



## An appraisal of Québec's extensive geochemical database

### Introduction

Over the last decade, the Province of Québec, in Canada, has remained amongst the world's five most attractive mining jurisdictions, largely due to its policies and mineral potential (McMahon & Cervantes, 2011). The *Ministère des Ressources naturelles et de la Faune* (MRNF), through *Géologie Québec*, is responsible for the development of Québec's geoscientific knowledge over an area exceeding 1.5 million km<sup>2</sup>. Its mandate was reaffirmed and clarified in 2009 within the scope of the Québec's Mineral Strategy (Government of Québec, 2009). *Géologie Québec*'s mission is to acquire, process, and disseminate knowledge on the mineral resources of Québec, in order to assess and promote its mineral potential in a sustainable development perspective. Since 2008, continued and stable funding through the Natural Resources Fund (Mining Heritage Program) provides *Géologie Québec* with the means to ensure the development of Québec's mineral potential.

Québec's territory consists of five geological provinces (Fig. 1) that contain rocks ranging in age from 3 800 to 120



Figure 1. The geological provinces of Québec in Canada.

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## President's Message



As I begin my two-year term as AAG President, I look forward to leading the organization. However, the proactive and stellar leadership of our past president, Paul Morris, leaves me with big shoes to fill. Paul has been ably assisted by long-time Executive Council Members Gwendy Hall and Dave Smith. I am glad that Paul, Gwendy, and Dave—along with our new Vice President Matt Leybourne—are here to advise me. However, there are many others behind the scenes who help with the operations of AAG and advancing it's causes: Business Manager Betty Arseneault, EXPLORE Editor Beth McClenaghan, EXPLORE Business Manager Sarah Lincoln, our new Website Coordinator Jamil Sader, and Webmaster and Web Specialists Andrew Ransom, Gemma Bonham-Carter, and Dan Brodhead. Thanks to all of you for helping to run a tight ship and efficient organization.

Also critical to AAG's continued success are the Council Members who step forward to volunteer their services. Continuing to serve as Council members are Rob Bowell, John Carranza, Patrice de Caritat, Bruno Lemiere, Romy Mathies, Ryan Noble, Cliff Stanley, Todd Wakefield, and Erick Weiland. Our new Council members are Alejandro Arauz and Bill Burstow. Regional Council Members are Neil Breward, Theo Davies, Benedetto De Vivo, João Larizzatti, Brian Townley, and Xueqiu Wang. Outgoing Regional Councillor J.B. De Smeth will soon be replaced by Pertti Sarala. All are thanked for helping to lead AAG forward. I hope I didn't leave someone off of this list!

AAG is run by volunteers on Council, with ex-officio members freely giving advice and other members serving on our various Committees. Many of you are repeat volunteers, but new faces and new ideas are always welcomed and needed for healthy growth of the organization. If you are a Regular Member of AAG, consider becoming a Fellow or becoming active on a committee. If you are a Fellow, consider running for Council or working on a committee. From past discussions, I know that many of you "have been thinking about it," but have not gotten around to helping shape and lead AAG. Details for conversion to Fellow and Committee listings are found on our website. Now is the time to step forward.

Most of you in the past have probably attended AAG's biennial International Applied Geochemistry Symposia

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## President's Message ... *continued from page 1*

(formerly International Geochemical Exploration Symposia). This symposium is AAG's single most important event. The very successful 25<sup>th</sup> IAGS was in Rovaniemi, Finland this past August (thanks Pertti Sarala!). The 26<sup>th</sup> IAGS will be held in Rotorua, New Zealand in 2013, and is shaping up nicely under Tony Christie's and Matt Leybourne's leadership. *Thus far, no one has stepped forward with a proposal for the 27<sup>th</sup> IAGS in 2015.*

In Rovaniemi, there were suggestions that the 27<sup>th</sup> IAGS should return to the USA. Where would you like to see the 27<sup>th</sup> IAGS and, most importantly, *are you willing to help organize it?* There are several people who have offered to help, but we need solid leaders to come forward with a proposal. Historically, this has been a volunteer effort, although professional meeting planners are commonly employed to help with symposium and venue organizational details. Past successful IAGS usually have involved a blend of organizers from industry, academia, and governmental survey organizations. The symposium does not organize itself. Again, now is the time to step forward. Contact David Cohen or me with ideas or self-nominations!

One of my goals as AAG President is to see the

completion during my tenure of a document describing the history of AAG and its forerunner AEG, from inception to the present. It is important that we capture this history—the events, the principal people involved, and the pathways to our present successful status—before this institutional knowledge is lost. I envision having the complete document, with companion documents showing a complete list of Officers and Council Members over time and also showing the IAGS venues and organizers, all available for .PDF download from the AAG website. A few years ago this task was begun by Gerry Govett and then passed on to Bob Garrett, who now wishes to hand the reins over to someone else. If you are interested in working on this project, please contact me.

AAG members are active in organizing conference sessions and workshops in 2012. Planning is well underway for the 34<sup>th</sup> International Geological Congress in Brisbane, Australia (August, 2012); AAG is an Institutional Supporter for this symposium. AAG members are involved in both a workshop (Geochemistry in Mineral Exploration, coordinated by David Cohen) and in organizing several sessions—Advances in Geochemical Exploration (David Cohen, Ravi Anand, Ryan Noble, David Lawie, Graham Closs, Andrew Rate, and Mark Arundall), Global Geochemical Mapping: Understanding Chemical Earth (Dave Smith, Xueqiu Wang, and Patrice de Caritat), Environmental Aspects of Mining (Bernd Lottermoser and Kirk Nordstrom), and Advances in the Evaluation and Interpretation of Geochemical Data at the Continental Scale (Eric Grunsky and Patrice de Caritat). See <http://www.34igc.org/>.

For the June 2012 Goldschmidt Conference in Montreal, Canada, AAG members John Carranza and Cliff Stanley are convening the session, Vectoring Towards Mineral Deposits: Integrated Spatial Analysis of Geochemical and Other Mineral Exploration Datasets. See <http://www.vmgoldschmidt.org/2012/index.htm>.

**Bob Eppinger**  
*President*

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## Notes from the Editor

Happy New Year 2012! EXPLORE continues in 2012 with our six corporate sponsors: Actlabs, ALS Minerals, Geosoft, Olympus Innov-X, Maxwell Geoservices and SGS. A very big thank you to these generous sponsors for supporting the publication of the Association's newsletter. The March 2012 issue of **EXPLORE** features one article by Charles Maurice and Daniel Lamothe that describes the impressive lithogeochemical and surficial geochemical databases available on line for the Province of Quebec in Canada. Thank you to all contributors to **EXPLORE** No. 154: Steve Amor, Betty Arsenault, Neil Breward, Eion Cameron, Bob Eppinger, João Larizzatti, Dave Smith, Wendy Spirito, and Erick Wieland,

**Beth McClenaghan**  
*Editor*




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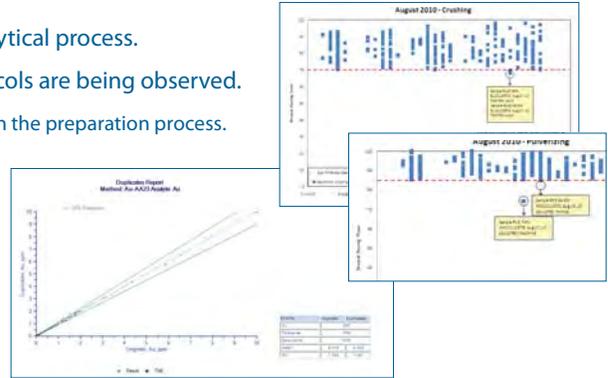
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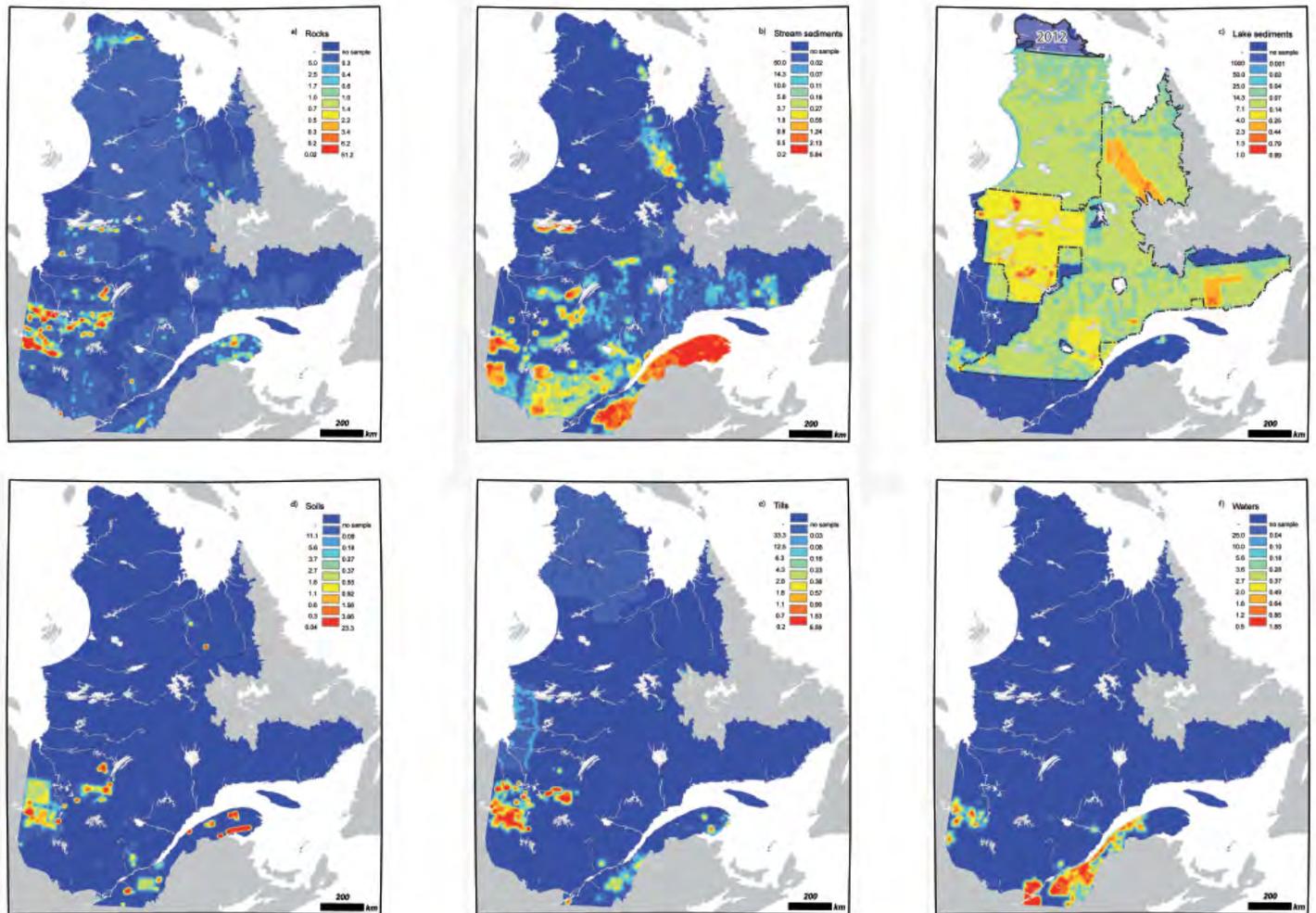


Figure 2. The sample density (or spatial resolution) of geochemical surveys conducted in the Province of Québec, Canada, accordingly to sample media. The images were produced using the Density tool from Spatial Analyst in ArcGIS. Search radii of 15 km and output cell sizes of 1 km<sup>2</sup> were computed. The color scale for the density plots are based on a division into 10 classes using the quantile method, with the exception of lake sediments for which the geometrical interval method was preferred. The values to the left of the colour chart represent the number of km<sup>2</sup> covered by a sample. The values to the right reflect the number of samples per km<sup>2</sup>. The dashed line in 2c) outlines the coverage of recent ICP-MS analyses.

million years. Most of the Province is comprised of rocks of Precambrian age that were covered by glaciers during the Quaternary, leading to the deposition of surficial deposits. Lithochemical and surficial geochemical surveys are a key element of mineral discoveries in remote glaciated terrains, and are an important component of *Géologie Québec's* geoscientific programme. The Province maintains a comprehensive geochemical database that includes more than 750,000 analyses for which a replacement cost was estimated in excess of 134 M\$. More than 243,000 samples are rock analyses acquired during geological mapping surveys and exploration programs, and over 510,000 samples were acquired from surficial geochemical surveys (Table 1). However, only 5% of the data for surficial geochemical surveys conducted on Québec's territory are actually included in the compilation of the Geological Survey of Canada (*cf.* the Geoscience Data Repository – GDR: Spirito & Adcock, 2009; Spirito & Adcock, 2010). This article describes the content of Québec's geochemical database to the applied geochemists' community, and reports on the recent advances made by additional coverage of its territory

and the reanalysis of archival samples. More precisely, we will show how the data are being used to enhance geochemical anomalies and produce first order exploration targets.

### Québec's gateway to geoscience data: the SIGEOM database

Geoscience data available in the Province are accessible via Québec's Geomining Information System (SIGEOM<sup>1</sup>). This system contains geoscientific data derived from work conducted by *Géologie Québec*, exploration and mining companies, and universities. It contains both raw data of a geological (descriptions of outcrops, mineral deposits, drill holes...), geophysical (electromagnetic, magnetic, gravimetric...), or geochemical (rock or surficial sediment) nature, as well as geological data interpreted by geoscientists (contacts, faults, geochronology, etc.). In addition, the documentary database (e-SIGEOM-Examine) provides access to the geoscientific documentation of Québec,

1 [http://sigeom.mrnf.gouv.qc.ca/signet/classes/I1102\\_indexAccueil?l=a](http://sigeom.mrnf.gouv.qc.ca/signet/classes/I1102_indexAccueil?l=a)

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whether it is derived from the work of *Géologie Québec* (geological reports and studies, geological maps, mineral potential assessment maps), or from exploration work conducted by industry (assessment work reports including results of mapping, drilling, geochemical and geophysical surveys).

Sample media	Number of samples	Comments
Rocks Litho geochemistry Assays	(243 549) 199 304 44 245	
Surficial - sediments and waters	(510 673)	
Stream	230 362	
Lake sediment	124 651	includes 85 542 samples analyzed by ICP-MS
Soil	76 036	undifferentiated horizons
Till	40 751	fine, heavy and/or light fractions
Water	38 873	ground, surface, spring, well and bore hole waters
Total	754 222	

Table 1. Summary of the content of Québec's geochemical database.

### Overview of geochemical data

The SIGEOM database keeps track of over 750,000 analyses collected from different media. As summarized in Table 1, rock samples consist mostly of litho geochemical analyses, whereas surficial samples contain mostly stream and lake sediments. Figure 2a shows the density of rock analyses, a measure that can be employed as a proxy for the extent of geological knowledge in the Province. For instance, areas with no rock samples represent those in which *Géologie Québec* has not yet undertaken mapping programmes or those that were mapped prior to the 1980s, when litho geochemical analyses were uncommon. As a counterpart, the greater density observed in the Abitibi Subprovince and the Cape Smith Belt reflects the large input of analyses from both surface outcrops and exploration drill holes.

Stream sediment surveys have historically been more common in the southern portion of the Province, in part because of easier road access, but coverage exists at different scales and spatial resolutions elsewhere (Fig. 2b). Conversely, lake-bottom sediments were the preferred sample medium in remote northern regions, and a large portion of Québec's territory is now covered at a density of at least ~1 sample per 15 km<sup>2</sup> (Fig. 2c). The coverage varies according to the sampling density chosen for the various programmes undertaken since the 1970s and is extended

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**To choose a map already carried out by the SIGÉOM.**

- **E-Sigeom (Atlas)**

**Products from the atlas**

E-Sigeom Atlas represents the overall geoscientific products in geomatic format of the sector of energy and mining of the Ministry of natural Resources and Wildlife. Functionalities include queries, viewing maps and online ordering.

**To create a map according to your own search criteria starting from the data of the SIGÉOM and of GESTIM.**

- + **E-Sigeom (Examine)**
- + **Mining titles**
- + **Geology**
- + **Geochronology**
- + **Geophysics**
- **Geochemistry**
  - Rock sample**

The rock samples designate the rock sampling on the site for the purpose of determining the content of various compounds and/or chemical elements.
  - Sediment sample**

The sediment samples represent the sampling of the site's secondary environment (tills, heavy minerals, brook or lake sediments, etc.) to determine the content of various chemical elements.
- + **Deposits**
- + **Glacial transport**
- + **Quaternary geology**
- + **Drilling**
- + **Hydrogeology**

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Figure 3. The SIGÉOM portal.

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by further sampling in the vicinity of specific geochemical anomalies. The nature of surficial deposits in given areas also influences coverage as, for instance, no lake sediment samples exist for a large portion of the Abitibi Subprovince because of the thick cover of glaciolacustrine clay.

Soils and tills have been sampled for a large portion of the Abitibi, and to a lesser extent the Appalachians (Figs. 2d and 2e). The coverage or spatial resolution for soil and till surveys remains restricted for other areas. Finally, analyses of water samples are focussed around the Montréal region, along the southern shore of the St. Lawrence River, and in the Abitibi Subprovince (Fig. 2f).

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Figure 4. The querying page for surficial samples.

## Access to geochemical data

The raw geochemical data are accessed from the SIGEOM portal (Fig. 3) under “Geochemistry”, and then by choosing either “Rock sample” (litho geochemistry and assays) or “Sediment sample” (surficial samples). A click then forwards the users to a querying page (Fig. 4) where their search can be refined by using geographical, physical, descriptive and/or analytical parameters. The available values for coded variables (e.g. NTS map-sheet, sample type, chemical element and analysis method) are accessed by clicking the “Values” button, and then by selecting the appropriate entry from the html popup or Java™ Platform window. The results of the query, including analytical results, may be directly consulted on the screen, and the location of the samples viewed from the Google Earth™ plug-in. Once the user has created an account, the data can be ordered and downloaded in ArcGIS(FGDB) or ArcView(Shape) format through a secured e-payment protocol.

## Acquiring new data and improving the database

Maintaining such a large geochemical database obviously presents challenges, as a large number of analytical variables (digestion and instrumental methods, accuracies, detection limits, laboratories...) acquired across many years are brought together (Grusky, 2007). Successfully integrating analytical data from a collection of geochemical surveys focused on distinct media or size fractions may become puzzling. As such, the improvement of Québec's geochemical database has recently been centered on the rejuvenation of its lake-bottom sediment database. Since 2008, over 85 000 samples were analyzed for a suite of 53 elements from a single laboratory using the ICP-MS method with *aqua regia* digestion (Fig. 2c). From this total number of samples,

12 000 represent newly collected samples and 73 000 are reanalyses from archived samples (Labbé & Moukhsil, 2008; Labbé, 2009; Hurtubise et al., 2009; Maurice & Labbé, 2009; Morin et al., 2010; Labbé, 2011). With the publication in 2012 of the analytical results for ~3 000 new samples from the northern portion of the Ungava Peninsula (Fig. 2c), the entire Province will have a near-complete coverage at a minimum density of 1 sample per 15 km<sup>2</sup> to the North of latitude 47°15'N.

## Geochemical levelling, exploration targets and assessment of mineral potential

Concerned with the need to offer both unprocessed data and integrated products to its customers, *Géologie Québec* publishes thematic projects that use and build upon the geochemical database. One of these projects is aimed at identifying anomalous geochemical zones for eleven metallic elements (Ag, As, Au, Co, Cu, Li, Mo, Ni, U, Y and Zn) from surficial sediment media (lakes, streams, tills and soils) existing in the SIGEOM database (Lamothe, 2009a, Lamothe, 2011a). An ArcGIS ModelBuilder model was built to define the anomalous zones using a natural break method based on populations from geological domains considered to be relatively homogenous. The favourability of these zones for containing metallic concentrations was then calculated using the weights of evidence method from a collection of known metal deposits. The resulting atlas constitutes a land management tool for the under-explored portions of the Province.

Another project has focused on the resolution of the discrepancies arising between lake-bottom sediment

## An appraisal of Quebec's extensive geochemical database ... *continued from page 7*

surveys and produced levelled images from 13 distinct surveys acquired between 1973 and 2009. To this end, a series of maps portraying the backgrounds of 23 elements at the scale of the Province has been produced in Google Earth™ format<sup>2</sup>. A set of 18 elements from this levelled

<sup>2</sup> The maps were produced using a software designed by CONSOREM (Trépanier, 2007) and are available at <http://www.mrnf.gouv.qc.ca/english/mines/publications/publications-maps.jsp> for the elements Al, As, Ba, Ca, Ce, Cr, Co, Cu, Fe, La, Li, Mg, Mn, Mo, Ni, P, K, Th, Ti, U, V, Y and Zn.

Models	Areas	References
Volcanogenic massive sulphides	Superior Province (Abitibi)	Lamothe et al., 2005; Lamothe, 2011b
Orogenic gold (Abitibi)	Superior Province 2006	Lamothe & Harris, 2006
Cu-Au-Mo porphyries	Superior Province (Abitibi)	Labbé et al., 2007
Orogenic gold	Superior Province (Baie-James)	Lamothe, 2008
Cu-Au-Mo porphyries	Superior Province (Baie-James)	Lamothe, 2009b
Rössing-type U and Iron oxide Cu-Au-U	Grenville Province	Trépanier, 2009

Table 2. List of mineral potential assessments made in the Province of Québec since 2005.

database was then used to define discrete exploration targets (Lamothe, 2011a) using a method of multivariate spatial regression (Trépanier, 2006 and references therein). This method has proven to be effective for determining exploration targets from samples that do not initially yield significant metallic concentrations. It was used to identify targets for five elements (Cu, La, Ni, U, Zn) that are not specifically associated with a geological context, and for three distinct metallogenic models: 1) Cu or Zn associated with volcanogenic massive sulphide (VMS) deposits; 2) Ni or Cu associated with magmatic deposits; and 3) Cu, U or La associated with enriched iron oxide deposits.

Finally, the geochemical data contained in the SIGEOM database are recurrently included into projects assessing the mineral potential for a variety of metallogenic models in given areas of the Province (Table 2). These assessments combine together various data sources (e.g. geology, geophysics, geochemistry) in order to quantify and identify exploration targets that are not currently under examination by mineral exploration companies. The continuous additions and upgrades made to the SIGEOM database help to better define the portrait of Québec's mineral potential, but also pave the way to better address environmental issues in a

world that sees sustained development becoming everyone's concern.

### Acknowledgments

J. Moorhead and S. Lacroix reviewed and contributed to the clarity of the message. J. Jobidon and O. Rabeau helped with drafting the figures. The authors also wish to thank B. McClenaghan and W. Spirito for reviewing and improving an earlier version of this article. *Ministère des Ressources naturelles et de la Faune* contribution #BEGQ-8439-2011-2012-06.

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## AAG Member John Hansuld: Mining Hall of Fame Induction

At a Gala Dinner held in Toronto on January 12<sup>th</sup>, 2012, and attended by an overflow assembly of 900, John A. Hansuld was inducted into the Canadian Mining Hall of Fame. He joins three other distinguished Association members who have received this honour: Bob Boyle, Tony Barringer and Harry Warren.

John was a founding member of the Association and its second president. In this position, he felt the need to enhance communication among the far-flung community of its members. He took a leadership position role in establishing the Newsletter, which blossomed into **EXPLORE** and the Journal of Geochemical Exploration. In retrospect, it seems bold that a young society, yet to celebrate its second birthday, one with a small membership, and an even smaller treasury, should found a scientific journal. John dedicated himself to the financial task of running the journal as Business Editor. Over a number of years he negotiated a series of contracts with the publisher that were highly advantageous to the Association. He was able to persuade the publisher to accept a profit-sharing agreement at a time when it appeared improbable that the specified



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*AAG member John Hansuld (right) at his induction into the Canadian Mining Hall of Fame, being congratulated by Steve Vaughan (left)*

sales targets could be met. However, with the growth of our Association and the journal, this savvy negotiation led to hundreds of thousands of dollars flowing back to the society's coffers. Indeed, every member benefited from a lesser membership cost thanks to John's efforts. Recognition of his many contributions to the Association were expressed by the Distinguished Service Award presented in 1982 at the Saskatoon Symposium and the Past-President's Medal presented in 1999 at the Vancouver Symposium.

John was born in Port Arthur, Ontario. His education as a geologist started at McMaster University where he graduated in 1954. From there he went to the University of British Columbia, graduating with a MSc in 1956. But it was at McGill University that his interest in geochemistry flowered, and he received a PhD in 1961 for studies on the mobility of metals, notably molybdenum, in the surface environment through the use of Eh-pH phase equilibrium diagrams. After leaving McGill, John joined Amax in Toronto, moving almost immediately to Amax's exploration activities in Puerto Rico. The following year, 1962, he was promoted to Chief Geochemist at the Amax headquarters

## John Hansuld: Mining Hall of Fame Induction ... *continued from page 10*

in Denver, followed by a further promotion to Manager of Exploration Research.

John Hansuld's principal contributions to mineral exploration were as a manager and a leader. In 1967, he returned to Toronto as Regional Exploration manager for Eastern Canada. Recognizing his talent, Amax supported further graduate studies at Harvard Business School, where he received a PMD in 1968. Moving further up the corporate chain, John became Canadian Exploration manager of Amax in 1973 and in 1978 Senior Vice-President of Amax with responsibility for the worldwide exploration budget. In 1982 John convinced Amax to spin out its Canadian operations into a separate company, Canamax Resources. He completed a \$29 million public issue largely through a new financial product and became recognized as the "father of flow-through shares". These continue to this day as a tax-efficient means of financing high risk resource projects. From 1983 to 1989 he was president and CEO of Canamax, during which time three gold mines were brought from exploration to production status: Bell Creek, Kremzar and Ketz River. This success led to him receiving the Northern Miner's "Mining Man of the Year" award in 1988 and the Prospectors and Developers Association of Canada (PDAC) "Developer of the Year" award in 1989. Since leaving the Amax organization in 1989, he has held and continues to hold a variety of executive and director positions with mining companies. John is also active in the broader mining community. Most notable among these activities was his presidency of the PDAC from 1993 to 1996. He developed a strategic plan to revitalize this organization and took its annual convention from one with a North American focus to one with global influence. What does he do in his spare time? He is an elected member of the Council for the Municipality of Georgian Bay, Ontario.

The Gala Dinner celebrated the accomplishments of John and his fellow inductees. Previous inductees in the audience were introduced, including Marsh Cooper at the age of 100. More than that, the dinner celebrated the Mining Industry and Canada, which have been bound together throughout the history of the country. Canada's most munificent philanthropists come from this industry, funding hospitals, medical centres and business schools. Several of these persons were introduced. John's presenters noted the breadth of his accomplishments: as a geochemist (yes, one of his Eh-pH diagrams was flashed on the screen), as an entrepreneur, as a mine-finder, as a financial innovator, and for his leadership contributions to two associations, ours and the PDAC.

*Canadian Mining Hall of Fame web site:*

<http://mininghalloffame.ca/about/>

**Eion Cameron**



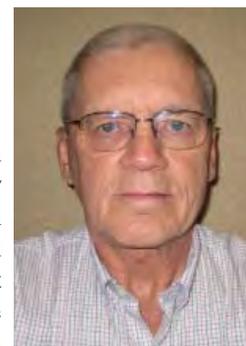
## AAG Councillors 2012 - 2013



### Alejandro J. Arauz

Alejandro J. Arauz is a Costa Rican geologist/geochemist with over 25 years of experience in mineral exploration, environmental studies and mining environmental management in Latin America. As exploration geologist he participated in the discovery of the Crucitas Gold Deposit (2.0 Moz Au) in Northern Costa Rica. As environmental

scientist and consultant he has provided technical and logistical support for several mining projects located in Mexico, Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, Dominican Republic, Panama and Peru. Alejandro Arauz is part time professor at Universidad de Costa Rica where he teaches Introduction to Geochemistry and Applied Geochemistry and is member of the editorial board of "Revista Geológica de América Central". Mr. Arauz has a BS degree in Geology from Universidad de Costa Rica, a MSc Degree in Geology from Colorado School of Mines and an MBA in natural resources from INCAE. He is a member of the AAG (since 1984), of the SEG (since 1986), of Colegio de Geólogos de Costa Rica (since 1986) and is honorary member of the Asociación Argentina de Geoquímica.



### William D. Burstow

Mr. Burstow received a B.Sc. in geology from McMaster University (Hamilton, ON) in 1970. Upon graduation he joined Inco Ltd. and worked as an underground geologist for a few years at several mines in the Sudbury district. His field career with ACNC (an Inco subsidiary) began in the Keweenaw district, MI, in 1974, where he managed parts of a large copper exploration joint venture. In the late 70's Bill was engaged in base metal reconnaissance exploration programs in the western USA.

In 1982, Mr. Burstow started his consultancy, focused on management of base and precious metals exploration programs. Over the years, he has worked with numerous junior and senior mining companies, directing domestic and international exploration projects. In North America, he has evaluated base and precious metal properties in the western USA (11 states) and Mexico. Comprehensive programs/studies have included the Mother Lode district, CA (Au), Hamilton district, NV (Ag) and Elk City district, ID (Au).

*continued on page 13*

## AAG Councillors 2012 - 2013

In the mid to late 90's, Bill concentrated on exploration of orogenic and low sulphidation epithermal gold deposits with international postings in a variety of settings. He managed reconnaissance and development programs in Central and South America, West and East Africa and western Asia. Recent work has included a detailed study (NI 43-101) of a developing orogenic gold deposit in the Eastern Andean Cordillera of south-eastern Peru.

Bill's interests include geochemical exploration methods, exploration for blind precious metal deposits and QA/QC of exploration data. He is also dedicated to mentoring young professionals.

Mr. Burstow is a Certified Professional Geologist (CPG) of the American Institute of Professional Geologists (AIPG), a Fellow of the Association of Applied Geochemists (AAG), a Fellow of the Society of Economic Geologists (SEG) and a Fellow of the Geological Association of Canada (GAC). He is a member of Society of Mining, Metallurgy and Exploration (SME), the Northwest Mining Association (NWMA), the Geological Society of Nevada (GSN) and the Denver Region Exploration Geologists' Society (DREGS).



### Rob Bowell

Rob Bowell has a PhD in Geochemistry from Southampton University and has worked as a geochemist in academic research and in the mining industry for Goldfields, Ashanti and BHP. Since 1995 he has worked for SRK Consulting where he is Corporate Consultant in Geochemistry. Rob has represented AAG as Councillor for Europe,

**EXPLORE** manager, general member of Council, Vice President and President for 2006 to 2007. Rob's main areas of expertise in SRK are applied geochemistry studies on uranium, exploration geochemistry (especially for uranium), environmental geochemistry of mine waste and waters and geometallurgy.

### Bruno Lemièrè

Bruno Lemièrè joined AAG in 1991 and is a Fellow since 1997. He explored most of the possible paths for a geochemist in the BRGM group (French Geological Survey). He began as a mapping geologist and igneous geochemist, then joined mineral exploration as Chief geochemist for BRGM Saudi Arabia from 1990 to 1993. He joined then the ANTEA engineering company to coordinate the geochemistry activities in the deep



storage of high activity nuclear waste sector, for the French agency (ANDRA). Back in BRGM analysis laboratories, he worked to open them to new markets for the geochemistry methods in the industry, and for laboratory engineering. Since 1998, he is a geochemistry expert and international projects manager with BRGM's Environment and Process Division, with activities for private or public clients in India, Egypt, Turkey, Romania, Greece and Tanzania. His main focus is on sampling, field analysis and instrumentation, not only for mining waste and mine water, but also for other environmental issues. He leads or contributes to European applied research projects, in the environment and waste sectors. Besides his activities for BRGM, he began geochemical consulting in 2011. Bruno holds a MS in industrial and analytical chemistry (1978) from the Lyon Chemistry School (CPE) and a PhD (1982) in geology and geochemistry from the University of Lyon.



### Ryan Noble

Ryan Noble is a research scientist and laboratory manager within the Division of Earth Science and Resource Engineering at CSIRO in Perth, Western Australia. He has been with CSIRO for six years working on geochemical research with application to the exploration industry.

He received his Ph.D. in Applied Geology from Curtin University of Technology (Western Australia) in 2007 where he studied the distribution of arsenic in soils and regolith from gold deposits in Victoria for application to exploration and environmental management. Prior to this Ryan completed a M.Sc (Soil Science, 2002) investigating the genesis of Russian chenzems and a B.Sc (Plant and Soil Science, 2000) both from the University of Tennessee (U.S.A.).

He has been a member (presently Fellow) of the Association of Applied Geochemists for six years and served as a Councillor for two years as well as being a member of the Education Committee. Ryan is also a member of the following societies: Geochemical Society, Soil Science Society of America, American Society of Agronomy and the International Association of Geochemistry. In the past he has also served as a conference organising committee member for the Asia-Pacific symposium on Environmental Geochemistry, 2005. He has authored more than 80 publications including papers, book chapters, reports, conference proceedings and abstracts

His current research interests are quite broad working on numerous projects in applied geochemistry involving groundwater, soil partial extractions, Ni, U and Au mobility in regolith, Au nanoparticles and shallow monitoring for CO<sub>2</sub> sequestration.

## AAG Councillors 2012 - 2013 ... continued from page 11

### Todd Wakefield

Mr. Wakefield received a B.Sc. in geology from the University of Redlands in 1986, and a M.Sc. in geology from the Colorado School of Mines in 1989. While at CSM, Todd worked for Westmont Mining, exploring for gold in Nevada. Upon graduation, Mr. Wakefield joined Newmont Mining Company, where he worked as an exploration geochemist for the next 13 years on exploration and mining projects in Nevada, Southeast Asia, and South America. For the past five years Mr. Wakefield has worked for AMEC, an international engineering services company, as Principal Geologist and for the past year as US



Manager of Consulting. For AMEC, he has worked on over 50 mining projects, including significant gold, copper, nickel, iron, vanadium, aluminum, and uranium projects in North America, South America, and Australia. Mr. Wakefield has published over 20 NI 43-101 Technical Reports on projects in North and South America, and has presented papers at technical conferences on subjects related to exploration geochemistry and mineral resource estimation. Todd's interests include reconnaissance exploration, blind deposit exploration, and exploration data quality related to mineral resource estimation. Mr. Wakefield is a Fellow and past Councilor of the Association of Applied Geochemists, and is a member of the Australasian Institution of Mining and Metallurgy (AusIMM), Society of Mining Metallurgy and Exploration (SME), and the Geological Society of Nevada (GSN). Mr. Wakefield is currently based in Reno, Nevada.



### New AAG Website Coordinator

AAG's web site has a new coordinator, Jamil Sader. Jamil takes over this volunteer position from Bob Eppinger, who is now our new AAG President.

Bob was coordinator of the AAG website for 6.5 years and we thank Bob for his time and efforts. Jamil is an exploration geochemist with MMG and is based in Vancouver, Canada.

Anyone wishing to provide content or feedback for the AAG website may contact Jamil at:

[jamil.sader@mmg.com](mailto:jamil.sader@mmg.com)



### 2012 AAG Membership Dues-pay online

To renew your 2012 AAG Membership, please go to the AAG website at [www.appliedgeochemists.org/](http://www.appliedgeochemists.org/) and click on "Membership" in the left hand side menu, then click on "Renew Membership Online". Making a voluntary donation to the *Distinguished Applied Geochemists Fund* or the *Developing Country Membership Fund* is also very much appreciated.

If you have any questions about your membership or receipts please contact the AAG Business Office at [office@appliedgeochemists.org](mailto:office@appliedgeochemists.org)

## Regional Councillor's Report for Great Britain and Ireland

In response to sharply rising world commodity prices and concerns over potential future shortages of key mineral and metal resources, the British Geological Survey has recently published the BGS Risk List. This is an independent and authoritative assessment of the current world resource situation and gives a quick indication of the relative risk in 2011 to the supply of the chemical elements or element groups which we need to maintain our economy and lifestyle. The position of an element on this list is determined by a number of factors, which include the abundance of elements in the Earth's crust, the location of current production and reserves, and the political stability of those locations. The list highlights economically important metals which are at risk of supply disruption including rare earths, platinum group metals, niobium and tungsten. The list also shows the current importance of China in production of many metals and minerals. Download the publication here: (<http://www.bgs.ac.uk/downloads/start.cfm?id=2063>).

The rise in commodity prices has also stimulated more activity in mineral exploration in the UK, and even breathed new life into the UK's moribund metal mining sector, as Scotland's Tyndrum gold mine is set to reopen following agreement with the Scottish Government and the National Park authorities to ensure the highest environmental standards are maintained. The record price for gold on the world

markets, plus the premium for the home-produced metal, may also yet see mines reopening in the Dolgellau (Wales) mining field. There is also increasing interest in other commodities, especially REEs, Tin and Tungsten in south-west England, with increasing exploration activity and hopes that the former tungsten mine at Hemerdon in Devon may reopen and tin production re-start at South Crofty in Cornwall.

A major new regional geochemical baseline survey of the northern border region of the Republic of Ireland is now well underway. The Geological Survey of Ireland are leading the geochemical aspects of the Tellus Border project's integrated regional geochemical and geophysical surveys of the counties of Donegal, Sligo, Leitrim, Cavan, Monaghan and Louth. Following the same systematic sampling methodologies of the British Geological Survey's G BASE national geochemical mapping and the Tellus project of Northern Ireland — collection of soil, stream sediments and stream waters is currently ongoing in Co. Donegal, with around 1000 sample sites completed to date. Visit [www.tellusborder.eu](http://www.tellusborder.eu) for updates on the progress of the project.

**Neil Breward,**  
AAG Regional Councillor for the UK and the Republic of Ireland  
British Geological Survey  
[nbr@bgs.ac.uk](mailto:nbr@bgs.ac.uk)



## Regional Councillor's Report for Brazil



CPRM – Geological Survey of Brazil has been conducting geochemical mapping surveys since 1970s in order to characterise the regolith. Stream sediments, overbank sediments, pan concentrates, soil and water samples are the main sample media collected from Amazon to Pampa

regions. Twenty geochemical maps were published in the last two years at 1:100.000 or 1:250.000 scales. Thirty five maps are in press. Twenty five sheets are being sampled. Sampling in seventeen new sheets are about to start in the following months. A special project will be conducted at Carajás Mineral Province and similar projects are also planned.

Brazil is experimenting an exciting moment and the Brazilian government raised its investments in geological knowledge. CPRM employed new geochemists and is conducting geochemical studies at various scales with objectives ranging from regional exploration to environmental remediation. For additional information: <http://www.cprm.gov.br>.

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## 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](http://www.appliedgeochemists.org)

### 2012

11-15 March 2012. The Minerals Metals & Materials Society 2012: Linking Science and Technology for Global Solutions, Orlando FL USA.  
Website: <http://tinyurl.com/4q388lq>

25-29 March 2012. Spring 2012 ACS Meeting - Symposium on Computational Chemistry for Geochemistry, San Diego CA USA.  
Website <http://tinyurl.com/85k9njx>

6-9 May 2012. CIM Conference and Exhibition 2012: Minerals for All Seasons. Edmonton AB Canada.  
Website: [www.cim.org/edmonton2012](http://www.cim.org/edmonton2012)

21-24 May 2012. Groundwater in Fractured Rocks, Prague, Czech Republic. Website: <http://web.natur.cuni.cz/gwfr2012/>

27-29 May 2012. GAC/MAC Annual Meeting, St. Johns NL Canada. Website: [www.stjohns2012.ca](http://www.stjohns2012.ca)

28 May-1 Jun 2012. Environmental Science and Technology, Mar del Plata, Argentina.  
Website: [www.aa2012.com.ar](http://www.aa2012.com.ar)

31 May-10 June 2012. Present and Future Methods for Biomolecular Crystallography, Erice, Italy.  
Website: <http://tinyurl.com/4vqxw7s>

2-8 June 2012. 11th International & 2nd North American Symposium on Landslides. Banff AB Canada. Website: [www.isl-nasl2012.ca](http://www.isl-nasl2012.ca)

9- 23 June 2012. 6th International Siberian Early Career GeoScientists Conference. Novosibirsk, Russia.  
Website: <http://tinyurl.com/3vlo8xq>

*continued on page 16*

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## CALENDAR OF EVENTS

*continued from page 15*

24-29 June 2012. Goldschmidt 2012. Montréal QC Canada. Website: [www.goldschmidt2012.org/](http://www.goldschmidt2012.org/)

2-6 July 2012. Eurosoil 2012 - Soil Science for the Benefit of Mankind and Environment, Bari, Italy. Website: [www.eurosoil2012.eu](http://www.eurosoil2012.eu)

11-15 July 2012. Euroscience Open Forum, Dublin, Ireland. Website: [www.dublinscience2012.ie](http://www.dublinscience2012.ie)

15- 20 July 2012. Geochemistry of Mineral Deposits, Andover NH USA. Website: <http://tinyurl.com/6mcan74>

15- 22 July 2012. 9th International Symposium of Environmental Geochemistry. Aveiro Portugal. Website: <http://9iseg.web.ua.pt>

28 July-2 August 2012. American Crystallographic Association (ACA) Annual Meeting. Boston MA USA. Website: <http://tinyurl.com/3dfn8lu>

29 July-2 August 2012. Microscopy and Microanalysis 2012. Phoenix AZ USA. Website: <http://tinyurl.com/428tyv6>

29 July-3 August 2012. Organic Geochemistry (Gordon Research Conference), Holderness NH USA. Website: <http://tinyurl.com/7k6mrme>

26-30 August 2012. 32nd International Geographical Congress: "Down to Earth". Cologne, Germany. Website: [www.igc2012.org](http://www.igc2012.org)

28 -30 August 2012. 2nd International Conference on Environmental Pollution and Remediation, Montreal QC Canada. Website: <http://icepr2012.international-aset.com/>

5-15 August 2012. 34th International Geological Congress, Brisbane Australia. Website: [www.34igc.org](http://www.34igc.org)

2-6 September 2012. 7th International Conference on Environmental Catalysis. Lyons France. Website: [www.conference-service.com/ICEC-2012/welcome.cgi](http://www.conference-service.com/ICEC-2012/welcome.cgi)

9- 13 September 2012. Planet Earth-from Core to Surface: First European Mineralogical Conference. Frankfurt Germany. Website: <http://emc2012.uni-frankfurt.de>

17- 20 September 2012. Geoanalysis 2012, Buzios Brazil. Website: [www.ige.unicamp.br/geoanalysis2012](http://www.ige.unicamp.br/geoanalysis2012)

1-4 October 2012. GeoHannover2012 "GeoResources in the 21st Century". Hannover, Germany. Website: [www.geohannover-2012.de](http://www.geohannover-2012.de)

4-7 November 2012. GSA 2012 Annual Meeting, Charlotte NC USA. Website: [www.geosociety.org/meetings/2012/](http://www.geosociety.org/meetings/2012/)

### 2013

18-21 November 2013. 26th International Applied Geochemistry Symposium, Rotorua, New Zealand. Website: [www.gns.cri.nz/iags](http://www.gns.cri.nz/iags)

Please let us know of your events by sending details to:  
**Steve Amor**  
*Geological Survey of Newfoundland and Labrador*  
P.O. Box 8700, St. John's NL Canada. A1B 4J6  
Email: [StephenAmor@gov.nl.ca](mailto:StephenAmor@gov.nl.ca)  
709-729-1161



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Student to Join!**



## **AAG Student Support Initiative**

### **In-kind Analytical Support for BSc (Hons), MSc and PhD Students**

In 2011, AAG began the process of implementing a coordinated program with analytical laboratories to provide In-Kind Student Support for applied geochemical research projects under the direction of AAG President Paul Morris. I am proud to announce that this program is officially underway. Laboratories have generously signed on to provide the In-Kind support in the form of laboratory analysis (see list of laboratories below that have signed up as of December 2011). The commitment by these laboratories is over \$35,000 in terms of analytical support. Additionally, AAG's Education Committee awarded its first applicant (Ms. Xin Du from University of Western Australia) with laboratory analyses that will be performed by Genalysis / Intertek in their Western Australia facility.

#### Investment in Applied Geochemistry

As an investment in the future, the AAG wishes to encourage and support students whose area of study is Applied Geochemistry. AAG believes that by identifying appropriate students, using a set of simple criteria, and coordinating with analytical laboratories that are willing to offer in-kind support in terms of geochemical analyses, high quality research and training in fundamental geochemical principles can result.

#### Today's students are tomorrow's clients

The Association of Applied Geochemists (AAG) invites analytical laboratories to participate in pairing their analytical facilities with student projects to develop emerging geochemists and their science.

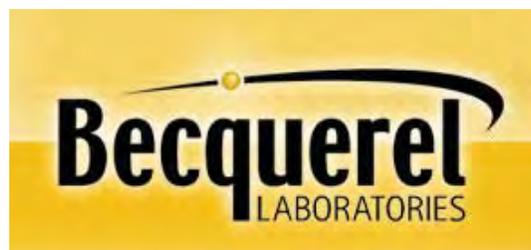
#### Laboratories Participating in the In-Kind Student Support Initiative

As of December 2011 AAG has enrolled four (4) analytical laboratories in this program:

- Becquerel Laboratories Inc., Mississauga, Ontario, Canada
- ALS Laboratory, North Vancouver, BC, Canada
- Genalysis / Intertek, Gosnells, Western Australia
- Ultratrace / Bureau Veritas, Canning Vale, Western Australia

If your laboratory or student is interested in being a part of this program, please contact the chair of AAG's Education Committee, Erick Weiland ([ErickWeiland@Terra-Technology.com](mailto:ErickWeiland@Terra-Technology.com) or [Erick\\_Weiland@fmi.com](mailto:Erick_Weiland@fmi.com)), who can provide you with details of this program. Student applications and instructions may also be found on the AAG web site: <http://www.appliedgeochemists.org/> student page under the In-Kind Student Support link.

**Erick Weiland**, Chair  
AAG Education Committee



## New AAG Members

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### Regular (non-voting) Members

Ms. Nadia Yavorskaya  
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Mr. Lars Dahlenborg  
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Mr. Craig J.R. Hart  
University of British Columbia  
Director  
Mineral Deposit Research Unit  
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Membership # 4081

Mr. Clyde A. Leys  
Round-mine Exploration Manager  
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Membership # 4082

## New AAG Members... *continued from page 18*

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Libertad 148  
Sector Manquimavida  
Chiguayante, Region del Bio Bio  
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Mr. Keith T. Grattan  
President  
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Mr. David A. Gratson  
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### Student Members

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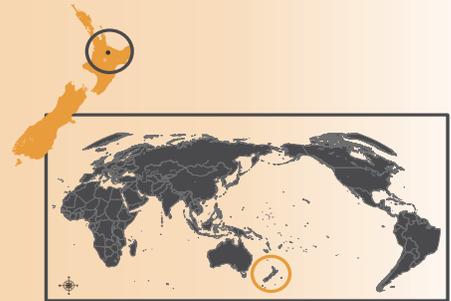
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# ioStipend



## ***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](http://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**



**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.

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|---|--|------|--------------|-------|
| 1 | 2012 member dues   | US\$ | 100          | _____ |
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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.

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**\*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

# EXPLORE

Newsletter No. 154

MARCH 2012

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EXPLORE is published quarterly by the Association of Applied Geochemists, P.O. Box 26099, 72 Robertson Road, Ottawa, ON Canada K2H 9R0.

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Type and layout of EXPLORE: Vivian Heggie, Heggie Enterprises, Thornton, CO (303) 288-6540; vjmheggie@comcast.net

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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.geolosc.org.uk/template.cfm?name=geea\\_instructions\\_for\\_authors](http://www.geolosc.org.uk/template.cfm?name=geea_instructions_for_authors)

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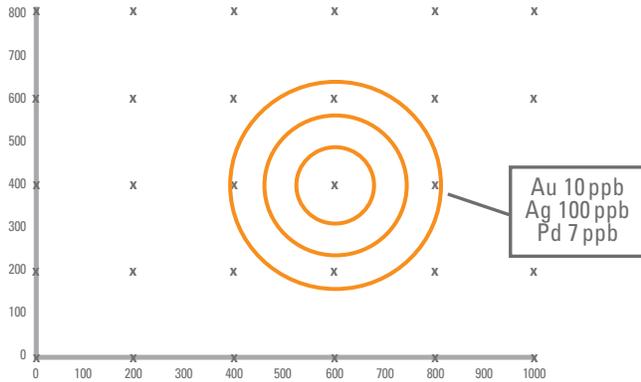
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