# President's Message

*Rob Bowell*

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*Newsletter for the Association of Applied Geochemists*

This year, 2007, appears to be one of growing demands for most in the mining and extractive industries. Certainly most consultancies and virtually all support companies that I know of are experiencing unprecedented demands for their services. Many of those seeking these services are in small scale or junior companies that are under a great deal of pressure to obtain and publish results quickly and progress exploration success into viable commercial ventures at a fast pace to exploit the high commodity prices. There is a very real danger here that such heavy demands on laboratories and consultancies will lead to premature publication of results that may not truly reflect the material being analysed. Certainly I have recently been engaged on two widely different projects where this has happened.

In the first, a gold project, the lack of time spent in verification of laboratory data overlooked unacceptable calibration for gold. In addition no attempt had been made to establish the appropriate sample size required to provide a meaningful sample for the mineralization despite problems of nugget gold being known on the project. Fortunately the press release was stopped prior to publication and a revised, lower, resource estimate was published. No less a problem was experienced on a copper project where again poor handling of laboratory data ignored anomalies in the analysis of extractable copper during a testwork program leading to an over estimate of acid soluble copper for a process. When a pilot operation was initiated, considerably lower copper was recovered. These problems were compounded by poor sampling practices biasing results and almost a complete ignorance of mineralogy of the ore that could have been used to explain the highly variable copper recoveries from different ore materials.

Environmental projects can also suffer from poor data handling and gross ignorance of problems associated with different analytical methods for different media leading to erroneous interpretation and application of inappropriate engineering solutions. Perhaps one of the most persistent errors, I have seen in review of environmental studies, is the assumption that an aqua regia digest of a silicate rock or soil matrix sample equates to the "total" element concentration.

I believe in the current environment and at the point we are at in the economic cycle for the mining industry it is essential that geochemists are involved to a greater degree in verification of assay and metallurgical results and are consulted on the most appropriate methods of analysis. Whilst this happens in many large companies, all too often these salient points are sacrificed in the race to promote company stock or viability of a promising exploration or mining project. I would welcome contributions from our members on these issues particularly any insight you feel you can offer on solving such issues either as an approach or case studies to illustrate innovative methods. Perhaps a reason for many of these problems is the demise of so many geochemistry courses in universities and the succession planning in the development of applied geochemists in academia. Very often such individuals are unique in a department teaching on the fringe of many courses. Along with this, many of our more distinguished members and AAG founders who have acted as mentors are no longer active or are passing on. Sadly this last quarter has witnessed the loss of one of the most distinguished applied geochemists who could rightly be considered a founder of the science, Professor John Webb. A brief note about his life is published in this issue of **EXPLORE** and an obituary will be published in the September issue. Professor Webb will join the honour roll of geochemists honoured by the AAG's distinguished geochemists fund.

To aid in the development of this and future generations of geochemists, the Association continues to promote the advance of applied geochemistry through research and teaching and it is hoped that the AAG's Distinguished Geochemists Fund will help in some way to support this goal. The Association also promotes a Distinguished International Lecturer who is available, at the expense of a host institute, to present benchmark presentations in applied geochemistry. I am pleased to announce the appointment of Professor Kurt Kyser of Queen's University, Ontario, Canada to this position for the next two years (2007-2008). A notice in the next **EXPLORE** will provide details of Kurt's proposed program of presentations and any Institute wishing to invite him may contact him through the AAG Business office.

In addition you have an excellent opportunity to improve your own learning and enjoy at the same time an excellent social and cultural experience by attending the International Applied Geochemistry Symposium (23rd IAGS) in Oviedo, Spain this June. Please see the final curicular information elsewhere in this issue of **EXPLORE**. At the meeting in Oviedo we will be holding the Association's Annual General Meeting on June 14 and further information about this meeting will be published on the AAG web site. Of which, Andrew Ransom and Bob Eppinger continue to add more information and the site is well worth a visit. Our thanks are extended to both gentlemen for all their hard work in developing this resource.

**Rob Bowell**
*President*
*Association of Applied Geochemists*

# The Ontario Geological Survey Lake Sediment Geochemical Program: Progress Towards a Geochemical Map of Ontario, Canada

**Introduction**

A geochemical map of North America will likely be realized in the next few years with the completion of the Tri-National (Canada, USA and Mexico) soil geochemical landscapes project. On the eve of this project, it is fitting to reflect on the geochemical mapping efforts within the province of Ontario in central Canada (Fig. 1) and in particular the contribution of an early and ardent supporter of landscape geochemical mapping, the late John Fortescue. John proposed the concept of a geochemical map of Ontario almost 25 years ago (Fortescue 1983). In the decade that followed, the only progress made at the Ontario Geological Survey (OGS) to specifically address this concept were several demonstration or "pilot" projects that involved either grid (module) sampling (e.g. stream sediments in southern Ontario; Fortescue 1984, 1992) or province-wide geochemical traverses (lake sediment and water; Fortescue & Dyer 1993, 1994a,b). These were "low density" geochemical sampling projects over diverse landscapes of Ontario, aimed at testing the ability to delineate province-wide geochemical patterns of pertinence to mineral exploration and environmental geochemistry. However, Fortescue was also instrumental in initiating the high density (approximately 1 sample per 3 km$^2$) lake sediment geochemical program at the OGS, which is now in its 20th year. This program takes advantage of the greater than 250,000 lakes covering almost 1/5th of Ontario's 1,000,000 km$^2$ surface area. The program mandate has always been twofold: 1) to support mineral exploration by sampling in areas of high mineral potential; and 2) provide high quality baseline geochemical data of the province.

Across the province, over 60,000 samples have now been collected covering an area of more than 200,000 km$^2$ (Fig. 1). Ironically, there are now so many contiguously sampled areas (Fig. 1) that the result is approaching Fortescue's vision of a province-wide geochemical map, at a much higher density than he might ever have hoped.

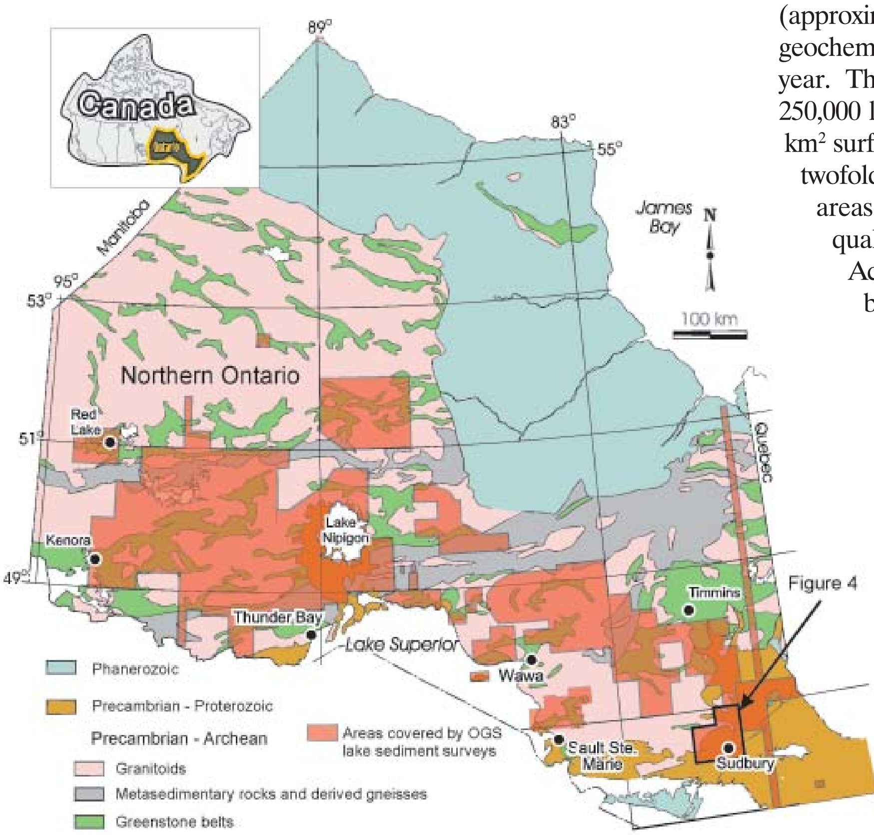


*Figure 1. High density lake sediment coverage of northern Ontario.*

The OGS lake sediment and water dataset is so large and high-density that displaying significant portions of the data using conventional geographic information systems (GIS) is sometimes very slow – even with fast computers. To address this problem, the OGS has developed "OGS-Earth" as an, as yet, in-house add-on to Google-Earth for the purpose of rapid integration of multiple geological data layers, including the lake geochemical datasets. The platform allows the visualization of geological, topographic and cultural information with overlain geochemistry in virtual 3-D through all scales and view angles. Even to novice users, profound geochemical trends and relationships between geochemistry and geology can be immediately apparent – and the platform is considerably easier to operate than a typical GIS.

**Sampling methods**

From the outset of the high density lake sampling program in 1987, the application of a robust and consistent sampling protocol was considered paramount and this is still the case. Lake sediment and water sampling is performed by 2-person teams primarily from float-equipped Bell 206B helicopters. During the mid-1980s, Fortescue developed a gravity coring device that allowed for the rapid collection of lake sediments and the reliable discrimination between surface and deep lake sediment (Fortescue 1988). The sampler and associated equipment

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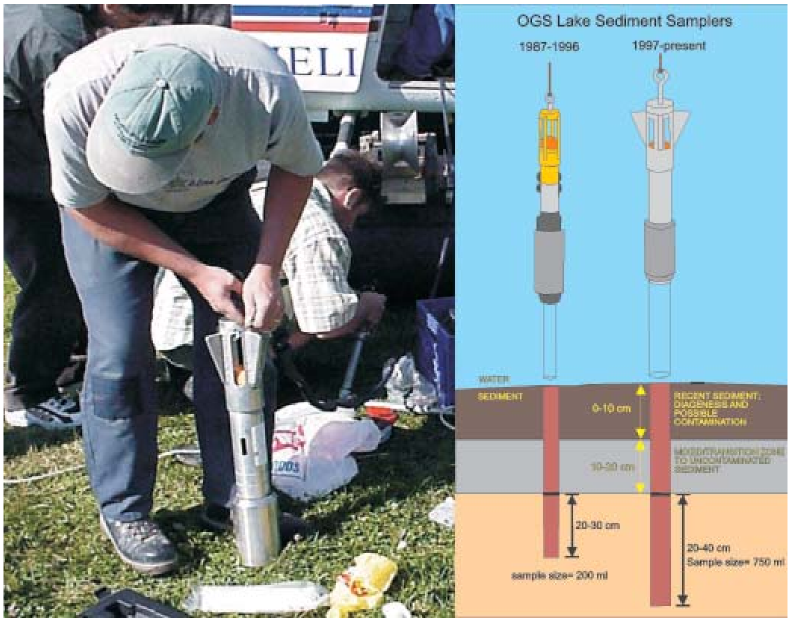


*Figure 2. Ontario Geological Survey lake sediment gravity core sampler.*

have been improved and refined over the past 20 years (Fig. 2), but the basic concept has remained the same. Intact lake cores are retrieved from the lake bottom in a polycarbonate tube. Bottom-up extrusion of the sediment allows for discrimination between shallow (0-15 cm) sediment and deeper sediment (e.g. >20 cm) (Fig. 2). All samples are taken from depths >20 cm below the sediment–water interface (SWI) in order to avoid anthropogenic influences and near surface diagenetic effects. Therefore, these deeper sediments more accurately reflect the natural geochemical inputs, which may be traced back to local bedrock geology. If required, the upper (shallow) sediment can also be kept as a separate sample to characterize potential anthropogenic inputs, for example, near industrial areas or existing mines.

Lake water samples are taken simultaneously with the sediment samples using a semi-automated water sampling apparatus, consisting of a pump, a multi-parameter water quality analyzer (for measurement of parameters such as pH, temperature and conductivity), and a variety of hoses and valves. Lake water is pumped through the system in order to purge it prior to the collection of a sample and for the measurement of water quality data. The water samples were kept cool immediately following collection and are processed (filtered/acidified), within 12 hours of collection.

Accurate sample site locations and flight tracks are recorded by GPS receiver. A new innovation in 2006 was the introduction of a GPS receiver mated to a tablet computer to provide "heads up" real-time navigation between lake sites, which in recent years had been the rate determining part of the methodology. Average sampling

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production is approximately 20-24 samples per flight hour.

**The use of deep lake sediment**

In order to avoid anthropogenic influences due to water and airborne contaminants, the sampling of deep lake sediment has always been considered an essential part of the OGS lake sediment sampling program. The practise of consistently sampling the deep (>20 cm) lake sediment was initially based on studies by Dickman & Fortescue (1984, 1991) and Fortescue et al. (1984) on the rise of *Ambrosia* pollen at a sediment depth of 10 to 15 cm within 8 test lakes in the Sudbury and Wawa regions. This rise in the ragweed pollen *Ambrosia* corresponds to the onset of extensive deforestation associated with agricultural development during the post-industrial period of the past 100 years. The age of the *Ambrosia* pollen rise has been verified by $^{210}$Pb dating of lake sediment cores, including two lakes north of Lake Wanapitei (Dickman & Fortescue 1991). At these lakes the pollen rise occurred between 14 and 17 cm depth with a calculated sedimentation rate of approximately 1.2 mm per year.

The standardization to a deeper 20 cm depth was done to account for variations in sedimentation rates between different landscape environments. Data from a recent study in the Sudbury area confirm that a sample depth of >20 cm is adequate to avoid contamination (Hunt 2003). Hunt's study involved Pb$^{210}$ age dating of lake sediment cores obtained with a KB gravity corer from 14 lakes. The sedimentation rate averaged 1.6 cm per decade, therefore a 20 cm depth in lake sediment corresponds to approximately 125 years ago. Eleven of the lakes cored by Hunt (2003) were sampled by the OGS with the coring torpedo shown in Figure 2. The geochemical results are very similar indicating that the OGS sampling methodology is successful at obtaining and discriminating between recent and pre-industrial sedimentation.

**Sample Preparation, Analytical Methods and Quality Control**

Sediment samples are partially air dried in the field prior to delivery to the OGS Geoscience Laboratory (GeoLabs) in Sudbury. Final drying is carried out at <40$^{o}$ C followed by dissagregation with a ceramic ring and puck pulverizer for approximately 20 seconds. Samples are sieved to obtain a -60 mesh (<250 mm) size fraction for analysis. Analysis at the OGS laboratory consists of aqua regia digestion of 0.5 g of sample pulp followed by inductively coupled plasma mass spectrometry (ICP–MS) and inductively coupled plasma optical emission spectrometry (ICP–OES) for the determination of approximately 50 trace, minor and major elements. Loss-on-ignition (LOI) is determined at 500º C under an oxygen atmosphere using an automated gravimetric technique. Approximately 10 g of each sample pulp are pressed into briquettes prior to instrumental neutron activation analysis (INAA) to determine Au, As and 24 other elements. Water samples are passed through 0.45 mm syringe filters and acidified to 1% with ultrapure nitric acid within 12 hours of sample collection. The analysis of water is by direct aspiration ICP–MS at the OGS laboratory to determine approximately 50 elements.

Quality control is monitored through sample pulp replicates, field duplicates, CANMET certified reference materials and internal (OGS collected) bulk standards. Quality control (QC) samples are inserted into the sample sequence at the rate of 1 QC sample per 10 unknowns. Analytical precision for each element is determined by plotting duplicates data on an X–Y chart and determining the variation of 95% of the data from a 1:1 ratio. Accuracy is determined by plotting the sequential values returned for certified reference standards inserted in the batch against a vertical scale of concentration and comparing this with the "provisional values" (Lynch 1990) for the standards.

**The controls on natural baseline lake geochemistry: An application of 'OGS-Earth'**

The integration of OGS geoscience data into Google-Earth through the OGS-Earth application has important advantages. In our experience, it is superior to conventional GIS in several ways:

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1. It is much faster for display, panning, zooming and rotation of large amounts of data.
2. Radio buttons and dimmer-bars allow an instantaneous visual assessment of the relationship between underlying layers of data, and are faster and easier to use than similar features in GIS applications.
3. Angled, oblique and DEM-based 3 dimensional views are possible, which helps to outline linear trends in data and topographic effects.
4. Since both cultural and geological data can be displayed simultaneously with geochemical data, OGS-Earth is particularly well suited for distinguishing the source of geochemical signals as geological or anthropogenic.
5. Google-Earth is optimized for web-browsers and is therefore potentially an excellent tool for the display of published OGS data on the internet.
6. The basic Google-Earth software is free and very easy to use, and therefore, in conjunction with OGS-Earth, it is likely to be more useable for a much wider audience than conventional GIS.

Figure 3 is an example of lake sediment data for northwestern Ontario, displayed using OGS-Earth. Calcium concentration in lake sediments varies widely across a total area of over 100,000 km$^2$ and broad regional trends related to geology are immediately obvious. Much higher concentrations of Ca occur in sediments north of Lake Nipigon, derived from local till which has been transported southwest by glaciers from the sedimentary carbonate rocks of the James Bay Lowland. The mafic rocks around Lake Nipigon (pale orange, Fig. 3b) are the source material for Ca in lake sediments to the southwest of the lake. Local trends are also obvious across a wide range of scales. In the Atikokan area, the greenstone belts (Fig. 3c; northeast and east-west trending green units) show significantly elevated Ca concentrations in sediments over the greenstone and immediately down-ice relative to those that occur over the surrounding plutonic rocks. Trace elements can also show excellent lithological associations in addition to being indicative of localized mineralization. For example, Cu is generally elevated over mafic rocks and Ni over ultramafic rocks but much higher concentrations are noted near sulphide mineralization known to host Cu and Ni ore minerals.

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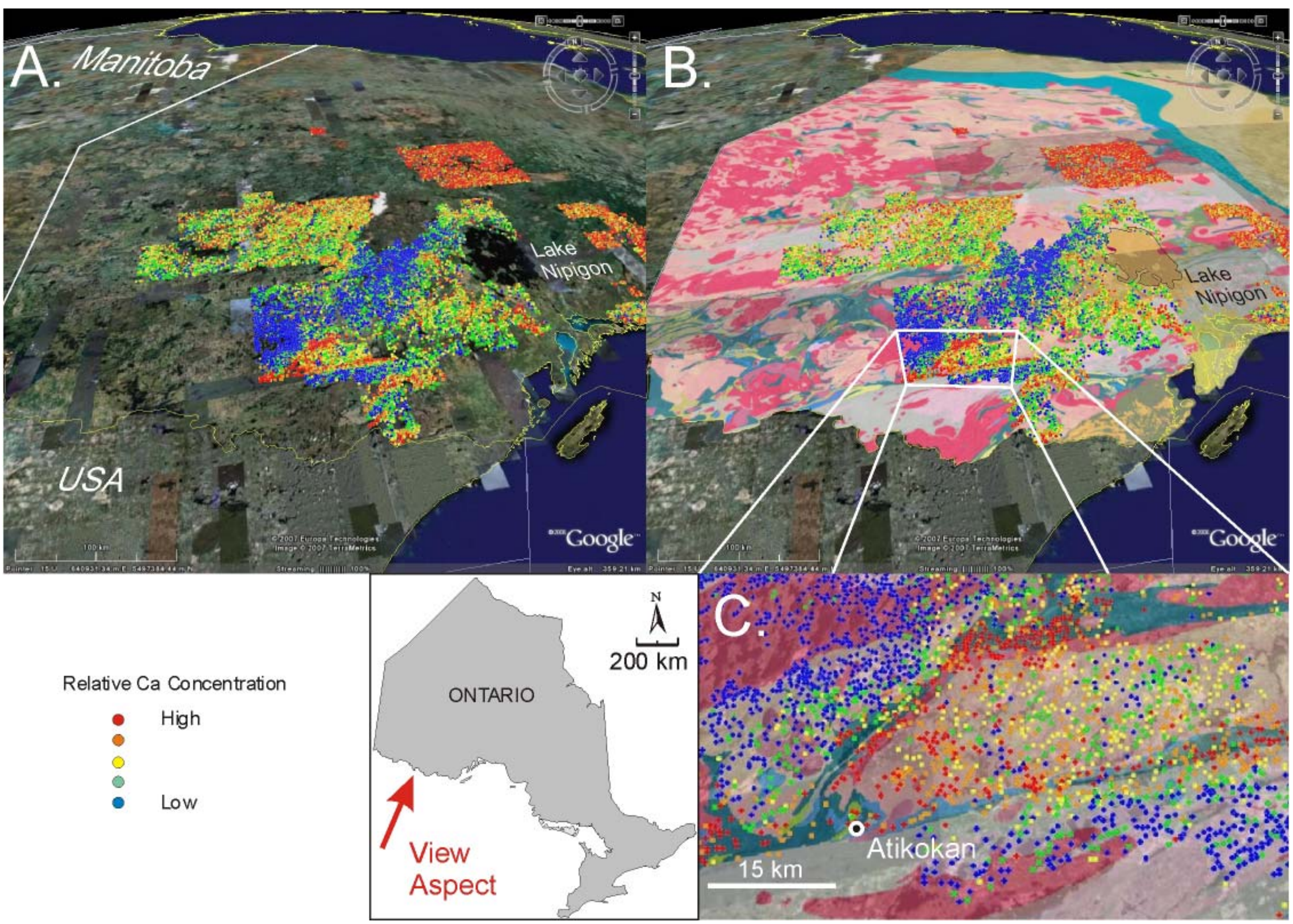


*Figure 3. Calcium in lake sediments in northwestern Ontario, displayed in Google-Earth® and plotted using the 'OGS-Earth' application. Fig. 3A shows sample locations colour-coded by concentration on the Google-Earth® satellite-image fabric. Fig. 3B shows the same sample locations overlain on OGS bedrock geology. Fig. 3C shows a blow-up of the Atikokan area with volcanic rocks shown in green.*

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The ease with which geochemical data can be visualized in Google Earth has important implications to geochemistry beyond the display of OGS data. This platform is not hindered by the size of the geochemical dataset and it can reach a worldwide audience. As such, Google Earth could be the platform for the integration of other provincial or continental scale geochemical mapping efforts, ultimately leading to a geochemical map of the Earth.

**Distinguishing natural geochemical baseline from anthropogenic lake sediment signal in the Sudbury Mining District**

***Environmental disturbance in the Sudbury area***

A significant mining and smelting "footprint" exists in the Sudbury basin which hosts numerous world-class Ni-Cu-PGE deposits. This footprint poses a challenge for the use of lake sediment geochemistry in the region. Whether the objective is baseline geochemical mapping or mineral exploration, it is difficult to "see" through the ecological disturbance to understand background geochemical conditions as they would have existed prior to industrial activity. Environmental impact in Sudbury and the surrounding area is the result of many factors that occurred throughout the century prior to the 1980s, when both remediation and major reductions in emissions took place. These factors include mining (sulfur dioxide fumigation and metal deposition), intense logging, bush fires, water and wind erosion and enhanced frost action (Winterhalder 1995). In particular, the roast yards that operated on the south range of the Sudbury basin from 1888-1929 created sulfuric acid fogs that suffocated and burnt vegetation and acidified the surrounding soils, lakes, streams and rivers. The smelter emissions over the years caused what is commonly referred to as the Sudbury "footprint", visible on satellite images, which resulted from the loss of vegetation in the vicinity of the smelters. The areal extent of vegetation damage in the Sudbury area, determined in the early 1970s, covered a surface area of approximately 720 $km^2$. Not so obvious is that lakes as far as 100 km to the northeast had also been affected (Neary et al. 1990).

Water quality monitoring in the 1970s revealed that 7000 lakes within a 17000 $km^2$ area have been measurably affected by the Sudbury emissions (Dixit et al. 1995). This disturbance is manifest as acidified lakes, metal-contaminated lake sediments, and indirect effects resulting from damage to vegetation in the lake basins. It is likely that these effects have been amplified due to the fact that Sudbury is situated on the Precambrian Shield. The rock offers very little buffering capacity and therefore local soils are sensitive to acidification. The minor amounts of calcareous rock and low carbonate drift materials over Precambrian shield rocks in the area cannot neutralize the acidity formed in the byproducts of Sudbury's mining industry (Bajc & Hall 2000).

**The lake sediment geochemical response in the Sudbury area**

The distribution of Ni in lake sediment for the Sudbury area is displayed in Figure 4(b) (Dyer et al. 2004). For comparison, data from the Geological Survey of Canada's National Geochemical Reconnaissance (NGR) program (Hornbrook & Friske 1988; Friske et al. 1997) are presented in Figure 4(a). The NGR sampling was carried out during the 1970s and 80s at a much lower density (approximately 1 sample per 13 $km^2$) than the current OGS program and using a different type of gravity sampler know as the Hornbrook sampler (Friske 1991). This device was not designed to discriminate between shallow and deep sediment, but rather, to obtain a very fast 'grab' sample of lake sediments. Because of its

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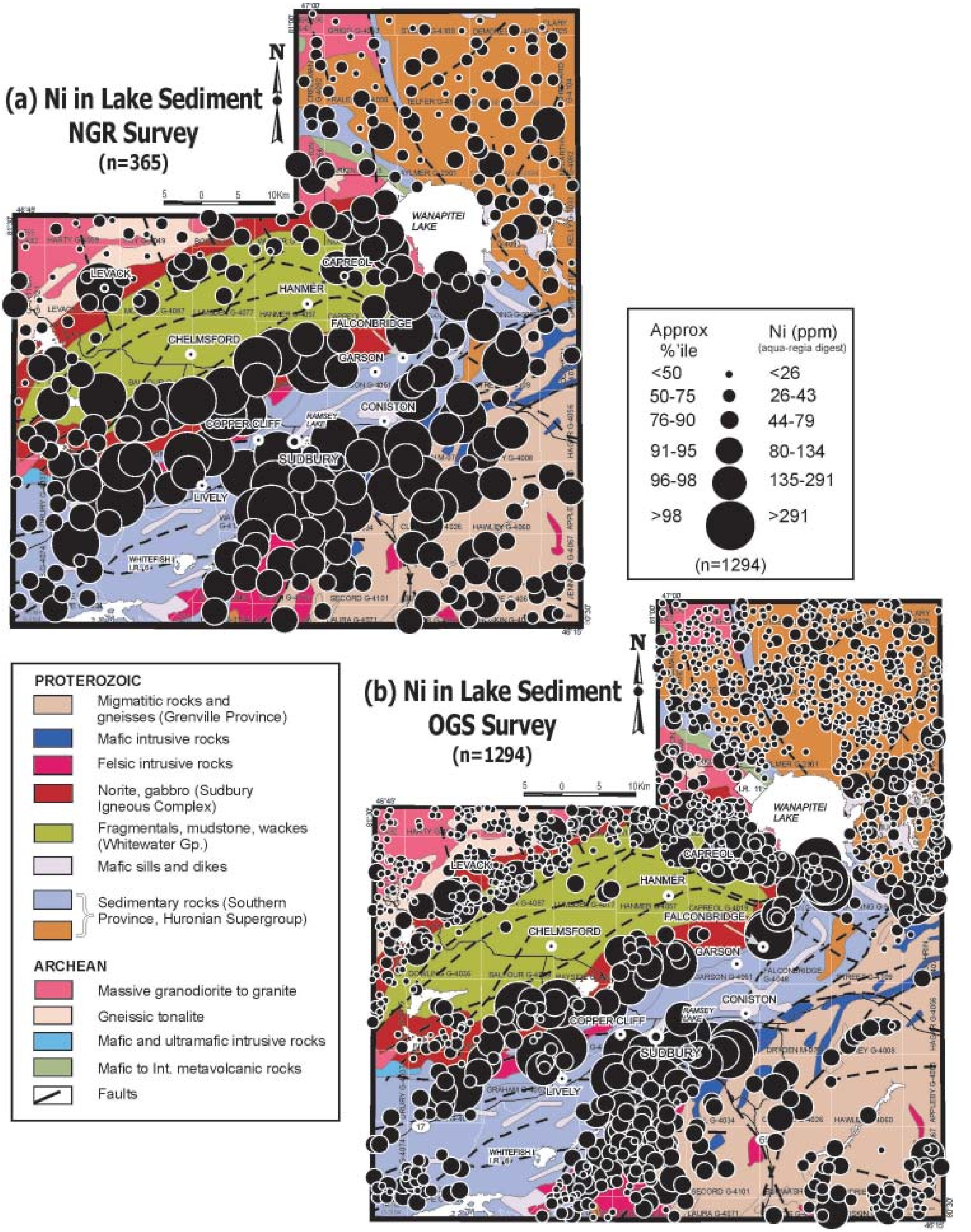


*Figure 4. Nickel concentrations in the greater Sudbury area lake sediments.*

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design, the entire 72 cm sampler must completely penetrate the bottom mud in order to be sure that the material retrieved is from a depth greater than 20 cm. Additionally, a butterfly valve in the nose of the sampler serves to disturb the sediment during penetration of the lake bottom. Therefore, this sampler obtains lake sediment from variable depth below the sediment water interface, depending on its depth of penetration into the lake sediment. The sample preparation and analysis of samples from both surveys were similar including the use of an aqua regia digest. Quality control for both NGR and OGS surveys was monitored through replicate analysis of unknowns and the insertion of CANMET certified reference materials (e.g. LKSD-1, LKSD-4).

Figure 4 (a) and (b) reveals that for most lakes, Ni concentrations obtained by the OGS survey are considerably lower than in the NGR data. Results for lakes that were sampled by both surveys (n=193) were compared because the differences in methodology of the two surveys provides insight into the sources of metals in sediments in this area (Fig. 5). To ensure consistent sample media from the two surveys and methodologies, the results for each lake that was sampled by both methods were examined closely to ensure a similar lake depth and LOI level. Any sample sites with a significant discrepancy were screened out of the comparison dataset and a visual check was done in ArcMap GIS to ensure sample sites from each survey were located within the same lake basin. Despite the differences in sample density, it is clear that many of the NGR samples contained significantly higher levels of Ni than the OGS samples.

Most of the regional distribution of Ni portrayed in Figure 4(b) is spatially associated with Sudbury Igneous Complex (SIC) rocks, which host most of the Ni mineralization in the Sudbury basin. Anomalies due to contamination are localized to lakes in close proximity to tailings/slag/waste rock, or lakes in which the natural sediment record has been compromised, possibly by higher sedimentation rates (resulting in more than 20 cm of young sediments) due to enhanced erosion of Sudbury area soils as a result of de-vegetation due to fumigation from roasting/smelting operations in the early 1900's. A

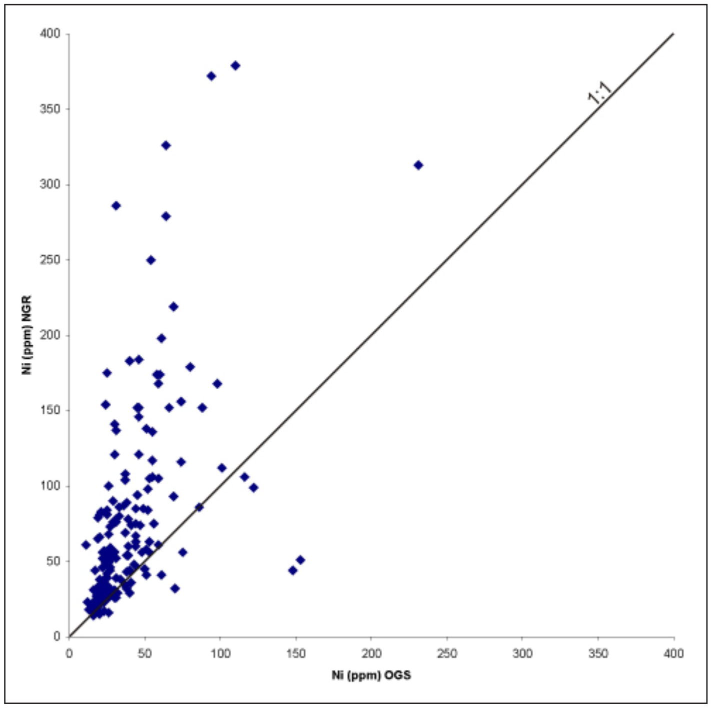


*Figure 5. Plot of Ni concentrations obtained from the same lakes by the National Geochemical Reconnaissance program and by the Ontario Geological Survey regional survey.*

pattern of elevated Ni concentrations occurs in some urban Sudbury lakes south of Ramsey Lake, Coniston and Copper Cliff. The elevated Ni which extends further to the south may be in response to the presence of the Ni-

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mineralized Copper Cliff offset dike and Nipissing gabbro rocks, as well as erosion and glacial dispersion southward from the Sudbury Igneous Complex.

The pattern differences between the two datasets suggests the OGS protocol of sampling a discreet depth interval of deeper sediments is successful in obtaining relatively undisturbed and uncontaminated sediments in the vast majority of cases. The results also demonstrate that natural concentrations of metals in the surficial landscape can exceed regulatory limits. For example, a total of 134 lake sediment samples from the OGS survey have natural Ni concentrations that exceeded the severe effect level of 75 ppm, as set by the Provincial Sediment Quality Guidelines for Ontario.

**Summary**

The OGS lake geochemical sampling program was designed to obtain a high density, high quality natural geochemical signal in areas of high mineral exploration potential. It is intended both as a record of natural baseline conditions in pre-industrial sediments and a mineral exploration tool. An excellent example of this is the high density survey over the Sudbury region, where, despite the significant mining activity and significant ecological disturbance, the OGS lake sediment sampling methodology was successful in obtaining relatively undisturbed and uncontaminated deep sediments in the vast majority of cases. Recent development of 'OGS-Earth', a prototype add-on to Google Earth has allowed very fast and easy visual display of the entire dataset at any scale and viewing angle. In future, it may be utilized to allow web access to the OGS lake geochemical dataset. Currently, all OGS lake sediment digital datasets and Open File Reports (OFR) are available for free download from the Ontario Ministry of Northern Development and Mines, Geology Ontario website (www.geologyontario.ca). Although the high-density lake sediment program was never intended as such, its coverage has increased in recent years to such an extent that it represents a quasi-provincial scale geochemical map of lake sediments, thus realizing one of the late John Fortescue's career-long goals. Other initiatives currently underway in Ontario and beyond will also likely realize this goal including the Tri-National Soil Survey and the Provincial Groundwater Geochemical Characterization study.

**Acknowledgements**

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### Notice of Annual General Meeting 2007

The 2007 Annual General Meeting (AGM) of the Association of Applied Geochemists will be held on Thursday, June 14, 2007, at 5:00 pm in the principal lecture theatre at the 23rd International Applied Geochemistry Symposium (IAGS) in Oviedo, Spain. The AGM will be followed immediately by a regular AAG Council meeting. The Officers and Council of the Association hope that all AAG members attending the 23rd IAGS will participate in the AGM.


**Toronto, Canada, Sept. 9 to 12, 2007**

**Invitation**
- Theme
- Who should attend
- Second Circular

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- Helping out with Exploration 07

# Invitation

Exploration 07 is the fifth in a series of oncea-decade meetings organized by the Canadianmineral exploration community to review the major advances in exploration technology made over the previous 10 years.

Designed with the global exploration community in mind, earlier meetings were attended by up to 1,000 delegates from as many as 60 countries. In addition to a world-class set of presentations and supporting workshops, a full documentation of the proceedings is one of the established traditions of these decennial reviews.

As with previous meetings, Exploration 07 will present the state of the art in exploration technology, with the focus on geophysics, geochemistry, remote sensing, data processing and integration and the application of these disciplines to ore discovery.

The organizing committee of Exploration 07 invites its colleagues from around the world to convene in Toronto in September 2007 to network with their international colleagues, build on their exploration expertise and to celebrate another 10 years of advancement of the exploration geosciences.

## Theme

Exploration 07 will review the current state of the art in geophysics, geochemistry, remote sensing, data processing and integration. Given the industry-wide emphasis of better integration of scientific capabilities and business imperatives, the meeting will seek to highlight the strategic linkage between the technological and commercial sides of the exploration industry from primary ore discovery to risk management through the entire mining cycle.

## Who Should Attend

The activities of Exploration 07 will be of interest and value to a wide spectrum of stake holders in mineral exploration, including geologists, geochemists, geophysicists as well as managers, academics and government scientists involved with mineral exploration and mining-related environmental programs.

### Information and Registration

To receive the information that you will need to participate as a delegate or exhibitor to Exploration 07, you should fill in the form on the information booklet and fax it back to the organizing committee at 1-905-474-1968, or email your contact details and items of interest to: interest@exploration07.com

# EXPLORATION 07

## *Exploration In The New Millennium*

Exploration 07 is the fifth decennial conference providing a global review of the previous decade's advances in exploration geophysics, geochemistry, remote sensing, data processing and integration. ***September 9-12, 2007, Toronto, Canada.*** Two exploration geochemistry workshops will be held in conjunction with the conference and will be co-sponsored by the Association of Applied Geochemists.

**Geochemistry Workshop 1: Exploration Geochemistry–Basic Principles and Concepts**
Saturday, September 8th, 2007
Cost: $450, students $100

- ***Exploration geochemistry - basic principles and concepts,*** *Bill Coker*, ***BHP Billiton***
- ***Sample preparation and analytical techniques,*** *Gwendy Hall*, ***Geological Survey of Canada***
- ***Quality control in geochemical analyses,*** *Barry Smee*, ***Smee and Assoc. Consulting Ltd***
- ***Geochemical data evaluation and interpretation,*** *Eric Grunsky*, ***Geological Survey of Canada***
- ***Regolith mapping, landform evolution, geochemistry applications,*** *Simon Bolster*, ***Newmont Mining Corp.***
- ***Till geochemistry and indicator minerals,*** *Beth McClenaghan*, ***Geological Survey of Canada***
- ***Soil geochemistry / selective extractions / soil gases,*** *Dave Lawie*, ***IOGeochemical***
- ***Drainage sampling – sediments, waters, HMCs,*** *Ray Lett*, ***British Columbia Geological Survey***
- ***Biogeochemistry,*** *Colin Dunn*, ***Consulting Geochemist***
- ***Groundwater Geochemistry,*** *Matt Leybourne*, ***GNS Science***

**Geochemistry Workshop 2: Indicator Mineral Methods in Mineral Exploration**
Sunday, September 9th, 2007
Cost: $450, students $100

- ***Introduction,*** *Harvey Thorleifson*, ***Minnnesota Geological Survey***
- ***Survey design,*** *Chris Benn*, ***BHP Billiton***
- ***Sample processing methods,*** *Beth McClenaghan*, ***Geological Survey of Canada***
- ***Mineral chemistry,*** *Bill Griffin*, ***GEMOC***
- ***QA/QC in indicator mineral recovery and analysis,*** *Mary Doherty*, ***ALS Chemex***
- ***Indicator mineral methods in precious metal exploration,*** *Dave Kelley*, ***Newmont Mining Corp***
- ***Indicator mineral methods in diamond exploration,*** *Herman Grutter*, ***BHP Billiton***
- ***Indicator mineral methods in base metal exploration,*** *Stu Averill*, ***Overburden Drilling Management***
- ***Laboratory case study: sample integrity,*** *Mike Michaud*, ***Overburden Drilling Management***
- ***Exploration case study: indicator mineral survey in India,*** *Dean Pekeski.* ***Rio Tinto***
- ***Public sector case study: indicator mineral survey of Minnesota,*** *Harvey Thorleifson*, ***Minnnesota Geological Survey***

**Additional information available at Exploration 07 website: http://www.exploration07.com/**

# The AAG Needs You as a Councillor

Each year the President of the Association of Applied Geochemists issues a plea to AAG Fellows (Voting members) for individuals willing to stand for election to the position of “Ordinary Councillor”. Unfortunately, this plea is usually relegated to the trash bin by most Fellows. Fortunately, however, each year some of our most outstanding Fellows are ready, willing, and able to meet this challenge. This is the second, in what is likely to become an annual, article in **EXPLORE** summarizing the job and describing how one goes about getting on the ballot. It is our sincere hope that this might entice more Fellows to step forward for election to this most important position.

**Job Description**

The AAG By Laws state that “the affairs of the Association shall be managed by its board of directors, to be known as its Council”. The affairs managed by Council vary from reviewing and ranking proposals to host our biennial Symposium to approving application for new membership to developing marketing strategies for sustaining and growing our membership. These affairs are discussed and decisions made at Council teleconferences usually held 3-4 times per year. Each teleconference lasts about 90 minutes. In addition, there is often a running email discussion about a selected issue or two between each teleconference. So for a commitment of about 8 hours of your time per year, you can help influence the future of your Association. If you want to spend more than the minimum time required, there is plenty of opportunity to do so through committee assignments and voluntary efforts that greatly benefit the Association.

**Qualifications and length of term**

The only qualification for serving as Councillor is to be a Fellow in good standing with the Association. Please note the difference between being a Member of AAG and being a Fellow. A Fellow is required to have more training and professional experience than a Member. Consult the AAG web site, Membership section, for further details. If you are not currently a Fellow and have an interest in serving on Council, please go through the relatively painless process of converting to Fellowship status in AAG.

Each Councillor serves a term of two years and can then stand for election to a second two-year term. The By Laws forbid serving more than two consecutive terms, although someone who has served two consecutive terms can stand for election again after sitting out for at least one year. Elections are usually held in the fall of the year for a term covering the following two years. Our next election will be in the fall of 2007 for the term of 2008-2009.

**How to get on the ballot**

If you are interested in placing your name into consideration for election to AAG Council, simply express your interest to the AAG Secretary (Dave Smith, dsmith@usgs.gov) by **August 31, 2007** and include a short (no more than 250 words) summary of your career experience. All that is asked is that you bring energy and ideas to Council and are willing to share in making decisions that will carry the Association forward into a successful future. We look forward to hearing from you.

**David B. Smith**
*Secretary, Association of Applied Geochemists*

# CALENDAR OF EVENTS

International, national, and regional meetings of interest to colleagues working in exploration, environmental and other areas of applied geochemistry. These events also appear on the AAG web page at: www.appliedgeochemists.org

## 2007

- June 14-19, 2007. **23rd International Applied Geochemistry Symposium,** Oveido, Spain. Contact: Jorge Laredo, University of Oviedo, Spain. Email: jloredo@correo.uniovi

- July 5-19, 2007. **9th International Conference on the Biogeochemistry of Trace Elements**((9th ICOBTE). Beijing, China. Website: http://www.conferencenet.org/conference/icobte.html

- July 8 - 13, 2007. **Gordon Research Conference: Catchment Science: Interactions of Hydrology, Biology & Geochemistry** New London, NH, USA. Web site: http://www.grc.org/programs/2007/catch.htm

- July 22-25th, 2007**. Urban Geochemistry and Health Conference**, New Orleans, Louisana, USA. Website: www.segh-nola-2007.com

- August 13-18, 2007. **WRI-12 International Symposium on Water-Rock Interaction,** Kunming, China. Website: http://www.wri12.org

- August 19-24, 2007. **Goldschmidt 2007 - *"Atoms to Planets"*** Cologne, Germany. Website: http://www.goldschmidt2007.org/

- August 20- 24, 2007. **SGA Meeting - 9th Biennel** Dublin, Ireland. Website: http://www.cpregistrations.com/sga2007

- September 9-12, 2007. **Exploration 07** Toronto, Canada. Website: http://www.exploration07.com/

- September 24-30, 2007. **AGS-2007 Symposium: Ores and Orogenesis-CircumPacific Tectonics, Geologic Evolution and Ore Deposits**. Tucson, Arizona, USA Website: http://www.agssymposium.org

- October 22-24, 2007. **World Gold 2007** Cairns, Australia. Website: http://www.ausimm.com/gold2007

- October 28-31, 2007. **GSA Annual Meeting, Earth Sciences for Society Beginning of the International Year of Planet Earth**, Denver, Colorado, USA Website: http://www.geosociety.org/meetings/2007/

- November 11-16, 2007. **18th International Symposium on Environmental Biogeochemistry** (ISEB-18). Taupo, New Zealand. Website: www.isebiogeochemistry.com/ISEBXVIII.htm

- November 27-29, 2007. **6th Fennoscandian Exploration & Mining FEM 2007** Lappia Hall, Rovaniemi, Finland. Website: www.lapinliitto.fi/fem2007/index.htm

## 2008

- May 26 - 28, 2008. **Geological Association of Canada/ Mineralogical Association of Canada Annual Meeting** Quebec, Canada. Web site: http://www.quebec2008.net

- July, 2008. **SEG-GSSA 2008 Resurgence of Economic Geology and the Minerals Industry in Africa,** Joint Conference of the Geological Society of South Africa and SEG Incorporating GEOFORUM 2008. Johannesburg, South Africa. Website: http://www.seg-gssa2008.org/

- July 13 -18, 2008 **Goldschmidt 2008,** Vancouver, BC, Canada. Web site: www.goldschmidt2008.org

- August 5-14, 2008. **33rd International Geological Congress**, Oslo, Norway. Website: http://www.33igc.org.

- August 10-15, 2008. **9th International Kimberlite Conference (9IKC)** Frankfurt, Germany. Website: http://www.9ikc.uni-frankfurt.de/

- August 18-22, 2008. **Geochemistry of the Earth's Surface 8**: Joint Meeting of the IAGC, Minsoc and Natural History Museum, London, UK. Contact: M.E. Hodson, m.e.hodson@reading.ac.uk

- October 58, 2008. **Geologcial Society of America Annual Meeting**, Houston, Texas, USA. Website: www.geoscoiety.org/meetings/index.htm

## 2009

- July 5-10, 2009. **Goldschmidt 2009.** Davos, Switzerland.

Please let this column know of your events by sending details to:

**Beth McClenaghan**
*Geological Survey of Canada*
*601 Booth Street*
*Ottawa, Ontario*
*CANADA K1A 0E8*
*Email: bmcclena@nrcan.gc.ca*
*613-992-7805*

# RECENT PAPERS

This list comprises titles that have appeared in major publications since the compilation in **EXPLORE** Number 134. Journals routinely covered and abbreviations used are as follows: Economic Geology (EG); Geochimica et Cosmochimica Acta (GCA); the USGS Circular (USGS Cir); and Open File Report (USGS OFR); Geological Survey of Canada papers (GSC paper) and Open File Report (GSC OFR); Bulletin of the Canadian Institute of Mining and Metallurgy (CIM Bull.): Transactions of Institute of Mining and Metallurgy, Section B: Applied Earth Sciences (Trans. IMM). Publications less frequently cited are identified in full. Compiled by L. Graham Closs, Department of Geology and Geological Engineering, Colorado School of Mines, Golden, CO 80401-1887, Chairman AEG Bibliography Committee. Please send new references to Dr. Closs, not to **EXPLORE**.

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## Obituary

John Stuart Webb, Emeritus Professor of Applied Geochemistry, Imperial College of Science and Technology, London, dubbed "Father of English Geochemical Mapping" on his award of the William Smith Medal by the Geological Society of London in 1981, died on 2 April 2007, aged 87.

He initiated the programme of research in applied geochemistry at Imperial College in 1949 and became founder and Director of the Geochemical Prospecting Research Centre in 1954. Initial work related to mineral prospecting in Africa, Asia and the British Isles, but in 1963-64 the scope expanded to include multi-element regional reconnaissance, marine mineral exploration and the application of geochemical surveys to animal epidemiology. Consequently, the Centre's name was changed in 1965 to the Applied Geochemistry Research Group (AGRG) to reflect the increasing breadth of applications.

By Webb's retirement in 1979, studies related to human health and pollution had been added, and over 80 PhD students had been trained. Many went on to teach applied geochemistry in academia, to leading positions in the mining industry, or to government establishments world-wide.

Webb's publications include the classic text *Geochemistry in Mineral Exploration* (1962) written with Herbert E. Hawkes (1912-1996) and a second edition with Arthur W. Rose and Hawkes (1979) and, jointly with members of AGRG, the *Provisional Geochemical Atlas of Northern Ireland* (1973) and *The Wolfson Geochemical Atlas of England and Wales* (1978) which together pioneered the now widely-used concept of national multi-element, multi-purpose geochemical atlases based on active drainage sediments, as first envisaged by Webb in the early 1960s. He was made an Honorary Member of AEG in 1977. (A full obituary will follow in the September issue of **EXPLORE**).

**Richard J. Howarth**

# Report on Laurentian University's Modular Course in Exploration Geochemistry (GEOL 5806)

The "Modular Course in Exploration Geochemistry" was offered by the Mineral Exploration Research Center (MERC) and the Department of Earth Sciences at Laurentian University from December 6-15, 2006. The course was organized by Steve Piercey of MERC/DES and consisted of 10 days of lectures and laboratory exercises given by speakers from academia, the government and the exploration industry. Participants consisted of both graduate students as well as industry geoscientists.

During the course, we heard talks from 14 different geochemists from throughout the mineral exploration world. The first 5 days of the course focused on geochemical theory and background. Presentations covered the topics of geochemical sampling and sample preparation, geochemical analytical techniques, quality assurance and quality control, lithogeochemistry, radiogenic isotopes, stable isotopes and alteration geochemistry including element mobility, mass and elemental changes during hydrothermal alteration and alteration indices. In addition to the talks, there were also 5 practicals assigned covering the topics of the first 5 days.

After 5 days of talks on geochemical theory and background, the next 3.5 days of the course focused on lithogeochemistry case studies. Topics for the numerous presentations included: lithogeochemistry of felsic and mafic rocks associated with Cu-Zn-Pb VMS deposits, the Superior Province plutonic suites and Archean lode gold deposits, geochemical data processing, massive sulphide associated iron formations, sediment hosted Zn-Pb sulphide deposits, Ni-sulphide exploration, komatiite-associated Ni-Cu-PGE deposits, the applications of geochemistry in diamond exploration, Sn-W deposits, scanning electron microscopy, portable XRF analyzers, energy dispersive spectrometry and the Reitveld refinement of powder X-ray data and mineral chemistry and applications in hydrothermal systems.

After 3.5 days of lithogeochemistry our focus was then switched to surficial geochemistry for the remaining 1.5 days of the course with presentations on soil geochemistry in areas of thick cover, regional surficial geochemical exploration techniques in Ontario, and till sampling methods in glaciated terrain, ice flow indicators and dispersal trains.

Aside from lectures and labs, participants were also given the opportunity to tour the Ontario Ministry of Northern Development and Mines Geoscience Laboratories which is located within the MERC/DES building at Laurentian University. After learning about the different analytical techniques, the lab tour provided an excellent opportunity to see geochemical analysis procedures and equipment in action. A portable XRF was also brought in by Jan Peter from the GSC for the participants to test. Beth McClenaghan from the GSC brought in kimberlite indicator minerals to view and try picking.

As a young geoscientist being trained as a geochemist I am always looking for ways to learn more about, and gain more experience in applied exploration geochemistry. This course provided that opportunity. Overall the course was 10 very intense days that covered a wide range of geochemical theory and application. Although the course was lithogeochemistry "centric", it provided an excellent geochemical framework. The lab exercises also provided practical applications for the participants to apply their newly gained geochemistry knowledge. The course was very well organized and provided a nice mix of theory and real world examples.

Many thanks to Steve Piercey for organizing this great course, and to all of the presenters: Balz Kamber (DES/MERC), Michael Lesher (DES/MERC), Thomas Hart (OGS/MERC), Gary Beakhouse (OGS/MERC), Eric Grunsky (GSC/MERC), Jan Peter (GSC/MERC), Wayne Goodfellow (GSC), Peter Lightfoot (Inco/MERC), Dave Crabtree (OGS), Dan Kontak (DES/MERC), Andy McDonald (DES/MERC), Stewart Hamilton (OGS), and Beth McClenaghan (GSC).

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# *Association of Applied Geochemists*
# APPLICATION FOR MEMBERSHIP*

Please complete only the relevant section for membership. See below for mailing instructions.

I, ______________________________________________, wish to apply for election as a ___Member / ___Student Member of the Association of Applied Geochemists. I have read the Code of Ethics of the Association and in the event of being elected a Member/ Student Member agree to honour and abide by them.

**MEMBER:** *State Employer and Employee title*
I am actively engaged in scientific or technological work related to applied geochemistry exploration and have been so for the past two years.
______________________________________________ as a ____________________________________________.
(employer) (employment title)

**STUDENT MEMBER:** *Student status must be verified by a Professor of your institution or a Fellow of the AAG*
I certify that the applicant is a full-time student at _____________________________________________ in pure or applied science.
(institution)

__________________________________________________ __________________________________________________
(Professor/ AAG Fellow Signature ) (Printed Name and Title)

Witness my hand this ______ day of____________, 20______. __________________________________________________
(Signature of applicant)

**NAME AND ADDRESS**: PLEASE PRINT (to be completed by applicant)

Name: __________________________________________________ Telephone bus: ________________________

Address: ___________________________________________________ fax: _____________________________

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**Annual Dues** :

All applications must be accompanied by annual dues . All payments must be in US funds. Select one of the four listed below.

| | | | | |
|---|---|---|---|---|
| 1 | 2007 member dues | US$ | 100 | ____________ |
| 2 | 2007 student member dues | | 10 | ____________ |
| | - If receipt required, include a self-addressed envelope and add | | 2 | ____________ |
| | - If your check is not drawn from a U.S.A. or Canadian bank, add | | 15 | ____________ |
| | | | **TOTAL** | ____________ |

Payment by check, International Money Order, UNESCO Coupons, International Postal Orders, VISA, American Express and Master Card are acceptable. For credit cards users, minor variations in your billing may reflect currency exchange rate fluctuations at time of bank transaction.

Type: VISA ___ American Express ___ Master Card ___ Credit card account number: ___________________________________________

Expiry date: ______________ Name: _______________________________________ Signature: ____________________________________

***Application for voting membership (Fellow) requires the sponsorship of three voting members. Request a voting member application from the Association office.***

**Please note**: Your application form will be acknowledged upon receipt. The Admissions Committee reviews all applications and submits recommendations to Council, who will review these recommendations at the next Council Meeting or by correspondence. If no objection is raised the names, addresses and positions of candidates will be listed in the next issue of the AAG Newsletter. If after a minimum of 60 days have elapsed following submission of candidate information to the membership no signed letters objecting to candidates admission are received by the Secretary of the Association from any Member, the Candidate shall be deemed elected, subject to the receipt by the Association of payment of required dues. Send completed application, together with annual dues to:

*Association of Applied Geochemists*
**P.O. Box 26099, 72 Robertson Road, Ottawa, Ontario, CANADA K2H 9R0**
TEL: (613) 828-0199, FAX: (613) 828-9288, email: office@appliedgeochemists.org WEBSITE: http://www.appliedgeochemists.org

# ioStipend

## *In-kind Analytical Research Fund for BSc(Hons), MSc and PhD students*

Much has been said and written about the broadening gulf between the demand for qualified explorationists and the supply coming out of our colleges, technical institutes and universities. One merely has to attend any geo-conference and gaze out over the sea of grey to fully grasp the situation our industry faces. This is all the more evident in the field of exploration geochemistry whose members have always been in short supply.

As consultants and service industries, we owe our livelihood to mining and exploration and thus have a vested interest in its development. We believe that any aid to promote fresh faces into our sector is helping to secure our future.

**Acme Analytical Laboratories Ltd**. and **ioGlobal** are taking the bold initiative of directly aiding students in the geosciences via the **ioStipend**. The **ioStipend** is a grant available to students conducting exploration-related geochemical studies at a recognized educational institution. The grant is in the form of analytical services using any package provided by Acme Analytical Laboratories Ltd. Students and/or their teachers/advisors can apply for the grant by submitting the application to ioGlobal who will vet the proposals.

The grant is intended to promote the collection of high quality, base-line data for comparison with more "esoteric data" (eg, isotopic data, partial digests, non-standard sample media) generated during the course of research, and to promote broad training in fundamental geochemical principals across the geosciences.

The **ioStipend** allows for amounts of approximately $5,000 (AUD, CAD or equivalent) for in-kind analytical work. Successful applicants will also be provided with 3 academic licences of **ioGAS**, the new exploratory data analysis software package available from ioGlobal.

The application form is available at www.ioglobal.net.

It is envisaged that three or four of these awards will be made each year.

Applications are reviewed by an expert group of ioGlobal's geochemists

**Eligibility Criteria**

Preference will be given to:

- students with no other source of funding
- students working on exploration geochemistry projects
- projects no or very minimal confidentiality requirements

The ioStipend is international. Applications are welcome from qualified institutions globally.

Some technical input may be provided by ioGlobal on request.

**Requirements for receiving the ioStipend**

Firstly, there are minimal strings attached. Recipients would have to agree to

1. Have their project promoted on the ioGlobal web site in an area devoted to R&D carried out under the program (couple of passport photo shots, brief description)
2. Acknowledge ACME Labs and ioGlobal for support in technical and public presentations of results
3. Write a short article for Explore describing the project outcomes, and allow this to be published on the ioGlobal web site.

**David Lawie, John Gravel**

# EXPLORE

Newsletter No. 135 JUNE 2007

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## EXPLORE Publication Schedule

Quarterly newsletters in March, June, September, December

**Deadlines** for submission of articles or advertisements:
March newsletter: January 15
June newsletter: April 15
September newsletter: July 15
December newsletter: October 15

**Manuscripts** should be double-spaced and submitted in digital format using WORD. Photos and figures (colour or black and white) should be submitted as separate digital files and as high resolution jpeg or PDF files. Tables should be submitted as separate digital files in EXCEL format. All scientific/technical articles will be reviewed. All contributions may be edited for clarity or brevity.

Formats for headings, abbreviations, scientific notations, references and figures must follow the Guide to Authors for *Geochemistry: Exploration, Environment, Analysis* (GEEA) that are posted on the GEEA website at: http://www.geolsoc.org.uk/template.cfm?name=geea_instructions_for_authors

**Submissions** should be sent to:
Beth McClenaghan, Geological Survey of Canada, 601 Booth Street, Ottawa, ON, CANADA K1A 0E8 Email: bmcclena@nrcan.gc.ca



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