



25th International Applied Geochemistry Symposium 22-26 August 2011, Rovaniemi, Finland

The 25th IAGS was held in 22-26 August in 2011 in Rovaniemi, Finland. About 350 full registrations, 30 partners and 15 assistants, totally almost 400 people took part in the symposium. The importance of applied geochemistry was seen as a wide spectrum of 120 oral and 90 poster presentations, six keynote lectures, and the whole symposium programme. Technical sessions were supported by the seven field excursions and six workshops.

The organizers, The Finnish Association of Mining and Metallurgical Engineers, the Geological Survey of Finland and the University of Oulu together with the Rovaniemi-Lapland Congresses want to thank the Association of Applied Geochemists, all keynote speakers and participants, sponsors and exhibitors, and all the volunteers for making the symposium successful. It was our pleasure to have the symposium held in Rovaniemi, at the Arctic Circle, in the home town of Santa Claus. At the same time, we wish good luck to the organizers of the next 26th IAGS symposium in New Zealand in 2013. See you there!



Symposium publications, including field excursion guide books, workshop notes, and presentation abstracts, are available as electronic versions (pdf) on the subpage 'Technical Programme' http://www.iags2011.fi/technical_programme.htm

The photo slide show that was shown in the closing session shows conference events and atmosphere. http://www.iags2011.fi/IAGS2011_photos.pdf.

More photos are available on a separate password protected page. The password has been sent to all symposium participants by the conference office.

Reviews of some of the field excursions and preconference workshops are included in this issue of **EXPLORE**.

AAG Gold Medal awarded to Eion Cameron

AAG presents the Gold Medal for outstanding scientific contributions to the field of applied geochemistry, particularly *exploration* geochemistry, to Eion Cameron. Most of Eion's long and illustrious career has been spent at the Geological Survey of Canada (GSC) as both a research geochemist and as Head of the Applied Geochemistry Subdivision comprising some 32 scientists



Eion Cameron

and technical staff. A major emphasis of Eion's research has been on the development, testing and application of new and improved methods of detecting ore deposits both at surface and buried at depth. His accomplishments in this area are diverse. For example, he established lake sediment and water geochemistry as an effective mineral exploration tool in Canada's north. Back in 1972, Eion carried out the first regional-scale geochemical survey in Canada, sampling lake sediments and waters over 93,000 km² of the NWT in only six weeks using three helicopters and one float plane. Some of the discoveries, as a result, are the Yava and Hackett River VMS deposits. This survey paved the way for Canada's National Geochemical Reconnaissance Program. Still in the 1970s, he led the first GSC multi-disciplinary multi-agency project – *Uranium Exploration in the Athabasca Basin*.

Through his extensive research globally on the genesis of different deposit types, Eion has developed new rock geochemical techniques for locating lode gold, porphyry copper and VMS/SEDEX base metal deposits. Still on the subject of locating buried deposits, he developed the phrase *Deep Penetrating Geochemistry* while leading the well-sponsored CAMIRO project investigating partial extraction signatures of soils at surface 10s or even 100s of metres above



CAMIRO Deep Penetrating Geochemistry project team assembled by Eion: (left to right) Gwendy Hall, Eion, Beth McClenaghan, Stew Hamilton.

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AAG Gold Medal ... *continued from page 1*

mineralisation. One of his greatest talents, demonstrated so well in all the publications from this particular work, is his ability to analyse, unravel and describe, in fairly simple terms, processes of complex geochemical phenomena. Just read a few of his many papers (they number ~ 200). It's this clarity of thinking that enables him to design a sampling and analysis program that both ensures the fundamental questions will be answered and leads to the creation of new concepts.

Other areas where Eion has made major scientific advances are too numerous to mention but he is highly acclaimed for his ground-breaking research on the sulphur cycle during the Archean-Proterozoic transition, which is critical to our understanding of ocean and atmosphere evolution. This seminal research, published in journals such as *Nature*, is still quoted extensively today and forms the basis of recent research on the sulphur cycle employing other isotopes, particularly ³³S.

One of the key factors that has led to such success in Eion's research is his early recognition that one needs to

Notes from the Editor

The December 2011 issue of **EXPLORE** features highlights of the exciting 25th IAGS held in Rovaniemi, Finland in August. This issue also contains one short article by Patrice de Caritat that describes a new continental-scale geochemical atlas and dataset for Australia. This being the last issue of **EXPLORE** for 2011, I would like to thank all contributors to **EXPLORE** in 2011, all of whom are listed below: Steve Amor, Betty Arsenault, Neil Breward, Charles Butt, Heather Campbell, Tony Christie, Graham Closs, Dave Cohen, Patrice de Caritat, Bob Eppinger, Toni Eerola, Eric Grunsky, Gwendy Hall, Laura Lauri, Matt Leybourne, Paul Morris, Fardin Mousivand, Jan Peter, Jouni Pihlaja, Ebrahim Rastad, Scott Robinson, Jamil Sader, Pertti Sarala, Dave Smith, Michael Solomon, Michelle Trommelen, and Nicholas Turner. Sarah Lincoln (**EXPLORE** Business Manager) and I wish all AAG members a safe holiday season and a successful 2012.

Beth McClenaghan, *Editor*



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Eion's 'mobile' geochemical lab in use in the wilds of northern Ontario, Canada.

incorporate knowledge or technology from peripheral fields of study such as soil science, analytical chemistry, statistics, physics, oceanography and microbiology. One of his first actions after arriving at the GSC was to establish a state-of-the-art emission spectrometry laboratory. He fostered the growth of multivariate statistics there; in fact, he wrote one of the first widely available programs for Factor Analysis in the 1960s. As Head, he always encouraged the acquisition of and research in cutting-edge technology through cooperative projects with such innovative companies as Scintrex and Sciex.

Besides Eion's many scientific achievements, he has mentored 10 lucky graduate students at the University of Ottawa, is a founding member of the AAG (then AEG) and established the *Journal of Geochemical Exploration* where he served as Editor-in-Chief for 25 years. He has also given much of his time as AAG's Investment guru, protecting and amassing AAG funds during these troubled financial times.

On behalf of the AAG and the nominating committee of Wayne Goodfellow, Gerry Govett, Matt Leybourne, David Garnett and myself, we award Eion Cameron the AAG Gold Medal.

Gwendy Hall,
Emeritus Scientist, Geological Survey of Canada





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Sample 20	75	80	0.348	0.25	3.25	7	40	0.15
Sample 22	80	85	0.156	0.25	1.89	30	20	0.35
Sample 23	85	90	0.185	0.8	3.84	9	30	0.28
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President's Message

Paul Morris

I trust that you are all looking forward to 2012. The new year marks the beginning of Bob Eppinger's presidency of AAG, and I am sure he will bring the high level of professionalism he has demonstrated as vice-president to his new role. I have enjoyed the last two years as president of AAG. We now have a revised committee structure and some new initiatives to support potential members from developing countries and applied geochemistry students. Due to Eion Cameron's stewardship, AAG finances are in healthy shape and our membership remains stable.

The Rovaniemi IAGS was a great success, and has set the bar a little higher for future meetings. In Finland, Tony Christie provided an update to the organisation of the 26th IAGS to be held in New Zealand in 2013, and it looks as if the tradition of well-organised, scientifically-attractive symposia in scenic parts of the world will be continued. At the Rovaniemi meeting, there was some discussion about the venue for the 2015 meeting, but no resolution was reached. This is still the case at the time of writing this message (October, 2011).

There has been an informal 'rule' that the symposia alternate between hemispheres, and if this is followed, the 2015 meeting should be in the northern hemisphere. The key ingredients for a successful symposium seem to be a committed organising committee drawn from industry, government and academia, and a venue that suits field excursions and offers cultural and scenic interests, so if any of you live in such an area, and can get together a suitable group, please let Bob Eppinger or David Cohen know.

As you are all aware, AAG continues to thrive due to the commitment of its members, especially those who take on roles associated with running the Association. A subset of the latter are the 'old hands' who have been doing their jobs (often quite varied within AAG) for a number of years, and have accordingly not only served us all well, but also accrued a large amount of corporate knowledge, which is an invaluable asset in terms of guiding new members. In the past few years, we have been fortunate in recruiting some new council members from a younger demographic, and I am hopeful that many of these will hang around AAG and become new 'old hands' as the existing 'old hands' move on.

I would like to welcome six successful candidates who have recently been elected to AAG Council for 2012-2013, including two (Alejandro Arauz and Bill Burstow) who begin their first terms. The remaining four (Rob Bowell, Bruno Lemière, Ryan Noble and Todd Wakefield) begin their second terms as Councillors, and I thank them for their continuing commitment to the Association.

Paul Morris

AAG President

IAGS Workshop 3: Indicator mineral methods in mineral exploration

On August 21st I attended the 2011 IAGS Indicator Mineral Workshop in Rovaniemi, Finland. The workshop was hosted by Beth McClenaghan (Geological Survey of Canada), Vesa Peuraniemi (University of Oulu, Finland) and Marja Lehtonen (Geological Survey of Finland). The presentations were highly informative and demonstrated the advancements that have been made in indicator mineral applications for exploration of several mineral deposit types. Contributors highlighted many of the ways in which indicator minerals can be used, particularly in covered, glaciated terrains.

The application of indicator minerals for exploration of sulphide deposits was explained by a number of presenters. N. Moles showed that the chemistry of Au grains can assist in defining what type of deposit the grains are originating from. For example, inclusions within the gold grains can identify the sulphidation state of epithermal Au deposits. G. Beaudoin explained that geochemical signatures of indicator minerals in the ferromagnetic fraction can assist in vectoring to mineralization. Geochemistry of these grains can fingerprint the type of mineral deposit they are from and can be very useful in large regional scale sampling surveys. B. McClenaghan demonstrated that in order to identify indicators at this scale it is necessary to determine a suite of minerals that is robust and not susceptible weathering and erosion (i.e., chromite and Cr-corundum). The robust nature of some minerals allow them to be identified much farther down ice compared with till geochemistry, which was shown to often be useful only in close proximity to mineralization. Identification of a suite of minerals common to the deposit type being explored for is critical. In the case study of the Pebble Cu-Au porphyry deposit, R. Eppinger explained that a single indicator mineral such as Au may signify one of several different deposit styles. In Alaska there are many styles of Au mineralization. However, the additional presence of andradite and Mn-epidote can be highly indicative of a skarn or porphyry, and the presence of jarosite could be an indicator of supergene enrichment.

Several presentations were given on diamond exploration in eastern Finland and western Russia. Kimberlite indicator minerals (KIMs) in Devonian sandstones described by V. Hodireva were shown to have utility in diamond exploration. R. Kepezhinskis presented information suggesting that conventional indicator minerals should be augmented with ones that have diamond inclusions, and with indicator minerals such as corundum that have high Cr, Ni, Fe, and Ti. Like indicator minerals related to Au and sulphides, he stressed the value of the crystallographic appearance and degree of chemical alteration of the minerals. The case study presentation of diamond exploration in Karelia, northwest Russia given by V. Ushkov brought together many aspects of indicator minerals by touching on Quaternary geology, KIM grain mineralogy, and grain spatial distribution.

Identification of the most appropriate size fraction



IAGS Workshops ... *continued from page 5*

geochemical analysis (WS1), Risk assesment of metal contaminated sites (WS2), Indicator minerals in mineral exploration (WS3), Prospectivity mapping in GIS (WS4), and Geochemical exploration for orogenic gold deposits with emphasis on glaciated Precambrian terrain (WS5).

Nineteen geologist from several private mining and exploration companies from Finland, USA, Australia, Canada, Sweden, Russia, and UK attended the last workshop, that was hosted by Drs. Juhani Ojala from Store Norske Gull AS, and Pasi Eilu, and the Chairman of the Symposia, Pertti Sarala, both from the Geological Survey of Finland. All of the lecturers are active authorities in their fields.

The workshop started at 9 am by Dr. Ojala, who gave an overview of the orogenic gold deposit type, and other types of deposits in shield areas. His impressionant knowledge and experience from Australia and Fennoscandia were exposed in a flood of 100 slides, divided by the coffee break. Slides and topics run fast and for those not very familiar with Finnish geology and deposits some things may have remained somehow obscure, because the names of Finnish localities are not very easy for foreigners. Fortunately the issues related with Finland are presented in more detail by Ojala (2007).

Still during the morning, Dr. Eilu, also with experience from Australia and Finland, gave a dynamic and logic lecture on alteration of orogenic gold deposits. According with Groves et al. (1998), the majority of the orogenic gold deposits share the same characteristics. They are usually related with extense shear zones, association of mafic to ultramafic volcanic and sedimentary rocks, and diagnostic alteration zones. Therefore, the recognition of this alteration is essential when exploring such deposits. It forms a complete sequence from distal to proximal around shear zones that host the deposits. They are the hydrothermal signs left by the mineralized fluids. A complete receipt to approach such alteration zones was gave by Eilu.

After lunch, Dr. Sarala brought the participants from Precambrian to Quaternary. He presented an overview on surficial geological and geochemical exploration for gold in glaciated terrains. Speaking calmly and slowly, he gave the main topics covering the basic principles on glacial

geology and transport with special exploration methods for such conditions. Boulder tracing and till geochemistry have been widely used for long time in mineral exploration at Fennoscandia. The new interesting method is the weak leach of till. It has low sampling and analytical costs and low environmental impact. This is is very important, because it can be done within the concept of "restricted sampling", allowed by the Finnish Mining Act, when there is no need for a claim. However, what came clear, is that ice flow directions, till stratigraphy and moraine structure should be known before planning sampling, analysing till geochemistry and interpreting the results.

Participants received their slideshows as a printed publication (Eilu et al. 2011), by which it was easy to follow the lectures and make notes.

At the end of the workshop, a collection of ore and alteration samples from Australia and Finland were exposed on tables, and a checking of their characteristics and meaning were conducted interactively by Dr. Eilu. It was also accompanied by notes on hand specimen display (Eilu 2011).

Australia and Finland seems to have a tight connection despite the distance, and so different climates. The countries have a long and strong relationship in the field of mineral exploration. Many Finnish geologist have made their post-graduate thesis on gold exploration there (e.g. Ojala and Eilu), having acquired positions of specialists in Finland, and today, many of the foreign companies operating in Finland are Australian. There is also frequent cooperation between Australian and Finnish geoscientific institutions and companies. This was also clearly seen in the workshop.

Surely one can have better things to do on a Sunday than listen to lectures on geochemistry. But when the workshop ended, participants came out from the underground to the fresh air of the still warm afternoon enlightened by the sun, satisfied and more wise to proceed with gold exploration at Fennoscandia than when they entered there. They certainly did not regretted the lost of that Sunday for geochemistry. The application of the learnt lessons would be probably seen in their further field work soon after, may be already before the hemisphere is covered by snow and darkness.

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IAGS Field Excursions

IAGS Field Excursion 1: Active and ongoing gold exploration and mining in northern Finland, August 18-20, 2011

Participants from ten countries headed to far northern Finland for a three day excursion to look over a number of gold shows, armed with an excellent excursion guide and expert commentary from our tour leaders, Pasi Eilu and Vesa Nykänen. The various Au deposits visited are hosted by the Protopalaeozoic Central Lapland Greenstone Belt and Peräpohja Schist Belt. First stop was the altered komatiitic sequence-hosted Pahtavaara Au deposit to view the pit and core. After lunch we went on to the small Mustajärvi regolith deposit that was discovered during regional reconnaissance geochemical surveys by the GTK. The weathered zone extends down a number of metres in some areas, especially at major structural intersections, emphasizing that saprolite can survive an extensive glaciation.



Field trip participants at the edge of the Pahtavaara Mine pit. Excursion leaders Vesa Nykänen and Pasi Eilu, second and fourth from the left, respectively.

The second day began at the large Kittilä Au Mine which is Europe's largest Au mine and contains a resource of 6 Moz. The deposit was discovered by GTK following geophysical and till geochemical surveys along the Kiistala Shear Zone. The Au is refractory and bound up in arsenopyrite and arsenian pyrite. Following lunch at the mine we continued on to the Hanhima prospect where Au mineralisation is hosted by metavolcanic and metasedimentary units within the Hanhima Shear. The vegetation delivered a range of berries for us to biogeochemically test while examining the geology in the shallow trenches.

The final day was devoted to clambering around the Rompas Au-U prospect which is at an early stage of exploration. The squeal from the Geiger counter, the large gold nuggets and reported outcrop channel samples containing over 1% Au grades at some outcrops were enough to excite the party (and cause us to take a few steps back from the more U-rich outcrops). We were certainly warned that any attempt to fly home with samples from this prospect would result in potentially unwanted attention at customs and immigration.

Both nights were spent at the resort town of Levi in northern Lapland. The venue provided excellent opportunity for early morning walks (or runs) for those of us still adjusting to the time zone and the 20 hours of daylight. Those of us who have not visited the region before were struck by the similarities in terrain, fauna and flora to northern Canada – and the challenges for exploration that such an environment presents.



Reindeer at the summit of the Levi ski resort.

We would like to thank the following for guiding us through the various field locations and their companies for allowing access: Risto Virkkunen (Pahtavaara Au mine; Lapland Goldminers), Harri Siitonen (Mustajärvi regolith Au project; Gold Mine Siitonen & Saiho), Jyrki Korteniemi (Agnico-Eagle Kittilä Au mine); Pentti Grönholm (Hanhimaa gold project; Polar Mining) and Erkki Vanhanen (Rompas Au-U project; Mawson Resources)

David Cohen, on behalf of the participants
University of New South Wales



IAGS Field Excursion 5: Geochemical and indicator mineral exploration methods and ongoing projects in the glaciated terrains in Northern Finland, 26-30 August 2011

Not content with being co-Chairmen of the Symposium Committee, Pertti Sarala and Juhani Ojala also took on the not inconsiderable task of leading this post-Symposium excursion to Northern Lapland. Nearly 30 delegates from 8 countries were treated to a 4 day technical and cultural tour, with a few adventures on the way. We commenced at the Geological Survey of Finland office in Rovaniemi with a demonstration of the Mine On-Line Services Oy truck-mounted core scanner, which provides digital images and XRF analyses of drill core. Not only can this instrument

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IAGS Field Excursions ... continued from page 7



Pertti Sarala at an outcrop of deeply weathered bedrock (saprolite) beneath clay-rich till, Vuotsu, Finland (photo Charles Butt)

produce analyses while you wait, when placed in reverse, it miraculously turns core into cans of beer – still in the trays of course. Thereafter, much of the excursion was devoted to aspects of glacial geology, and the mineralogical and geochemical expression of buried mineralization in glacial overburden. We visited Agnico-Eagle's Kittilä mine, the largest gold mine in Western Europe, First Quantum's new Kevitsa Ni-PGE Cu-Au mine and several other geological sites and prospects, including the Ravnnaluhppu Cu-Au occurrence near Karasjok in Norway, about 325 km north of Rovaniemi. Each of these illustrated challenges facing exploration in the region: not only the technical issues posed by the ever-present glacial overburden, but others such as access (pine and birch forests, boggy ground) and competing land-use (reindeer herding, tourism), not to mention mosquitoes in the summer and darkness, cold and snow in the winter. Even where the glacial overburden is thin (<5 m), the need to understand its geology was shown to be paramount for successful geochemical exploration. Lateral dispersion of a few tens of metres from sub-cropping mineralization seems common in the lower till units. However, such anomalies are generally absent from later overlying deposits, especially those related to retreat phases and deglaciation, requiring careful sample selection. Of particular interest is the apparently widespread preservation of a deeply weathered residual regolith beneath the glacial deposits. This possibly dates from the early Tertiary, when much warmer conditions prevailed across northern Europe, although older dates have also been proposed. The preservation of this regolith implies that the region must have been close to the ice divide during each phase of the last glaciation, thus resulting in little erosion. In places, its presence is indicated by the till being unusually clay-rich.

From my own experience, no excursion is trouble free, and this was no exception. A bus breakdown in the rain disrupted the second day, but our imperturbable hosts again demonstrated their organizational abilities by providing shelter and an *ad hoc* barbecue, whilst finding alternative transport. By re-arranging the timetable, they also managed for us to visit all of the sites planned on the itinerary. These included an introduction to the history and culture of Lapland, with visits to the Tankavaara gold village, which gave an insight into the quest for gold in the region, and to Siida, the Sámi Museum and Northern Lapland Nature Centre at Inari. This is a national museum which portrays the spiritual and material lives of the Finnish Sámi people, set within the context of the cycle of the seasons, the demands of survival under extreme conditions and their interactions with other nations. And of course, there was the ritual of the sauna, enjoyed by some in their cabins and by others in the communal saunas of the hotel. On the final night, there was also a traditional smoke sauna, but your correspondent did not participate, being somewhat averse to overheating his slender frame and then plunging it into cold stream water. This was followed by an excellent dinner – though without reindeer on the menu – and my fellow participants even endured an impromptu presentation on gold nuggets and related topics without becoming too restless. Overall, it was a most enjoyable and instructive excursion, with a good balance of technical visits, each excellently documented, and an introduction to a land and people that invites a return in the future, either as a geochemist or as a tourist. Thanks not only to Pertti and Juhani, but to their colleagues in the Geological Survey of

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IAGS Field Excursions ... continued from page 9



Tour group at the Ravnnaluhppu Cu-Au occurrence near Karasjok, Norway (photo Pertti Sarala).

Finland and Store Norsk Gull AS for their assistance in the field, and to our guides Leena Rajavuori and Jussi Niemelä at Kittilä and Frank Santaguida and Janne Siikaluoma at Kevitsa.

Charles Butt

CSIRO Earth Science and Resource Engineering, Western Australia



IAGS Field Excursion 7: Geochemistry in Khibiny mountains and Monchegorsk, Kola Peninsula, Russia, August 27-31, 2011

The excursion to the ore deposits of the Kola Peninsula, led by Yury Voytehovsky and Jouni Pihlaja, started from Rovaniemi on 27th of August by a 10-hour bus trip to the town of Apatity in Russia. The multi-national geoscientist group consisted of representatives from Finland, Canada, Japan, England and Australia. The official program started the next day with a workshop hosted by the Geological Institute of the Kola Science Center, Russian Academy of Science. The director Yuri L. Voytekhovskiy introduced the institute and told about the recent gold exploration projects in the Kola Peninsula. Dr. Andrey A. Arzamastsev gave a presentation on the petrology and geochemistry of the Khibiny alkaline massif. The workshop was concluded by Dr. Tamara B. Bayanova with a talk on the isotope geochemistry and geochronology of the Kola Peninsula. After the workshop

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IAGS Field Excursions ... *continued from page 9*

the group had a chance to visit the museum and mineral collection of the institute. The collection comprises samples from the various ore deposits of the Kola Peninsula, including many rare and exotic minerals originally discovered from the area.

On Monday the group, guided by Mr. Arkady K. Shpachenko from the Geological Institute, was taken to see the Khibiny alkaline complex. The morning was spent at the Koashva open pit in the southern part of the massif, where apatite ore has been mined since 1978. The ore is present as up to 300 m thick lens-shaped bodies that grade into the surrounding ijolite-urtite. The excursion group had an excellent opportunity to collect rare mineral samples from the ore pile waiting to be transported to the processing plant.

In the afternoon Arkady took the group to the heart of the Khibiny Mountains behind the town of Kirovsk. The four-hour walk went past the ruins of an old Soviet time geologists' field base all the way to the foot of the Mount Takhtarvumchorr, where phonolite dikes cross-cut the foyaitic rocks of the Khibiny complex. The marginal parts of the phonolite dikes display an unusual cellular-zoned texture.

Tuesday was spent at the Monchegorsk area with Mr. Pavel V. Pripachkin from the Geological Institute acting as

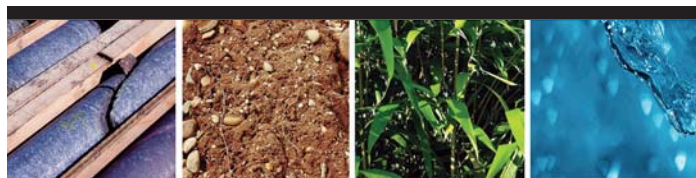


The excursion group at the Koashva apatite mine. Photo: JP Hunt.

a guide. The focus of the day was to see the early Paleoproterozoic layered complexes that are a prominent geological feature with high ore potential in the northern Fennoscandian Shield. On the way to Monchegorsk Mr. George A. Fedotov briefly introduced the Imandra layered complex and showed some outcrops with chromite layers at the marginal part of the complex. At Monchegorsk the comfortable excursion bus was exchanged to a Russian all-terrain vehicle, which took the group to the Nud Mountain to see the critical zone of the Monchepluton layered complex. PGE mineralization is found in several stratigraphic levels of the complex. The group visited the "Terrace" deposit, which consists of a breccia zone and mafic pegmatites and the "Vurechuaivench" prospect, which is found within gabbro-noritic rocks.

On Wednesday it was time to say good bye to the beautiful Khibiny Mountains. The excursion group returned to Rovaniemi with good memories and abundant samples. Many thanks to the IAGS organization and the Kola Science Center for arranging the field trip!

Laura S. Lauri and Jouni Pihlaja,
Geological Survey of Finland GTK



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AAG Member News

25-Oct-2011: John Hansuld, a founding member of the Association, its second President, and the first journal business editor, is a 2012 inductee to the Canadian Mining Hall of Fame.

John began his career as a geochemist, but quickly transitioned into a business leader and entrepreneur. Most significantly for the Association, he established the Journal of Geochemical Exploration as a financially viable entity at an early time in the history of the Association and he was instrumental in founding the Newsletter, which then evolved into one of our key assets, **EXPLORE**.



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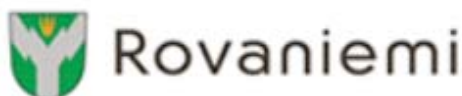
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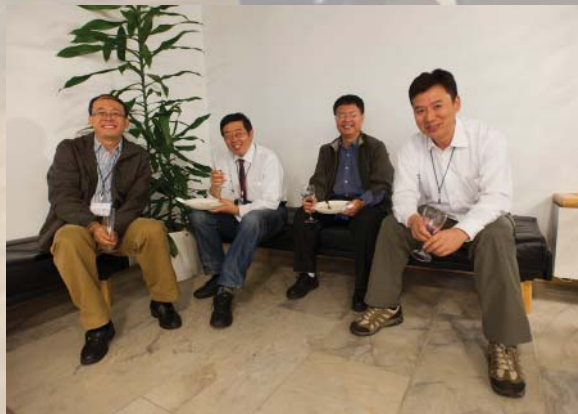


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2011 STUDENT PAPER PRIZE JOHN KOZUSKANICH

The Association of Applied Geochemists and SGS are pleased to announce John Kozuskanich as the winner of the 2010 Student Paper Prize. This prize is awarded for the best paper published in *Geochemistry: Exploration, Environment, Analysis (GEEA)* by a student, on work performed as a student and published within three years of graduation, which addresses an aspect of exploration geochemistry or environmental geochemistry related to the mining industry. His winning paper is based on research that John undertook for his PhD at Queen's University, Kingston, Canada.

His award-winning paper is entitled 'Dendrochemical variation over the Cross Lake VMS mineralization – a tool for mineral exploration and decoupling anthropogenic input from background signals' which was published in 2009 in *Geochemistry: Exploration Environment Analysis*, 9:151–157, and was co-authored by Kurt Kyser, William MacFarlane and Stewart Hamilton. The abstract of the paper is:

"Dendrochemistry is the study of chemical constituents in tree rings. Dendrochemistry in mineral exploration can provide the fourth dimension of time not afforded by other sampling media, thereby potentially decoupling anthropo-

genic input from ore-derived and background signals. In this study, black spruce trees were cored on their south and west facings along a transect line intersecting volcanic hosted massive mineralization buried beneath 50 m of glacial till at Cross Lake near Timmins, Ontario in Canada. This area is NE and downwind from the Falconbridge Cu-Ni smelter which began operation in 1972. Tree rings were counted and 5-year segments representing pre- and syn-smelter conditions were analysed using a high-resolution inductively coupled plasma mass spectrometer. Results show that Cu, Zn, S, As and Mg are highly anomalous in both pre- and syn-smelter samples from trees over the mineralization, whereas other metals, such as Pb, Mn, and Ni, do not show the same response to mineralization, and are more influenced by bed-rock lithologies and overlying sediments. Metal concentration trends are similar between the south and west facings of the trees, although the south samples are typically better for delineating the mineralization. A tree selected to represent nonmineralized background values shows increases in most of the metals in post-1960 tree rings, indicating that the Falconbridge smelter and mining activities have increased some metal contents of the surrounding soil. The results demonstrate that black spruce tree cores are useful for detecting metal anomalies from buried VMS mineralization under glacial till."

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Student Paper Prize... *continued from page 14*

John receives a \$1000 cash prize from SGS, a two-year membership of the Association of Applied Geochemists, together with our journal, *Geochemistry: Exploration, Environment, Analysis and newsletter, EXPLORE*, and a certificate of recognition.

The Association of Applied Geochemists would like to thank SGS for, once again, generously supporting this prize. The 2011-2012 competition is now open. Papers must have been published (or accepted for publication) in *GEEA*.

D.R. Cohen

Chair, AAG Student Paper Competition Committee



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

2012

23-26 January 2012. Mineral Exploration Roundup 2012. Vancouver BC Canada. Website: <http://tinyurl.com/3k9tqgb>

6-11 February 2012. 10th International Kimberlite Conference, Bangalore India. Website: <http://10ikbangalore.com>

6-8 February 2012. First International Conference on Environmental Challenges in Arid Regions, Jeddah, Saudi Arabia. Website: <http://tinyurl.com/5v8uaha>

20- 24 February 2012. Ocean Sciences Meeting, Salt Lake City, UT, USA. Website: www.sgmeet.com/osm2012/

24- 26 February 2012. 5th Cordilleran Tectonics/Metallogeny Workshop, Victoria BC, Canada. Contact JoAnne.Nelson@gov.bc.ca

4-7 March 2012. XIV EMPG (Experimental Mineralogy, Petrology and Geochemistry) Meeting, Kiel, Germany Website: www.empg2012.uni-kiel.de/

4-7 March 2012. Prospectors and Developers Association of Canada Annual Convention. Toronto ON Canada. Website: www.pdac.ca/pdac/conv/

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>

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

28 May-1 Jun 2012. Environmental Science and Technology, Mar del Plata, Argentina. Website: 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/

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

24-29 June 2012. Goldschmidt 2012. Montréal QC Canada. Website: www.goldschmidt2012.org/

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

11-15 July 2012. Euroscience Open Forum, Dublin, Ireland. Website: www.dublinscience2012.ie

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>

26-30 August 2012. 32nd International Geographical Congress: "Down to Earth". Cologne, Germany. Website: 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

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

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

2013

18-21 November 2013. 26th International Applied Geochemistry Symposium, Rotorua, New Zealand. Website: 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

709-729-1161



Obituary

Prof. Leevi Kalevi Kauranne (1927-2011)



Prof. Leevi Kalevi Kauranne (1927-2011) was a distinguished Finnish geologist and in the frontier of the geochemical exploration. In the beginning of his career, during 1950s, the focus of his research was in developing till geochemical exploration, new innovative method in glaciated terrains. He started his geochemistry research by studying the mineral dispersion, geochemistry and composition of till in the Outokumpu area. In 1970, his doctoral thesis dealt with the problems concerning the durability of stone materials used in road construction.

At the Outokumpu mine, he started as a research assistant and finally worked as a mine geologist (1949-1950). In 1952, he got a position at the Geological Survey of Finland (GTK). After that he worked as a geologist and the head of the central laboratory in the National Board of Roads and Waterways (1960-1967), and an assistant professor at the Tampere Technical University. An important advance in his career happened in 1973, when he started to work as head of the new geochemistry department at GTK (1973-1978). Since then he was the research director (1978-1979) and finally general director (1980-1991) of GTK before retiring in 1991.

Prof. Kauranne worked in several countries: in 1954 and 1958 as geochemist in Norway, in 1963 representative of the United Nations in Togo and in 1983 representative of the Asian Bank on the Philippines. He was active in many international societies; a member of the Finnish Academy of Sciences, a member of the Board of International Geological Correlation Programme at UNESCO/IUGS, an honorary member of the Finnish Geological Engineering Society and the Estonian Geological Society, and an honorary doctor of Uppsala University. He had also many confidential posts in scientific societies in Finland.

Kauranne was an author of about 150 research papers and reports, and an editor of several scientific publications. He was one of the editors of a text-book on engineering geology and the handbook of exploration geochemistry; *Regolith Exploration Geochemistry in Arctic and Temperate Terrains* published by Elsevier. His papers and publications are still commonly cited in modern scientific papers.

Prof. Kauranne was awarded in 1991 by the Oskari Vilamo Foundation (engineering) and in 2011 by the Eero Mäkinen bronze medal to honor his contribution to the Finnish exploration and mining industry.

Pertti Sarala

Geological Survey of Finland

Continental geochemical survey opens up fresh avenues for mineral exploration and natural resource management in Australia

A new continental-scale geochemical atlas and dataset for Australia were officially released into the public domain at the end of June 2011. The National Geochemical Survey of Australia (NGSA) project, which started in 2007 under the Australian Government's Onshore Energy Security Program at Geoscience Australia, aimed at filling a huge knowledge gap relating to the geochemical composition of surface and near-surface materials in Australia. Better understanding the concentration levels and spatial distributions of chemical elements in the regolith has profound implications for energy and mineral exploration, as well as for natural resource management.

In this world first project, a uniform regolith medium was sampled at an ultra-low density over nearly the entire continent, and subsamples from two depths and two grain-size fractions were analysed using up to three different (total, strong and weak) chemical digestions. This procedure yielded an internally consistent and comprehensive geochemical dataset for 68 chemical elements (plus additional bulk properties). From its inception, the emphasis of the project has been on quality control and documentation of procedures and results, and this has resulted in eight reports (including an atlas containing over 500 geochemical maps) and a large geochemical dataset representing the significant deliverables of this ambitious and innovative project. The NGSA project was carried out in collaboration with the geoscience agencies from every State and the Northern Territory under National Geoscience Agreements.

Technicalities

From 2007 to 2009, the National Geochemical Survey of Australia (NGSA) project collected sediment samples from 1315 sites located in 1186 catchments (~10 % of which were sampled in duplicate) from across Australia. The total area covered by the survey is 6.174 million km², or ~81% of Australia. The resulting average sampling density is 1 site per ~5200 km².

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Continental geochemical survey...

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Figure 1. Helicopter access was required at a number of remote sites accessed by the NGS field teams between 2007 and 2009 (Photo: Joseph Tang, Geological Survey of Queensland).

Catchment outlet sediments, in most cases similar to overbank sediments, were chosen as the sampling medium, with a near-surface sample (Top Outlet Sediment, TOS, from 0-10 cm below the surface) and a bottom sample (Bottom Outlet Sediment, BOS, between on average 60-80 cm below the surface) being collected at each site. In order to minimise the effect of natural sort-scale compositional variability of soils, the TOS sample was collected from material mixed from a ~ 1 m² shallow (10 cm) pit, and the BOS sample was a composite of material originating from generally three or more auger holes drilled within a 100 m² area. The sample sites were selected to be near outlets or spill points of large catchments, so that overbank sediments there could reasonably be assumed to represent well-mixed, fine-grained composite samples of all major rock and soil types present in the catchment. Finally, sampling sites were selected to be well away (and preferably upstream) from major human activities or infrastructure, such as mines, urbanisation, or roads, in order to provide background, i.e., as devoid of human influence as practically possible, chemical compositions.

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A number of parameters were recorded in the field, including GPS coordinates, and dry and moist Munsell® colour and field pH of the soil. The sampling sites were described and photographed, with all field data captured digitally for easy subsequent upload into databases. In the laboratory, the samples were air-dried, homogenised and split into an archive sample for future investigations and an analytical sample for immediate analysis. The latter was further split into a bulk subsample, a dry-sieved <2 mm grain size fraction subsample and a dry-sieved <75 μ m grain size fraction subsample. The bulk subsample was analysed for electrical conductivity of 1:5 (soil:water) slurries (EC1:5), pH of 1:5 (soil:water) slurries (pH1:5) and grain size analysis using a laser particle size analyser.



Figure 2. Auger holes drilled to collect BOS samples at a site in the Northern Territory. Note that several auger holes were sampled at each site and combined into the BOS samples to minimise the effect of natural local compositional variability (Photo: Andrew Wygralak, Northern Territory Geological Survey).

During 2009 to 2010, the coarse (<2 mm) and fine (<75 μ m) fractions were analysed using a variety of analytical methods to determine (1) Total element content, (2) Aqua Regia soluble element content, and (3) Mobile Metal Ion (MMI™) element content (the latter done only on the TOS coarse subsamples). Total element content was determined using a combination of X-Ray Fluorescence (XRF) on fused beads made with lithium borate flux, Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) after total digestion of XRF bead fragments in hydrofluoric and nitric acids (both for determining multiple elements); Fire Assay (FA) for Platinum Group Elements (PGEs) gold, platinum and palladium; Ion Specific Electrode (ISE) after alkaline fusion for fluoride; and hydrochloric and nitric acids digestion followed by ICP-MS analysis for selenium. Gold concentrations were also determined after Aqua Regia and MMI digestion.

A total of 68 chemical elements were determined by at least one of the above methods, including low level gold, platinum and palladium, and rare earth elements (all 14

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Continental geochemical survey...

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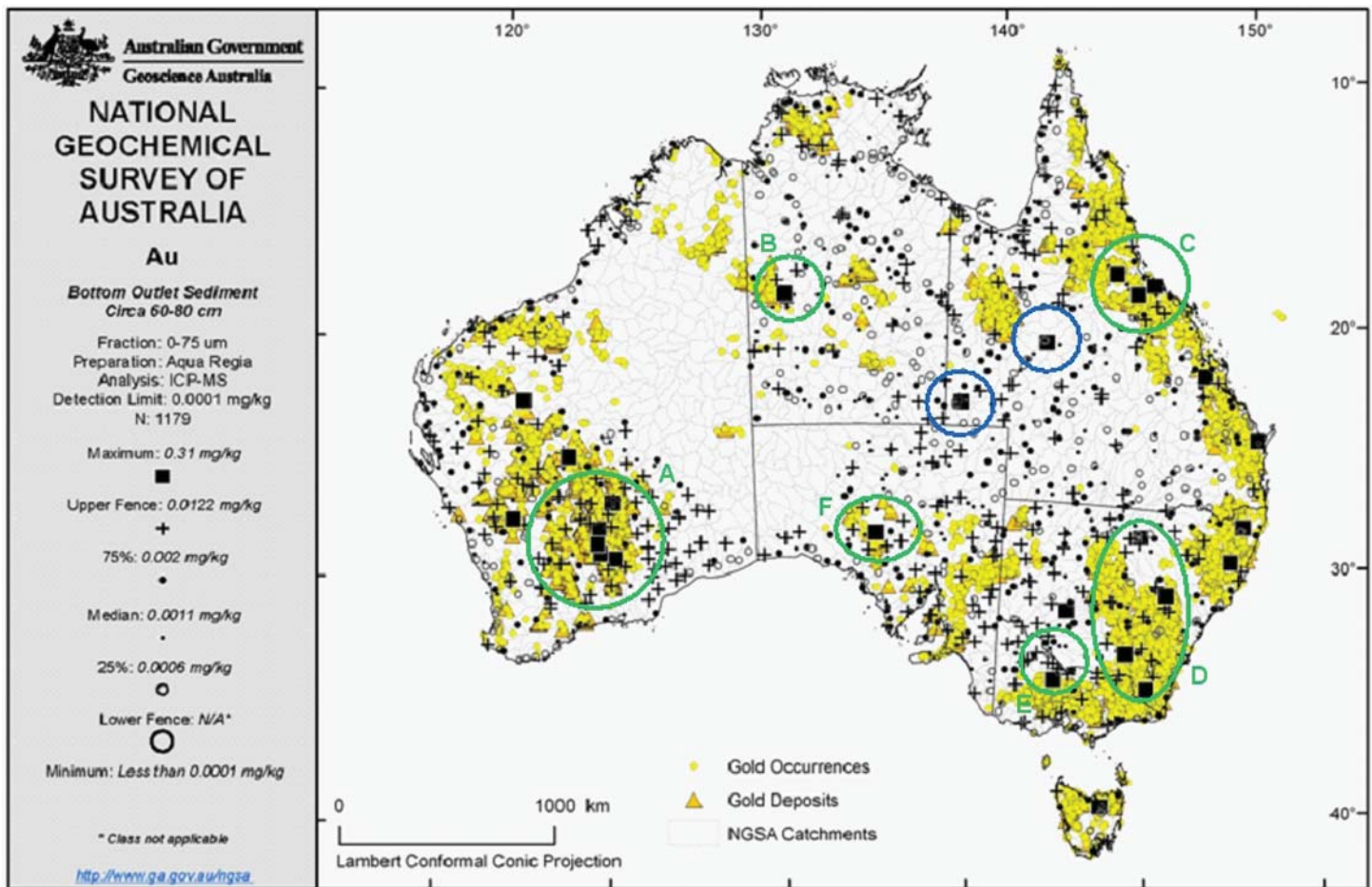


Figure 3. Distribution of gold concentrations determined by the NGSa project in BOS fine samples after aqua regia digestion (solid and open black symbols as per scale on left side of map), overlain on known gold occurrences (grey dots) and deposits (grey triangles). Ellipses marked "A" to "F" illustrate the coincidence of elevated geochemical concentration in catchments with known gold occurrences and/or deposits. Unmarked ellipses are examples of elevated aqua regia gold values in areas with no known gold occurrences and deposits.

stable lanthanides plus scandium and yttrium). Thus, with two depths sampled, two grain size fractions separated, and three analytical methods applied, up to nine concentration determinations were obtained for any given element at each sampling site. These geochemical data plus the bulk properties were collated in a 700,000+ cell spreadsheet and graphically represented as a series of maps. The latter is available in a geochemical atlas (Caritat & Cooper, 2011) downloadable from the project website (www.ga.gov.au/ngsa).

The geochemical atlas (Caritat & Cooper, 2011) is a compilation of 529 geochemical maps from the NGSa project. These constitute the first continental-scale series of geochemical maps based on internally consistent, state-of-the-art data pertaining to the same sampling medium collected, prepared and analysed in a uniform and well documented manner and over a relatively short time period (four years).

Applications

The maps and data delivered by the NGSa project have significant potential to aid reducing risk in energy and

mineral exploration in Australia when used in conjunction with other geoscience datasets and tools. A preliminary investigation (Caritat *et al.* 2011) suggests that many of today's known deposits and occurrences for energy related elements (uranium and thorium) as well as common metal (e.g., gold, copper, lead, zinc) and rare earth element (e.g., cerium) commodities are located in catchments with elevated concentrations in these elements as revealed by NGSa results. Additionally, and encouragingly, several catchments with no known deposits and occurrences can easily be identified as anomalous above local background and are obvious places to focus more detailed follow-up exploration effort. Initial feedback from the industry suggests that some of these areas indeed hold promise for future discovery.

The radiometric map of uranium (Minty *et al.* 2010) could also gain from NGSa results because for the first time we have available a nation-wide sample base that can be used to ground-truth the radiometric data. NGSa results indicate that airborne based uranium equivalent concentrations (eU) are generally lower than the geochemically determined uranium concentrations. The eU values are estimated from

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Continental geochemical survey...

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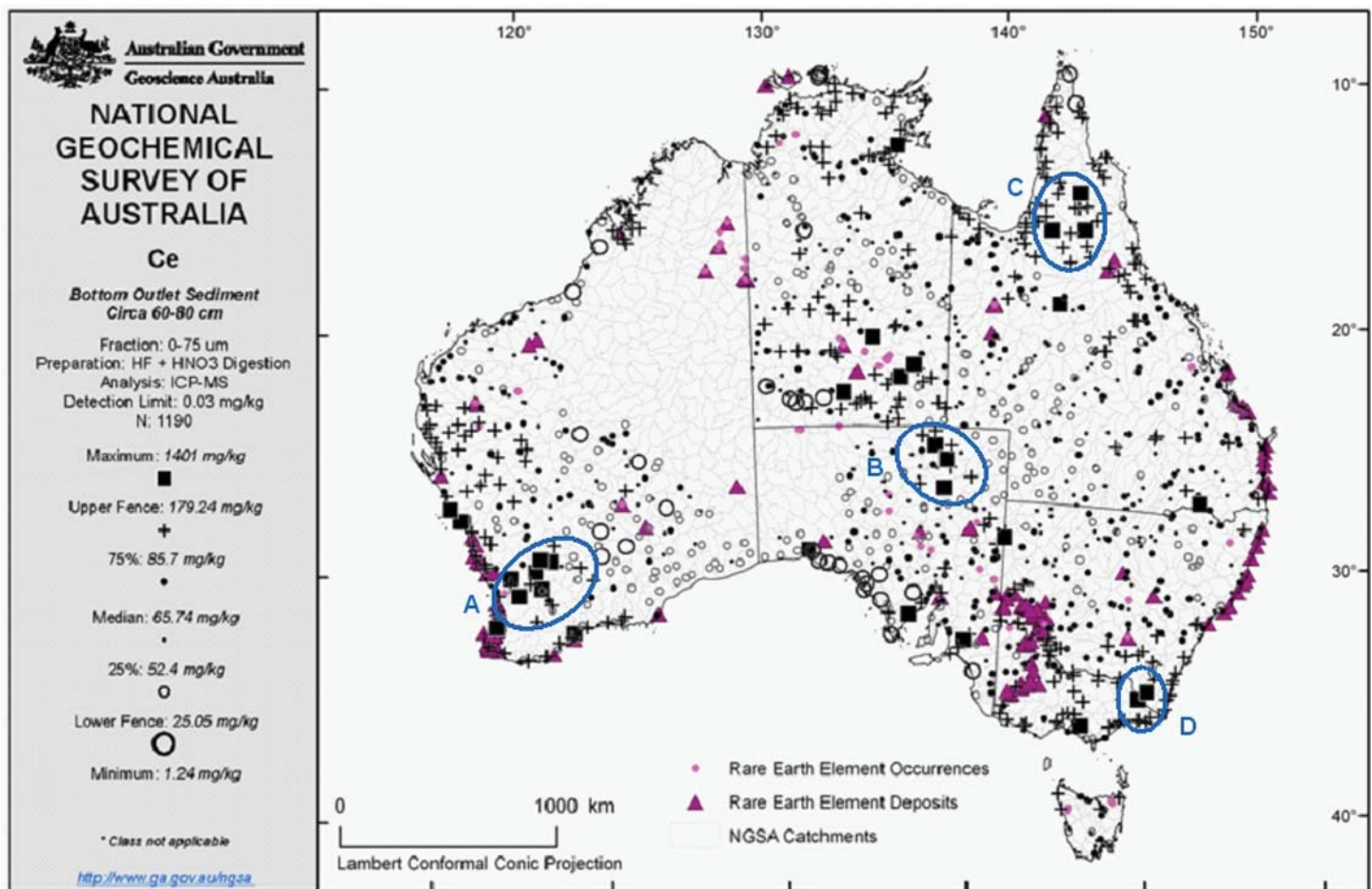


Figure 4. Distribution of cerium concentrations determined by the NGS project in BOS fine samples (solid and open black symbols as per scale on left side of map), overlain on known REEs occurrences (grey dots) and deposits (grey triangles). Ellipses marked "A" to "D" are examples of elevated cerium values in areas with no known REEs occurrences and deposits.

the gamma radiation emitted by bismuth-214, assuming equilibrium in the uranium decay chain above that isotope. It is known, however, that this decay chain can be plagued with disequilibrium problems whereby one or several of the daughter products (e.g., radium or radon isotopes) can be mobilised away, or accumulate into particular landscape and regolith settings. This can render the eU values unreliable or noisy. Based on the NGS data, calculation of a correction factor for uranium distribution is under way (Wilford *et al.* 2011).

Another field of application for the NGS data is in the environmental disciplines, where the wide spatial coverage and comprehensive geochemical element database will enable better decision making relating to landuse decisions, geohealth (i.e., identifying areas where potential excesses or deficiencies of nutrients or toxicants in soils may be expected), dust source fingerprinting and the shaping of knowledge-based soil management strategies, to name a few.

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Geoscience Australia

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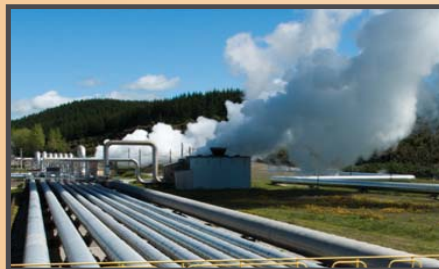


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David Lawie, John Gravel



Association of Applied Geochemists
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EXPLORE

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September newsletter: July 15

December newsletter: October 15

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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.

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Submissions should be sent to:

Beth McClenaghan, Geological Survey of Canada, 601 Booth Street, Ottawa, ON, CANADA K1A 0E8 Email: bmcclena@nrca.gc.ca

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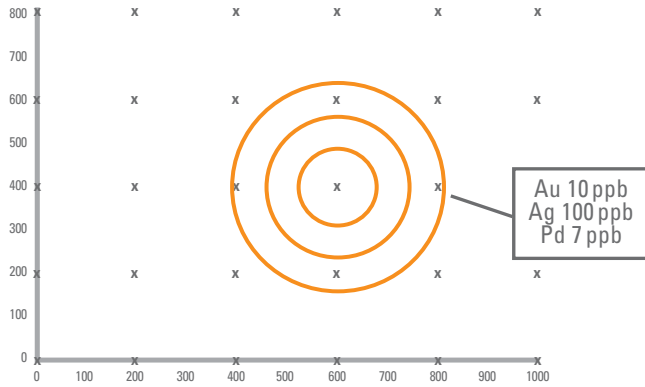
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