EXPLORE
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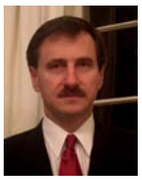
Newsletter for the Association of Applied Geochemists

President's Message


David Cohen

A happy new year to all AAG members and supporters. I would like to congratulate Bob Eppinger, Chris Oates, Erick Weiland, Elizabeth Bailey and John Carranza on their election to Council for the period 2009-2010. John joins Council for the first time. With a new Council in place, we are also looking at the committee structure of the Association to ensure it supports the key AAG activities and functions. This may involve merging some committees that are closely linked in function or purpose and creating some new committees.

The moves to obtain registration of the AAG as a charitable organisation by Canada Revenue Agency (and therefore allow donations to the Distinguished Applied Geochemists Fund to be tax deductable in Canada) were not approved. The problem lies in the wording of a couple of the AAG's objectives. We are appealing the decision, but this will require rewording of the objectives to emphasise the principal purpose of the AAG which is the advancement of education in applied geochemistry (through support of students, the holding of technical symposia and publication of the journal and newsletter). Some changes are required anyway to complete the transition from the AEG to the AAG and ensure the objectives and other parts of our by-laws reflect the current purposes and activities.

An interesting conflict of interest has arisen for me this week. For decades we have been taking our third year undergraduate geochemistry classes to an abandoned sulphide mine a couple of hours west of Sydney. The site is one of the best field teaching laboratories available for exploration geochemistry, environmental geochemistry, ecological studies and even mining history.

Groundwater continually seeps from the old adits with a pH 2.9 to 3.2, depending on rainfall, and contains around 11 ppm arsenic and 1 ppm lead. As the water leaves the adit it oxidise and progressively deposits a range of aluminium minerals, followed by thick mats of iron oxyhydroxides with over 1% arsenic and lead downstream. The acidity and toxic metal concentrations in the water allow green algae to thrive due to the lack of predators. The rocks in the area offer very little acid neutralisation capacity and 3 km downstream the waters display a pH of 4.5 and 2 ppm As. The mine waters are gradually diluted by other streams in the area but eventually find their way to reservoirs used for drinking water by towns in the region. The eucalypts and acacia in the area of the mine were stripped to fuel the ore roasting plant and, in recent years, parts of the site have been colonised by non-native radiata pines seeded from the surrounding timber plantations.

Due to the contamination and the danger of falling down shafts, the site was made off-limits to the general public a few years ago. The government is therefore proceeding to develop and implement a remediation plan for the site. So, the conflict is whether one should support the remediation of the site for the good of the environment or oppose the remediation on the grounds of its educational benefits and the preservation of mining heritage.

David Cohen
President, AAG

Natural and Experimental Clues to Understand the Transport and Deposition of Supergene Gold in Western Australia

INTRODUCTION

Supergene gold deposits are relatively small (<1.5 Mt) and of low grade (1-5 g/t), but provide easy start up options for early cash-flow generation for small mining operations (Butt 1998), and such operations are abundant in Western Australia. One question asked is "can the information provided by studying the supergene Au be used as a vector to primary systems?" Hough *et al*. (2007; 2008) have investigated the morphology and geochemistry of Au to unravel some of the mysteries of nugget and single crystal formation that has indicated a need to look closer at both natural and synthetic Au morphologies and environmental constraints that will assist exploration.

Secondary Au deposition occurs through weathering of a primary hypogene Au deposit, dissolution of the Au from the host quartz or sulfide primary minerals, with the Au being mobilized in solution, transported and then deposited via precipitation at a later stage. Gold is inert in many weathering conditions, but can mobilize when complexed to stable ligands that are commonly found in soil and groundwater (Gray *et al*. 1992). Thiosulfate, organics and halides are believed to be the main ligands that mobilize Au (Butt 1998). In tropical environments cyanide, hydroxide and ammonia may also be functional ligands (Vlassopoulos & Wood 1990; Bowell *et al*. 1993). Bacteria have been shown to influence Au solubility and precipitation (Reith *et al*. 2006; Reith & McPhail 2006). A more detailed understanding of the mechanisms of formation of micro- and indeed nano-particulate Au may lead to a better understanding of supergene Au deposits, distance and conditions of mobilized Au, and in turn develop the capability of using morphology of supergene Au in the near surface environment to target larger hypogene Au systems.

A study of saprock fractures at an abandoned open-pit

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Au deposit was conducted to investigate the morphology of Au in the supergene zone and to search for nanoparticulate components. The pit, south of Southern Cross in Western Australia (Fig. 1), was a small Au deposit where localised primary mineralisation occurs as small, high grade quartz veins, blanketed by 30 m of weathered cover (Fig. 2).

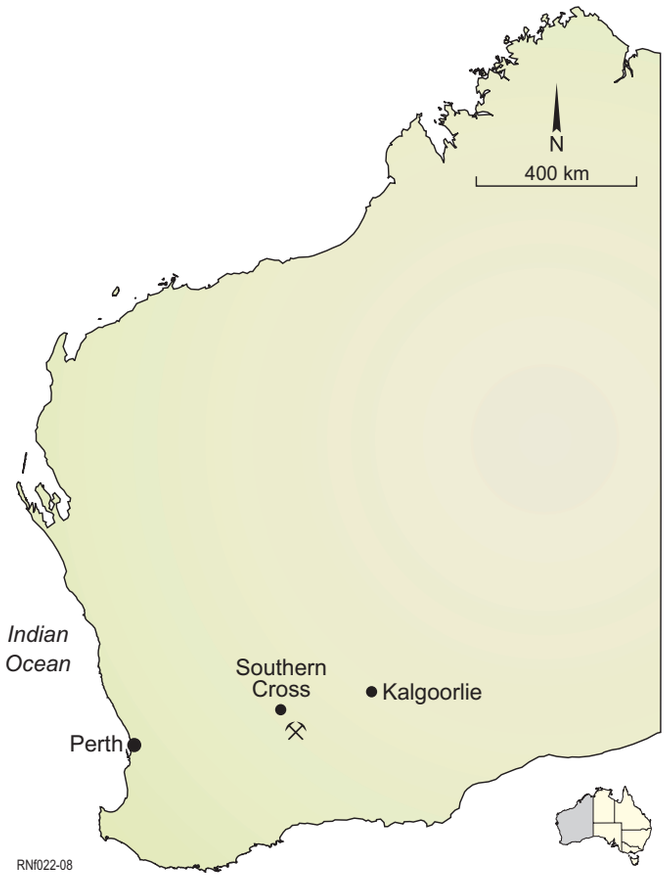

Figure 1. Location of the abandoned open-cut Au pit, approximately 400 km west of Perth, in western Australia.

Figure 2. The regolith profile at the abandoned open cut Au pit near Southern Cross. Regolith depth is approximately 30 m, with significant Fe staining of the upper profile. The approximate location of the saprock sample is shown by the white arrow.

Following the field observations, laboratory experiments were conducted to determine if the morphologies of Au observed in nature could be produced synthetically, and as a result indicate potential mechanisms of formation and deposition, as well as to identify key ligands involved in transportation.

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Notes from the Editor

The March issue of **EXPLORE** (No. 142) includes one scientific article. Ryan Noble, Robert Hough and Elizabeth Grenik describe their study of gold morphology and its contributions to the understanding the transport and deposition of supergene gold in Western Australia. Kiel Arndt reports on the modular exploration geochemistry course recently taught at Laurentian University in Sudbury, Canada. Scientific and technical editing assistance for this **EXPLORE** issue was provided by Owen Lavin, Newmont Mining Corp., an anonymous reviewer and Roger Paulen, Geological Survey of Canada. Coming in the June issue of **EXPLORE** will be an article describing Falconbridge's kimberlite discoveries in Botswana in the late 1970s and early 1980s. The deadline for submitting abstracts for the upcoming IAGS, June 1-4 2009 in Fredericton, Canada has passed, but members should continue to check out the IAGS website for updates on the technical sessions, workshops and field trips.

If you have not already done so, AAG strongly encourages members to renew their membership online to support AAG and help maintain uninterrupted delivery of GEEA and **EXPLORE**.

Beth McClenaghan

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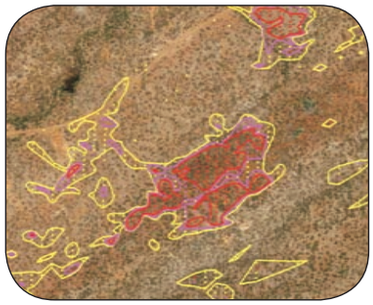

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METHODOLOGY

Saprock materials were collected from the open-pit at approximately 30 m depth, above the primary mineralised zone. The fracture surfaces in the quartz blocks from this zone were covered in finely disseminated Au crystals. Selected pieces with this visible Au were then imaged using optical microscopy and Scanning Electron Microscopy (SEM, Philips XL-40) with an Energy Dispersive X-ray Spectrometer (EDS) used to obtain low magnification images using the backscatter electron (BSE) detector and compositional data (EDS), operating at 30 kV. Field Emission Gun Scanning Electron Microscopy (FEGSEM, Zeiss) images were collected at the Centre for Microscopy at the University of Western Australia. A low accelerating voltage of 3kV was used; with 1 kV used for some images to provide true surface images at high magnifications.

Synthetic Au crystals were manufactured in the CSIRO laboratory (Kensington, WA) by evaporation of 500 ppm chloroauric acid at ambient temperature or on a hot plate at approx. 120°C in a fume hood. In some cases additional ligands such as 0.01 M oxalic acid ($C_2H_2O_4.2H_2O$) was added to the solution and pH and temperature were adjusted. Characterization of the synthetic Au was conducted in the same manner as with the natural samples.

RESULTS

The use of various microscopy techniques revealed the morphology and chemical composition of the saprock materials. On the surfaces of the fractures, numerous populations of Au crystals were observed with the common euhedral, face centred, cubic, crystal structure. The Au shapes were triangles and hexagons. Other minerals such as halloysite and barite were also detected.

The laboratory work produced Au particles in all experiments. The solutions did not change their absorbance characteristics over time or with the different conditions. Following evaporation, microscopy and EDS analysis showed microparticles and nanoparticles of Au in triangular and hexagonal morphologies. Some variation existed in the number and size of Au particles depending on the treatments of the AuCl solutions.

DISCUSSION

Primary Au typically occurs as a Au-Ag alloy. However, secondary Au is commonly pure, although secondary Au-Ag alloys have also been shown to form in isolated cases (Webster & Mann 1984; Bowell *et al*. 1993). Supergene deposits are formed via chemical and mechanical weathering. This two-phase weathering results in Au being mobilized in solution and precipitating as pure secondary Au crystals in other areas. The mobilization of Au is probably in the order of a few metres to a few hundred metres in the Yilgarn Craton (Anand et al. 2007; Hough *et al*. 2008). Weathering fractures above primary mineralisation are the ideal place to observe this secondary deposition of Au. Studying the morphologies coupled with laboratory experiments can also provide clues into the natural conditions, mechanisms and associated ligands that are involved in the transport and deposition of Au.

The hypogene quartz veins at the base of the pit contain visible Au with approximately 10% Ag in an Au-Ag alloy. The surrounding groundwater also contains large concentrations of both Au and Ag, 44 and 293 ppt, respectively (Hough *et al*. 2008). A study of saprock fractures above this zone shows significant populations of Au crystals. The Au is pure, and exists as euhedral, isometric crystals. These particles vary in diameter from 300 μm to 0.02 μm (Fig. 3). Initial imaging of these samples did not show

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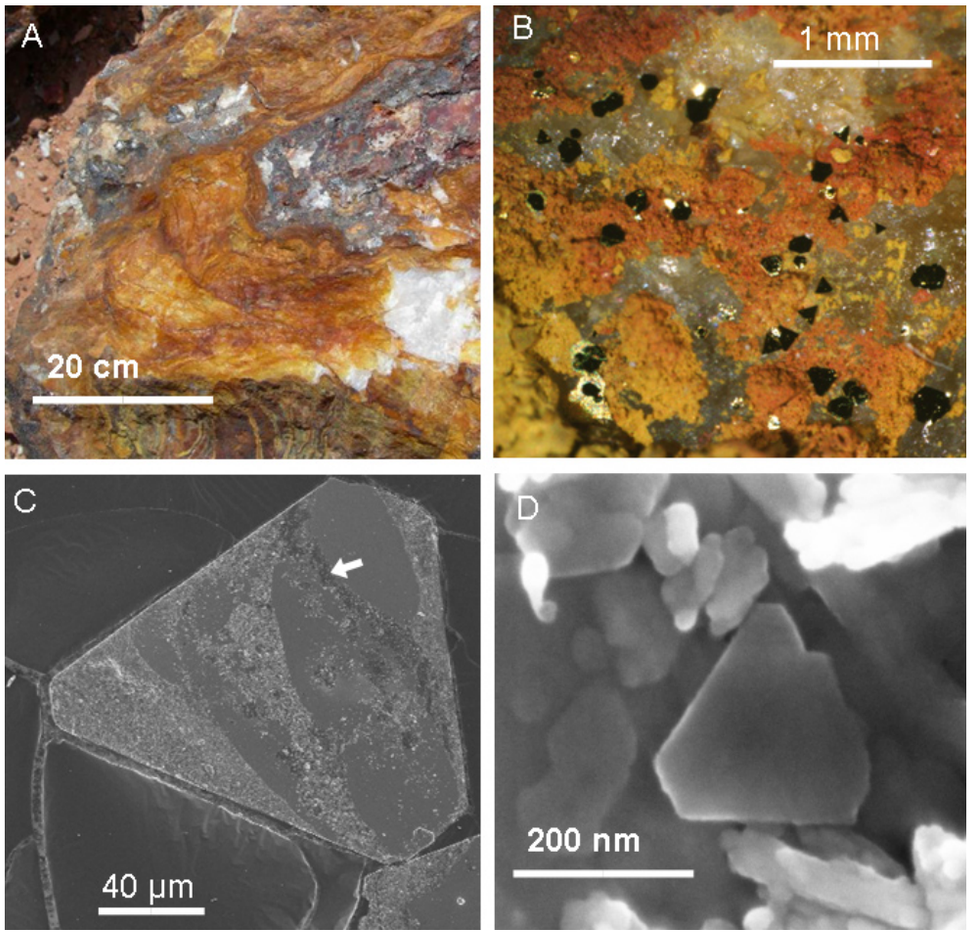

Figure 3. Clockwise from top left, increasing the magnification on the surface of a weathered quartz saprock fracture: A) a larger block of quartz saprock, B) light microscope image of black and shiny Au triangular and hexagonal crystals , C) FEGSEM image of a microparticulate Au crystal, and D) a close up of the darker band shown in C with an arrow, depicting nanoparticulate Au and halloysite.

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some of the large triangles and hexagons of Au as they are extremely thin (<20 nm; Hough *et al*. 2008). The SEM images produced at the commonly used voltage of 30 kV were seeing "through" these plates as the atomic number contrast was not great enough in the SEM BSE (Fig. 4).

Imaging of the surfaces of the large Au triangles using FEGSEM and secondary electrons revealed banded patterns that represent the smaller population of Au nanoparticles and halloysite. Hough *et al*. (2008) states that these phases are not coprecipitated (one forming nucleation sites for the other), but they are randomly coexisting in a drying pattern related to differential precipitation during evaporation and particle deposition. The halloysite is supported by a matrix of Au nanoparticles (Fig. 3D), these nanoparticulate Au crystals may also occur in smaller size fractions (left of centre in Fig 3D). These weathered fractures in the saprock also contain various Fe oxides, clays, sulphates and salts.

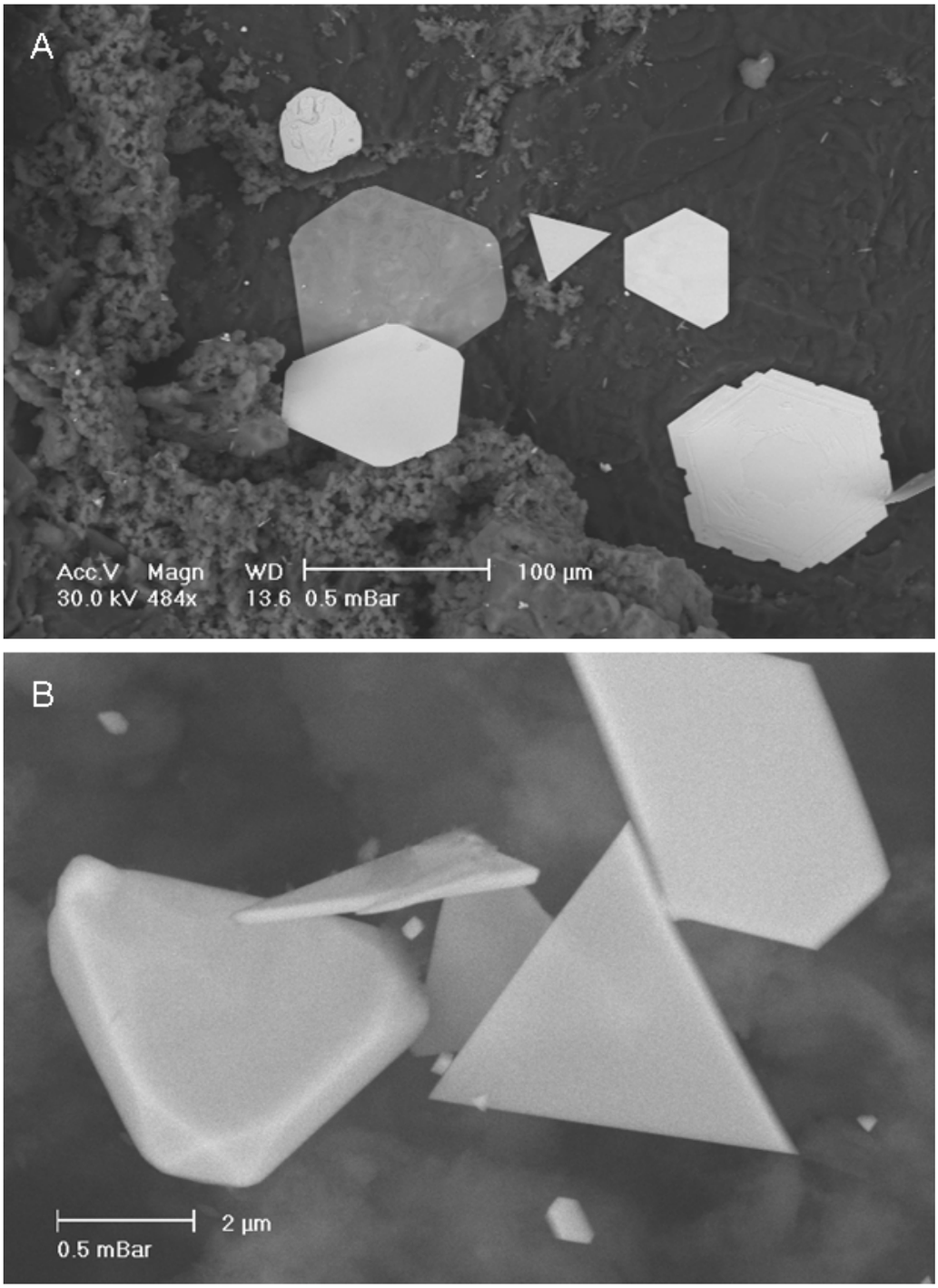

Figure 4. Naturally occurring hexagons and triangles of Au in the saprock fractures. Some of these plates are very thin and are partially transparent, showing the underlying Fe oxides and silicates (A), where as others are growing into cubic pyramid forms (B).

The size of these Au populations may be relevant to our understanding of partial extraction results and transport mechanisms. Partial extractions may only dissolve the smaller, nanometre-sized, more labile Au crystals resulting in biased results. Understanding the constraints on Au morphology may reveal more information about the formation of secondary Au deposits and Au fractions in soils, although more work is required. The aim would be to use the chemistry and morphological information of supergene Au to vector in to primary hypogene systems.

Regolith and groundwater chemistry influence the mobility of Au. In the southern areas of Western Australia groundwaters are highly saline, greater than 3x seawater (67,000 mg/L Cl) and acidic (pH down to 3), and soluble Au primarily occurs in solution as the Au-chloride complex (Gray 2001). Evaporation of chloroauric acid ($HAuCl_2$) was conducted in the laboratory to observe the morphology that can be expected with Cl as the primary ligand and compared to the natural samples (Figs. 3 & 4). Results show the morphology of Au to be similar to those observed in saprolite from the study site (Fig. 5). Populations of microparticulate and nanoparticulate triangles and hexagons occur on top of Au-chloride salt crystals as determined by SEM EDS analysis. The triangles and hexagons range in size from 100 μm to 0.060 μm.

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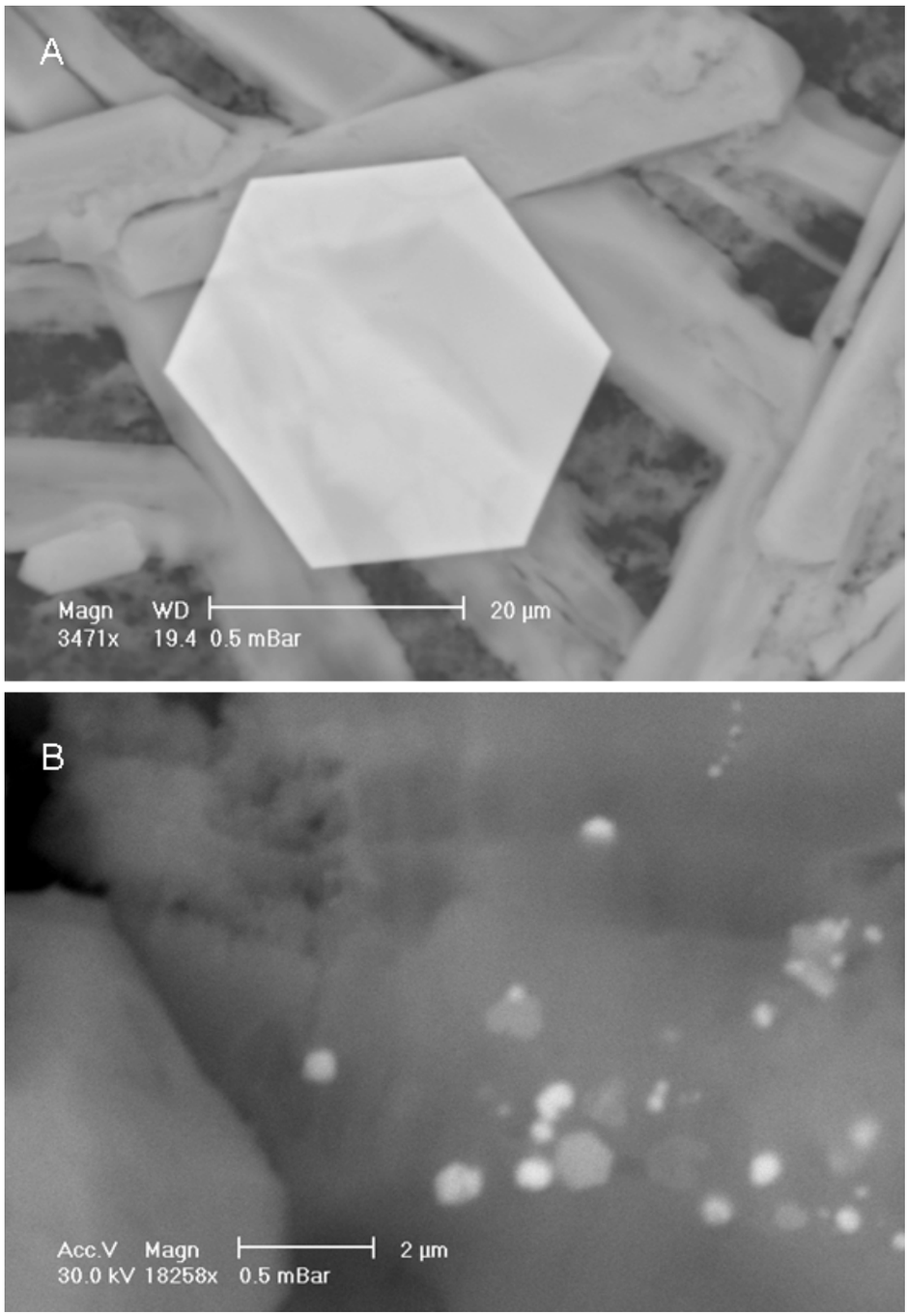

Figure 5. A) Gold formed from the evaporation of Au-chloride.The common hexagonal pure Au crystal is sitting on top of Au-chloride crystals. B) An additional nanometre sized population of Au hexagons is also present.

The Au-chloride solution was not evaporated immediately, and the visible light absorption was measured over time. Previous work in the area of materials science and nanoparticles has shown those Au colloids forming in solution change the solution colour as the reaction progresses, with colour controlled by the size of the colloidal Au. Using evaporation as the mechanism of formation, the absorption did not change during the experiments, indicating the Au is not colloidal during this time and formed after the solution was placed on the slide as a result of evaporation.

Other organic ligands may also be important for particulate Au formation; combining Au-chloride with oxalic acid produced numerous forms of Au (Fig. 6). Not only were the common hexagons and triangles observed, but also larger 3D pyramids and wires of Au. The reduction of the Au-chloride by the oxalic acid rapidly precipitates Au crystals in minutes compared with the hours of formation via evaporation. In natural conditions, a Au-chloride bearing solution would form supergene Au quickly, particularly in the presence of oxalic acid (or other strong reductants). Organic compounds are usually used in the nanotechnology manufacturing as capping agents to control size and shape of Au (Bi *et al*. 2008; Tan *et al*. 2003). The common supergene environment (especially in this study region) does not contain a large concentration of organic ligands, and in turn these compounds are unlikely to act as controlling variables, hence the bulk of formation is likely driven by slightly slower, inorganic evaporation.

Additional evaporite minerals are also evident in the study area and indicate that the evaporation mechanism of Au deposition is plausible. Gold microparticles are clearly visible in barite crystals (Fig. 7). Once bound in the barite, this Au is much less easily mobilized, which again indicates the importance of understanding the morphology as well as the host minerals of secondary Au in the near surface and deeper environments. This understanding may have significant implications for i) the formation and deposition of supergene Au, ii) secondary mineral fractions removed from soils in partial extractions with relation to Au, and iii) the ability to develop methods of using partial extractions and secondary mineral fractions to vector to mineralisation.

CONCLUSIONS

Studying the natural Au crystal morphologies, coupled with laboratory experiments has provided insight into the environmental conditions, mechanisms and associated ligands that may be involved in the transport and deposition of supergene gold in Western Australia. In the southern Yilgarn Craton supergene gold deposits are most likely formed through the evaporation of AuCl complexes in a relatively short time. Whether the use of the secondary Au crystal characteristics and associated minerals can be linked

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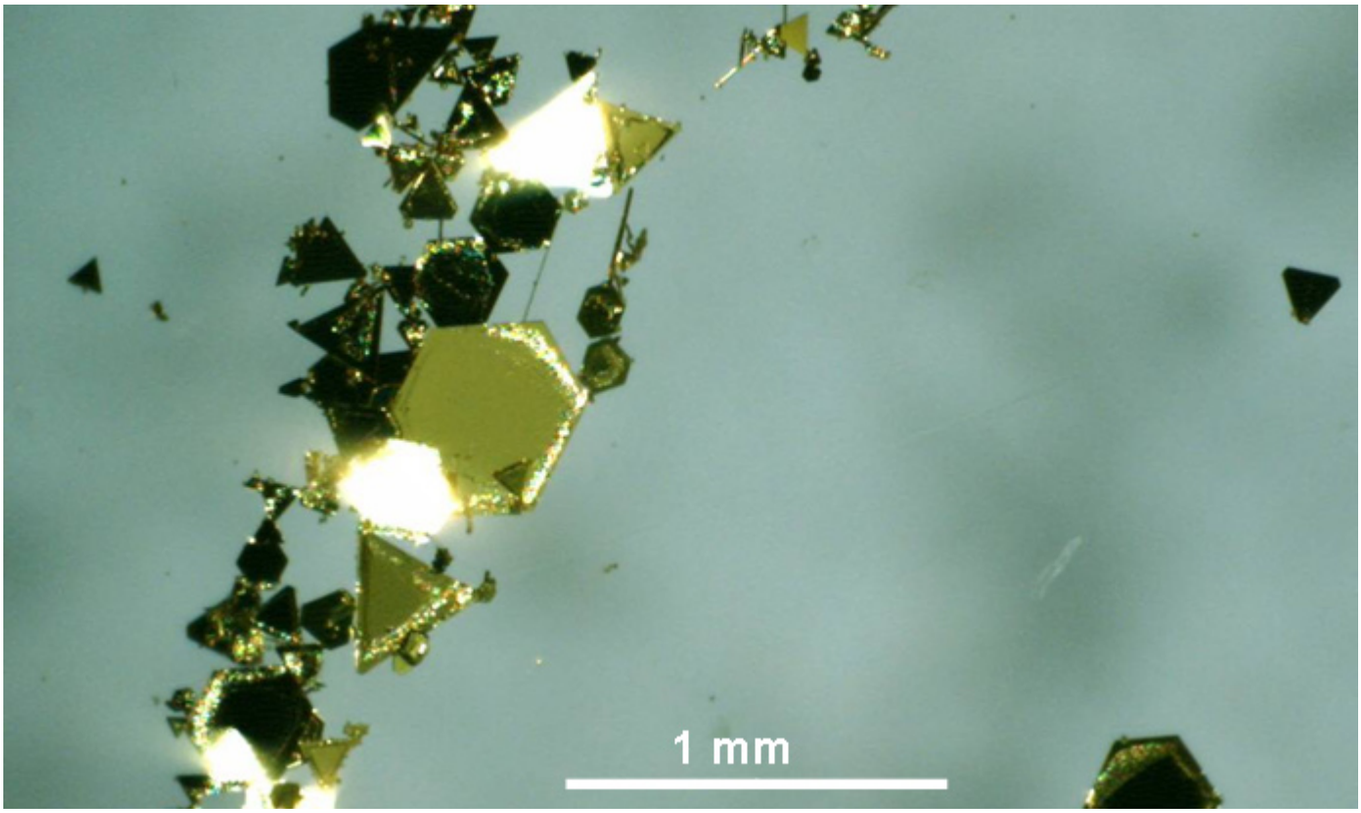

Figure 6. Particulate Au triangles and hexagons formed from the reduction reaction with oxalic acid.

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Figure 7. Visible Au formed within barite.

to primary hypogene systems is unclear, but it provides an ultimate goal and direction for future research.

ACKNOWLEDGEMENTS

Peta Clode (UWA), Michael Verrall (CSIRO) and Greg Hitchen (CSIRO) assisted in SEM work. The National Measurement Institute allowed use of the absorbance spectrophotometer. Funding for this work was provided by CRC LEME and CSIRO Minerals Down Under Flagship program. Owen Lavin, Beth McClenaghan, David Gray, Nathan Reid, Ravi Anand and an anonymous reviewer are thanked for reviewing this manuscript.

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Modular Course in Exploration Geochemistry (GEOL 5806) Laurentian University, Sudbury, Ontario, Canada

Laurentian University, located in Sudbury, Ontario, presented the Modular Course in Exploration Geochemistry from December 3 – 12, 2008. This course was offered by the University's Department of Earth Sciences and Mineral Exploration Research Centre (MERC) as one module of an Applied M.Sc. Program at Laurentian (http://www.earthsciences.laurentian.ca). A total of 16 people attended the course this year: 11 students, 2 industry geologists, and 3 industry geologists that will commence the Applied M.Sc. Program through taking this course. Some of the students came straight from undergraduate studies, whereas others had varying levels of industry experience. Industry professionals were welcome to attend as a one-time enrollment for continuing education. Unfortunately, industry enrollment was down from past years.

Geochemistry, as it relates to mineral exploration, was presented in ten days of intensive lectures and laboratory practicals. The organizer and head lecturer of the course was Dr. Stephen Piercey, PGeo (SJPGeoConsulting/Memorial University of Newfoundland/MERC). Other presenters for the course came from the mineral exploration industry as well as academia and government.

The first day of the course provided an introduction to geochemistry with topics of sampling, sample preparation, and different analytical techniques. In the afternoon session, QAQC methods and best practices were covered. Following the lecture, data sets were provided for hands-on use of several of the methods. The next four days were spent on theoretical geochemistry. Topics covered were lithogeochemistry, radiogenic isotopes, stable isotopes, and hydrothermal alteration geochemistry, which included mass balance methods, element mobility, and how to set up alteration indices to a specific style of mineralization. In the afternoons, laboratory practicals were assigned with sample datasets. The next three days consisted of presentations from guest lecturers covering the geochemistry of different styles of mineralization and associated case studies. The final two days covered surficial exploration geochemistry presentation topics including soil, till, and take sediment geochemistry.

Topic	**Lecturer**
Hydrothermal Sediments and Applications in Exploration	Jan Peter (Geological Survey of Canada/MERC)
Portable XRF/ASD Units in Exploration Geochemistry	Jan Peter (Geological Survey of Canada /MERC)
Statistical Applications in Geochemistry	Eric Grunsky (Geological Survey of Canada /MERC)
Geochemistry of Sulfide Deposits in Sedimentary Basins	Wayne Goodfellow (Geological Survey of Canada)
Lithogeochemistry of VMS Systems	Stephen Piercey
Magmatic Ni-Cu-PGE Sulfide Systems	Michael Lesher (Dept. Earth Sciences/MERC)
Komatiite-hosted Ni-Cu-PGE Sulfide Systems	Michael Lesher (Dept. Earth Sciences /MERC)
Kimberlites and Diamond Indicator Mineral Chemistry	David Crabtree (Ontario Geoscience Labs)
Mineral Chemical Methods in Exploration Geochemistry	Stephen Piercey
Overview of Surficial Geochemistry: Soil Development and Processes, Sample Media and Methodology, and Designing Sampling Programs	Bill Coker (BHP-Billiton)
Drift Prospecting: Till Sampling, Ice Flow Indicators and Dispersal Trains, Indicator Minerals	Beth McCleneghan (Geological Survey of Canada)
The Use of Lake Sediment Geochemistry for Mineral Exploration	Richard Dyer (Ontario Geological Survey)
Soil Geochemistry in Areas of Thick Cover	Stewart Hamilton (Ontario Geological Survey)
Forest Rings and Their Implications to Geochemical Exploration for Oil, Gas, and Mineral Deposits	Stewart Hamilton (Ontario Geological Survey)

Speakers for the final days of the modular course: (left to right) Stew Hamilton, Beth McClenaghan, Steve Piercey, Richard Dyer, Bill Coker.

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The Ontario Geoscience Laboratories (OGL), which is part of the Ontario Ministry of Northern Development and Mines, invited the course participants to tour the labs for an afternoon. During the tour, the participants were shown sample storage, sample preparation, nickel fire assay, partial digestions by acid, ICP-MS, preparation of glass bead and pressed pellet for XRF, loss on ignition analysis, particle size analysis, and electron microprobe analysis and images. During the course, an Innov-X portable XRF analyzer was provided by Jan Peter (Geological Survey of Canada) for hands on use. A suite of massive sulfide hand samples were also available for closer inspection. Microscopes were set up for a laboratory exercise in grain picking of kimberlite indicator minerals as well.

Glenn House of Vale Inco Ltd. looking at indicator mineals in the lab session of the drift prospecting module.

This course provided the participants with a broad spectrum on the background and recent advances of geochemistry and its application to mineral exploration. The first five days provided a great introduction to theoretical geochemistry as well as comprehensive laboratory practicals that ensured an understanding of the material presented, whereas the final five days provided a wealth of knowledge from the geochemistry of different styles of mineralization to surficial geochemistry presented by highly respected individuals in the field of geochemistry. The training of geologists in exploration geochemistry is essential to the maintenance and growth of this field. It is important that universities, such as Laurentian, continue to offer courses in exploration geochemistry.

A special thank you to Dr. Steve Piercey for organizing this course and passing on your expertise. Many thanks to the guest lecturers for taking the time to travel to Sudbury to ensure the advancement of geochemistry. Also, a thank you to the Mineral Exploration Research Centre, Department of Earth Sciences at Laurentian University.

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AAG Newsletters on the Web

All issues of the Association's newsletters are now available as pdf files on the AAG website, starting with issue No. 1 published in February, 1971. While scanning these valuable archives you will notice that in October 1987 (issue No. 61), the newsletter adopted a new format and the official title of **EXPLORE**. These old issues of the newsletter are a great source of AEG/AAG history and scientific communications some of which are still relevant today. Thanks to Bob Garrett, Chris Benn, Bill Coker, Andrew Ransom, Bob Eppinger, Sherman Marsh and Geological Survey of Canada staff for their help in making the complete set available in digital format to all AAG members.

AAG Member News

Gwendy Hall, AAG's Treasurer, Editor of *Geochemistry: Exploration, Environment, Analsyis*, and emeritus research scientist in exploration geochemistry at the Geological Survey of Canada was named Honorary Fellow of the Geological Society in 2008. The Geological Society of London was founded in 1807. It is the United Kingdom's national society for geoscience, and the oldest geological society in the world.

Minutes of the 2008 Annual General Meeting of the Association of Applied Geochemists held by telephone conference on November 5, 2008

I. Call to Order – Establishment of Quorum

President D. Cohen called the Annual General Meeting (AGM) to order at 3:05 PM MST and determined that 16 Fellows were present for the meeting. This number represented one more than the required 15 for a quorum.

II. Discussion and approval of 2007 AGM minutes

The minutes for the 2007 AGM had been distributed previously to all AAG members. One typographical error had been noted.

It was moved (D. Cohen) and seconded (D. Lentz) that the minutes of the 2007 AAG Annual General Meeting be accepted. The motion was passed unanimously.

III. Business manager's report (B. Arseneault)

We have 505 paid AAG members for 2008 compared to 550 members for 2007 (20 Students, 289 Members, 196 Fellows). Eleven of these members have a senior membership and 16 have opted for the *EXPLORE* and *ELEMENTS* only option. Seventeen of these are new memberships (3 Students, 14 members). There has been one member upgraded to Fellow status in 2008. At the present time, our Developing Country membership fund has a balance of $10,800 US. The Distinguished Applied Geochemists Scholarship Fund contains $18,300 US. The Association sponsors two members, one from Pakistan and one from Iran.

IV. President's Report (D. Cohen)

In 2007, the following Fellows were elected to Council to serve a 2-year term (2008 and 2009):Mark Arundell, Rio Tinto Exploration, David Garnett, Cooperative Research Centre for Tropical Savannas Management, David Lentz, University of New Brunswick, Ray Lett, British Columbia Geological Survey, Cliff Stanley, Acadia University

AAG continues to pursue the establishment of the Distinguished Applied Geochemists Fund. We are currently waiting final approval of charitable status from Canadian authorities.

The Association is stable in terms of its structure, membership and finances and is conducting activities as expected. These include the production of the journal *Geochemistry: Exploration, Environment, Analysis*, the publication of AAG's quarterly newsletter *EXPLORE*, the hosting of the biennial International Applied Geochemistry Symposium, the sponsoring of workshops focusing on various topics in Applied Geochemistry, and providing support for students to attend the symposium and workshops.

AAG must look at future growth of the Association and ways that we can develop closer ties with kindred societies to better serve our membership. The Association must play an increased role in the education of future applied geochemists as we are seeing fewer and fewer universities teaching applied geochemistry.

President Cohen thanked all the Members of Council and other members of AAG who have been involved Association activities and committee work over the past year. The Association is looking forward to a successful IAGS in Fredericton in 2009.

V. Treasurer's Report (G. Hall)

Auditor's report for 2007 (previously distributed to Council by email): Our auditor continues to be McCay, Duff and Co. Our current assets as of 31 December 2007 stand at $483,878 (US), up by ~ $60K from the previous year. Against these are liabilities, such as accounts payable and scholarship funds, that total $58,244, slightly higher than those for 2006 ($52,622). Our investments for 2007 did well in the hands of our manager, Eion Cameron, bringing in an income of $44,067, up substantially from 2006 ($24,022). The other major source of revenue explaining the increase over 2006 is that gained from the two workshops presented at Exploration '07, in excess of $20,000. For this we thank not only the presenters, but the organisers, especially Beth McClenaghan. A small net surplus was recorded for the publication of *Geochemistry: Exploration, Environment, Analysis (GEEA)*, as was the case in 2006. We appear to have spent considerably more in 2007 for the Explore Newsletter which should be examined if it continues into 2008.

It was moved (G. Hall) and seconded (D. Smith) that AAG accept the 2007 auditor's report by McCay, Duff and Co. and that this firm be retained for preparing the 2008 report. President Cohen asked for a vote on this motion and it passed unanimously.

Investments: Eion Cameron had been warning us, for many months, of the impending financial crisis and was sending reports to the AAG Executive more frequently than the usual monthly rate. On 24 September 2008, he sold most of our securities, converting 76% of the $415K into cash and money market funds; he retained gold-weighted holdings. This action saved the AAG a lot of money and we are

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extremely grateful to Eion for his foresight, knowledge and stewardship. In these highly volatile times, Eion feels slightly uncomfortable as the person responsible for our investments; however, we have assured him that he has our complete confidence and gratitude.

One outstanding financial report is that from the 23rd IAGS which was held in Oviedo, Spain in June 2007. This conference may not have garnered any major revenue for the AAG; seed money was not requested.

VI. GEEA (G. Hall)

There have been two special collections of papers in the 2008 issues of the AAG journal, *Geochemistry: Exploration, Environment, Analysis (GEEA)*. The first issue of 2008 led off with selected papers originating from the 'Workshop on Environmental Geochemistry' held in Naples. We thank Benedetto de Vivo, Jane Plant and Annamaria Lima for organising this excellent contribution demonstrating multi-disciplinary methods of characterising contaminated sites using geochemistry. Parts 3 and 4 of 2008 GEEA comprise a superb compilation of papers in honour of Arthur G. Darnley for his leadership in international- and global-scale geochemical mapping. The twelve papers describe the various methods used in, and highlight the multi-faceted applications of, geochemical mapping around the world. We are indebted to Clemens Reimann and Dave Smith for all their hard work in creating this valuable special double issue which should serve as a reference in the field of geochemical mapping for years to come.

The Geological Society of London (GSL), our partners in publishing GEEA, launched the Lyell Collection (www.lyellcollection.org) in 2007; GEEA has now been added to this fully searchable online collection of most of GSL's books and journals (go to www.geea.lyellcollection.org). Members of the AAG are entitled to access all online content for the journal free of charge. Amongst the features of the Lyell collection, there is full-text linking to other key earth science journals, including those of GeoScienceWorld (www.geoscienceworld.org; 45 journals, GEEA being one).

Full online electronic submission to GEEA will take place in 2009; we are in the process of defining the protocols currently. By 2011, as with other GSL journals, GEEA will be available online only but those who cling to the printed copy can still receive this for an additional price.

A special thank you is given by Council to Marcia Scrimgeour, the Editorial Office Manager for GEEA, for her contributions that make the journal possible.

VII. EXPLORE (B. McClenaghan)

Explore 141 (December issue) is in press and will be mailed out at the end of November. It includes technical articles on the Canadian portion of the North American Soil Geochemical Landscapes Project by I. Kettles et al. and on the national-scale geoscience initiatives that are under way in Australia, by Patrice de Caritat et al.

Regional Councilors were asked by President Cohen after the March 2008 AAG Council meeting to submit short reports, new items or photos of activities in their region that would be suitable for publication in EXPLORE. One excellent contribution from Boudewijn de Smeth was received so far.

Payments from advertisers/sponsors for 2008 are slowly coming in. Five of the 13 advertisers/sponsors have paid to date. All of the CIBC banking issues have now (finally!) been resolved. Account statements are now being sent directly to the EXPLORE office rather than to the AAG office in Ottawa. Online banking for the Explore account was activated on October 10.

VIII. ELEMENTS (D. Lentz)

The December 2008 issue of *ELEMENTS* will contain a profile of AAG President D. Cohen as well as a call for papers for the International Applied Geochemistry Symposium. Upcoming themes for *ELEMENTS* include bentonite, scientific exploration of the moon, mineral magnetism, gold, and nontraditional stable isotopes.

IX. Symposia (P. Morris, D. Lentz)

Fredericton 2009

Local Organizing Committee Chairman Dave Lentz has an active website for the 2009 AAG Symposium (www.unb.ca/conferences/IAGS2009), and is actively pursuing sponsorship, and taking out advertising.

AAG 2011

Following the Oviedo meeting and the acceptance of Fredericton as the venue for the 2009 meeting, expressions of interest were shown by potential organisers in South Africa, China, Portugal and Finland to host the 2011 meeting. To date, the only proposal received has been from Finland. This was circulated to the AAG Symposium Committee and AAG Council. It is customary to announce the location of the

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subsequent AAG Symposium at each meeting, so a decision about the 2011 location needs to be made, for announcement at Fredericton. An early decision also gives the 2011 LOC more time for preparation.

Future Symposia
In the course of circulating the Finland proposal, a few Council members suggested that the USA should consider hosting an upcoming symposium given that a Symposium has not been held there for a while, and a good part of the membership is domiciled in North America.

Symposium Questionnaire
In order to assess AAG members' impressions of its Symposia, a questionnaire was published in EXPLORE v136, with a request for responses from those who had attended at least one of the last three AAG Symposia (Dublin, Perth, or Oviedo). A rather disappointing 41 responses were received. A few things that came out of the responses: most showed an interest in exploration (compared to environment, data handling, analysis), with academics showing the greatest interest in exploration and environment; 61% of respondents preferred a single-session with only academics preferring parallel sessions in terms of venue; although most preferred to present orally, posters were seen as important; industry and privately-employed members preferred an upmarket location, whereas government and academia members preferred lower-cost venues; 73% of those who responded thought associated field excursions were an important part of the meetings, and the vast majority wanted workshops, and subsidies for students.

Revision to Symposia Guidelines
A revised set of Symposia guidelines were circulated to AAG Council and the AAG Symposium Committee earlier in 2008. There was general agreement with the content of the revised guidelines, with the main areas of debate over the level of control that AAG has over the format and content of the Symposium, and the agreement of the LOC to adopt both profit and loss sharing arrangements. A recurring comment in discussions about organising Symposia and formulating guidelines is the diminishing amount of time that potential LOC members have to devote to conference organisation. One solution to this is to involve other societies in conference organisation, but this has implications in terms of profit (and loss) sharing, and whether it is still an 'AAG Symposium'. To date, the revised guidelines have not been posted on the website - in order to let potential organisers know what AAG expects, perhaps they should be posted in the near future.

X. Web Site (B. Eppinger)
AAG's webmaster, A. Ransom, took a new job with Rio Tinto and has had a lot of associated travel. These factors have impinged on his ability to make timely updates to the website and he apologizes for this. The pace is slowing down for him, so he should be able to devote more time to the website work. Because of his irregular updates, he has not submitted to the AAG Business Office any bills yet for his services. B. Eppinger has encouraged him to do so for this latest batch of updates.

Updates to the Website
- All issues of Explore should now be available from the website, thanks to A. Ransom, B. McClenaghan, and S. Marsh, who rummaged around his attic to find and scan the two final issues)
- ThermoScientific logo added to the Explore webpage
- 24th IAGS link moved to the top of the homepage; red lettering added to highlight it
- Graphic for 24th IAGS added to the homepage
- Immediately below the 24th IAGS link is a link to the symposium guidelines for submitting papers and posters
- *EXPLORE* publication dates added to the *EXPLORE*/ Contributions webpage
- Upcoming Events on homepage updated
- D. Cohen's report from *EXPLORE* # 139 added to Latest News on homepage
- New entries for What's News added
- Memorial for David McConchie added (bottom of the homepage/Memorials)

Needed
- What's News contributions
- Committee heads to look at the website and ensure that the committee membership and contact info is up to date

XI. Other Business
Student Chapters (D. Lentz)
To grow the Association, we must aggressively go after new members. Establishing Student Chapters is one way of doing this. Our chapters at the University of Nevada (Reno) and in Chile are currently inactive. In an effort to revitalize these chapters and add new chapters, D. Lentz has been in discussions with C. Stanley and B. Townley about making a group to look after Student Chapters and expedite the process to bring in student members. Contacts have been made with universities in Iran, South Korea, Argentina, and India. D. Lentz has volunteered to build and host an AAG Student Chapter web site for each chapter that is formed. Advice from Council is needed regarding possible financial support for Student Chapters to make them more viable for various universities throughout the world.

XII. Adjournment
President Cohen thanked all attendees for their participation and declared the 2008 Annual General Meeting adjourned at approxmately 3:50 PM MST.

AAG Councillors for 2009-2010

Elizabeth Bailey

Elizabeth received her degree from the Pennsylvania State University in 1980 and completed graduate coursework at the University of Alaska Anchorage. She joined the U.S. Geological Survey in 1982 and has worked in a variety of positions starting as laboratory/field assistant and now as a research chemist. Her primary areas of research include regional-scale stream sediment geochemistry and biogeochemical cycling of mercury near mines. She has contributed to the mineral resource assessment of several areas in Alaska, has been part of a team that developed an on-line digital database for USGS geochemical data from Alaska, and has conducted research on the microbial transformations of Hg near abandoned Hg mines in Alaska. Elizabeth has been a member of AAG since 1993 and a fellow since 2001. She has served as an assistant editor for *Explore* and is currently on the editorial review board of *GEEA*. Elizabeth also served as a Councillor for the 2007-2009 term.

John Carranza

Emmanuel John M. Carranza (born 08 October 1962) obtained a BSc degree in geology (Adamson University, Manila, Philippines) in 1983, an MSc degree (with distinction) in mineral exploration (International Institute for Geo-Information Science and Earth Observation, Enschede, Netherlands) in 1994 and a PhD degree in GIS-based mineral potential mapping (Delft University of Technology, Delft, Netherlands) in 2002. He started his professional career in 1983 as a geologist in the Bureau of Mines and Geosciences of the Philippines where he was involved with geological mapping, stratigraphic studies, geological hazard mapping, evaluation of industrial rocks/minerals and geochemical exploration for gold. His work on exploration geochemistry led to recognition of a previously unknown mineralized area in a Quaternary volcanic terrane in Bicol Region of the Philippines. He received the 1998 ITC Research Award for his paper on catchment-basin analysis of stream sediment geochemical anomalies. In 2001-2003, he was a Researcher in the Earth Systems Analysis (ESA) department of ITC where he is involved with (a) research in developing geospatial data infrastructure

Robert Eppinger

Bob Eppinger is a Fellow and past Councilor in AAG, joining the organization in 1984. He is presently the Chair of the AAG Website Committee, and previously was an assistant editor for AAG's *EXPLORE* newsletter from 1997

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GEOCHEMICAL ANOMALY AND MINERAL PROSPECTIVITY MAPPING IN GIS, 11

By E.J.M. Carranza

Included in series:

Handbook of Exploration and Environmental Geochemistry

Description: The book documents and explains, in three parts, geochemical anomaly and mineral prospectivity mapping by using a geographic information system (GIS). Part I reviews and couples the concepts of (a) mapping geochemical anomalies and mineral prospectivity and (b) spatial data models, management and operations in a GIS. Part II demonstrates GIS-aided and GIS-based techniques for analysis of robust thresholds in mapping of geochemical anomalies. Part III explains GIS-aided and GIS-based techniques for spatial data analysis and geo-information synthesis for conceptual and predictive modeling of mineral prospectivity. Because methods of geochemical anomaly mapping and mineral potential mapping are highly specialized yet diverse, the book explains only methods in which GIS plays an important role. The book avoids using language and functional organization of particular commercial GIS software, but explains, where necessary, GIS functionality and spatial data structures appropriate to problems in geochemical anomaly mapping and mineral potential mapping. Because GIS-based methods of spatial data analysis and spatial data integration are quantitative, which can be complicated to non-numerate readers, the book simplifies explanations of mathematical concepts and their applications so that the methods demonstrated would be useful to professional geoscientists, to mineral explorationists and to research students in fields that involve analysis and integration of maps or spatial datasets. The book provides adequate illustrations for more thorough explanation of the various concepts.

Audience: Professional geochemists, geologists, geoscientists, mineral explorationists and researchers and graduate students in fields that involve analysis and integration of maps or spatial datasets.

Bibliographic details:

Hardbound, 368 pages, publication date: NOV-2008

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ISBN-10: 0-444-51325-6

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to 2002. He is a research geologist for the U.S. Geological Survey, specializing in exploration geochemistry, mineral resource assessment of public lands, and environmental geochemistry related to abandoned mines and unmined mineralized systems. Current and recent projects include exploration geochemical studies at the giant Pebble porphyry Cu-Au-Mo deposit in Alaska; environmental geochemical studies of an unmined volcanogenic massive sulfide deposit in the Bonnifield district, Alaska, and of abandoned mines in the upper Salmon River basin, Idaho; a regional geochemical study in the Colorado Front Range; and mineral resource assessments of Afghanistan and Mauritania. Bob received a B.A. in geology (1979) from the University of Colorado and an MS degree (1988) in exploration geochemistry from Colorado School of Mines.

Chris Oates

Chris Oates began his career as an exploration geochemist with WMC, January 1981 based in Kalgoorlie, Western Australia. During his time with WMC in Kalgoorlie (1981-1989), he was Exploration Geochemist and subsequently Senior Exploration Geochemist for exploration programs throughout Western Australia for Ni and Co Laterites, Ni sulphides, Archaean VMS deposits, Archaean Au deposits, PGE's and Proterozoic Cu-Zn and Au deposits. In 1998, Chris joined Anglo American plc as Vice President - Geochemistry and over the last 10 years has been involved in the establishment of an Anglo American global exploration geochemical team, and establishing sampling and analytical policies and protocols, mine sampling & mine laboratory "Best Practice" & audits, analytical round robins and the development of internal and external exploration and environmental geochemical research programs. In January 2008, he was appointed Head of Geochemistry for the Anglo American plc group of companies and now manage all AAplc Sampling, Analysis and QA/QC protocols and Best Practice, and Exploration and Environment Geochemistry Best Practice and Research at 4 universities globally involving honors, masters, PhD and PDF students as well as a range of university undergraduate applied geochemistry scholarships.

Erick Weiland

An internationally respected geochemist with over thirty years of professional experience and technical knowledge across multiple disciplines, Mr. Weiland has successfully completed projects throughout many countries. Expertise includes: mining/mineral geochemistry, rock/waste characterization, environmental impact assessments, water quality and soil remediation investigations, material characterization, geochemical evaluation of surface water, groundwater, and mineral interactions, and assessing the acid generation potential (acid rock drainage) with associated leaching of hazardous constituents from natural materials. He is an expert in the application of geochemistry supporting engineering/environmental projects including site characterization, feasibility studies, permitting, remediation, water quality, soil remediation, evaluation of acid mine drainage, waste rock dumps and tailings dam engineering/design, and mine closure activities. Mr. Weiland joined the association in 1978 and has been an active member ever since. He has participated as Councilor, President, Database Chairman, Editorial board, Canadian and Australian Geosciences Council representative, and other miscellaneous duties for mineral resource management, (b) teaching at post-graduate level and (c) supervising MSc and PhD students. Since 2003 to the present, he has been Assistant Professor in the ESA department of ITC with more-or-less similar teaching and research tasks as his Researcher appointment. He has supervised and led to graduation 4 PhD students and at least 20 MSc students.

Arsenic in Groundwater: A World Problem

ISBN/EAN: 978-90-808258-2-6

Editor: T. Appelo

Contents:

1. Introduction
2. Sources and distribution of arsenic in groundwater and aquifers
3. Geochemical experimentation and modelling are tools for understanding the origin of arsenic in groundwater in Bangladesh and elsewhere
4. Review of arsenic behaviour from groundwater and soil to crops and potential impacts on agriculture and food supply
5. Health effects in inorganic arsenic
6. Mapping of hazardous substances in groundwater on a global scale
7. Arsenic in the Dutch coastal provinces
8. Regional occurrence with relation to drinking water production in the Netherlands

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To download: Full report [15 Mb pdf] http://www.igrac.nl/publications/302

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To renew online, please go to the AAG website at www.appliedgeochemists.org and click on "Membership" in the left hand side menu, then click on "Renew Membership Online". Making a voluntary donation to the *Distinguished Applied Geochemists Fund* or the *Developing Country Membership Fund* is also very much appreciated. If you have any questions about your membership or receipts please contact the AAG Business Office at office@appliedgeochemists.org.

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.

2009

• May 9-13, 2009. **U2009 - Global Uranium Symposium** Keystone, Colorado, USA. Website: www.U2009.org

• May 21-23, 2009. **3rd International Symposium on Trace Elements in the Food Chain – Deficiency or Excess of Trace Elements in the Environment as a Risk of Health (TEFC2009)**, Budapest, Hungary. Website: http://www.medicalgeology.org/

• May 24-27, 2009. **AGU/Geological Association of Canada/ Mineralogical Association of Canada Joint Meeting** Toronto, Canada. Website: http://www.gac.ca/activities/index.php

• June, 2009. **Ore Deposit Geochemistry, Hydrology and Geochronology.** ARC Centre of Excellence in Ore Deposits (CODES), Hobart, Tasmania. Website: http://fcms.its.utas.edu.au/scieng/codes/cpage.asp?lCpageID=55

• June 1-4, 2009. **24th International Applied Geochemistry Symposium,** Fredericton, New Brunswick, Canada Website: http://www.unb.ca/conferences/IAGS2009

• June 21-23, 2009. **Xi'an Ni-Cu Symposium**, Xi'an, China. Website: http://2009xani.chd.edu.cn/home1.htm

• June 22-26, 2009. **Goldschmidt 2009.** Davos, Switzerland. Website: http://www.goldschmidt2009.org

• June 23-26, 2009. 8th International Conference on Acid Rock Drainage, Skelleftea, Sweden. Website: www.securing.skelleftea.se

• July 12-17, 2009. Gordon Research Conference: Catchment Science: Interactions of Hydrology, Biology and Geochemistry, Andover, USA. Website: www.grc.org/programs.aspx?year=2009&program=catch

• August 17-20, 2009. Society for Geology Applied to Mineral Deposits 10th Biennial Meeting, Townsville, Australia. Website: www.sga2009.jcu.edu.au

• September 7-11, 2009. **Geoanalysis 2009**. Drakensberg Region, South Africa. Website: http://geoanalysis2009.org.za

• September 21-26, 2009. **Association of Environmental and Engineering Geologists** 52nd Annual Meeting, Lake Tahoe, USA. Website: http://www.aegweb.org/i4a/pages/Index.cfm?pageID=3696

• October 18 to 23, 2009. **VIII International Symposium onEnvironmental Geochemistry,** Ouro Preto/MG, Brasil. Website: http://www.12cbgq.ufop.br/12cbgq/principaleng.htm

• October 18-21, 2009. **Geological Society of America Annual Meeting**. Portland, Oregon, USA. Website: www.geosociety.org/meetings/index.htm

• December 7-11, 2009. **AGU Fall Meeting**, San Francisco, USA. Web site: www.agu.org/meetings

2010

• April 6-10, 2010. 13th Quadrennial IAGOD Symposium **Giant Ore Deposits Down Under**, Adelaide, Australia. Website: http://www.iagod.info/index.php?option=com_content&task=view&id=11&Itemid=12

• May 101-3, 2010. **Geological Association of Canada/ Mineralogical Association of Canada Annual Meeting.** Calgary, Canada. Website: http://www.gac.ca/activities/index.php

• June 13-18, 2010. **Goldschmidt 2010.** Knoxville, USA. Website: www.goldschmidt2010.org/

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CALENDAR OF EVENTS

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• June 21-24, 2010. **11th International Platinum Symposium** Sudbury, Canada. Website: http://11ips.laurentian.ca

• June 27-July 2, 2010. **27th Society for Environmental Geochemistry and Health, European Conference**, Galway, Ireland. Website: http://www.nuigalway.ie/segh2010/

• October 31-November 3, 2010. **Geological Society of America Annual Meeting**. Denver, Colorado, USA. Website: www.geosociety.org/meetings/index.htm

2011

• May 25-27, 2011. **Geological Association of Canada/ Mineralogical Association of Canada Annual Meeting** Ottawa, Canada.

2012

• August 5–15, 2012. **34th International Geological Congress**, Brisbane, Australia. Website: http://www.ga.gov.au/igc2012

• 2012. **Geoanalysis 2012**. Brazil

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

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RECENT PAPERS

This list comprises titles that have appeared in major publications since the compilation in **EXPLORE** Number 141. Journals routinely covered and abbreviations used are as follows: Economic Geology (EG); Geochimica et Cosmochimica Acta (GCA); the USGS Circular (USGS Cir); and Open File Report (USGS OFR); Geological Survey of Canada papers (GSC paper) and Open File Report (GSC OFR); Bulletin of the Canadian Institute of Mining and Metallurgy (CIM Bull.): Transactions of Institute of Mining and Metallurgy, Section B: Applied Earth Sciences (Trans. IMM). Publications less frequently cited are identified in full. Compiled by L. Graham Closs, Department of Geology and Geological Engineering, Colorado School of Mines, Golden, CO 80401-1887, Chairman AEG Bibliography Committee. Please send new references to Dr. Closs at chezctc@comcast.net, not to **EXPLORE**.

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David Lawie, John Gravel

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