of proxy climate records, reconstruction of Peyto Glacier mass balance and Bow River streamflow, and examination of large-scale atmospheric indices such as PDO and ENSO. Brian Menounos (UNBC) presented 'North-south asymmetry of late-Pleistocene glacier advances in the Canadian Cordillera', in which he dated moraines in the Coast Mountains and north-central mountains of British Columbia using ^{14}C methods. He is trying to determine the causes of these advances, which show considerable north-south asymmetry. Joe Koch (SFU) ended the session with 'Holocene glacier history of the Canadian Cordillera in a global context'. Joe collated the results of studies from the Cordillera to examine the timing of glacier fluctuations relative to those recorded in Europe and Patagonia, suggesting that sunspot activity and insolation variations were the dominant mechanism behind these glacier fluctuations.

Wetland Special Session (Reported by Jonathan Price, Chair, CGU-HS Wetlands Committee)

The Wetlands Committee of the CGU-HS organized a Special Session on Northern Wetland Hydrology. There were two keynote speakers, D. Rosenberry (The Hydrology of Northern Peatlands: Current Developments and Research Needs) and A. Baird (Peatland ecohydrology: hydrological processes and their degrees of freedom in a biogenic deposit), whose expenses were generously covered by CGU. These two presentations

provided a remarkably good overview of some of the difficulties and challenges in hydrology of northern wetlands, particularly peatlands.

There were also four other Invited Speakers (K. Devito, B. Branfireun, N. Roulet, B. Quinton). In total there were 26 oral presentations and 9 posters. The response was extremely positive, and the papers were excellent. Both Keynote Speakers commented that this was one of the best wetland meetings they had ever attended!

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The 2005 GAC Logan Medal

One of CGU's long-standing members, Ron Clowes, was awarded The Logan Medal of the Geological Association of Canada at its Annual Meeting in Halifax in May 2005. The Logan Medal is the highest award of the GAC and is awarded "to an individual for sustained distinguished achievement in Canadian earth science". The primary basis of the award is Ron's contributions to Lithoprobe. It is always rewarding to see a geophysicist so recognized by our geological colleagues. It is not often that a geophysicist is given this distinguished award. The last two geophysicists to win it were Michael Keen and David Strangway, in 1986 and 1984, respectively. Congratulations, Ron!

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HYDROLOGY SECTION NEWS

Hydrology Section Committee Reports

Compiled by Dirk de Boer, University of Saskatchewan (deboer@duke.usask.ca)

Committee on Glaciers and Environment

Chair: Prof. D. Scott Munro, Department of Geography, University of Toronto at Mississauga, Mississauga, ON, L5L 1C6, smunro@eratos.erin.utoronto.ca.
Vice-Chair: Michael N. Demuth, P. Eng., Geological Survey of Canada;
Advisory Members: Prof. Martin J. Sharp, University of Alberta; Dr. Roy M. Koerner, Geological Survey of Canada; Jeffrey Schmok, Golder Associates Ltd.

Mandate and Objectives

a. Assist the CGU and its executive in promoting glaciological research that is relevant to hydrological and environmental problems.
b. Provide CGU members with information about glaciological research activity, as well as identify opportunities for collaboration among individuals and groups.
c. Provide CGU members with information about the scope and extent of glaciological data, and promote efforts to improve accessibility to such data.
d. Influence research development by establishing lines of communication with other working groups in snow and ice, such as the Cryospheric System (CRYSYS) to monitor global change in Canada and identify personnel training opportunities.

Identify and promote opportunities for educating other members of the scientific community and the general public about glaciers and their role in the environment.

Meetings and Activities

a. Michael Demuth and Roy Koerner continue to build the National Glaciology Program (NGP) in the Geological Survey of Canada (GSC), supported by Natural Resources Canada, Environment Canada and

University partners, consolidating research in Arctic and Western Canada.

b. A book entitled *Peyto Glacier: One Century of Science*, M.N. Demuth, D.S. Munro and G.J. Young (eds.), has completed the copy editing phase and will proceed to press.

c. Michael Demuth continues as Canadian Correspondent to the International Glaciological Society, and Canadian National Representative to the International Commission on Snow and Ice.

d. Scott Munro has recently completed *A revised Canadian perspective:* p*rogress in glacier hydrology,* which appears in ***Hydrological Processes*** 19: 231-245.

e. Martin Sharp and Scott Munro gave individual presentations at the *10th Annual CRYSYS Science Meeting*, Kananaskis, Alberta, March 2005; Martin has been selected as one of four authors coordinating an omnibus paper describing advancements in cryospheric research under CRYSYS.

Progress on Issues and Objectives

The NGP work, in partnership with others, is central to the first objective of this committee where progress occurs through continued development of the AWS program at the Peyto, the Place and the Ram River Glaciers. *Peyto Glacier: One Century of Science* and *A revised Canadian perspective:* p*rogress in glacier hydrology* address the second objective. Improvements to the NGP program require new sites in Yukon and British Columbia, and better data management, key points in addressing our third objective. The NGP consolidation effort is essential to our fourth objective: linking research among universities and agencies (e.g., Mike Demuth, NGP; Scott Munro, University of Toronto; Dan Moore, University of British Columbia). Our fifth objective, public education on glaciology, continues: Canadian Geographic's *Mysteries in the Ice*, Mike Demuth on the CBC program, *Country Canada*, January 2003 and a BBC telephone interview on glacier cover change with Scott Munro, April 2005.

Future Meetings and Activities

As committee chair, I note progress toward a collaborative Canadian glacier network, a need identified in the GSC Workshop, Ottawa, January 2000. Needs to better late to the Cryospheric System (CRYSYS) to monitor global change in Canada were addressed at annual CRYSYS meetings in March 2003, 2005 and, to the world community, at a workshop in Pontresina, March 2004. Mike Demuth and I will speak at the CGU session on Glacier Change in Western Canada, May 2005.

Other Business

The glacier inventory is a continuing matter of concern, particularly as it relates to water resources in Western Canada; as is continued development of research infrastructure and new personnel, finding additional research positions rather than merely replacing or terminating existing ice science positions. The opportunity to collaborate in a new research initiative headed by John Pomeroy, University of Saskatchewan is being explored as a way to expand glacier research activity.

Committee on Erosion and Sedimentation

Chair: Peter Ashmore, Department of Geography, University of Western Ontario, London, ON, N6A 5C2, pashmore@uwo.ca

Members: Dr. Dirk de Boer, University of Saskatchewan; M. Conly, Environment Canada (CWS), Saskatoon; Dr. M. Church, University of British Columbia; Dr. A. Roy, Université de Montréal. Dirk de Boer is IAHS-International Commission on Continental Erosion Secretary and ICCE Canadian Delegate.

Objectives:

a. The scientific advancement and practical application of knowledge of erosion, transport and deposition of sediment in fresh water systems – topic coverage similar to that of the IAHS Commissions on Continental Erosion some aspects of Water Quality – through

i) Communication of current research via discussion, meetings, conferences and publications;

ii) Identification and promotion of high priority research topics in the Canadian context;

iii) Promotion and encouragement of the transfer of knowledge and technology in the field of interest.

Meetings & Activities

a. Continued representation at CGU-HS meetings. No organized sessions at 2005 Annual Conference but several papers on topics relates to E&S activities were presented.

b. Reciprocal membership arrangement and affiliation between CGU and Canadian Geomorphology Research Group have been resolved. Details for CGRG members were

published in the Spring 2005 CGRG Newsletter http://cgrg.geog.uvic.ca/news20.pdf . CGRG-sponsored sessions can now be held at CGU meetings (in addition to CAG, GAC, CANQUA and AQQUA). There has been initial discussion of a joint CGU-CGRG meeting possibly in 2008.

Canadian National Committee for the
International Association of Hydrological Sciences (CNC-IAHS)

Chair and Senior Canadian National Representative: John Pomeroy, Centre for Hydrology, Department of Geography, University of Saskatchewan, 9 Campus Drive, Saskatoon, SK, S7N 5A5, pomeroy@usask.ca

Members: Dan Moore, Junior Canadian National Representative and Secretary
Spyros Beltaos, President, CGU-HS
Lawrence Martz, Vice-President, CGU-HS
Allyn Clarke, President, CMOS
Al Pietroniro, Delegated by the President, CWRA.
Garth van der Kamp, delegated by President, CNC-IAH
Bill Quinton, Member-at-Large, CNC-IAHS.

CNC-IAHS Representation and Leadership in IAHS

IAHS Commission Representatives
The following persons are the Canadian National Representatives to IAHS Commissions:
Don Burns, International Commission on Surface Water
Jim Hendry, International Commission on Groundwater
Miriam Diamond, International Commission on Water Quality
Dirk de Boer, International Commission on Continental Erosion
Wayne Rouse, International Commission on Coupled Land-Atmosphere Systems
Al Pietroniro, International Commission on Remote Sensing
Mike Demuth, Union Commission on Cryospheric Science
Slobodan Simonovic, International Commission on Water Resources Systems.

IAHS Commission Leadership
Canada also provides for the leadership of the International Commission on Continental Erosion (ICCE), International Commission on Remote Sensing (ICRS), International Commission on Ground Water (ICGW) and International Commission on Tracers (ICT) through the activities of:
Dirk De Boer, Secretary, ICCE
Al Pietroniro, President-Elect, ICRS.
Jim Barker, Vice-President, ICGW
John Gibson, President, ICT.
Catrina Valeo, Hydrology 2020 Working Group
John Pomeroy, Prediction in Ungauged Basins (PUB) Science Steering Committee
Lawrence Martz, Prediction in Ungauged Basins (PUB) Science Advisory Committee

Activities, June 2004 to May 2005

Recent Changes to the Terms of Reference of CNC-IAHS
The following procedure for mid-term replacement was added to the Terms of Reference for CNC-IAHS, adopted by membership vote at the CGU-HS meeting, Montreal in May 2004: "Should either one or both the junior or senior representative resign and leave the post during the term of office, then CNC-IAHS will appoint replacements to the end of the current term. The Member at Large will compile a list of candidates for these positions and they will be decided upon by a simple vote of the CNC-IAHS"

Special Issue of Hydrological Processes
Eight papers on Progress in Canadian Hydrology were submitted for review and publication in the journal *Hydrological Processes* in 2003. The Guest Editorial Board for this issue was Spyros Beltaos, Lawrence Martz, Dan Moore and John Pomeroy. The special issue was published in January 2005 as Vol. 19, Issue 1.
The papers are:

1) Advances in Canadian Forest Hydrology. Principal Author, Jim Buttle.
2) Advances in Canadian Wetland Hydrology and Biochemistry. Principal Author, Jonathan Price.
3) Snow, Frozen Soils and Permafrost Hydrology in Canada. Principal Authors, Hok Woo/Phil Marsh.
4) Advances in River Ice Hydrology. Principal Authors, Brian Morse/Faye Hicks.
5) Progress in Glacier Hydrology. Principal Author, Scott Munro.
6) A review of Canadian Remote Sensing Applications in Hydrology. Principal Author, Al Pietroniro.
7) Recent Canadian Research on Contemporary Processes of River Erosion and Sedimentation. Principal Author, Dirk de Boer.
8) Progress in Isotope Hydrology, Author, John Gibson.

International Commission on Snow and Ice Hydrology
In response to the departure of the International Commission on Snow and Ice (ICSI) from the International Association of Hydrological Sciences (IAHS), Canada proposed to IAHS and the new Union

Commission on Cryospheric Sciences (UCCS) that a new inter-association commission on snow and ice hydrology be formed. This was deemed essential to the interests of Canadian hydrologists who routinely deal with snow and ice issues. UCCS at its meeting in Quebec City in December, 2004 rejected the idea of an inter-association commission but encouraged IAHS to establish a commission itself. As such Canada has proposed to IAHS an International Commission on Snow and Ice Hydrology (ICSIH). IAHS will discuss this at its assembly in Foz do Iguassu, Brazil in April 2005.

Predictions in Ungauged Basins: Approaches for Canada's Cold Regions

This edited book was prepared from a PUB workshop held during March 2004 in Yellowknife, NWT. It was published in March, 2005 by the Canadian Water Resources Association and edited by Chris Spence, John Pomeroy and Al Pietroniro. The book includes contributions from invited authors on statistical hydrology and hydrometric network planning, cold regions hydrological processes, application of hydrological models to cold regions, and advances in distributed hydrological modelling. The book is part of Canada's contribution to the IAHS Decade for Prediction in Ungauged Basins or PUB Decade.

IAHS 7th Scientific Assembly, Foz do Iguassu, Brazil

Canada has been involved in organizing the following symposiums and workshops at Foz for the April meeting:

S#4 Symposium on Dynamics and Biogeochemistry of River Corridors and Wetlands: co-convener, Masaki Hayashi

S#7 Prediction in Ungauged Basins (PUB): Promises and Progress: co-convener, John Pomeroy

W#1 Workshop on Hydrology in 2020: What shall we target now? (Hydrology 2020): co-convener, Caterina Valeo

W#6 Workshop on Transferring Hydrological Data Across Spatial and Temporal Scales: convener, Lawrence Martz, co-conveners, John Pomeroy and Al Pietroniro

W#8 Workshop on Isotope Tracers and Remote Sensing Techniques for Assessing Water Cycle Variability: convener, John Gibson, co-conveners, Al Pietroniro

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Committee on River Ice Processes and the Environment (CRIPE)

Chair: David Andres, P.Eng., Northwest Hydraulic Consultants Ltd., Edmonton
phone: 780.436.5868; fax: 780.436.1645,
dandres@trilliumeng.ab.ca
Email: dandres@nhc-edm.com

Secretary: Brian Morse, Université Laval, Quebec

Treasurer: Kersi Davar (retired), University of New Brunswick

Members: Terry Prowse, Martin Jasek, Faye Hicks, David Milburn, Rick Carson, Terry Miles, Jay Doering, Spyros Beltaos, Raymond Bourdages, Brian Burrell, Steve Daly

Mandate and Objectives:

(1) Identify specific high-priority topics for research and development and promote the undertaking of relevant research programs;

(2) Facilitate information dissemination and exchange of ideas among practitioners, researchers, and resource managers; and

(3) Encourage the incorporation of pertinent lectures or courses in undergraduate and graduate studies at Canadian Colleges and Universities.

Meeting and Activities:

12th Workshop, Edmonton, Alberta, 2003.

The workshop returned to Edmonton in 2003 after an absence of 21 years. Co-chairs Faye Hicks and Chandra Mahabir organized a very successful event; attracting 24 papers covering topics ranging from fundamental issues such as frazil transport and ice-related flood wave propagation to remote sensing, numerical modelling, and forecasting and monitoring. The proceedings are available on electronic media at a nominal cost – contact Faye Hicks at faye.hicks@ualberta.ca.

2003 Annual Meeting

The meeting was held in conjunction with the 12th Workshop in Edmonton. Spyros Beltaos, after more than 20 years as committee chair, stepped down due to increasing responsibilities with other facets of CGU.

David Andres assumed the duties of the chair. News arising out of this meeting included the completion of the first phase of the evaluation of numerical ice jam models (Rick Carson), the completion of the work undertaken by the task force on "Ice in Tidal Rivers and Estuaries" (Brian Morse and Brian Burrell), the completion of the draft of the 'Monograph on River Ice Breakup" (Spyros Beltaos), and the completion of the special issue of CJCE on "River Ice" (Brian Burrell and Spyros Beltaos).

2004 Annual Meeting

The 2004 annual meeting was held in Winnipeg in November. The meeting focused on committee renewal, the role of the committee and expectations of membership, and future directions and programs (task forces).

2005 Special Technical Session

As part of an effort to define the future directions and programs a technical session was held in Winnipeg in March. The objective of the meeting was to develop a consensus on the emerging issues in river ice and to identify areas in which the committee could make a contribution. A short list of potential topics was developed and priority projects will be developed in the near future. Stay tuned for more on this front.

13th Workshop, Hanover, New Hampshire

The 13th Workshop will be held in Hanover, New Hampshire on September 15 and 16, 2005, in part to acknowledge the contributions made by our American colleges to the success of the workshops over the last twenty five years. The theme of the workshop is "Hydraulics of Ice Covered Rivers" and twenty nine papers have been accepted for presentations. For additional information please visit www.riverice.ualberta.ca and follow the pointers, or email Steve Daly at cripe@erdc.usace.army.mil>.

2008 IAHR International Symposium on Ice – Vancouver, Canada

The committee is actively supporting the organization of the 2008 IAHR International Symposium on Ice. Martin Jasek has assumed the chair of the local organizing committee. The date and venue – downtown Vancouver in July – has been selected. Work is now underway to flesh out the organizing committee, including bringing some "sea ice" people on board and finalizing the conference themes. Stand by for more news about this exciting and prestigious event.

Committee on Wetland Hydrology

Chair: Jonathan S. Price, Wetlands Research Centre and Department of Geography, University of Waterloo, Waterloo, ON, N2L 3G1, jsprice@fes.uwaterloo.ca

The primary activity of the wetlands group this year was organizing the Wetlands Hydrology Special Session at the annual CGU meeting in Banff. The executive committee discussed and decided upon keynote speakers (D. Rosenberry and A. Baird), and invited speakers (K. Devito, B. Branfireun, N. Roulet, B. Quinton). There were 26 oral presentations and 9 posters. The response was extremely positive, and the papers were excellent.

A strong wetlands contingent was also present at the CGU-HS student meting at Queen's University, in December.

The number of wetlands papers at CGU-HS meetings is growing annually. The executive committee has begun discussing plans for a Wetlands Special Session at the 2007 CGU annual meeting in St. John's, coupled with a field tour of Newfoundland peatlands.

The collaborative effort of Wetlands Committee members was instrumental in contributing to the now published - "Advances in Canadian Wetland Hydrology, 1999-2003" (Hydrological Processes, 18, 201-214. DOI: 10.1002/hyp.5774).

A call was made at the CGU-HS meeting (Wetlands Special Session) for new members for the wetlands committee. The list is being updated and maintenance of the Wetlands Committee website continues (http://www.fes.uwaterloo.ca/u/jsprice/CGU-HS/Wetland%20Committee3.htm).

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GEODESY SECTION NEWS

As has been the case in the previous years, the Geodesy Section of the Canadian Geophysical Union had a series of important activities during the Canadian Geophysical Union Annual Meeting 2005, held in Banff, May 8-11: Meeting of the Executive, Annual General Meeting, Host of meeting sessions, Student Paper Competition and the Ninth Geoid Workshop.

The Geodesy Section undertook the organization of two Annual Meeting sessions, one on Geodesy and the other one on Gravity and Geocomputations. There were a total of 15 geodesy papers plus 4 posters spread out in these two sessions.

There were six ***student papers*** competing for the $500 prize awarded by the Geodesy Section sponsored by the Geodetic Survey Division of NRCan. The winner was Ms. Azadeh Koohzare, a PhD student from the Department of Geodesy and Geomatics Engineering, University of New Brunswick. The competing papers were:

- Azadeh Koohzare: Compilation of a map of vertical crustal movements in Eastern Canada using Spline Polynomials
- Raymond Tsoi: GPS Based Navigation for Future Geopotential Missions
- Elena Rangelova: On the Time Dependence of the Gravimetric Geoid in Canada
- Chen Xu: Gravity Field Recovery from a Time-Variable Satellite Ground Track Pattern
- Robert Kingdon: Corrections for the improvement of the Canadian height system
- Mohamed El-Habiby: On the Evaluation of Geodetic Integrals Using the Wavelet Transform

Other geodetic papers were recognized during the CGU Annual Meeting. Mr. R. Tsoi (see above) won the Shell Canada Outstanding Student Poster Paper (non-Hydrology), and Dr. Dragert was one of the co-authors of the paper that won the "Best Student Paper" award written by Mr. Thompson entitled Quantitative characterization of seismic tremors in the Northern Cascadian Margin.

The ***Ninth Geoid Workshop*** that took place on 12 May 2005. This year, the main topic of the Workshop was a discussion on the adoption of the Canadian Gravimetry Geoid 2005 as the new vertical reference for Canada. A picture of some of this year's participants is shown below.

Past and Future Meetings related to Geodesy:

- The Scientific Assembly of the International Association of Geodesy *Dynamic Planet* will take place in Cairns, Australia, from 22 to 26 August, 2005. For details go to http://www.dynamicplanet2005.com/

Participants of the 9th Geoid Workshop, May 12, 2005, Banff Convention Centre. Photo taken by Mr. Baladji.

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CGU 2005 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 $500 monetary prize. The awards were announced and presented at the CGU Awards Banquet on Wednesday, May 11, 2005. To be considered for an award, the student must be the first author and presenter of the paper. The winners are listed below, and their abstracts or extended abstracts are printed below.

The Organizing Committee of the CGU 2005 Annual Meeting 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.

Student Oral Presentation Winners :

CGU Best Student Paper Award (all fields of geophysics)

Winner:

Phillip J. Thompson, School of Earth and Ocean Sciences, University of Victoria, "Quantitative Characterization of Seismic Tremors in the Northern Cascadia Margin". Coauthors: Honn Kao and Herb Dragert.

Honourable Mentions:

Frank Wilschut, Department of Earth and Ocean Sciences, University of British Columbia, "Sediment transport in subglacial channels: towards a simulation of esker genesis". Coauthor: G. K. C. Clarke.

Pete Whittington, Department of Geography, University of Waterloo, "The effects of water table draw-down (as a surrogate for climate change) on peatland hydrology". Coauthor: Jonathan S. Price.

Chevron Canada Outstanding Student Paper in Seismology

Winner:

Soo-Kyung Miong, University of Manitoba, "Mantle Fabric and Lithospheric Thickness Beneath the Superior Province". Coauthor: Andy Frederiksen.

Honourable Mention:

Andrew F. McNeill, School of Earth and Ocean Sciences, University of Victoria, "Contribution of Post-critical reflections to Ground Motions from Mega-thrust Events in the Cascadia Subduction Zone". Coauthors: George Spence, Gary Rogers and John Cassidy.

D. M. Gray Award for Best Student Paper in Hydrology

Winner:

Brian D. Smerdon, Department of Earth and Atmospheric Sciences, University of Alberta "Can Lakes and Ponds Be Represented in a Hydrologic Model Without Excessive Numerical Intervention?". Coauthors: C.A. Mendoza, and K.J. Devito.

Geodesy Award for Best Student Paper in Geodetic Research & Education

Winner:

Azadeh Koohzare, Department of Geodesy and Geomatics Engineering, University of New Brunswick, "Compilation of a map of vertical crustal movements in Eastern Canada using Spline Polynomials". Coauthors: Petr Vaníček, Marcelo Santos.

Student Poster Presentation Winners :

Shell Canada Best Student Poster Award (in areas other than hydrology)

Winner:

Raymond Tsoi, Department of Geomatics Engineering, University of Calgary, "GPS Based Navigation for Future Geopotential Missions:. Coauthors: Nico Sneeuw, Elizabeth Cannon

Honourable Mention:

Pierre Lyons-Thomas, Department of Physics, University of Toronto, "An examination of Absorption Velocity Dispersion Effects Using Broadband Vibroseis VSP".

Campbell Scientific Award for Best Student Poster in Hydrology

Winner:

Maria Strack, School of Geography and Geology, McMaster University, "The Impact of Gas Dynamics on Peatland Surface Level-Water Table Relationships". Coauthors: Erik Kellner, and J.M. Waddington.

The CGU 2005 Student Award Winners, plus abstracts / extended abstracts

Left: Hugh Geiger (left), Awards Chair, presenting the CGU Best Student Paper Award to Philip Thompson.

Right: Hugh Geiger presenting the Chevron Outstanding Student Paper in Seismology Award to Soo-Kyung Miong.

Left: Lawrence Martz (right), CGU-HS President, presenting the D. M. Gray Award for Best Student Paper in Hydrology to Brian Smerdon.

Right: Spiros Pagiatakis (left), CGU-GS President, presenting the Geodesy Award for Best Student Paper in Geodetic Research and Education to Azadeh Koohzare.

Left: Hugh Geiger (left), CGU Awards Chair, presenting the Shell Canada Best Student Poster Award (for areas other than hydrology) to Raymond Tsoi.

Right: Peter Laffin (right), Campbell Scientific, presenting the Campbell Scientific Award for Best Student Paper in Hydrology to Maria Strack.

Quantitative Characterization of Seismic Tremors in the Northern Cascadia Margin

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The regular occurrence of episodic tremor-and-slip (ETS) events in the northern Cascadia margin has been remarkable. In addition to the 14-month period, secondary tremor activities, most of them last less than one or two days, are also found with no corresponding GPS signatures. However, the identification of tremor activity is mainly based on visual examination of regional/local seismic records. In this study, we attempt to develop an algorithm that can quantitatively characterize the level of tremors from a collection of seismic waveform data. For each hour of waveform at a given station, the process begins with the calculation of moving average and scintillation index with various time lengths. The scintillation index, defined as "normalized variance of intensity of the signal", is adapted from the studies of pulses in radio waves and is an efficient tool to identify the pulse-like characteristics of tremor signals. Then, the results are fed into a series of logic gates that use a combination of both parameters to determine if sufficient tremor activity exists. Finally, a genuine tremor event is declared when at least 3 stations within a radius of 50 km give consistent indications. To demonstrate the effectiveness of our algorithm, seismic waveform data are collected for the known February/March 2003 ETS event. Our analysis gives consistent results to the work done manually. Implementation of our algorithm is straightforward and free from human intervention. Thus, it is potentially possible to automate the tremor monitoring process that may give early warning of the exact arrival time of ETS events.

Mantle Fabric and Lithospheric Thickness Beneath the Superior Province

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The Superior Province, the largest Archean craton in the Canadian Shield, represents an ideal laboratory for understanding the nature and development of cratonic lithosphere. Ontario spans a major portion of the Superior, and, under the auspices of the POLARIS and FEDNOR projects, is in the process of being instrumented with broadband seismometers on a large scale. We present the result of SKS splitting analyses for FEDNOR and CNSN stations spanning the breadth of Ontario, covering the Eastern and Western Superior Province. The Western Superior exhibits very large SKS splits (averaging 1.4 seconds) with a consistent ENE fast direction (averaging 69° azimuth). In the Eastern Superior, the fast directions are much more variable (ranging from east to northeast), with smaller split times averaging 0.8 second. In the Western Superior, the split times align closely with both the current direction of absolute plate motion and the orientation of structural belts in the crust; we therefore interpret the strong splits in this region to represent a combination of lithospheric and asthenospheric fabric sharing a common alignment. In the east, the fast directions show appreciable scatter around the direction of plate motion, though there is general agreement; given the weaker split times in this area, we take the variability to reflect a weaker and more inconsistent lithospheric fabric, since the asthenospheric fabric should vary little across the Superior. Results from other studies, including tomography, heat flow, and elastic plate thickness studies, suggest the possibility that the cratonic lithosphere may have been significantly reworked or thinned beneath the eastern portion of the Superior Province.

GPS Based Navigation for Future Geopotential Missions

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The idea to apply the technique of formation flying to future space missions has been recognized by many researchers and scientists. One of the key missions that has reinforced this approach is the Gravity Recovery and Climate Experiment (GRACE) mission, where two identical satellites are configured into a Leader-Follower formation to recover the signature of Earth's gravity field from space. Although the current GRACE mission can provide significant knowledge regarding the Earth's gravity field, it still have its limitations due to its simple configuration. To overcome these limitations more complex formation types such as the CartWheel and LISA formations can be considered but one of the essential aspects is precise relative navigation. This accurate relative information is especially important for avoiding collision and maintaining specific configuration.

The ideal navigation sensor for Low Earth Orbit (LEO) formation flying mission would be GPS, due to its relatively low cost, reliability and availability. When utilizing GPS on large satellite configurations, dual frequency receivers are required for precise relative navigation. The access to dual frequency observables allows for correction of the relative ionosphere delay which is crucial for double difference ambiguity resolution. An extended Kalman filter that incorporates the Hill's equation of motion as the dynamic model has been developed to estimate the relative motion of formation cluster. The filter processes double difference GPS pseudorange and carrier phase observations to estimate the relative position and velocity of satellites. At the same time, double difference carrier phase ambiguities are being resolved using the Least Squares Ambiguity Decorrelation Adjustment (LAMBDA) technique to fully exploit the highest estimation accuracy. This proposed method can validate the use of GPS for future formation flying mission with more complex configuration.

Can Lakes and Ponds Be Represented in a Hydrologic Model Without Excessive Numerical Intervention?

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Abstract

An integrated surface-water/groundwater model has been applied to study the hydrologic controls on lake-groundwater fluid exchange in the sub-humid, Boreal Plains of northern Alberta. Findings from a 3-year water budget study indicate that lakes on this landscape capture groundwater as major source of water input, and function as evaporation windows during the ice-free season. We applied the numerical model to an area of glacial outwash that contained a flow-through lake, which has no surface-water input, and can only generate ephemeral surface outflow through a small channel outlet. We found that the robust, coupling mechanism allowed lake-groundwater exchange fluxes to be computed as part of the simulation, and that the lake did not need to be explicitly defined as a hydraulic boundary condition. The ability of this model to represent an integrated hydrologic system was demonstrated by successfully simulating field observations of a drought year, in which the study lake level declined by 0.2 m. We found that lake-groundwater interaction is generally controlled by atmospheric demand and the hydraulic conductivity and anisotropy of outwash sediments. However, we also found that exchange fluxes were sensitive to the presence of riparian peatlands and lakebed sediments (i.e., gyttja), and their associated hydraulic characteristics.

Introduction

Effective management of water resources on all landscapes requires an understanding of water cycling processes, which depends on climate, geology, and the interaction of surface water and groundwater (Devito *et al.*, in press). Research at the Utikuma Research Study Area (URSA), in the Boreal Plains region of northern Alberta, reveals complex surface and groundwater interactions (Ferone and Devito, 2004; Smerdon *et al.*, in press), which are largely controlled by regional climate (e.g., York *et al.*, 2002). To adequately simulate water cycling processes in this landscape, and to be able to predict hydrologic response for future scenarios (e.g., climate change, landscape disturbance), numerical models must represent integrated surface water/groundwater flow, and widely distributed lakes, ponds and wetlands, without assuming surface-subsurface connections *a priori*.

The objectives of this study are (1) to represent a flow-through lake and groundwater system on a glacial outwash terrain, in a watershed model without defining the lake as a boundary condition; (2) to simulate field observations for a drought year; and (3) to determine the landscape heterogeneity and spatial distribution of atmospheric fluxes required to represent hydrologic field observations. These objectives were met through modelling groundwater conditions, lake levels, and lakebed seepage fluxes for an instrumented study lake at the URSA, for summer 2002.

Study Site: URSA Lake 16

Lake 16 (39 ha) is located within the Boreal Plains region, 370 km north of Edmonton, Alberta, Canada (56°6' N, 116°32' W; Fig. 1), on a 200 km^2 coarse-textured glacial outwash plain. Surface drainage is poorly developed, with no evidence of surface inflow to Lake 16, and ephemeral outflow through a narrow channel to a fen on the west side of Lake 16. The 3 lakes in the study area exist as a series of 'steps', where Lake 16 was 1.8 m higher than Lake 5, but 2.4 m lower than Lake 17. The region is characterized by a sub-humid climate (EWG, 1989), sedimentary bedrock that is covered by 80 to 240 m of heterogeneous glacial sediments (Pawlowicz and Fenton, 2002), and low topographic relief. Annual average precipitation (P) and potential evapotranspiration (PET) are 433 mm (EnvCan, 2003) and 517 mm (Bothe and Abraham, 1993), respectively.

Measurements of hydraulic head (70 piezometers), lake level (3 lakes), and groundwater seepage (8 lakeshore segments) were made from April 2001 to October 2003, as part of a 3-year water budget study (Smerdon *et al.*, in press). Hydraulic conductivity (K) was found to vary by six orders of magnitude (10^{-3} to 10^{-8} m/s), for 8 soil types (Fig. 2; Table 1), and annual P and PET was 283 mm and 336 mm for the 2002 hydrologic year (Nov to Oct), with 44 mm of snow water equivalent (SWE). Lake 16 was found to be well connected to the groundwater flow system, and maintained by a consistent source of groundwater discharge. Although the coarse-textured outwash sediments allowed the formation of water table mounds in spring months (from SWE recharge), evaporation was found to be the largest hydrologic flux annually, exposing captured groundwater to the atmosphere via evaporation windows (i.e., lakes). This dynamic relationship between precipitation, groundwater interaction, and evaporation controls lake-groundwater exchange, and is expected to be very sensitive to the onset of warmer spring air temperatures, which may be enhanced under future landuse and climate change scenarios.

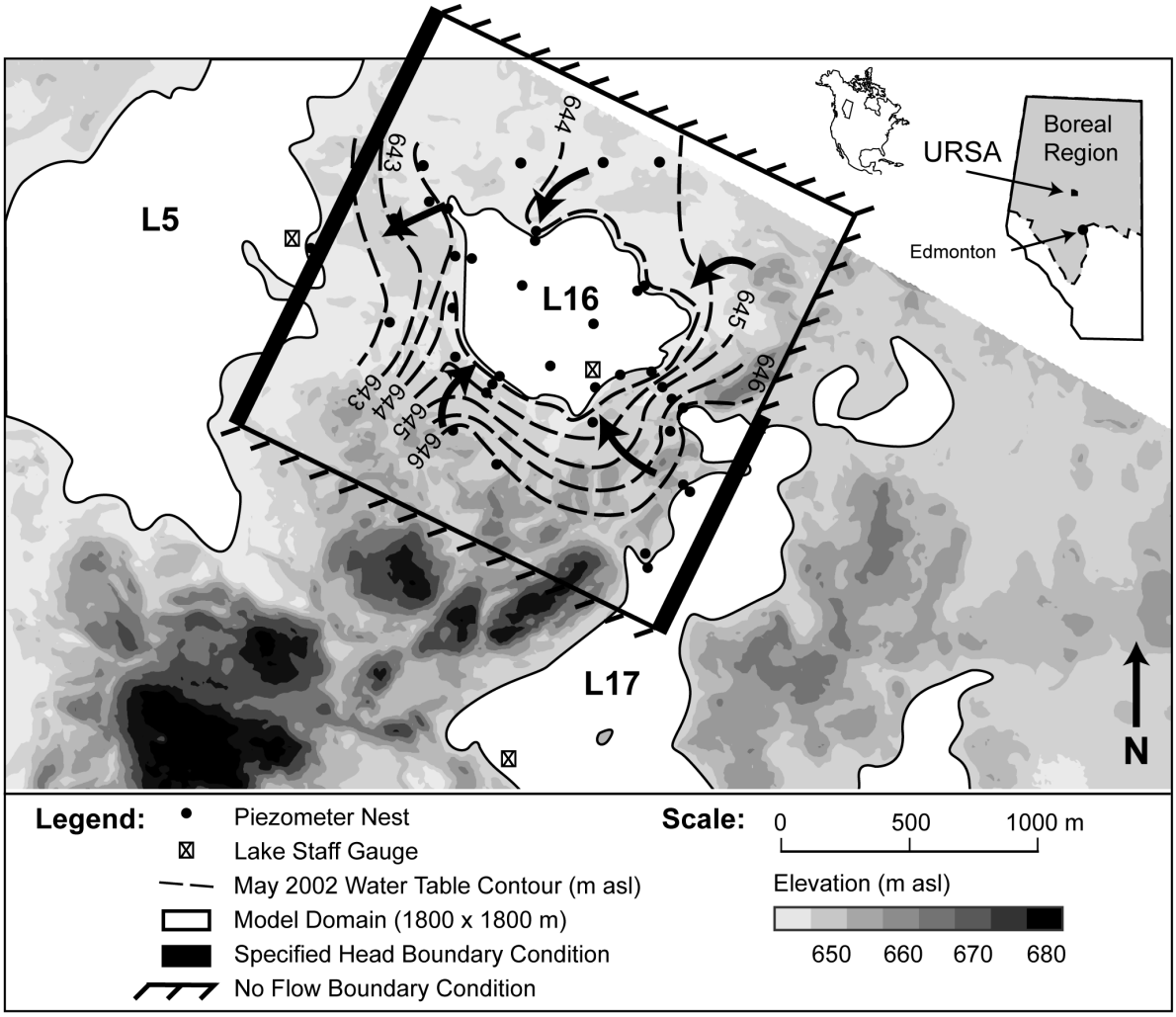

Figure 1. Lake 16 study site with topography, field instrumentation, numerical model domain, and boundary conditions. Arrows indicate groundwater flow direction. URSA and Boreal Plains region in Alberta, Canada on inset.

Methods

A 3D simulation of lake-groundwater interaction was completed using the Integrated Hydrology Model (InHM; VanderKwaak, 1999), which simultaneously solves fully-coupled, variably-saturated flow through porous media and overland flow, using a first-order flux relationship. The model presented here determines hydraulic head, water saturation, and surface water depth, for a finite-element mesh representing an 1800x1800 m area of the study site, including Lake 16 (Fig. 1). The principles of lake-groundwater simulation have been well documented by the work of Winter (1976; 1982), Townley (Smith and Townley, 2002; Townley and Trefry, 2000), and through development of the 'LAK3' Package for the MODFLOW groundwater model (described in Hunt *et al.*, 2003). Thus, in this study, we seek to enhance modelling of lake-groundwater exchange further, by using a numerical model capable of determining the location and depth of surface water bodies (i.e., lakes and ponds) and surface-subsurface exchange fluxes, without prior definition. This allows lake-groundwater interaction to be investigated without defining Lake 16 as a boundary condition, thereby minimizing the amount of numerical intervention (Loague and VanderKwaak, 2004).

The top surface of the model was based on ground topography from a 1 m resolution digital elevation model, and measured lake bathymetry, which was combined and smoothed to 20 m resolution, to minimize the complexity of the surface features. The bottom surface of the model domain slopes from east to west (Fig. 2), corresponding to the base of the glacial outwash, as determined from field investigation (Smerdon *et al.*, in press). The model is comprised of 243,000 subsurface elements (prisms), and 16,200 surface elements (triangles: the top of prisms) that are variably spaced in the vertical direction, with finer spacing (0.25 m) in the vicinity of the lake basin and expected water table depth. Elements were uniformly spaced at 20 m laterally. Eight zones of porous media properties were defined, based on site geology, and specified with field measured K values and estimates of

anisotropy (Fig. 2; Table 1). A rectangular zone of coarse sand represented remnants of an east to west trending esker. Within the lake basin, the bathymetry corresponds to the top of the gyttja (i.e., top of model domain), thereby allowing fluid flow, and more importantly, lakebed seepage flux, to be simulated. Gyttja and lakebed K decrease with depth, such that the gyttja more easily transmits water than lakebed mineral sediments.

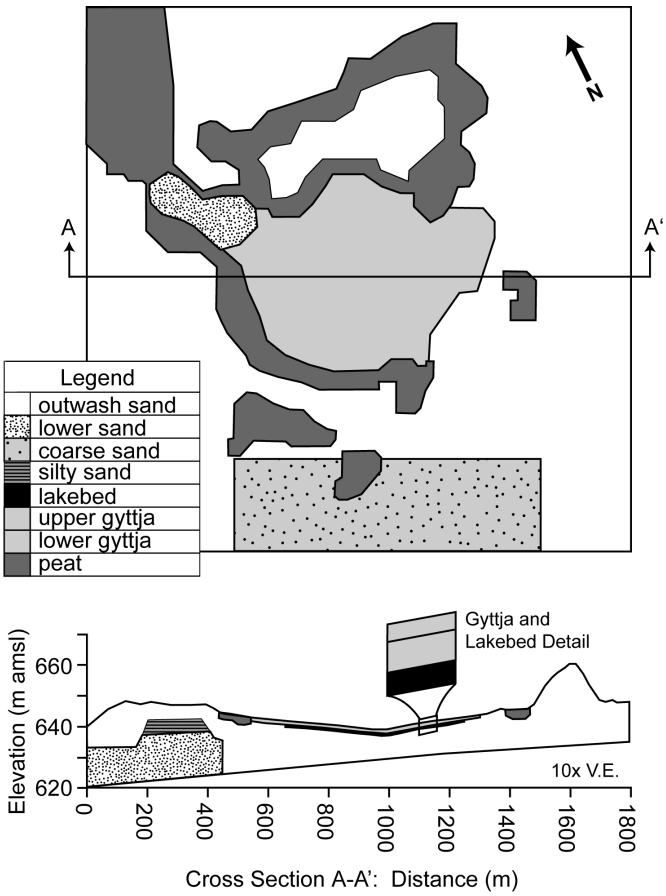

Figure 2. Plan view and cross section of model domain from Fig. 1, showing porous media zones. Details of upper and lower gyttja and mineral lakebed zones shown on inset.

Summer 2002 had drought conditions, and Lake 16 declined by 0.2 m. Thus, simulating this timeframe accurately was considered a suitable numerical experiment to elucidate key landscape features and hydrologic controls on lake-groundwater interaction. Boundary conditions for the numerical model are shown on Fig. 1. Lake levels were specified for Lakes 5 and 17 (field measured), and subsurface outflow was enabled from the lower sand zone (Fig. 2) by specifying a hydraulic head value of 640 m, which represents connection with larger-scale, regional groundwater, downgradient in the outwash system. Since the model domain was oriented in the direction of groundwater flow, the remaining sides (and bottom) were considered no-flow boundaries. Separate positive and negative time-series fluxes were applied to the top of the model domain, corresponding to P and PET, respectively. Positive fluxes were scaled depending on the presence of forest canopy and assumed throughfall (based on Price *et al.* 1997). For spring and fall months (March to June, and October) throughfall was assumed to be 100%, for summer months (June to August) throughfall was assumed to be 80% of daily precipitation greater than 15 mm, and for September throughfall was assumed to be 95% of daily events greater than 5 mm. Open areas received 100% of P. PET was only removed from the lake, assuming that the throughfall fluxes on the forested areas were considered net precipitation, and therefore implicitly accounted for evapotranspiration.

Table 1. Porous Media Zone Parameters.

Zone	K (m/s)	K_{XY}:K_Z
outwash sand[1]	$1x10^{-5}$	10:1
lower sand	$5x10^{-5}$	1:1
coarse sand[1]	$1x10^{-4}$	1:1
silty sand[2]	$2x10^{-6}$	50:1
lakebed	$1x10^{-8}$	1:1
upper gyttja	$3x10^{-6}$	1:1
lower gyttja	$1x10^{-7}$	1:1
peat[3]	$3x10^{-6}$	1:1

Soil Water Retention Functions:

[1] Abdul, 1985 (Borden sand)

[2] Carsel and Parrish, 1988 (silt)

[3] Silins and Rothwell, 1998

Since InHM solves variably-saturated and overland flow equations, initial conditions are required for hydraulic head, water saturation, and surface water depth for each node in the model domain. Initial conditions were determined by specifying the March 2002 hydraulic heads to the boundary lakes (i.e., beginning of summer 2002 simulation), and running the simulation to steady state, starting from a completely saturated state. The simulated hydraulic head, water saturation, and surface water depths were compared to March 2002 field observations, and then used as the starting point for the transient simulation of summer 2002. Minimal calibration was required, through minor adjustment of hydraulic parameters to better match field observations.

Results

Steady State Initial Conditions

As the simulation progressed from an initially saturated condition, to the steady state condition, the groundwater flow field developed, and the lake basin filled with water. At steady state, the water table configuration, and level of Lake 16, were similar to field observations for March 2002 (Fig. 3a). For 10 wells/piezometers distributed around the study site, the RMS error was 0.49 m. The resulting flow system illustrates the flow-through style lake, and large groundwater capture zone. These initial conditions were

sensitive to K and anisotropy of the outwash sand (the largest porous media zone). For the field measured outwash K, the anisotropy required was 10:1 (K_{xy}:K_z), and variation of K by half an order of magnitude resulted in an incorrect regional water table gradient and lake level.

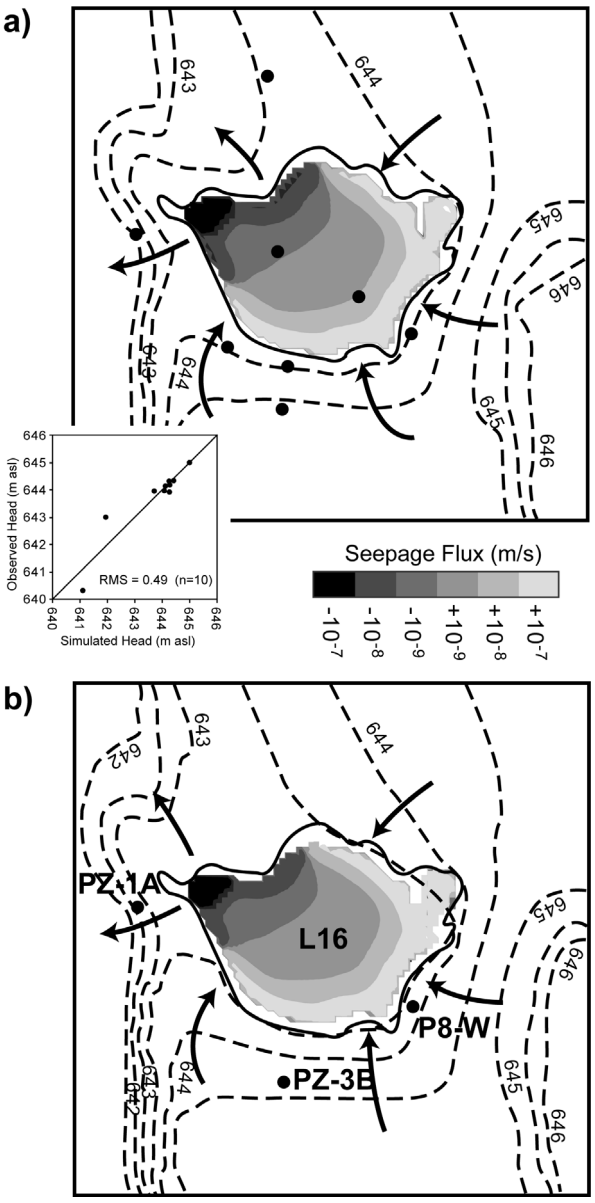

Figure 3. Simulated water table (dashed lines) and lakebed seepage flux (shading) for a) March 2002 with observed vs simulated hydraulic heads shown on inset for 10 piezomters (dots, 2 are multilevel); and b) September 2002 with location of 3 piezometers used on Fig. 4.

Transient Simulation: Summer 2002

The steady state simulation results were input as initial conditions for the transient simulation. Simulated lake levels, water table configuration, and the response of lake levels and hydraulic heads throughout the summer matched field observations very well (Fig. 4). For wells upgradient of Lake 16, the amount of simulated groundwater recharge from melting snow appears slightly lower than indicated by field measurements; however, the majority of the water table time-series is well represented in the model. Downgradient of Lake 16, groundwater recharge is not as well represented (PZ-1A; Fig. 4), and improvement of the unsaturated hydraulic parameters is warranted.

Simulated exchange fluxes, between the subsurface and surface elements, for the lake basin area, represent lakebed seepage (Fig. 3). Groundwater discharge measurements along the southeast lakeshore varied from $2.4x10^{-6}$ to $5x10^{-8}$ m/s, with a geometric average of $6.3x10^{-7}$ m/s from 3 seepage meters (Smerdon *et al.*, in press), for the summer of 2002. Simulated seepage flux at corresponding locations within the model is $2.5x10^{-7}$ m/s. Although simulated seepage varies less than measured with the seepage meter at individual points, the patterns and magnitude of recharge and discharge honour field observations.

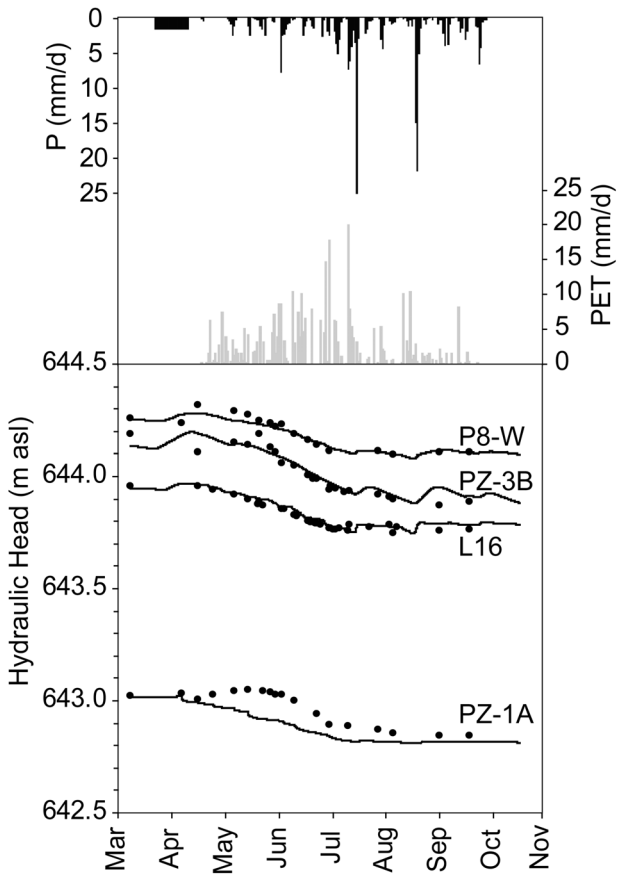

Figure 4. Daily atmospheric flux boundary conditions (P and PET), and time-series plots of simulated (line) and observed (dot) hydraulic head. Piezometer locations shown on Fig. 3b.

Discussion and Conclusions

In this study, InHM has been used to simulate a flow-through lake and groundwater flow system on a glacial outwash plain at the URSA. The robust, first-order coupling mechanism allowed lake-groundwater exchange fluxes and lake levels to be calculated as part of the simulation, and correspond with field observations. Replication of the water table configuration and lake levels, for the specified atmospheric fluxes (P and PET), supports the hypothesis that shallow lakes act as evaporation windows on the Boreal Plains landscape.

Although the model developed in this work relies on 8 different zones of heterogeneity, we found that the broad-scale flow system is well defined by the parameters of the 'bulk' outwash K, with anisotropy of 10:1. Correctly simulated lakebed seepage, required that riparian peatlands be parameterized with a K of $3x10^{-6}$ m/s, and relatively high water retention characteristics, to maintain lake levels throughout summer months. In addition, K of lakebed sediments and gyttja control vertical fluxes; however, it appears that the results are not as sensitive to these parameters as to those for the peatlands.

This study illustrates that InHM can be applied to lake-dominated hydrologic systems, and used to investigate landscape and atmospheric controls on hydrologic processes. For larger areas, and longer-term applications (i.e., landscape management and reclamation), the modelling framework presented here would be appropriate, because it is not hampered by excessive numerical intervention. However, successful application will depend greatly on the ability to define spatially variable, subsurface hydraulic properties (Devito *et al.*, in press).

Acknowledgements

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The impact of gas dynamics on peatland surface level-water table relationships

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Introduction

Peatlands may experience substantial seasonal surface level fluctuations in response to shifts in water table position due to the floating nature of some peat systems (Hogg and Wein, 1988; Fechner-Levy and Hemond, 1996) and the high compressibility of peat soils (Roulet, 1991; Kellner and Halldin, 2002; Price, 2003). Peatland surface level position may also be significantly influenced by entrapped gas (primarily methane (CH_4)) content (Hogg and Wein, 1988; Fechner-Levy and Hemond, 1996; Glaser et al., 2004). While relationships between surface level, water table and gas content have been investigated in a variety of peatland systems, few studies have investigated differences in these relationships within a peatland and most do not report direct measurements of gas content and CH_4 release. Therefore, the objectives of this study were to: 1) determine relationships between surface level position, water table position and gas dynamics at locations that differed in vegetation cover and peat properties, 2) explain these differences by comparing subsurface gas contents and the timing and magnitude of CH_4 ebullition events between sites and 3) develop a conceptual model integrating these results.

Study Site

The study was conducted at a poor fen in central Québec (46°40'N 71°10'W) with pool-ridge topography. All measurements were carried out at three local topographic low-lying zones (hollows/pools). Two of these had highly moveable surfaces and were classified as floating (FA and FB). These sites had vegetation covers dominated by liverworts (*Gymnocolea inflata*, *Cladopodiella fluitans*) and sedges (*Rhyncospora alba*). The third site, classified as non-floating, (NF) had a more stable surface dominated by *Sphagnum* moss.

Methods

Measurements were carried out between May 13 (day 134) and August 17, 2004 (day 230). Surface level and water level were recorded continuously with a recording well combined with weekly manual measurements at FA and NF. The relationship between surface level and water level position was assessed for periods of at least three days in which both were consistently rising or falling. In all cases this assessment occurred during periods of falling water table. Relative surface levels were computed as the variation around this relationship (residuals) and compared to atmospheric pressure recorded 50 km from the study site in Québec City (Environment Canada, 2004). Since surface level and water table position were measured as a distance below an arbitrary datum, positive residuals indicated that the surface was sinking and negative values that it was rising. Thus, a negative relationship between the relative surface position and atmospheric pressure suggests that falling atmospheric pressure is related to periods when the surface level is sinking, suggesting a reduction in entrapped gas volume, or ebullition. In contrast, a positive relationship indicates that falling atmospheric pressure leads to rising of the surface and thus a larger gas volume. This observation would be consistent with gas which is not released from the peat and which has a volume varying according to the ideal gas law and Henry's law.

Subsurface gas content at FA, FB and NF was determined by measuring peat water content below the water table (30 and 50 cm depth) using Campbell Scientific moisture probes calibrated for peat soil. Changes in water content were corrected for changes in peat volume due to compression and swelling (see Kellner et al., 2004) and the remainder of the change was assumed to result from changes in entrapped gas volume.

Ebullition was measured using inverted funnels with a surface area of 0.032 m^2 placed on pool or hollow surfaces. Funnels were filled with water and sealed, allowing ebullition to be measured as gas displacement of water in the neck of the funnel. Gas was collected after several milliliters had accumulated and its CH_4 concentration determined using a Varian 3800 gas chromatograph.

Results and Discussion

Entrapped gas volume was important for controlling surface level seasonally with the relative surface level at FA and NF changing by 8 and 1 cm in response to gas volume changes of 0.7 and 0.1%, respectively. At both FA and NF the majority of the variation in surface level position within a short time interval was related to changes in water table position (Table 1). During the early part of the season (before day 205) the slope of this relationship was closer to 1 at FA (mean = 0.92) than at NF (mean = 0.74) supporting the observation that the surface moved more at FA. Deviation from this slope at FA later in the season was likely due to the influence of gas dynamics. Of the 11 time periods assessed, six had significant relationships ($p<0.05$) between relative surface level and atmospheric pressure (Table 1). These relationships were negative at FA suggesting that the dominant effect of atmospheric pressure was for controlling the release of entrapped gas by ebullition. In contrast, two of the three significant relationships at NF were positive indicating that atmospheric pressure was more important for controlling the volume of entrapped gas according to the ideal gas law and Henry's law. These observations suggest that differences in gas dynamics may exist between hollows which differ in vegetation cover.

Table 1: Slope and R^2 of water table-surface level relationships and direction of relative surface level-atmospheric pressure relationships at FA and NF. Significant ($p<0.05$) relative surface level-atmospheric pressure relationships are marked (*).

Site	Dates (day of year)	Water table-surface level relationship		Relative surface level-atm pressure relationship
		Slope	R^2	
FA	155-159	0.90	0.98	+
	160-166	0.91	0.99	**- ***
	185-190	0.76	0.81	+
	193-197	1.05	0.85	-
	200-205	0.98	0.94	**- ***
	209-213	0.53	0.82	**- ***
	215-221	0.57	0.85	-
NF	193-197	0.65	0.92	-
	200-205	0.83	0.98	**+ ***
	209-213	0.89	0.98	**+ ***
	215-221	0.77	0.98	**- ***

Comparison of entrapped gas content at 50 cm depth revealed frequent gas build-up and release at NF and a more gradual accumulation at FA with large shifts corresponding to a small number of periods of falling atmospheric pressure. This confirms the differences in the relative surface level-atmospheric pressure relationships observed between the two sites and supports the hypothesis that the dominant trigger for gas release at FA is a reduction in atmospheric pressure.

Low atmospheric pressure has also been observed to correspond to periods of ebullition in other peatland studies (Rosenberry et al., 2003; Glaser et al., 2004; Strack et al., 2005). However, the pattern of entrapped gas content at 50 cm depth at FB is more similar to NF than FA suggesting that the differences in gas dynamics are not simply related to differences in surface vegetation cover. Also, both FB and NF have a seasonal build-up of gas at 30 cm depth suggesting that heterogeneity of gas dynamics within the peat profile also may exist.

Despite these complications, it was observed that several ebullition events (as recorded by gas trapped in inverted funnels) were spatially widespread, occurring at the majority of gas samplers. These tended to occur later in the season and corresponded to periods of low atmospheric pressure, observed gas volume reductions at depth and falling relative surface level positions. However, other ebullition events were spatially heterogeneous and corresponded to local changes in subsurface gas measurements. Using the available data it was not possible to determine a threshold value of entrapped gas content or atmospheric pressure which could trigger gas release and more investigation is needed to determine controls on this value.

Conclusions

These findings suggest that surface level position of hollows in the study peatland is temporally variable and controlled on short time scales primarily by shifts in water table position and seasonally, by the accumulation of entrapped gas. Variability around the surface level-water table relationship can be related to subsurface gas dynamics; however, the controls on entrapped gas volume related to shifts in atmospheric pressure differ between sites. Ebullition corresponding to declines in atmospheric pressure was the more important control on gas volume at FA, while changes in gas volume and solubility predicted by the ideal gas law and Henry's law were the main controls at NF.

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Compilation of a map of vertical crustal movements in Eastern Canada using spline polynomials

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Overview

In order to obtain representations of the recent Vertical Crustal Movements (VCM) in Eastern Canada, algebraical polynomial surfaces of different order were first computed from sea level data recorded by 17 reliable tide gauges and 2972 filtered relevelled segments of the first order Canadian levelling network in the region. The filtering of levelling data included the elimination of levelling segments that showed anomalously high local tilts along with elimination of those segments that were too short to contribute to the analysis. The resulted velocity surfaces were indicative of only the crude features of VCM because of the sparsity of data coverage. In order to get the details needed for the map to be physically meaningful, without increasing the degree of polynomials, we then decided to divide Eastern Canada into two zones: Maritimes zone and the southern part of St. Lawrence River zone. The border of these two zones is dictated by the actual data distribution and the preliminary knowledge of the geodynamics of the area (See figure 1). The vertical movement was then represented by a different polynomial surface in each zone. The polynomials were joined together at the interval knots along the border in such a way that a certain degree of smoothness (differentiability) of the resulting function was guaranteed. In this paper, we use polynomial spline function.

In general, if we divide the area of study into *m* zones and the degree of the polynomials is *n*, the resulting function is a polynomial spline function of degree *n* with *m* zones. A given spline polynomial in the *m*-th zone looks as follows:

$$V_m(x,y) = \sum_{i,j=0}^{n} c_{ij,m}(x - x_m)^i (y - y_m)^j \qquad (1)$$

where V_m is the algebraic least squares velocity surface for zone *m*, fitted to the desired data located at (*x, y*) in an arbitrary selected local horizontal coordinate system and (x_m, y_m) is the knot located in the predefined border between two zones.

In this study, the polynomials have to satisfy the following conditions:

$$\text{i) } V_m(x_m, y_m) = V \qquad (2.a)$$

$$\text{ii) } V_m(x_{m+1}, y_{m+1}) = V_{m+1}(x_{m+1}, y_{m+1}) \qquad (2.b)$$

$$\text{iii) } V'_m(x_{m+1}, y_{m+1}) = V'_{m+1}(x_{m+1}, y_{m+1}) \qquad (2.c)$$

$$\text{iv) } V''_m(x_{m+1}, y_{m+1}) = V''_{m+1}(x_{m+1}, y_{m+1}) \qquad (2.d)$$

Conditions (2.a) make sure that the spline fits to the knot points. The second condition ensures that the spline is continuous everywhere in the region.
Conditions (2.c) and (2.d) ensure that the polynomial spline is continuous in slope and curvature respectively throughout the region spanned by the points. The appropriate degree of the velocity surface was determined by testing the predicted error (a posteriori standard deviation) and the capability of the surface to portray the main features.

Results

Several tests were made to determine the appropriate degree of the velocity surface to be computed. All degrees of the polynomials yielded the a posteriori variance factor equal to 8-8.5. The value n=4 was finally selected as the highest degree compatible with data distribution.
The map of vertical crustal movements in Eastern Canada produced by spline polynomials is shown in Figure 1.

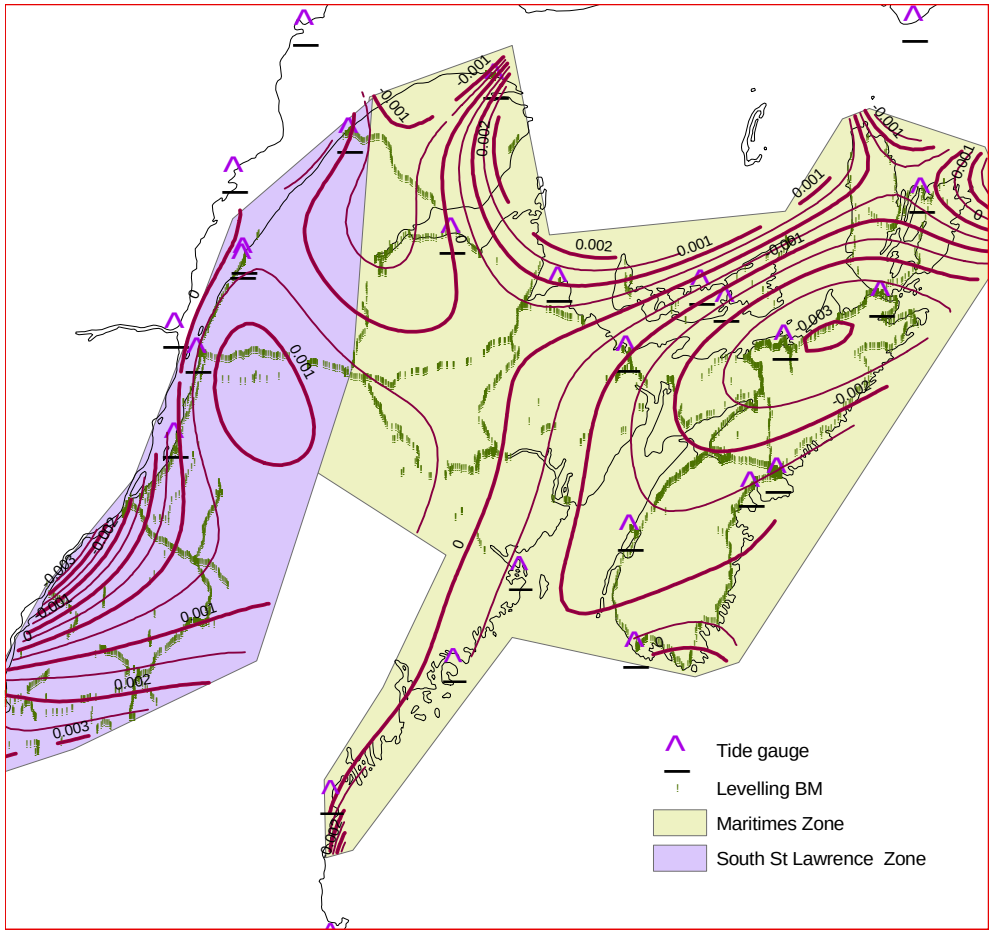

Fig. 1. Map of vertical crustal movements in Eastern Canada compiled using cubic spline polynomials. Contours are in m/year. Splines used for joining the VCM surfaces.

The solution is evidently much generalized. The map depicts clearly the zero line of the postglacial rebound. The zero line follows the St. Lawrence River (Figure 1). Present-day radial displacement predictions due to postglacial rebound over North America computed using VM2 Earth model and ICE-4G adopted ice history show a zero line very similar to ours along St.Lawrence River. (See Peltier et al 2004 for ICE-4G model predictions).The general Northwest Southeast trend of vertical crustal movements is consistent with the predictions of Glacial Isostatic Adjustment models**.**

With respect to the individual features on the map, the subsidence in Maritimes predominantly in Nova Scotia and eastern New Brunswick is due to postglacial rebound. This area lies immediately outward of the region that was covered by the Laurentide Ice Sheet at the last glacial maximum (see Peltier, 1994 for maps of surface ice cover from LGM to present). As the Laurentian ice started to decay, this area began to collapse. The map of VCM in this area reflects this phenomenon and is also compatible with the recent map of gravity changes (See Pagiatakis et al, 2003 for the map of gravity changes).

The pattern shown in the north eastern margin of the former Laurentide ice sheet (the border of which has been postulated to have been parallel to St.Laurence River) is complicated due to the probable discontinuities of the crust in this zone. The map seems to justify the concentration of seismicity in Lower St Lawrence Zone (See Lamontage, 2003 for the definition of Lower St. Lawrence Seismic Zone), which opens new doors into the study of geodynamics of this complex area.

The earlier reported uplift of the northern New Brunswick and the subsidence of the South St. Lawrence River (Carrera et al. 1990) are here more sharply defined.

Conclusions

This study shows that spline polynomial surface can represent the available data in a unified map. The local pattern of the map gives more details of the south Lawrence River, compared to the previous maps. However, the computed value, 8.2, for the a posteriori variance factor indicates the probability of the existence of some shorter wavelength features that could not be modelled by a surface of such a low degree. Increasing the number of intervals (zones) in the area of computation, might be a solution for representing shorter wavelength features of VCM which would be the next step in our studies. Compilation of a unified map which satisfies all the observations and is consistent with most of the geological evidences requires further investigations.

Acknowledgement

We would like to thank the GEOIDE (GEOmatics for Informed DEcisions) Network of Centres of Excellence of Canada and CIDA (Canadian International Development Agency) for their financial support of this research.

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Statement of Cash Receipts and Disbursements (2004)

Receipts	2004	2003	2002	2001
Memberships				
Canadian Association of Physicists	210	135	345	233
Geological Association of Canada	1,299	1,377	118	1,293
Memberships Direct	3,242	3,513	3,586	3,597
Annual Meeting	16,163*	-	64,232	-
Annual Meeting (Montreal 2004, Banff 2002)	10,640*	-	24,326	-
Bank Interest	1,288	423	2,045	789
CGU Conference Support	-	-	4,000	11,000
GSC Grant (Student Support)	4,000	4,000	4,000	-
Miscellaneous	231	-	337	1,062
TOTAL Receipts (Note 1)	37,073	9,448	102,989	17,974

* Includes Banff 2003 meeting income

Disbursements				
Postage	-	-	-	15
Newsletter	810	5,244	3,369	1,039
Prize for Best Student Papers/Poster	2,000	2,000	1,500	1,500
Student travel	4,225	5,700	5,600	6,875
Annual meeting (Translation, Travel)	1,709	5,906	8,720	43,940
CGU Executive Meetings	43	359	-	-
CGU-HS Student Conferences	572	244	-	-
Miscellaneous	453	30	250	90
Membership in Can. Geoscience Council		400	1,288	1,288
Bank charges	32	-	54	2
J. Tuzo Wilson Medal	-	4,344	-	-
Seismix 2004 Student Support	3,000	-	-	-
Graphic Design (Display Panels)	-	-	-	2,442
PAGSE Membership	300	300	300	600
GAC Geophysics Division Award	300	-	-	-
Accountant, Lawyer Fees	-	-	5,906	-
Secretariat	3,400	200	3,500	3,350
TOTAL DISBURSEMENTS (Note 1)	16,844	24,727	30,488	61,140
Income less expenses (note 1)	20,229	-15,280	72,501	-43,166
TOTAL CREDIT: Canadian Dollars:	141,211	120,416	135,696	63,341
US Dollars:	0	438	438	345

Note 1. Includes US funds converted to Canadian Dollars

STATEMENT OF ASSETS	31 Dec-04	31 Dec-03	31 Dec-02
Savings account	76,446	58,982	68,948
Chequing account	16,552	12,687	18,525
Guaranteed income certificate	48,190	46,933	46,544
Credit with Canadian Ass'n of Physicists	46	1,836	1,701
Cash on hand	-23	-23	-23
Total: Canadian Dollars	141,211	120,416	135,696
US Dollars	0	438	438

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Tenure-Track Professorship & Post-doctoral Fellowship Positions (Immediate Openings in Solid-Earth Geophysics)

Tongji University, Shanghai, China

Professorship in Seismology

Applications are invited for a tenure-track appointment at the rank of Associate Professor, in the Global Seismology and Geodynamics Program, within the School of Ocean and Earth Science. The appointment is available immediately.

Applicant should have a Ph.D. in seismology and a strong record of original research using broadband waveform data. Demonstrated breadth in application of modern methods in quantitative seismology is an asset, as is prior research experience in a variety of international settings. Candidates with global perspectives in plate tectonics are preferred. The successful applicant is expected to study the deep interior of the Earth and seismic source attributes, in collaboration – when necessary – with other Chinese and international research institutions.

Postdoctoral Positions in Seismology

The School of Ocean and Earth Science, Tongji University, in Shanghai, China announces three postdoctoral openings in its Global Seismology and Geodynamics Program. The positions are available immediately.

We seek energetic individuals to study theoretical and observational aspects of seismic wave propagation to probe the deep interior of the Earth. Our research thrusts pertain to the development and application of: a) novel techniques for analysis of broadband seismic data; and b) theoretical formulations for treating frequency-dependent Eikonal and frequency-dependent rays. Interest in plate tectonics and mantle convections is an asset.

The successful candidates must have a Ph.D. in seismology or in a relevant branch of mathematics. A postdoctoral fellowship in China is normally for a period of two years, but it may be extendable through mutual agreement between the parties involved.

Application Instructions

Application materials for the above positions should include a CV, statement of research interests, list of publication, and the names and contact information of three references. Compensations will be competitive. Interested persons should send their applications immediately to Tongji University via Professor Kin-Yip Chun at chun@physics.utoronto.ca

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CGU Webmaster

The CGU is seeking to hire a part-time webmaster whose tasks will include; 1) re-designing and streamlining the CGU website while maintaining the current content and functionality, 2) adding new contents such as password-protected membership directory, 3) routine maintenance and update of the new site. The webmaster is expected to spend 20-30 hrs on site re-design and 3-4 hrs/week on routine maintenance. The contract is one year with possible renewals. Priority will be given to a person who lives in the Calgary area, has interests in Earth Sciences, and has at least a limited background in French. The webmaster does not have to be a CGU member. If you are interested or know someone who may be interested, please contact Dr. Masaki Hayashi at CGU Secretariat (cgu@ucalgary.ca).

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Some Upcoming Scientific Meetings

CGU or CGU-sponsored Meetings:

2006: Joint Annual Meeting of the CGU and the Canadian Society of Soil Science (CSSS), May 13-17. For details, contact Rod Blais, blais@ucalgary.ca, 403-220-7379, or visit the CGU web page http://www.cgu-ugc.ca.

2006: The 100th Anniversary Earthquake Conference Commemorating the 1906 San Francisco Earthquake, April 18-22, San Francisco. For details, visit the web page http://www.1906eqconf.org/index.htm.

Other Meetings:

2005: IAG Scientific Assembly: Dynamic Planet, Cairns Australia, August 22-26. For details, visit the web page http://www.dynamicplanet2005.com/

2005: Earth System Processes, August 8-11, Calgary. For details, visit the web page http://www.geosociety.org/meetings/esp2/.

2005: AGU Fall Meeting, December 5-9, San Francisco. For details, visit the web page http://www.agu.org/meetings/fm05/, or send an email to fm-help@agu.org.

2005: IAHS: 9th International Symposium on Water Management and Hydraulic Engineering, Ottenstein, Austria, September 4-7. For details, visit the web page http://www.wau.boku.ac.at/4182.html.

2005: IASPEI: Scientific Assembly, Santiago, Chile, October 2-8. For details, visit the web page http://www.igm.cl/iaspei/iaspei.htm.

2005: IASPEI: 4th International Symposium on Geophysics, Tanta, Egypt, November 25-27. For details, visity the web page http://www.tanta.edu.eg/EN/isg.htm.

2005: SEG Annual Meeting, November 6-11, Houston. For details, visit the web page http://meeting.seg.org/.

2005: GSA Annual Meeting, Salt Lake City, October 16-19. For details, visit the web page http://www.geosociety.org/meetings/.

2006: GAC/MAC Annual Meeting, Montreal, May 14-17. For details, visit the web page http://www.esd.mun.ca/~gac/ANNMEET/annmeet.html.

2006: Ocean Sciences Meeting, February 20-24, Honolulu. For details, visit the web page http://www.agu.org/meetings/os06/.

2006: IAHS: 4th World Water Forum, Mexico City, March 16-22. For details, visit the web page http://www.worldwatercouncil.org/forum_4.shtml.

2006: Western Pacific Geophysics Meeting, July 24-28, Beijing. For details, visit the web page http://www.agu.org/meetings/wp06/.

2006: SSA Annual Meeting, April 18-22, San Francisco. Part of the 100th Anniversary Earthquake Conference Commemorating the 1906 San Francisco Earthquake (see above).

2006: EGU General Assembly, Vienna, April 2-7. For details, visit the web page http://www.copernicus.org/EGU/meeting_overview.html.

2007: SSA Annual Meeting, April 11-13, Waikoloa, Hawaii. For details, visit the web page http://www.seismosoc.org/.

For information on IUGG meetings, visit the web page http://www.iugg.org and click on “Meetings Calendar”.

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***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.**

General submissions should be sent to the Editor:
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Hydrology-specific submissions should be sent to:
Dr. Garry Thorne, Email: thorneg@aecl.ca.

Geodesy-specific submissions should be sent to:
Prof. Marcelo Santos, Email: msantos@unb.ca

Electronic submission is encouraged.

Canadian Geophysical Union
Union Geophysique Canadienne

Canadian Society of Soil Science
Société Canadienne des Sciences des Sols

ANNUAL MEETING / RENCONTRE ANNUELLE

The Banff Centre

13-17 May/Mai 2006

Ideas/suggestions for new sessions, short courses and field trips are solicited!

Commercial and educational exhibits are always welcome!

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CSSS Coordinator: Anne Naeth, Univ. of Alberta, anne.naeth@ualberta.ca

Info/Exhibits: M.A. Stroh, Conference Concepts, mastroh@ucalgary.ca

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