



## The SGS Mineral Services–AAG Student Paper Prize

David Cohen, Student Paper Prize Committee

The SGS Mineral Services–Association of Applied Geochemists prize for the best paper published in *Geochemistry: Exploration, Environment, Analysis* (GEEA) 2013/2014 was awarded to **Farhad Kaveh** for a paper entitled “**Direct analysis of soils by ETV-ICP-AES: a powerful tool for mineral exploration**”, based on his thesis research at Queen’s University, Kingston, Canada. It was co-authored with Christopher Oates and Diane Beauchemin and was published in 2013 in GEEA (v. 14, no. 4, p. 305-313). The research examined the geochemical response of soil samples to underlying mineralisation at the Talbot Lake VMS Cu-Zn prospect in Manitoba using electrothermal vapourization and element analysis by ICP-AES and compared the results with the more conventional aqua regia digestion ICP-MS. The winner receives \$1000 from SGS Mineral Services, \$500 towards conference attendance from AAG, and two years membership of the AAG.

### Abstract:

*A fast method for the direct analysis of soils, namely solid sampling (SS) electrothermal vapourization inductively coupled plasma atomic emission spectrometry (ETV-ICP-AES), was validated through the accurate analysis of a soil standard reference material (SRM) using another soil SRM as a calibration standard and an Ar emission line as internal standard to compensate for sample loading effects on the plasma. Good agreement was obtained between the measured concentrations and certified values according to a Student’s t-test. The validated method was applied to the determination of the distribution of elements in depth profile soil samples from across the Talbot Lake VMS Cu-Zn prospect, in the Flin Flon-Snow Lake terrane, Manitoba, Canada. These profiles revealed that: Zn, P and Ag had anomalously high concentrations at 20–50 cm depth at 400 m, above where the easternmost part of the ore deposit is located along a 0–1000 m sampling line; Cu, Al, Ba, Pb and Hg were concentrated on the surface and at 40-cm depth mostly between 500 and 600 m; and Cl, Br and I were concentrated at depth at 400 m and over all depths at 600 m. As the geochemical anomaly is known to lie from 400 to 600 m, all these elements could be used to locate the ore. Good agreement was obtained with results by ICP mass spectrometry (ICP-MS) following aqua regia (AR) digestion, for those elements that could be determined by ICP-MS. In fact, not only is sample dissolution unnecessary but qualitative analysis by SS-ETV-ICP-AES is sufficient to obtain depth profiles, including for elements like Cl, which cannot be determined when AR is used for digestion.*

## Symposium Report: 27th International Applied Geochemistry Symposium April 18 - 24, 2015; Tucson, Arizona, USA

The 2015 AAG 27th IAGS is now complete and can be considered a professional and technical success based on the excellent technical presentations, well attended short courses, and unique field trips, but unfortunately not a financial success due to the state of both mining and oil industries. IAGS registration was 200+ professionals, 34 students, and 25 guests. From the table below, one can observe the diversity of the country of origin for attendees. Unfortunately a few registrants were unable to attend in the end, mostly due to visa restrictions.

AUSTRALIA	27	IRELAND	1
BRAZIL	2	ISRAEL	1
CANADA	75	NEW ZEALAND	1
CHILE	5	PAKISTAN	1
CHINA	7	PERU	3
COSTA RICA	1	PORTUGAL	1
CROATIA	5	RUSSIAN FEDERATION	1
ECUADOR	1	SOUTH AFRICA	5
FINLAND	1	SWEDEN	1
FRANCE	1	UNITED KINGDOM	8
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Spinifex Ridge Iron Ore Mine, Western Australia, courtesy Moly Mines Limited

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# EXPLORE

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## EXPLORE Publication Schedule

Quarterly newsletters in March, June, September, December

**Deadlines** for submission of articles or advertisements:

March newsletter: January 15

June newsletter: April 15

September newsletter: July 15

December newsletter: October 15

## Information for Contributors

Manuscripts should be double-spaced and submitted in digital format using Microsoft® WORD. Do NOT embed figures or tables in the text document. Each photo and/or figure (colour or black and white) should be submitted as separate high resolution tiff, jpeg or PDF (2400 resolution or better) file. Each table should be submitted as separate digital file in Microsoft® EXCEL format. All scientific/technical articles will be reviewed. All contributions may be edited for clarity or brevity.

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

In addition to the technical article, authors are asked to submit a separate 250 word abstract that summarizes the content of their article. This abstract will be published in the journal **ELEMENTS** on the 'AAG News' page.

Submissions should be sent to the Editor of **EXPLORE**:

Beth McClenaghan

Email: [beth.mcclenaghan@nrcan-rncan.gc.ca](mailto:beth.mcclenaghan@nrcan-rncan.gc.ca)

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## Notes from the Editor

The September 2015 issue of **EXPLORE** features highlights of the 27th IAGS in Tucson, Arizona, USA held in April 2015. **EXPLORE** thanks all contributors to this third issue of 2015: Steve Amor, Al Arseneault, Dennis Arne, Jeff Bigelow, David Cohen, Tony Christie, Mary Doherty, Sue Driberg, Colin Dunn, Bob Eppinger, Stew Hamilton, Karen Kelley, Kurt Kyser, Daniel Layton-Matthews, Ray Lett, Matt Leybourne, Allan Lion, Ken McQueen, Jamil Sader, Dale Sutherland, and Erick Weiland.

**Beth McClenaghan**

Editor



## President's Message

Greetings and I hope that those in the Northern Hemisphere are having a warm and productive summer and those where it is winter, I hope that the cold is not too severe. It is relatively quiet here in Sudbury, Canada; the continued slow-down in the mineral exploration industry may have dampened activity, but not enthusiasm for our science.

Our Association continues to be well managed financially, and although some of our investments have declined in value with the financial markets owing to the softness in the energy and minerals sector, the AAG is well-positioned thank you to the efforts of Gwendy Hall, and prior to Gwendy, Eion Cameron. The same cannot really be said for our membership numbers, which have declined year over year. I would welcome any and all suggestions from our members as to novel ways to increase the exposure of the AAG and therefore increase the number of active (especially student) members. Our journal, GEEA, reflects the importance of exploration geochemistry to the environmental and analytical geochemistry fields. We need to broaden our membership to reflect the diverse applications of exploration geochemistry.

The 27th IAGS in Tucson has come and gone, and typically, AAG would already have selected a venue for the next IAGS in two years time. However, the state of the economy in general and the minerals sector in particular, has meant that we have had to be more cautious in determining the

next location. Although there are no specifics to report at this stage, I can say with some confidence that the 28th IAGS will be held somewhere in Canada – it's a big country, we just need to narrow the options down a little.

The last year has been difficult for the Association as we have lost several important members in our field; the most recent being Eric Hoffman. Eric was a key figure on the analytical side of the work of the Association, and will be sorely missed by us all. There is an obituary for Eric in this issue of **EXPLORE**. Finally, the AAG has selected a Distinguished Lecturer for 2015-2016: Daniel Layton-Matthews from Queen's University in Kingston, Canada. Dan's research has focused on genetic models of VMS, SEDEX and magmatic Ni-Cu deposits. However since his appointment at Queen's University in 2007, he and his research group within the Queen's Facility for Isotope Research (QFIR) have been involved in: 1) chemical indicators of mineralization in sedimentary and magmatic rocks from ore systems, 2) post-depositional chemical modification of sulfide, silicate and oxide minerals, and the chemical and physical dispersion of these minerals as indicators of mineralization in ore systems, and 3) the development of tools and concepts to aid in the discovery and understanding of formation and redistribution of ore deposits.

I wish you all the best for the fall/spring as the case may be.

**Matt Leybourne,**  
*President*



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## 27th International Applied Geochemistry Symposium... *continued from page 1*

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The IAGS venue, Hilton El Conquistador, delivered a great backdrop to the technical portion of the program. The hotel served excellent food during the am/pm breaks as well as lunches at the “Last Territory”. The IAGS Dinner was well attended (109), including 24 students many of whom were sponsored by Newmont staff.

Two pre-symposium field trips were provided: 1) the Grand Canyon; and, 2) Colorado Mines and Mills. Matt Leybourne led the Grand Canyon field trip while David Bird and Rob Bowell led the Colorado field trip. Both were well attended with 19 folks floating the Colorado river through the Grand Canyon with Wayne Ranney guiding the way and highlighting the geology and history of the Canyon.

The Colorado field trip attendees found that snow can come late in the Colorado Rockies. However, everyone enjoyed the field trip stops and generally stayed warm.

### Pre-Symposium Short Courses:

Graham Closs and Owen Lavin pulled together five excellent pre-symposium short courses and a student workshop. We had a full house for these short courses.

- Application of Indicator Mineral Methods to Exploration (Beth McClenaghan & Dan Layton-Matthews)
- Metal Mobility in Hydrothermal and Supergene Environments (Bill Chavez & Erich Peterson)
- Adding Value in Exploration and Remediation with Isotope Geochemistry (Kurt Kyser & Matt Leybourne)
- Application of Field Portable X-Ray Fluorescence in

Exploration and Mining (Gwendy Hall)

- The Interpretation of Geochemical Survey Data (Eric Grunsky)
- A Student Publishing Workshop (Matt Leybourne) which was free to all Students

### IAGS Technical Program:

Holding to the IAGS format of 4 days of technical content with a free day in the middle, twelve (12) Keynote presentations, twenty (20) technical sessions covering 72 technical presentations, with 62 poster presentations were delivered over the symposium week. The technical keynote presentations started off with Steve Reynolds (ASU) providing a spirited discussion on the geology and geochemistry of Arizona including his favorite field exposure where rocks that constitute many 1000s of feet in the geological record at the Grand Canyon are replicated, down to the sub-units, by a cross-section that is only 10's of feet thick. One of the many highlights of the week were the two technical sessions, including a keynote address, presented by the Medical Geology researchers. We thank Laura Ruhl for her many efforts in pulling these sessions together for the IAGS.

Two student prizes were awarded during the IAGS. The first was for the best oral presentation going to Antonio

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## 27th International Applied Geochemistry Symposium... continued from page 5

Celis from Vancouver BC, Canada and the second was for the best poster that went to Stacie Jones from Kingston ON, Canada. Second place in each category went to: Steven Kramar (oral presentation) from Wolfville, NS, Canada and Yadi Wang (poster) from Tucson AZ, USA.

On the Wednesday "free day" many attendees took advantage of the organized trips to see areas surrounding Tucson that provide a basis for tourism from around the world. These trips included:

- Arizona Sonora Desert Museum + Old Tucson Movie Set
- Bisbee, AZ
- Kartchner Caverns + Tombstone, AZ

During the course of the week, Ortrud Schuh organized a great partner program. Based on the comments heard

after each trip, everyone had a great time. The partner program included:

- "Tucson Art Crawl" (Monday)
- "Tucson City Tour" (Tuesday)
- "Biosphere 2" (Friday)

From your IAGS Co-Chairs:

**Erick Weiland, Sarah Lincoln, and Rob Bowell**

*Thank YOU!!!*

May our times be prosperous!  
May your health be exceptional!  
We hope to see everyone at the  
28th IAGS.



## AAG support for students travelling to the 27th IAGS

The AAG provides financial support students around the world to assist them in their travels to the International Applied Geochemistry Symposia. In 2015, the AAG provided \$400 to \$600 US to the following 12 students for travel to the 27th IAGS in Tucson, Arizona, USA.

1. Matthew Bodnar, University of British Columbia, Vancouver, Canada
2. Will Carson, Queen's University, Kingston, Canada
3. Oliver Delves, University of New South Wales, Sydney, NSW, Australia
4. Sarah Hashmi, Simon Fraser University, Vancouver, Canada
5. Stacie Jones, Queen's University, Kingston, Canada
6. Steven Kramar, Acadia University, Wolfville, Canada
7. Valérie Lecomte, Université de Sherbrooke, Sherbrooke, Canada
8. Galina Miasnikova, Moscow State University, Moscow, Russia
9. Shane Rich, University of British Columbia, Vancouver, Canada
10. Kun Tang, Institute of Geophysical and Geochemical Exploration, Langfang, China
11. Thomas Bagley, Acadia University, Wolfville, Canada
12. Camilo Yáñez, University of Chile, Santiago, Chile



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MINERALS

## Best student paper and poster at the 27th IAGS in Tucson, April 2015.

### Oral presentation winner (\$500 plus 1 year membership of AAG)

**Antonio Celis**, University of British Columbia

Paper: Titanite as a Porphyry Indicator Mineral for alkalic Cu-Au porphyry deposits in south-central British Columbia.  
Co-authors: F. Bouzari, C.J.R. Hart, T. Bissig, and T. Ferbey

### Oral presentation runner up (1 year membership of AAG)

**Steven Kramar**, Acadia University

Paper: Rocks under western Hanson Lake – building a chemostratigraphic model to aid base metal exploration; Hanson Lake assemblage, Flin Flon Domain, Saskatchewan, Canada.

Co-author: C.R. Stanley

### Poster paper winner (\$500 plus 1 year membership of AAG)

**Stacie Jones**, Queen's University

Paper: Geochemical characterization and exploration implications of the Kiyuk Lake gold project, Kivalliq region, Nunavut.

Co-author: K. Kyser

### Poster paper runner up (1 year membership of AAG)

**Yadi Wang**, University of Arizona

Paper: Assessment of a DTPA Single Extraction Method for Prediction of Plant Availability of Metal(loid)s in Acid Mine Tailings.

Co-authors: R.A. Root, M.K. Amistadi, R.M. Maier, and J. Chorover



Steve Kramar, David Cohen (AAG Student Awards Committee), Antonio Celis



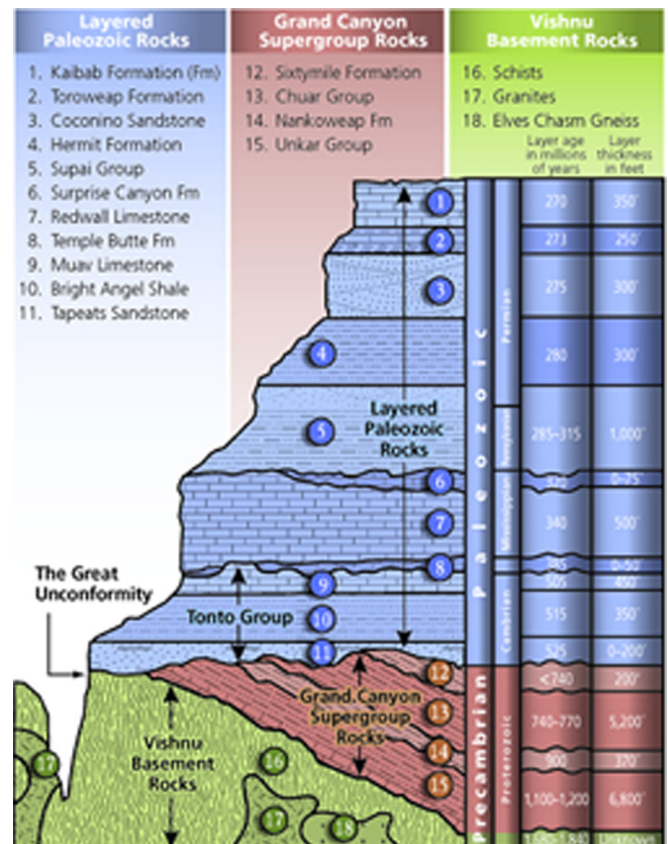
Yadi Wang and David Cohen (AAG Student Awards Committee)



## 27th IAGS Grand Canyon Field Trip

As part of the 27th IAGS, this pre-meeting field trip began in Flagstaff, Arizona on April 8th and ended at the Bar Ten Ranch on April 16th, 2015, completing a 300 km run of the Colorado River. The 16 participants of the field trip included a wide diversity of academic, industry and amateur geologists and was organized by the AAG. The trip was led by Wayne Ranney, a lecturer at Northern Arizona University with over 40 years of research, lecturing and river guiding in the Grand Canyon. In all, we would examine over 2 billion years of Earth history over the eight-day trip.

**Day 1:** After a leisurely sleep in Flagstaff we boarded two vans for our transfer to Lees Ferry, the departure point for our field trip. On the way we made a geological stop to examine the Sunset Crater National Monument, a basaltic cinder cone within the 1085 A.D. San Francisco Volcanic Field. In the afternoon we departed from the historical Lees Ferry after a quick duffle pack and safety briefing. We were then fitted with our life jackets and we rafted to our first stop at Badger Creek, examining the contact between the Moenkopi Formation (Lower Triassic; red, slope-forming, fine-grained, thin-bedded shaley siltstones



Simplified geological section of the Grand Canyon (en.wikipedia.org).

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## 27th IAGS Grand Canyon Field Trip... *continued from page 7*

and sandstones) and the Kaibab Formation (Lower Permian; gray, cliff-forming with interbedded carbonate and siliciclastic rocks) (Fig. 1). At Badger Creek we scrutinized the fossilized reptile-tracks in the Coconino Sandstone Formation (Lower Permian).

**Day 2:** After our first open-aired night on the river within the Supai Group (Pennsylvanian), we hiked up North Canyon at River Mile 20 to traverse the Supai Group upwards into the Permian. Back on the river, we stopped at Mile 24.5 to look at well-preserved Mississippian sponges, corals and silicic concretions in the Redwall limestone. Lunch was at the Redwall Cavern to see if John Wesley Powell was correct that the cavern could hold 50,000 people (if stacked, perhaps). After a great lunch we continued on to Buck Farm Canyon and hiked up a slot canyon to hear the red-spotted toads (*Bufo punctatus*).

**Day 3:** We headed out early to the confluence of the turquoise-blue, carbonate-saturated, Little Colorado River and the green, Colorado River for a brief warm-ish swim. After a quick lesson in aqueous chemistry, we proceeded to a hike along the Butte fault and down Lava Canyon loop to examine the middle to late Proterozoic sedimentary rocks of the Grand Canyon Supergroup.

**Day 4:** Waking up at the Nevillis Camp at mile 75, we proceeded to hike up 75 Mile Creek Canyon to examine the soft sediment deformation and hydrothermal alteration of the Precambrian (Mesoproterozoic) Shinumo Quartzite. After rafting a short distance through the Hakatai Shale and a diabase dyke, we quickly ran Hance Rapids, dropping 9 m into Granite Gorge, and entered the basement rocks of the Early Proterozoic. We finished the day at river Mile 110 near Shinto Creek with a spectacular view of the basement granodiorites and gneisses.

**Day 5:** An early morning hike to Elves Chasm at Mile 117 provided an opportunity to examine massive deposits of travertine that document that this little stream was much



Figure 2. The Great Unconformity. Stew Hamilton for scale.

different in the Ice Age, when conditions here were wetter and provided more groundwater discharge via springs. Before lunch we proceeded to Blacktail Creek to hike up Blacktail Canyon to observe one of the best outcrops of the Great Unconformity. Here, the Cambrian Tapeats sandstone is in direct contact with orthoamphibole-bearing gneisses of the Early Proterozoic (Fig. 2). After lunch we rafted through Dubbeddorff Rapid to hike Stone Creek Canyon to observe more travertine and more importantly to have a much needed shower under Stone Creek's clear water cascades. Nightfall took us a short trip downstream to Mile 133 to the Talking Heads camp.



Figure 3. Thunder River gushing out of the Mississippian Redwall Limestone.

**Day 6:** Enjoyed by some, and dreaded by others, our sixth day included the longest hike of the field trip (a.k.a., the ~20 km "Death March"). This hike started at Tapeats Creek up a rugged climb to Thunder River, where water gushes out of the Mississippian Redwall Limestone (Fig. 3). The hike then proceeded across Surprise Valley, allowing the investigation of the massive Surprise Valley Landslide. The hike ended with a steep descent into Deer creek, a vista view of the Colorado River, and the spectacular Deer Creek Falls. Many exhausted, we rafted a short distance to Doris Rapid Camp at Mile 139.

**Day 7:** Given our strenuous day of hiking the day before, many welcomed a long day of rafting that covered almost 65 km. Highlights of the day included a short hike up the blue-green pools of Havasu Creek and the spectacular travertine formations. The highlight for some was the 830,000 to 100,000 year old Lava Flows that appeared in the cliffs and riverbanks near Mile 177 (Fig. 4). For others, the highlight was the much-anticipated Upper Lava Falls Rapid, the largest in the Grand Canyon. Thoroughly soaked and excited, we made camp at Chock Rock Camp at Mile 184.9 with great exposures of the columnar-jointed basalt flows. In fact, for many of the hard-rock geologists on the trip, this location provided one of the most memorable toilets on the field trip!

*continued on page 9*



## 27th IAGS Grand Canyon Field Trip... *continued from page 8*



Figure 4. Oblique aerial looking east of the 830,000 to 100,000 year old basaltic lava flowing over the canyon walls.

**Day 8:** After packing up our cots and sleeping bags for the last time, we rafted a short distance downstream to Whit-

more Helipad, adjacent to the Colorado River, but on Hualapai Reservation lands. With a sad goodbye to the river we were airlifted out of the Canyon fourteen kilometres to the North to the working Bar 10 Ranch. Many welcomed the trading post, lunch and most importantly the hot showers. The field trip ended with a spectacular fixed-winged flight from Bar 10 to Flagstaff that provided an aerial view of a section of the Grand Canyon that we had just rafted. This field trip for some of the participants was a 20 to 40 year wait to raft the Grand Canyon and see first hand the amazing geological history it presents. With the amazing river guiding by Colorado River & Trail Expeditions (CRATE) and the geological interpretation of Wayne Ranney this will be a geological field trip that those who participated (Fig. 5) will remember for the rest of their lives.

**Daniel Layton-Matthews, Matthew Leybourne & Kurt Kyser**



Figure 5. Group photo of field trip participants.



## 27th IAGS Colorado Field Trip

Mine sites, their environmental management and spring snowfalls were the key themes of this four day field trip through scenic, southern Colorado. On a brisk April morning a select group of five participants and their two intrepid guides, David Bird and Rob Bowell, set off through the busy outskirts of Denver to Idaho Springs for stop 1 at the Argo Water Treatment Plant. Early gold and silver miners in the Rocky Mountains took advantage of the high-relief topography to make drainage adits in the valleys to dewater their workings. These are a major ongoing source of acid mine drainage and metal pollution into the adjacent streams. The Argo gold mine operated from 1890 to 1943 and a 4.12 mile long tunnel was constructed from 1893 to 1910. In 1997 a sophisticated water treatment plant with a capacity of 700 gallons per minute was built using funds from the US EPA Superfund. We received a detailed explanation and tour of the site and a quick walk around the adjacent heritage listed historic mill and museum, unfortunately not open at the time of our visit.

Next was an underground tour of the Henderson molybdenite mine on route to Leadville. This included an introductory lecture and discussion with the mine staff over lunch. Henderson is a large porphyry-type molybdenum deposit discovered in 1964, with first production in



Field trip group at the Henderson Mine.

## 27th IAGS Colorado Field Trip... *continued from page 9*



*Mining area, Leadville, Colorado.*

1976. The mine was modernised in 1996-97 and to date has produced ca. 1.1 billion pounds of Mo. The current owners, Freeport-McMoRan, use a block caving method to mine stockwork ore with an average grade of 3 lbs/ton Mo, which we were able to view and sample on our tour to the 7065 and 7210 levels. An overview of the Urad tailings dams and water treatment plant concluded our visit, before we headed south for our overnight destination at the Silver King Inn, Leadville. Leadville sits at just over 10,000 feet (3,094m) and some of our party were feeling the altitude. That night it snowed.

The following morning, Wednesday, we headed back down the road to Climax to ponder snow covered tailings storage facilities related to the nearby mine and view the spectacular surrounding peaks. Icy conditions and sliding wheels precluded close inspection of the water treatment plant. Returning to Leadville, we met local EPA remediation officer, Linda Kiefer, who walked us through part of the historic mining area east of the town and described the various measures to remediate the old workings, mullock dumps and associated acid mine drainage. Leadville is one of the most historic mining towns in Colorado. Alluvial gold was discovered at nearby California Gulch in 1859 and then rich silver lodes that led to the Colorado Silver Boom and the establishment of the town in 1877. It is estimated that the district has produced 2.9 million ozs

of gold, 240 million ozs of silver, 1 million tons of lead, 785,000 tons of zinc and 53,000 tons of copper. After lunch at the Yak tunnel, another drainage adit and treatment works, we drove up California Gulch to the Black Cloud mine, to inspect the rehabilitation works. This was the last mine in the area to close in 1999 and the rehabilitation of the extensive tailings dams is impressive. There was time for a quick look through the informative Leadville mining museum before a long drive south via Beuna Vista, down the western side of the Sangre de Cristo range to Sagua-che, Del Norte and our next overnight stop at South Fork on the Rio Grande.

Thursday we toured the historic mining camp of Creede, starting with the Bulldog Mine, an interesting example of a site entering a new cycle of exploration, following previous modern exploration, mining and rehabilitation. Our hosts were Manager, Randy McClure and Project Geologist, Jonathon Moore from Rio Grande Silver Inc., a subsidiary of Hecla Mining. An excellent introduction to the history and geology of the Creede area from Randy and Jonathon was followed by extensive discussion and a visit to the core shed to examine some of their high-grade



*Historic workings and mine dumps, Pyrenees Mine, Leadville.*



*Downtown Creede and Willow Creek Canyon after the snow.*

## 27th IAGS Colorado Field Trip... *continued from page 10*



*View of Creede from the Bulldog Mine.*

drill intersections. Creede was the gateway to the San Juan Mountains for early prospectors and uneconomic silver was discovered in 1869. Following discovery of the Holy Moses vein in 1889 and then the famous Amethyst vein, the township of Creede developed along Willow Creek to a population of ten thousand. The mineralisation consists of low-intermediate sulfidation, epithermal gold-silver veins developed along faults in Oligocene tuff deposits within large caldera structures. Creede is one of the best known epithermal districts in the world because of a number of research studies by the USGS in the 1970s and 1980s. Total production to date is 86 million ozs of silver and 160,000



*Field trip party on the re-vegetated margins of Summitville open pit.*

ozs of gold, with a current exploration focus on gold. A visit to Willow Creek Gorge and the Creede Underground Mining Museum, showcasing an excellent display of mining techniques, was followed by a chance to look around the historic town before returning to South Fork for lunch.

After lunch we drove to Summitville to inspect remediation works and a 'state of the art' water treatment plant designed to clean up the Summitville historic and more recent large open-cut gold mining operation. The plant had been recently built at a cost of US\$20 million, again

with support from the US Superfund Scheme. It will have an ongoing operating cost of about US \$2 million per year in perpetuity, to neutralise acid drainage from the Reynolds drainage tunnel and remove the dissolved copper and aluminium.

Heavy snow falls over Thursday night meant that our planned trip to Cripple Creek the next day had to be cancelled due to blocked roads. So in the morning it was Creede revisited, but with a picturesque mantle of new snow. It was a long trip back to Denver via an alternate route through Alamosa, Walsenburg and Colorado Springs. On the way we were able to stop at the Western Museum of Mining and Industry in Colorado Springs before arriving back at Denver International Airport. Overall a most enjoyable and instructive pre-conference field trip fuelled by essential coffee stops for discussion and travelling rations in the van of beef jerky, corn chips and non-alcoholic root beer.

**Ken McQueen and Tony Christie**



## 27th IAGS Bisbee tour

Eleven IAGS delegates participated in the mid conference 1-day Bisbee tour, Wednesday 22 April. On the way to Bisbee, we passed through Tombstone and saw tempting signs such as OK Corral, but didn't stop. Our tour guide Suzanne gave us a running commentary at intervals during our journey so we learn't lots about Tucson, Arizona, Bisbee and the many types of local cacti.

Bisbee was founded as a mining town in 1880, following discovery of mineralisation in 1877 by Jack Dunn a civilian scout with a contingent of cavalry tracking renegade Apaches. The town was named in honor of Judge DeWitt Bisbee, one of the financial backers of the Copper Queen Mine in the hill beside the town. Initial underground mining was at a grade of 23% Cu, plus byproduct Ag and Au. It was acquired by Phelps Dodge (now Freeport McMoRan) in 1885. Grades drastically reduced in the 1900s and

## 27th IAGS Bisbee Tour... *continued from page 11*

in 1950 open pit mining commenced. The open pit mine closed in 1974 having produced about 86 Mt of ore at 0.7% copper for 0.6 Mt of Cu, mostly from the excavation of the former Sacramento Hill. The undeveloped Cochise deposit, located immediately north of the Lavender pit, contains an estimated 190 Mt containing 0.4% Cu, which may be mined in the future.



*Bisbee town in foreground and remnant Sacramento Hill and Lavender open pit in middle distance. Hills in far distance are in Mexico (Bisbee is only 10 km north of the border).*

Our first stop in Bisbee was the Copper Queen Hotel originally built by Phelps Dodge where we met our tour guides and started our tour through the hilly streets of Bisbee. The town was built up two steep gulches, Mule Gulch



(the original track down from the nearby mountains) and Brewery Gulch. Many Cornish miners were employed in the early mining period and their influence can be seen in the historic houses connected by numerous stairways that are part of the route for the annual Bisbee 1000 Stair Climb, a 5 km run that traverses 1,034 stairs and is billed as "the most unique physical fitness challenge in the USA!" by its organizers. Bisbee's population is 5400, but was once about 10,000 according to Wikipedia (although Suzanne suggested up to 50,000) so there are many 1800's style civic buildings now prominent in a small town. Fires took their toll on several occasions and in 1908 three quarters of the town was destroyed so that many buildings are second generation. Our guide added a quick trip for an overlook

of the Lavender open pit (named after Harrison Lavender, 1890–1952, VP and President of Phelps Dodge) covering an area of 1.2 km<sup>2</sup>, and depth of 274 m. We went back to the town for lunch and free time. Some of us visited the Bisbee museum to see some magnificent specimens of malachite, azurite, cuprite, native copper and turquoise,



*Lavender open pit (1950-1974) with workshops top left.*

including a mock up of a "crystal cave". There were some exhibits of underground mining and a magnificently stocked book store. The town has many interesting antique and rock shop/jewelry stores, many with turquoise jewellery. Bisbee's turquoise is prized because of its typical deep blue colour (Bisbee Blue) and complex brown-black "matrix". Our tour group assembled again at 2 pm for an underground visit to the Copper Queen tourist mine. After kitting up in PPE, a ride on a small mine train took us to various stops to view underground mining techniques. In the stope (mining cavity) we could see some malachite on the back (roof). We took a different route into Tucson so we could pass by the 'Boneyard' of mothballed military aircraft, the World's third largest airforce as noted by Suzanne. A great day with beautiful weather and thankfully cooler in Bisbee than Tucson because of the higher altitude.

### Tony Christie and Ken McQueen



*Entering the Copper Queen mine straddling the mine train.*



## 27th IAGS Short Courses

### 2: Application of Indicator Mineral Methods to Mineral Exploration

The 3rd biennial resistate indicator minerals (RIMs) short course at the 27th IAGS in Tucson, AZ, was hosted by Beth McClenaghan (Geological Survey of Canada) and Dan Layton-Matthews (Queen's University). The 24 participants from industry, government and academic organizations met together to present and discuss issues and recent developments in the field of indicator minerals. The 10 presenters, all leaders in the field of RIMs application and/or RIMs research, covered a wide variety of topics in a very full day and every talk was followed by often-times lively discussion. A full list of presenters and their topics can be found in the December 2014 issue (No. 165) of the EXPLORE newsletter. The talks were centered around three broad themes: real world case studies, analysis and imaging advances, and mineralogical research.

The use of RIMs is applicable to a huge diversity of mineral deposit types and, with on-going active research, the list is growing. This short course presented RIMs for porphyry and epithermal systems, VMS, metamorphosed massive sulfide, skarn  $W \pm Mo$ , rare metal pegmatite and carbonatite, diamonds, and Sn greisen deposits. The direct application of RIMs ranges from simple grain counts in a sample through to the intricate trace element substitutions within a single mineral phase or grain. As several speakers reiterated, the key features of a good mineral for RIMs applications are that it is resistant to chemical and mechanical weathering, resistant to post-crystallization resetting, and occurs with a range of major and trace element chemistry. RIMs may be common minerals that occur in a wide variety of geological environments or rare minerals that are uniquely associated with specific styles of mineralization; regardless, they must have distinctive mineralogical or chemical characteristics that can be directly related to ore-forming processes.

The research and application of RIMs is a field undergoing rapid and exciting change due to technological advancements in mineral imaging and analysis. As we increase our ability to rapidly, accurately and cheaply identify and analyze minerals, new possibilities are opening up. Several presenters discussed their research into new minerals that potentially could be used in future RIMs applications, including minerals such as rutile, biotite, tourmaline and scheelite. Along with discussions of new RIMs minerals and instrumentation advances, presenters discussed their ability to rapidly interrogate huge datasets and mineral populations. As an example, Paul Agnew of Rio Tinto Exploration told the short course participants that the Rio Tinto RIMs Analytical facility generates 1 GB of mineral data each day. Clearly the research into and applications of indicator minerals is an exciting area to watch for future developments.

**Sue Driberg**  
*Rio Tinto*

### 3: Metal Mobility in Hydrothermal and Supergene Environments

As part of Tucson IAGS 2015 short course series, a one day short course was given by Dr. William (Bill) Chavez (New Mexico School of Mines) and Dr. Erich Petersen (University of Utah). This short course focused, as the title implies, on how and by what processes metals become mobile within various ore forming environments and conditions. Both presenters provided dynamic presentations that kept everyone's interest and focus (even with inviting views outside of palm trees and margaritas by the pool). The presentations were augmented with many photos and useful diagrams. In addition, there were group assignments that provided the opportunity to apply some of the material presented to real-world problems.

The course was broken into two sections. The first section was presented by Dr. Chavez and focused on the processes that control metal mobility. His examples referred to several deposits in Chile, Spain, Arizona, and Utah, and the topics included:

- 1) Variable mobility of elements under different redox and pH conditions,
- 2) Paleoenvironments including the significance of cycles of drought and moist conditions,
- 3) Levels of exposure to weathering processes,
- 4) Host rock mineralogy,
- 5) Structural aspects that control fluid movement, including microfractures to large scale regional faults,
- 6) Biological processes (including sulfur oxidizing bacterial communities that thrive in low pH conditions, and neotocite bacteria found as deep as 400 m below the surface at the El Abra porphyry copper deposit).

The second half of the short course was presented by Dr. Petersen. This part focused on the systematics of skarn and high sulfidation systems and how metal mobility and geochemical processes impact ore mineral and alteration zonation. The skarn deposit examples make good case studies because they involve isochemical metamorphism of the host rocks, metasomatism (i.e., formation of calc-silicates including garnet + pyroxene), and retrograde metasomatism. Included were discussions on the geochemistry of endo and exoskarns. Dr. Petersen's presentation on metal mobility and how it drives alteration in high sulfidation systems was also excellent. The progression of alteration and the relation to the variable geochemistry of hydrothermal fluids (i.e., from vuggy quartz to kaolinite to illite to montmorillonite to chlorite) was discussed in detail. Significant time was also spent on alunite and its significance in both supergene and hypogene systems.

Normally, this course is given over several days, and given the opportunity, I would certainly take the extended version.

**Jamil Sader**  
*Bureau Veritas*

## 27th IAGS Short Courses

### 4: Adding Value in Exploration and Remediation with Isotope Geochemistry

The 2015, 27th IAGS conference included a one-day short course organized by Kurt Kyser and Matthew Leybourne, titled “Adding Value in Exploration and Remediation with Isotope Geochemistry”. The course covered application of the 3 isotope systems (radiogenic, stable and non-traditional) from primary mineral deposit settings, to alteration systems and into the surficial environment. An eloquent presentation of isotope systematics by Kurt Kyser was followed by detailed isotope systems in VMS exploration (Leybourne), porphyritic Cu deposits (Mathur and Cooke), Au deposits (van Hees), Uranium deposits (Kyser), environmental and mine remediation studies (Wanty) and was wrapped up by a summary of analytical breakthroughs, and possible future application for isotope studies. The short course provided a balance of fundamental isotope principals and case studies in which isotopes were applied to mineral exploration. An ample supply of fine wine was added for a final discussion of the potential for future isotope applications and keys for moving isotopic work from research into applied geochemistry.

The course began with an overview of basic isotope principles and consideration of the elements which have potential for isotope tracing. This was an excellent education and review of the fundamentals and how geological processes fractionate isotopes. The case studies provided evidence that recognizing these processes from a variety isotopic systems can add significant value to mineral exploration. The more traditional stable isotope systems such as H, O, C and S can provide useful vectors within epithermal, porphyry, VMS, uranium and orogenic gold deposits. Some interesting examples of non-traditional and radiogenic isotopes such as Zn, Fe, Cu, Pb and U can fingerprint blind mineralisation under cover, supergene enrichment, and mine waste contamination in river systems. A remaining challenge is to understand the extent to which isotopic fractionation changes in the surficial environment and whether a signature related to mineral deposits is retained with dispersion through cover, through water tables, supergene environments and with interaction with biota. This transition and change in isotope fractionation is not yet well characterized and is an important to application to surficial mineral exploration programs.

Kurt returned for a second talk discussing isotopic techniques in exploration for uranium Deposits. In the Athabasca Basin, uranium deposits are covered by both glacial till and variable thickness of overlying Athabasca Sandstone. Geophysical methods are used to identify favorable reduced graphitic zones, of which there are many, and define structural complexity. Secondary dispersion geochemical responses include Pb, V, As, Co, Ni, U, Tl, REE, Zn, S, B, I, Ba and He. Radiogenic Pb has dispersed significantly from these deposits with distinctive ratio of  $Pb^{207}/Pb^{206}$ . Indications from an orientation survey at Cigar Lake are that significant dispersion vertically upward 450

m provides a Pb signature retaining the  $Pb^{207}/Pb^{206}$  ratio  $<0.7$  as measured in core, till and clay samples. Supporting anomalies in black spruce cores are intriguing.

Ed van Hees reminded the group of the challenge in exploring for gold deposits and demonstrated case histories involving old gold mining camp oxygen isotope signatures, and the fractionation of  $O^{18}/O^{16}$  in quartz fluid inclusions. A wide range in  $^{18}O$  from 4 to 16 in most silicified gold deposits can be refined within a specific district wherein barren vein fluid inclusions are lower ( $<13.5$ ) than gold-bearing veins (13.5 – 16). Vectoring within the district apparently did not prove effective.

Matt Leybourne summarized our current understanding of isotopes in VMS deposits including radiogenic (U, Pb), stable (O, S, H, C) and nontraditional isotopes (Cu, Fe, Zn, Mo, Si, Se). These are useful for dating age of host rock and mineralization, and understanding source of contained metals (in particular S source). The  $^{34}S$  values within hypogene VMS mineralization vary widely, generally from seawater (0) up to  $^{34}S$  12.

Mathur provided a discussion of Cu isotopic systematics and various orientation studies.  $Cu^{65}/^{63}Cu$  fractionation varies in ore, weathered regolith and surface waters. In the Pebble example presented, the isotopic ratios are repeatable from one year to next and waters are consistently higher than associated ore, with higher  $^{65}Cu$  related to higher grade ore zones. David Cooke represented the CODES work of isotopic signatures around Bingham Canyon.

Rich Wanty with the USGS described various applications of isotopic systematics to mine related environmental applications including use as tracers in water to evaluate basin water flow dynamics. Several examples demonstrated isotopic ratio shifts with redox variation, and within plants, suggesting complexity of evaluating isotopic system in surficial environments for which there is much yet to learn.

Many of the speakers described new instrumentation which is allowing measurement of isotopes with greater accuracy and cost effectiveness and will ultimately allow the work to move from research organizations into commercial laboratories. The Agilent triple quadrupole /collision cell ICP-MS may provide cost effective commercial isotopic data in future.

Very specific isotopic signatures appear to provide “silver bullet” vectors such as  $Pb^{207}/Pb^{206}$  near uranium deposits,  $\delta^{34}S < -2\%$  in alkalic porphyry deposits and  $\delta^{18}O > 13.5\%$  in orogenic lode gold deposits. This short course was a strong introduction to this developing geochemical technology that is transitioning into a routine part of the modern geochemical toolkit for both environmental and exploration applications. Thank you to Kurt, Matt and all of the speakers for an interesting and thought provoking day. The course was one of several highlights of the 27th IAGS symposium and very well executed.

**Jeff Bigelow and Mary Doherty**  
Newmont Mining Corporation

## 27th IAGS Short Courses

### 5: Application of Field Portable X-Ray Fluorescence (XRF) in Exploration and Mining

A one-day short course organized by Gwendy Hall on the application of field portable XRF was held during the 27th IAGS in Tucson, Arizona. The range in topics by speakers from industry, government, and academia made this workshop of interest to a broad audience.

Gwendy Hall provided a foundation for later talks by covering the basic principles and strengths and weaknesses of the method. Her presentation and the two that followed by Alexander Seyfarth and Pim van Geffen illustrated the growing importance of pXRF in geochemistry, and the need for users to carefully design the sample collection/preparation to suit study goals, adhere to QAQC protocols, and be aware of data quality and calibration issues. Also covered were: (1) performance differences among different handheld and benchtop devices; (2) the causes of variations in precision and accuracy for different elements; (3) the most common element spectral interferences; and (4) inherent factors associated with in-situ analysis such as sample heterogeneity, particle size, and moisture content.

Two presentations focused on specific issues. Paul Morris discussed advances that have been made in analysis of REE/light elements, and why caution with interpretation must still be used despite the fact that pXRF now routinely determines these elements. Bruno Lemiere focused on analysis of wet soils and sediments; based on case studies he presented, partial drying of samples with a hand press provides the most consistent results.

Other presentations illustrated the use of pXRF in exploration for specific types of mineral deposits. George Simandl tested the targeting capability of stream sediment samples for known pegmatite and carbonatites. The pXRF method satisfactorily detected elements of interest (e.g., Ta, Nb, Zr, Hf, Li, REE, and Be) and allowed determination of the optimal size fraction of stream sediments. Alice Davies described a pXRF study designed to determine the potential for uranium mineralization in Namibia, an area characterized by calcrete and gypcrete cover. In general, the results were successful in rapidly and reliably quantifying the U concentrations.

The presentations included the many uses of pXRF in mineral resource studies, including exploration by mining companies, drilling programs, government mapping or soil sampling programs, and environmental evaluations. From the prospective of exploration companies, Peter Winterburn, Nigel Brand, and Dennis Arne presented case studies of the use of pXRF in vectoring to deposits, real-time follow-up of anomalies, and defining drill targets. Peter and Nigel both used examples of exploration for Ni-Cu deposits in Africa, areas of abundant cover by lateritic or saprolitic soils. Dennis Arne used deposit case studies in Canada to show that (1) exploration of gold deposits using pXRF must necessarily use proxy elements such as As (high detection limit for Au by pXRF), and (2) geochemistry of till samples

is useful in exploration for Ni sulphide deposits. All of the above case studies stressed the necessity for submittal of a sample subset for laboratory analysis, and emphasized that although the correlation between the methods is good, some variations exist in the absolute concentrations of specific elements.

Of increasing interest in the future is real-time acquisition of geochemical pXRF data at the drill rig, as exemplified by a presentation by Dave Lawie. As Dave emphasized, one of the biggest challenges is processing the amount of generated data and how to best evaluate it to optimize the information gained. Yulia Uvarova showed how pXRF data of drill core can contribute to geochemical logging, and be used to verify results from portable XRD and vice versa. The Geological Survey of Western Australia (GSWA) is using pXRF data to support soil sampling, mapping, and mineralization projects as discussed by Paul Morris. All data collected by the GSWA are in a web-accessible database with a current sample population of >35,000 analyses. Environmental geochemical studies also greatly benefit from the use of pXRF data as presented by Ruth Warrender, who showed the benefits and limitations of pXRF in risk assessments, contaminant mapping, sample selection and baseline assessments.

The presentations were highly informative and demonstrated the advancements and current limitations of the pXRF method. As paraphrased from one speaker, the pXRF method could be considered the most significant development in the field of exploration geochemistry since that of the ICP-MS method in the 1980's.

**Karen Kelley**  
USGS

### 7: The Interpretation of Geochemical Data

I decided on short notice to register for this short course when, by chance, I met Eric Grunsky in Tucson and learned that there were only about ten people registered for his course. By the time we assembled in the meeting room our numbers had increased to twenty with a good representation of participants from industry, academia and government. Eric began by outlining the basic objectives of geochemical data analysis and in particular the difference between variable geochemical data spaces such as statistics to characterise data, and the geographical representation of data using GIS systems. He continued by explaining the difference between an exploration approach to analysis using methods such as Q-Q plots and box plots, where there are few assumptions about the nature of the data, and the modelling approach where data are separated into populations based on an identifiable characteristic such as lithology before the populations are tested statistically to classify samples. This was followed by a very lucid explanation of transformation methods and the impact of censored data on statistical analyses. This, Eric remarked, is a common

## 27th IAGS Short Courses

problem when a large number of reported gold values are below instrumental detection limits and are simply replaced by a value equal to a fraction of the detection limit (e.g. 1/2) prior to statistical analysis. A simple, but not necessarily valid strategy. Eric demonstrated more sophisticated methods for dealing with censored data such as the EM algorithm approach using gallium values from a regional geochemical lake sediment survey. He then showed how closure can invalidate an analysis, because statistics assume that variables are independent. Closure, he explained, occurs when geochemical values reported as weight percent invalidate the independence of variables because when one value changes all other values change to maintain a constant sum. However, as Eric then showed, converting values to ratios and log ratios makes the element variables independent of each other and eliminates the effect of closure.

More examples of data evaluation followed. A case history of levelling and quantile regression applied to regional lake sediment data from northern Ontario highlighted zinc anomalies. Eric then gave a succinct explanation of the theory underlying principal component analysis, cluster analysis and chi squared plots. He demonstrated how these multivariate methods could be applied to interpreting bedrock geology using an analysis of geochemical data from the Blake River, Ontario area. There were several more

examples of applying principal component analysis including one using regional soil geochemical data from a survey covering much of continental United States. This example clearly distinguished between areas with different bedrock geology, climates, and vegetation. It provoked a lively discussion including a suggestion from one member of our group that the analysis revealed areas dominated by aeolian sand. From principle component analysis the course moved on to the use of variograms and predictive mapping applied to litho-geochemical data from the Abitibi Greenstone belt.

The course concluded with a recommended strategy for geochemical data analysis, a review of available statistical tools and a guide to on-line resources. Those parts of the course that made particular impressions on me were how censoring geochemical data could affect a statistical analysis, and how principal component analysis could strengthen an interpretation of a geochemical data set.

The lectures were accompanied by an excellent bound set of notes comprising power point slide images and several paper reprints. One of these papers\* provides more background about the statistical topics covered in the course.

\*Grunsky, E. C, 2010, The interpretation of geochemical survey data; *Geochemistry, Exploration, Environment, Analysis*, Volume 10, pp 43-90.

Ray Lett



## 27th IAGS Medal Winners

### Colin Dunn, AAG 2014 Gold Medal

Dr. Colin Dunn has worked tirelessly for decades in advancing the field of biogeochemistry as it relates to exploration. He is recognized as the preeminent leader in the world on the topic. Many geoscientists have been mentored by Colin over the last several decades. His work has been documented through over 200 peer-reviewed publications, as well as presentations at international venues, short courses, informal conversations with many prospectors, geologists, and geochemists, and through the publication of his definitive book on the subject, *Biogeochemistry in Mineral Exploration*. Colin has assisted commercial analytical laboratories in the development of analytical techniques and establishment of analytical control materials. In addition, he has been a long-standing member and Fellow of the Association of Applied Geochemists, a past councilor and has volunteered on numerous AAG committees. As an applied geochemist, Colin has been a stalwart for the geochemistry profession in general, and for biogeochemistry in particular.

Colin received his PhD from London University in

1972. Spanning government and industry, Colin's career began at the Saskatchewan Geological Survey, and moved to the Geological Survey of Canada in 1985. Colin retired from the GSC in 1998 as the Head of the Geochemical Research Section. As a consultant since then, he continues to be very active globally in the field, having undertaken surveys for major and junior companies, governments in Canada, Australia, New Zealand and Finland, and numerous projects sponsored by Geoscience BC and CAMIRO, among others. Having championed the use of biogeochemical exploration for a wide range of commodities, such as Ag, Au, PGE, base metals, Mo, U, REE, and diamonds, Colin's approach has always been practical, distilling procedures to the most basic in order to facilitate their use by industry.

### Ravi Anand, AAG 2015 Gold Medal

Dr. Ravi Anand has a long, proven record for developing a vast knowledge on regolith geoscience processes, landscape evolution, and secondary dispersion in deeply weathered terranes, and applying this knowledge to mineral exploration. Understanding regolith is critical for correctly interpreting soil geochemistry and Ravi's research on the subject has involved numerous empirical field studies combined with extensive laboratory experimentation. Ravi's role has been pivotal in changing the exploration industry's view of regolith as a great hindrance to seeing it as a potential ally in the quest for new mineral deposits. The outcomes of his research have made significant and lasting changes to the philosophy and practice of geochemical exploration in



AAG President Matt Leybourne, Colin Dunn, Beth McClenaghan, Ravi Anand, AAG Vice President Ryan Noble.



## 27th IAGS Medal Winners

Australia and elsewhere in deeply weathered terranes and contributed directly to major mineral discoveries.

Ravi's recent projects have studied the role of plants, termites, bacteria, groundwater, weathering and gases to understand metal mobility in the environment. These landmark projects in exploration geochemistry led by Ravi created a truly dynamic multidisciplinary team from government, academia and industry, to better understand how elements migrate from depth and therefore how best to detect them at surface. Ravi has transferred his knowledge on the subject to the scientific and professional community through more than 300 scientific publications and conference presentations, four journal issues/monographs, numerous additional reports, and at over 60 workshops and courses requested by mining companies. A Fellow of the Association of Applied Geochemists, Ravi served as the association's Distinguished Lecturer in 2013-2014, giving presentations on several continents.

Ravi's career began in the 1970s as an Assistant Professor at Himachal University and Assistant Scientist at Punjab University. Following receipt of a PhD at the University of Western Australia in 1984, Ravi continued his career at UWA as a Research Fellow, moving in 1987 to a Research Scientist position at CSIRO Division of Exploration Geoscience. There he has led numerous research projects locally and globally, such as the successful projects for AMIRA and CRC LEME. Ravi is presently a Chief Research Scientist at CSIRO Mineral Resources Flagship and an Adjunct Professor at Curtin University.

### Beth McClenaghan, AAG 2015 Silver Medal

The Association of Applied Geochemists' Silver Medal is awarded to those who voluntarily devote extraordinary time and energy to the affairs of our organization. This year's Silver Medalist, Beth McClenaghan, is strongly deserving of this reward. Beth has been an AAG Fellow for some 23 years. During this time she has served the Association as a Councilor, has organized numerous workshops presented at our IAGS symposia including the 27th IAGS, has served on IAGS organizing committees, and has chaired sessions for the same. She is currently editor of the Association's newsletter, **EXPLORE**, a position Beth has held since 2005. As you all know, this newsletter is extremely important for promoting the Association, as a vehicle for disseminating information to AAG membership, and for promoting the science of applied geochemistry. Under Beth, the newsletter has been enhanced on several fronts. Beth was instrumental in getting all of the AEG and AAG newsletters—from the earliest 1970s to the present—digitized, on-line, and available for download from the AAG website. As most of you know, Beth is also a very accomplished research scientist with the Geological Survey of Canada where she has worked for the past 24 years. Her research has focused on till geochemistry and indicator mineral methods applied to exploration in glaciated terrain, with particular emphasis on gold, diamonds, and base metal deposits.

**Robert G. Eppinger**

*Chair, AAG Awards and Medals Committee*



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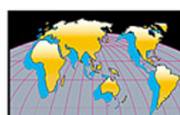
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## Obituary



### Dr. Eric Laurence Hoffman, President and Founder of Actlabs

It is with great sadness that we inform the AAG community that Dr. Eric Laurence Hoffman, Ph.D., P.Geo, President and founder of Activation Laboratories Ltd. (Actlabs) passed away on July 10, 2015.

to the sole use of ICP/OES. Eric saw the huge potential that this instrumentation offered and in 1993 Actlabs acquired their first ICP/MS, a Perkin Elmer-Sciex Elan 5000 that was used for Enzyme Leach analyses continuously, 24 hours a day, 7 days/week. The instrument proved that this generation of ICP/MS could support a viable commercial ICP/MS operation. Experience with the Elan 5000 was sufficiently successful and Eric then acquired the first Elan 6000 in the world. After initially struggling to debug this new instrument for Sciex, the superior stability and sensitivity of this fourth generation instrument was established. It permitted several new commercial developments including:

- Lithium metaborate/tetraborate fusion linking ICP/OES for major elements and ICP/MS for the trace elements including REE and high field strength elements
- Multielement hydrogeochemistry packages by ICP/OES and ICP/MS
- Low cost 60+ element packages by ICP/MS on aqua regia, four acid (near total) digestions and peroxide fusions
- Analysis of vegetation ash and dry tissues by ICP/MS
- Lead isotope analysis by ICP/MS

As the next stage of instrumental evolution entered the market, in 2002, Eric realized that High Resolution ICP/MS using a magnetic sector ICP/MS was a way of resolving interferences and increasing analytical sensitivity by orders of magnitude. Actlabs became the first commercial mineral laboratory in the world to acquire this instrument, a Thermo Finnegan Element 2 HR-ICP/MS. Among the applications that were then developed were:

- Research projects to link capillary electrophoresis, high pressure liquid chromatography and ion chromatography to the HR-ICP/MS. Metal speciation was one of the targets of this research and methods for arsenic, chromium, selenium, iron, and other metals were established and commercialized.
- By 2004, new low level gold in water technology was developed using the HR-ICP/MS permitting detection down to 0.05 ppt and avoiding the major problem of adsorption of gold on the polyethylene sample containers. This methodology was still not sufficient for PGE and a new ion exchange technology was developed for PGE in water to reduce detection levels to low ppq levels.
- This technology was used to determine low levels of platinum group elements in vegetation primarily for environmental studies trying to link catalytic converters to PGE levels in roadside vegetation.
- The HR-ICP/MS also allowed development of

#### Accomplishments

Eric began his working career in industry in 1978 as an NRC Postdoctoral Industrial Fellow commercializing the nickel sulphide fire assay/INAA method for low level platinum group elements he developed for his PhD thesis. He was instrumental in forming a commercial INAA partnership with McMaster University. This was one of the first commercial neutron activation facilities in the world, and where he developed for the exploration community applications of INAA, delayed neutron counting and prompt gamma analysis. Some of the innovations included:

- Analysis of dried humus or vegetation for gold+34 elements using large 15-30 g samples
- Analysis of silver fire assay beads for gold, platinum and palladium
- Analysis of 30 g samples of rock, soil or sediment for multielement INAA packages
- Analysis of kilogram samples for gold by INAA thus reducing the nugget effect
- Analysis of vegetation ash in conjunction with the Geological Survey of Canada
- Development of an automated delayed neutron counting system for trace to major levels of uranium; this is still one of the most effective methods to carry out total uranium analyses quickly, accurately and at low cost.
- Development of an automated prompt gamma system for determining elements such as boron, gadolinium and hydrogen.

In 1987, Eric established Activation Laboratories Ltd. (Actlabs) and began by offering INAA services. He quickly expanded to include atomic absorption and ICP/OES analyses. In 1992 Actlabs, jointly with Bob Clark, commercialized a selective extraction Enzyme Leach, a new technology that had been developed at the USGS. This has proved to be a precise weak selective leach of soils frequently used by the mineral exploration community.

First and second generation ICP/MS units were tried by commercial labs in the early to mid 1980's and their application in the geochemical industry was not that successful. A number of laboratories disposed of their ICP/MS units as a result of their poor stability and reliability, instead returning

## Dr. Eric Laurence Hoffman...*continued from page 18*

analyses by ion exchange to detect REE to sub ppb levels in rocks.

- Methods to determine ultralow levels of metals in water were developed for specific elements where detection levels or interferences make analyses difficult by conventional ICP/MS.
- In 2004 methods for mercury isotope determinations were developed using the HR-ICP/MS and this was extended to multicollector ICP/MS and is now being widely used by Environment Canada amongst others.
- Eric's acquisition of a 213 nanometer New Wave laser (2004) for laser ablation linked to the HR-ICP/MS allowed development of spatial technologies for metal and isotopic evaluations; for example U/Pb Terrane Geochronology similar to that developed in Australia.
- A Geochronology department was established to determine isotope ratios and age dating.

Concurrent with all of the instrument and method development, in 1994 Eric established a Materials Testing Division at Actlabs, doing work for the automobile and aircraft industries, performing physical testing and metallurgical failure analysis.

On another front, in 1995 Actlabs purchased its first Gas Chromatograph/Mass Spectrometer (GC/MS) and began research on new innovative technologies for a number of applications based on analyses of organic species. These applications included:

- Development of a forensics division that was recognized by the ASTM committee in Criminalistics as a world research leader in the analysis of fire debris to detect residues of ignitable liquids.
- The first application of a geochemical technology utilizing semi-volatile organic compounds to oil and gas exploration.
- Soil Gas Hydrocarbon (SGH) was developed for mineral exploration.
- As a result of the determination that the SGH anomalies were microbiological in origin, a new Bioleach technology was developed.
- The customization and use of the latest instrumentation further led to the development of the detection of Organo-Sulphur compounds (OSG) that represent the first "Pico" technology.
- New technology aimed at fingerprinting mineral deposits using DNA is currently under development.
- New research into the analysis for Petroleum Biomarkers made discoveries that included the development of more sensitive techniques for higher molecular weight organic biomarkers.

In pursuit of his fundamental interest of applying to mineral exploration technologies from other scientific disciplines, Eric continued to diversify and in 2003 he established a pharmaceutical department and again acquired

state-of-the-art expertise and equipment, including a liquid chromatograph linked to a tandem mass spectrometer with a Q-trap (Applied Biosystems ABI-4000 Q Trap). This technology was used for cancer research (pancreatic cancer treatment for submission to the FDA), biomarker research and the detection of new priority pollutants, like pharmaceuticals and perchlorates in waste water. The development of this department allowed Actlabs to add a laser particle size analyzer, FTIR, differential scanning calorimeter, differential thermal/thermogravimetric analyzer (DTA/TGA), polarimetry, UV/VIS spectrophotometry and many other types of equipment. Applications of some of this equipment to geological applications are still in progress.

To round out the facilities to handle virtually any type of geological application, in more recent years new wavelength dispersive and energy dispersive XRF as well as XRD instruments were acquired. Research was successful in developing a rapid low cost XRD screening for locating mineral deposits based on mineralogy. This now permits XRD at a price point that makes mineralogical zonation studies a viable exploration tool.

New geological services were developed and included Geometallurgy and a full metallurgy department (Thunder Bay) with the acquisition of new state of the art FEG-MLA and FEG-QEMSCAN. Actlabs was the first commercial mineral lab in the world to acquire and develop this high resolution automated mineralogy technology. New corporate divisions were also established including the High Technology Agriculture division which became GLP and OMAFRA accredited and provides GLP studies of the fate of newly developed pesticides in the environment, a new NIR facility for analysis of low cost and rapid animal feeds, identification of crop pests (like soybean cyst-nematodes) and possible remediation of infected soils and conventional soil analysis with plant growth specific leaches. A new biotech project using Elisa analysis progressing to multiplexing of up to 100 proteins simultaneously using laser induced Luminex methods is nearing completion and a patent will be applied for the development of a screen of biomarkers to detect muscle damage.

A new corporate lab was developed as Actlabs Global Headquarters in Ancaster Ontario which now houses 200,000 square feet of the most modern mineral lab and analytical scientific instrumentation in the world. The design embraced Lean technology, LEED construction and included large scale robotization.

Under Eric's ongoing guidance, Actlabs continued to Beta test equipment for most of the major analytical equipment manufacturers including Perkin Elmer, Thermo, Agilent and ESI. New generations of nitrogen based plasma ICP - the Agilent MP 4100 which runs on air (rather than argon) promises to be very useful in developing countries in places like Africa where the cost of argon is exorbitant or not available. Eric was currently trialing and helping to develop the next generation ICP/MS including the newest instruments from three manufacturers. All of these

## Dr. Eric Laurence Hoffman...*continued from page 19*

advances are aimed at providing lower detection limits, better reliability and lower cost of analyses to end users.

Eric's vision took the company forward into areas where he perceived automation to give an advantage in quality, price to customer and turnaround time. These include a robotic lithium borate fusion process for ICP and ICP/MS; automated digestion blocks for microprocessor controlled aqua regia and 4 acid digestions so that the digestions are not operator dependent; and a robotic LOI cell. Currently, research is underway to be able to provide robotic sample preparation which is simple and reliable and overcomes the carryover problems and exceptionally high cost of existing multimillion dollar robotic cells.

In an effort to provide customers with matrix matched certified reference materials, Eric initiated a new Reference Materials Division to produce and certify reference materials. This continues to help customers improve the reliability of data originating from commercial laboratories.

Eric contributed regularly to the development of exploration technologies by providing free or heavily discounted analyses to many research projects being undertaken by CAMIRO, CMIC, USGS, Geological Survey of Canada, and a number of universities as well as providing free analyses to help develop new certified reference materials by many organizations including CANMET, USGS, Central Geological Laboratory of Mongolia and OREAS.

### Worldwide Laboratories

The business model that Eric established is substantially different from that of large multinational company competitors in that he followed the belief that complete analyses can be performed in locations close to where samples are being generated rather than in central labs halfway across the world. This allows the customer base to obtain analyses more rapidly yet still at the highest quality.

Following this philosophy, international expansion began in 1994 with the opening of a laboratory in Lima, Peru. Rapid expansion in recent years has seen Actlabs grow to 30 labs in 12 countries with most of these facilities being full service laboratories offering a wide range of services. Internationally these include full or partial service labs in Nuuk, Greenland; Ulan Bator, Mongolia; Ouagadougou, Burkina Faso; Windhoek, Namibia; Georgetown, Guyana; Medellin, Colombia; Coquimbo, Chile; Zacatecas, Mexico, and many sample preparation labs scattered around the world. Additional labs were recently opened in Africa in Cote d'Ivoire and a service partnership established in Finland. In Canada there are comprehensive labs in Stewart; Kamloops, Dryden, Thunder Bay, Geraldton, Timmins and Sudbury, Ste. Germaine Boule and Val D'Or. Sample preparation facilities have been established in Fredericton and Goose Bay.

Another direction that Eric developed for Actlabs was the building and/or operating mine site labs include the main application and metallurgical labs at the Oyu Tolgoi Mine in Mongolia, as well as six other labs at iron ore

mines, gold mines, and graphite projects in various parts of the world as a part of a new Laboratory Outsourcing Division established in the last two years.

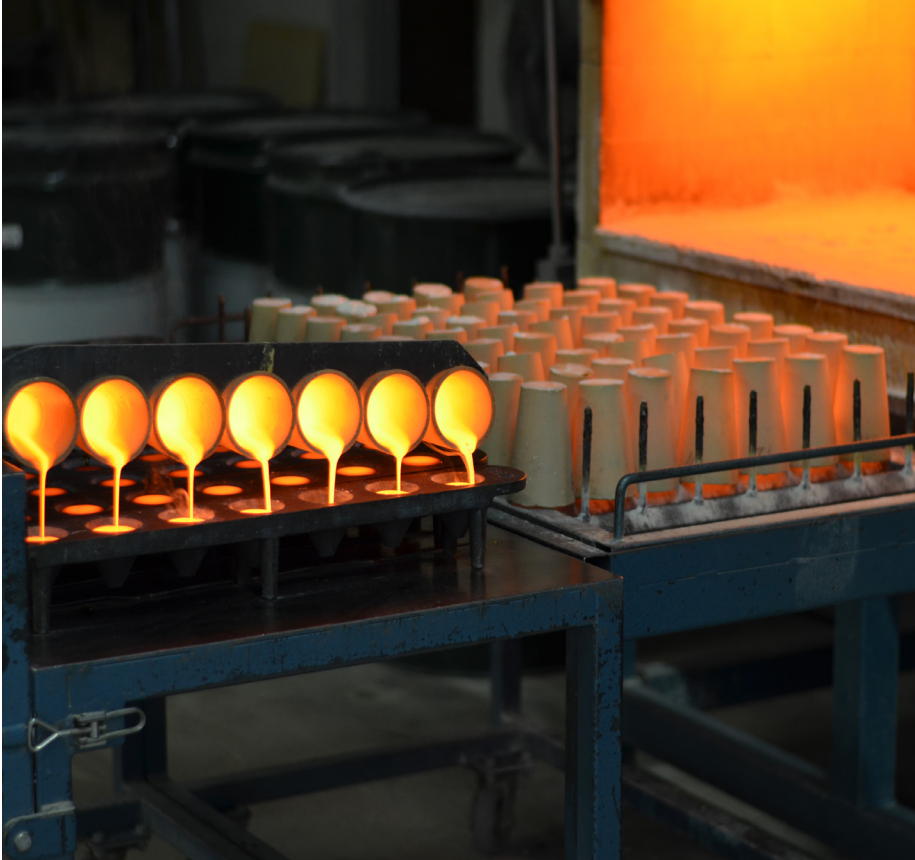
Through Eric's ongoing guidance Actlabs was recognized as an Innovation Leader in Canada recently when it was presented with an award by the Federal Minister of State for Science and Technology. Finally, in addition to the wealth of innovation and services that Eric had brought to exploration, and in particular the geochemical exploration community, he somehow found time to produce more than 40 publications and academic presentations at conferences worldwide.

The above represents an updated version of the accomplishments of Eric Hoffman and Actlabs. However, it misses the true essence of the man. Truly the business model of having analyses conducted in close locations to the client which allowed for a more personalized service, was a reflection of himself. He was always available to talk directly to clients and offer advice and suggestions to match the right analytical technique to their objectives. Using today's rapid and widespread email communications meant that nearly every day, no matter what part of the world he happened to be in, he was always within reach of his clients. Aside from his great pride in the achievements of his children, Michael, Robbi and Ariella, and the opportunity to guide and work alongside them with his wife Felyce; his life, his hobby, and his passion was steadfastly focused on the development, diversification and well-being of Actlabs. The aforementioned achievements were due to his tireless dedication which was recognized in receiving the 2013 Association of Applied Geochemists' Gold Medal for Outstanding Scientific Achievement in Applied Geochemistry, an award that he was deeply proud of.

The members of the AAG should know that the IAGS conferences were his most favourite to attend, not only due to their global flavour, and that they highlighted the latest direction and developments in geochemistry, but more importantly that it was an opportunity to meet and reconnect with his many colleagues and friends, that are too numerous to mention, who were highly valued and never forgotten. A large number of attendees at the most recent conference held in Tuscon, Arizona noted Eric's absence, and asked about him. This first-ever absence was due to medical testing to try and understand the illness that has since taken his life. His problem solving ability, knowledge, and expertise cannot be replaced, but the foundation he built in Actlabs will allow a near seamless continuance of providing high quality analytical services using the latest that science can offer. His legacy will live on through the continued efforts of the Hoffman family and the Actlabs family of employees around the world. It has been my privilege and pleasure to have worked and travelled alongside Dr. Eric Hoffman. It goes without saying that he will be sorely missed by all.

**Dale Sutherland**





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- Standards Council of Canada (SCC): Tests within our scope of accreditation



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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).

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) Tel: +1-709-729-1161

### 2015

- 16-19 SEPTEMBER 13th International Symposium on Biomineralization. Granada Spain. Website: [granada-en.congresoseci.com/biominXIII](http://granada-en.congresoseci.com/biominXIII)
- 20-25 SEPTEMBER 8th Hutton Symposium on Granites and Related Rocks. Florianopolis Brazil. Website: [www.hutton8.com.br](http://www.hutton8.com.br)
- 21-25 SEPTEMBER 11th meeting on Applied Isotope Geochemistry. Orléans France. Website: [aig11.brgm.fr](http://aig11.brgm.fr)
- 27-30 SEPTEMBER Society of Economic Geologists 2015 Conference: World-Class Ore Deposits: Discovery to Recovery. Hobart Australia. Website: [www.seg2015.org/](http://www.seg2015.org/)
- 28 SEPTEMBER-2-OCTOBER International Society for Environmental Biogeochemistry 22nd Symposium. Piran Slovenia. Website: [www.iseb22.ijs.si](http://www.iseb22.ijs.si)
- 5-6 OCTOBER 4th Annual International Conference on Geological & Earth Sciences. Singapore. Website: [www.geoeearth.org/](http://www.geoeearth.org/)
- 6-9 OCTOBER 3rd International Workshop on Antimony in the Environment. Leipzig Germany. [www.ufz.de/index.php?de=33277](http://www.ufz.de/index.php?de=33277)
- 9-11 OCTOBER New England Inter-Collegiate Geological Conference. Middletown CT USA. Website: [tinyurl.com/pd5d9ez](http://tinyurl.com/pd5d9ez)
- 18-21 OCTOBER 4th International Conference on Selenium in the Environment and Human Health. Sao Paulo Brazil. Website: [tinyurl.com/knrujup](http://tinyurl.com/knrujup)
- 25-31 OCTOBER Fall Course on Geochemistry of Hydrothermal Ore Deposits. Ottawa ON Canada. Website: [science.uottawa.ca/earth/short\\_course](http://science.uottawa.ca/earth/short_course)
- 1-5 NOVEMBER GSA 2014 Annual Meeting. Baltimore MD USA. Website: [www.geosociety.org/meetings/2015](http://www.geosociety.org/meetings/2015)
- 3-5 NOVEMBER 10th Fennoscandian Exploration and Mining. Levi Finland. Website: [10times.com/fem-levi](http://10times.com/fem-levi)
- 9-13 NOVEMBER Introduction to Secondary Ion Mass Spectrometry in the Earth Sciences. Potsdam Germany. Website: [www.gfz-potsdam.de/SIMS/short-course](http://www.gfz-potsdam.de/SIMS/short-course)

20-21 NOVEMBER 13th Swiss Geoscience Meeting. Basel Switzerland. Website: [tinyurl.com/p7pq3wb](http://tinyurl.com/p7pq3wb)

30 NOVEMBER-4 DECEMBER American Exploration and Mining Association Annual Meeting. Spokane WA USA. Website: [tinyurl.com/papq5jx](http://tinyurl.com/papq5jx)

### 2016

- 10-16 JANUARY Winter Conference on Plasma Spectrochemistry. Tucson AZ USA. Website: [icpinformation.org/Winter\\_Conference.html](http://icpinformation.org/Winter_Conference.html)
- 19-21 JANUARY 10th International Symposium on Environmental Geochemistry. Perth Australia. Website: [www.iseg10.com/](http://www.iseg10.com/)
- 25-28 JANUARY Mineral Exploration Roundup. Vancouver BC Canada. Website: [amebc.ca/roundup](http://amebc.ca/roundup)
- 5-6 FEBRUARY Atlantic Geoscience Society Annual Colloquium. Truro NS Canada. Website: [www.acadiau.ca/~raeside/ags2016/](http://www.acadiau.ca/~raeside/ags2016/)
- 21-26 FEBRUARY 2016 Ocean Sciences Meeting. New Orleans LA USA. Website: [osm.agu.org/2016/](http://osm.agu.org/2016/)
- 6-9 MARCH Prospectors and Developers Association of Canada Annual Convention. Toronto ON Canada. Website: [www.pdac.ca/convention](http://www.pdac.ca/convention)
- 17-22 APRIL European Geosciences Union General Assembly 2016. Vienna Austria. Website: [www.egu2016.eu/](http://www.egu2016.eu/)
- 22-25 MAY 10th South American Symposium on Isotope Geology. Puerto Vallarta Mexico. Website: [www.ssagi10.geofisica.unam.mx/](http://www.ssagi10.geofisica.unam.mx/)
- 1-3 JUNE GAC/MAC Annual Meeting. Whitehorse YT Canada. Website: [whitehorse2016.ca/](http://whitehorse2016.ca/)
- 13-17 JUNE 8th International Siberian Early Career GeoScientists Conference. Novosibirsk Russia. Website: [conf.ict.nsc.ru/sibconf2016](http://conf.ict.nsc.ru/sibconf2016)
- 26-30 JUNE Australian Earth Sciences Convention. Adelaide SA Australia. Website: [aesc2016.gsa.org.au](http://aesc2016.gsa.org.au)
- 26 JUNE-1 JULY Goldschmidt 2016. Yokohama Japan. Website: [www.geochemsoc.org/programs/goldschmidtconference/](http://www.geochemsoc.org/programs/goldschmidtconference/)



## CALENDAR OF EVENTS

*continued from page 13*

- 10-13 JULY 3rd International Conference on 3D Materials Science. St. Charles IL USA. Website: [tinyurl.com/psr55at](http://tinyurl.com/psr55at)
- 24-28 JULY Microscopy & Microanalysis 2016. Columbus OH USA. Website: [tinyurl.com/pdyxkpz](http://tinyurl.com/pdyxkpz)
- 21-25 AUGUST 33rd International Geographical Congress. Beijing China Website: [www.igc2016.org](http://www.igc2016.org)

- 27 AUGUST – 35th International Geological Congress. Cape Town South Africa. Website: [www.35igc.org](http://www.35igc.org)
- 4 SEPTEMBER
- 5-9 SEPTEMBER 13th International Nickel-Copper-PGE Symposium. Fremantle WA Australia. Website: [www.iagod.org/node/58](http://www.iagod.org/node/58)
- 9-13 OCTOBER World Water Congress & Exhibition. Brisbane QLD Australia. Website: [tinyurl.com/pgrbkwu](http://tinyurl.com/pgrbkwu)
- 11-15 SEPTEMBER 2nd European Mineralogical Conference. Rimini Italy. Website: [emc2016.socminpet.it/](http://emc2016.socminpet.it/)
- 16- 21 OCTOBER Water Rock Interaction 15. Évora Portugal. Website (pdf): [tinyurl.com/lch75x8](http://tinyurl.com/lch75x8)



## 2015-2016 AAG Distinguished Lecturer



The AAG's Distinguished Lecturer for 2015-2016 is Dr. Dan Layton-Matthews of Queen's University, Kingston, Canada. The distinguished lectures are one of AAG's efforts to educate the existing and young upcoming geochemists that will be tomorrow's leaders in applied geochemistry. Geology/geochemistry professors and student groups are encouraged to contact Dan ([dlayton@queensu.ca](mailto:dlayton@queensu.ca)) to arrange talks at their universities and institutions worldwide.

Dr. Dan Layton-Matthews' research has traditionally been involved in genetic models of VMS, SEDEX and magmatic Ni-Cu deposits. However since his appointment at Queen's University in 2007, he and his research group within the Queen's Facility for Isotope Research (QFIR) have been involved in: 1) chemical indicators of mineralization in sedimentary and magmatic rocks from ore systems, 2) post-depositional chemical modification of sulfide, silicate and oxide minerals, and the chemical dispersion and physical dispersal of these minerals as indicators of mineralization in ore systems, and 3) the development of tools

and concepts to aid in the discovery and understanding of formation and redistribution of ore deposits.

Dan's current research goals, and that of his research group, are to document the background and anomalous trace element compositions and isotopic ratios of all minerals within sedimentary and magmatic rocks related to ore systems, including the mineral, elemental and isotopic transfer to surficial media. Layton-Matthews is a young and dynamic researcher and has been awarded both the William Harvey Gross and Julian Boldy Certificate awards by the Mineral Deposits Division of the Geological Association of Canada. He has active research projects on five continents that relate to geochemical exploration and the detection of buried mineralization. Dan gave his first distinguished lecture entitled "An Applied Geochemist Convert" at the 27th IAGS in Tuscon, AZ. He is currently planning several lecturer tours starting in December 2015, which will be an excellent opportunity for the applied geochemistry community to hear his presentations.



## AAG Councillors Needed

Each year the Association of Applied Geochemists (AAG) needs motivated and energetic AAG Fellows to stand for election to the position of “Ordinary Councillor.” Fortunately, each year some of our most outstanding Fellows are ready, willing, and able to meet this challenge. This is the annual reminder to AAG Fellows that we need your participation on Council. It is our sincere hope that this email might entice more Fellows to step forward for election to this most important position.

### Job Description

The AAG Bylaws state that “the affairs of the Association shall be managed by its board of directors, to be known as its Council.” The affairs managed by Council vary from reviewing and ranking proposals to host our biennial Symposium to approving application for new membership to developing marketing strategies for sustaining and growing our membership. These affairs are discussed and decisions made at Council teleconferences usually held 3-4 times per year. Each teleconference lasts about 1 hour. In addition, there is often a running email discussion about a selected issue or two between each teleconference. So for a commitment of about 5 hours of your time per year, you can help influence the future of your Association. If you want to spend more than the minimum time required, there is plenty of opportunity to do so through committee assignments and voluntary efforts that greatly benefit the Association.

### Qualifications and length of term

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

Each Councillor serves a term of two years and can then stand for election to a second two-year term. The Bylaws forbid serving more than two consecutive terms, although someone who has served two consecutive terms can stand for election again after sitting out for at least one year. Elections are usually held in the fall of the year for a term covering the following two years. Our next election will be in the Fall of 2015 for the term of 2016-2017.

### How to get on the ballot

If you are interested in placing your name into consideration for election to AAG Council, simply express your interest to the AAG Secretary (Dave Smith, [dsmith@usgs.gov](mailto:dsmith@usgs.gov)) by October 10, 2015 and include a short (no more than 250 words) summary of your career experience. This summary should include the following:

- Your name
- Year you became a Fellow of AAG

- Earth science degrees obtained, year of graduation of each, and institution of each
- Employment—list major employers and state years worked for each, e.g. 1980-1990, and type of work
- Position held as part of AAG or other past contributions to AAG
- 1-2 sentences about your professional experiences in applied geochemistry

All that is asked is that you bring energy and ideas to Council and are willing to share in making decisions that will carry the Association forward into a successful future. We look forward to hearing from you.

**Matt Leybourne**

*President, Association of Applied Geochemists*



## Elements June 2015 Issue Apatite: A Mineral for All Seasons



The June edition of *Elements* focuses on the mineral apatite and its many uses in the earth sciences. It includes articles on the mineralogy of the apatite supergroup (Hughes & Rakovan), its uses in fingerprinting the chemistry and temperature of magmatic (Webster & Piccoli) and metasomatic processes (Harlov) on our own planet, as well as on extraterrestrial bodies (McCubbin & Jones), its importance in low- to high-temperature thermochronology and geochronology (Chew & Spikings), and its many practical uses in a wide variety of applications (Rakovan & Pasteris). Having spent a large chunk of my geological career working with apatite, I was humbled by how little I knew of its other uses!

**Dennis Arne**





## Upcoming Short Course — Geochemistry of Hydrothermal Ore Deposits

The University of Ottawa Modular Courses in Hydrothermal Ore Deposits are intensive 8-day short courses on the geology and genesis of ore deposits in a variety of crustal environments. This year's course, October 24 to 31, 2015, will focus on the practical aspects of ore element geochemistry, mineralogy and fluid chemistry and their bearing on the understanding of the origins and evolution of hydrothermal ore deposits. Leading experts will introduce the basic principles that govern the formation of ore-forming fluids, their interaction with different rock types, and the role of different ore-fluid reservoirs, with applications of these concepts to exploration. Case studies involving field and laboratory data sets will be developed for some of the world's most important hydrothermal ore deposits in both continental and submarine environments. The emphasis will be on understanding the fundamental controls on the behavior of ore elements and minerals and fluid-rock interactions, as well as the tools used to interpret them. The material will be suitable for graduate students with advanced 3rd and 4th-year training in ore deposits and for professionals in industry.

The course will be presented as four 2-day modules that will focus on the following topics:

- practical guides to the ore elements, minerals, and fluids;
- analyzing rocks, minerals, and fluids in hydrothermal systems;
- fluid-rock interactions and processes of hydrothermal alteration;
- case studies of porphyry, epithermal, VMS, and orogenic Au systems;
- applications to exploration.

Participants will gain a working knowledge of the use of physics and chemistry in the interpretation of hydrothermal ore deposits, including concepts that are critical for exploration. The lectures will draw from standard texts, such as *Geochemistry of Hydrothermal Ore Deposits*, and the experience of experts to explore the sources of hydrothermal solutions, their reactions with host rocks, and the causes of mineral precipitation. We will examine mineral stabilities and controls on metal solubility, P-T-pH-redox conditions and their importance in ore formation, and the integration of basic field and laboratory studies to unravel fluid-rock interactions – from drill core to the laboratory and back. The lectures will combine both theory and practical applications, emphasizing the use of information that is readily accessible to exploration and mining geologists, including geological maps and cross sections, mineralogy, and the chemical compositions of the ores and host rocks. This training is intended to provide the non-specialist with the ability to use techniques widely applied in research and exploration for hydrothermal ore deposits. Exercises will be performed in class on the interpretation of field data, as well as laboratory analyses of rocks, minerals, ores and fluids, emphasizing concepts and approaches that can be employed by professional geologists in the field.

### Course Schedule

- October 24, 25: Practical Guide to Ore Elements, Minerals and Fluids (Mark Hannington)
- October 26, 27: Analyzing Rocks, Minerals and Fluids in Hydrothermal Systems (Matt Leybourne)
- October 28, 29: Fluid-rock Interaction and Processes of Hydrothermal Alteration (Dan Kontak)
- October 30, 31: Porphyry, Epithermal, VMS and Orogenic Au Systems (Al Galley)

### Registration

Please contact Sarina Cotroneo to obtain the registration form.

Department of Earth Sciences,  
University of Ottawa,  
25 Templeton Street,  
Ottawa, Ontario, K1N 6N5  
Tel: +1 (613) 562-5292  
Fax: +1 (613) 562-5192  
Email: [icsr@uottawa.ca](mailto:icsr@uottawa.ca)

Web link: [http://science.uottawa.ca/earth/short\\_course](http://science.uottawa.ca/earth/short_course)

## AAG New Members

### Fellow:

Marian (Swanny) Skwarnecki  
Senior Manager Geochemistry, Asset Development &  
Brownfields  
COO International  
AngloGold Ashanti Ltd  
Level 14, 44 St Georges Terrace  
Perth, WA 6000 Australia  
Membership # 2244

Katherine Knights  
Geological Survey of Ireland  
15 Coronation Gardens  
Isle of Wight, England  
United Kingdom PO37 7DZ  
Membership # 4304

### Regular Member:

Emily Taylor  
Research Scientist  
Alberta Innovates-Technology Futures  
2407 17 Street SW, Unit 12  
Calgary, AB  
CANADA T2T4M9  
Membership # 4286

Liam Bullock  
Geological Consultant  
Tactical Environmental Response Ltd  
15 Applegarth Close  
Fenpark  
Stoke-on-Trent  
UNITED KINGDOM STS ST4 3RN  
Membership # 4289

John Siriunas  
VP Exploration  
51-7 Corporation,  
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Natacha Fournier  
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Membership # 4291

Marilena Stimpfl  
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Membership # 4292

Douglas Baillie  
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CANADA V8R1N8  
Membership # 4293

James Bartle  
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Leederville, WA  
AUSTRALIA 6007  
Membership # 4295

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Associate Professor  
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Department of Geological Sciences  
1250 Bellflower Blvd.  
Long Beach, CA  
USA 90840  
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**AAG New Members...***continued from page 26***Student Members:**

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**AAG Member News**

*Stew with his wife, Flora, after receiving Canada's National Committee of Provincial and Territorial Geologists medal.*

AAG Fellow Dr. Stew Hamilton, Senior Geoscientist at the Ontario Geological Survey was awarded with Canada's National Committee of Provincial and Territorial Geologists medal in July 2015. He has been recognized as the 2015 outstanding geoscientist from one of Canada's provincial or territorial geological surveys. The medal was presented at the annual Energy and Mines Ministers Conference, in Halifax, Nova Scotia. Stew's work has advanced geoscience to the benefit of Government priorities, the geoscience profession, and societal needs. Stew is also an enthusiastic mentor to numerous undergraduate and graduate level students and is a leader in contributing to a new generation of geoscientists with expertise in geochemical and hydrogeological mapping techniques. Stew is recognized provincially, nationally and internationally as a pre-eminent expert on the science of geochemistry and hydrogeology and their application to numerous geoscience problems across Ontario including the origin of forest rings in northern Ontario; kimberlite (diamond) exploration in the Far North; geochemical techniques to aid mineral exploration in regions of thick overburden cover; and mapping groundwater quality in southern Ontario.



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 Bob Eppinger, *Ex Officio*

2015-2016

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 Pertti Sarala  
 Romy Matthies

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#### ELEMENTS

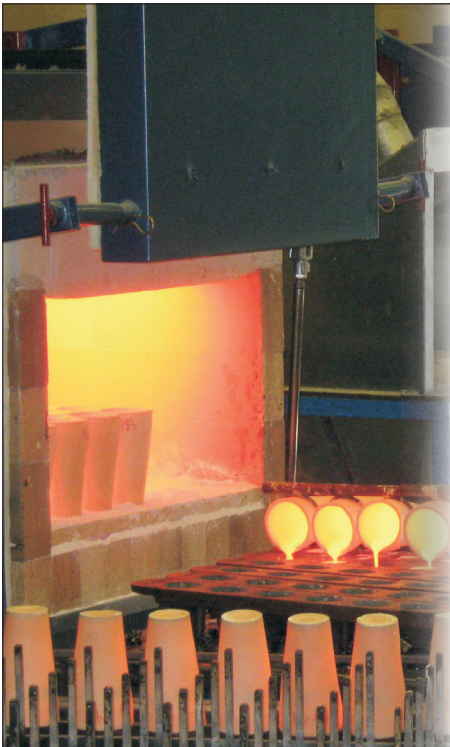
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