

## Lithological Discrimination in Deeply Weathered Terrains Using Multielement Geochemistry – An Example from the Yanfolila Gold Project, Mali

### Introduction

Lithochemochemistry has been successfully applied to mineral exploration in deeply weathered terrains (e.g. Prendergast 2007; Whitbread & Moore 2004). Previously published studies have concentrated on the application to fresh rock but have used elements that are sufficiently immobile for the outcomes to be applied at different levels of regolith profile. A challenge for many exploration projects is to be consistent in the logging of lithologies, particularly when these are weathered. This article describes an ongoing case study from an exploration project in Mali, West Africa for the application of lithological discriminators determined first in fresh rock and then applied to saprolite and soil material. Robust classification templates are constructed for the fresh, saprolite and soil material and incorporated into a commercial software program so that the project team can rapidly classify new data.

- since even colour is not a reliable discrimination criterion.

The project team was interested in determining if robust classification templates could be established for the discrimination of rock types in fresh samples that could then be applied to the weathered zone and then even to surface soil samples. Furthermore there was particular interest in finding out if any successful outcomes could be reproduced with data from a field portable XRF (pXRF) instrument.

For the fresh material, pulps of drill core samples at a 20 m interval were submitted for multielement analysis using a 4-acid digest followed by a combination of ICP-MS and ICP-AES which allowed the detection of a wide range of elements at low detection limits (method ME-MS61 at ALS). With the data from the drill core, exploratory data analysis was carried out using the geochemical software ioGAS© in order to de-

*continued on page 2*

### Yanfolila Gold Project

Gold Fields Ltd. is actively exploring in West Africa and one of their major projects is the Yanfolila Gold Project in Southwest Mali (Fig. 1). The project includes two significant deposits, Komana West and Komana East, and has a previously announced resource of 0.84 Moz. This case study is focussed on Komana East. The deposits are hosted in a volcano-sedimentary sequence that is part of a middle Proterozoic Birimian age greenstone belt. The stratigraphy from west to east is basalt, sandstone and siltstone, intrusive dolerite and sandstone. The mineralization is hosted in siltstones and intrusive dolerite and the style is typical of orogenic gold systems with gold associated with pyrite and albite/K-feldspar alteration. Consistent logging of the main rock types is difficult because of the intense weathering and strong hydrothermal alteration. Even differentiating between basalt and sandstone/siltstone can be difficult when the rocks are weathered

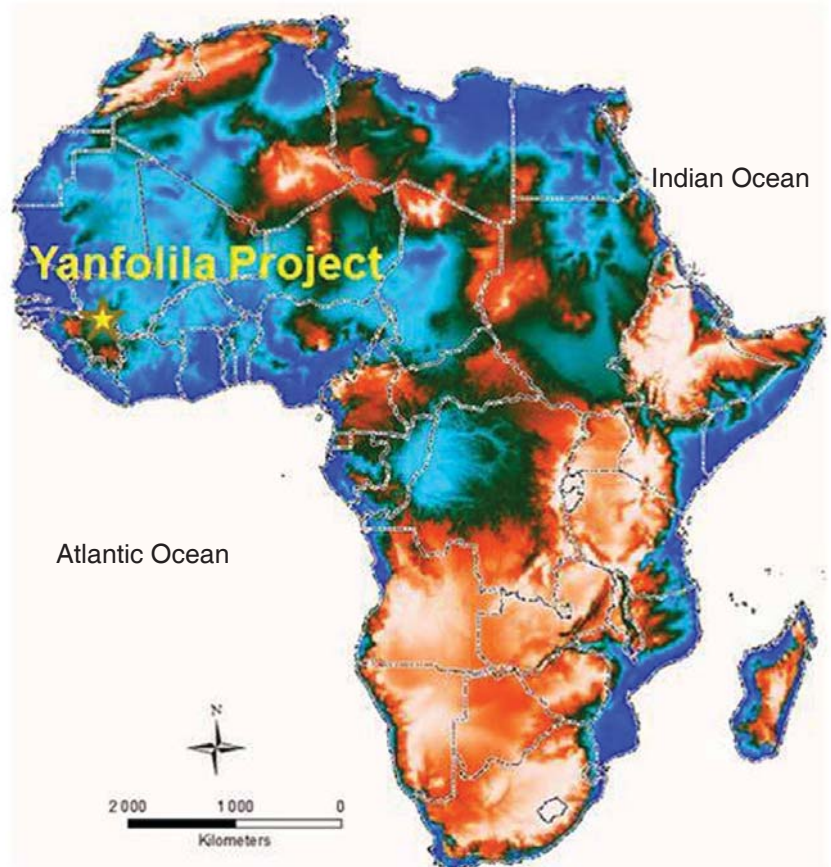


Figure 1. Location of the Yanfolila Gold Project in southwest Mali (backdrop is a digital elevation model for Africa).

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## President's Message



In the past, there has been concern about the cumbersome process for awarding Gold and Silver Medals to deserving leaders in AAG. The Chair of the Awards and Medals Committee, Paul Morris, has populated the committee with new members Eion Cameron, Pertti Sarala, and Chris Benn. The new committee immediately charged forward and has streamlined the guidelines and procedures for nominating and ratifying candidates. Following approval by AAG Council, the revised guidelines were emailed to AAG Fellows in May and forwarded to Beth McClenaghan and Jamil Sader for posting in **EXPLORE** and on the AAG website, respectively. As one clarification, the Silver Medal, which was also known as the Past Presidents' Medal, is now simply called the Silver Medal. Thank you to the Awards and Medals Committee for taking this on and completing the revisions in record time. With the 2013 IAGS in Rotorua, New Zealand fast approaching, now is the time for AAG Fellows to nominate deserving individuals. Please consider not only those from academia and government, but also industry leaders and geochemistry entrepreneurs. Regular AAG Members should consider becoming Fellows so that they can become part of the nominating process. The new guidelines are presented elsewhere in this issue of **EXPLORE**.

Beth McClenaghan is in need of new ideas and articles for the **EXPLORE** newsletter for 2013. What do readers want to read? The ideas should also include recommendations of people to write the articles. Please forward suggested topics and articles to Beth (beth.mcclenaghan@nrca-nrcan.gc.ca). Similarly Gwendy Hall, editor of AAG's journal, mentioned at the June AAG Council meeting that the number of articles submitted for publication in **Geochemistry: Exploration, Environment, and Analysis** is decreasing. AAG members are encouraged to find the time to write up and publish their work in GEEA. Submissions have slowed to a trickle.

Finally, I want to congratulate Ravi Anand (CSIRO) for being the Association of Applied Geochemists' Distinguished Lecturer for 2013 and 2014. The AAG Council is excited that Ravi has agreed to be our next Distinguished Lecturer. We look forward to hearing Ravi's talks in the coming months. Ravi is planning a CSIRO-funded round-the-world trip in February/March of 2013 that will be an excellent opportunity for the applied geochemistry community to hear his presentations. Ravi will be in contact with AAG Councillors and Regional Councillors to inform them of his travel plans so they can help get the word out locally. Ravi will be working with Jamil Sader to make sure the plans are on AAG's website. The following is a list of tentative presentations (subject to change):

- [Understanding anomaly formation through transported cover: field and experimental approaches](#)
- [Regolith-landscape processes and evolution and their implications to mineral exploration](#)

- [Role of palaeoclimates, mineralogy and geochemistry in forming anomalies on interfaces in areas of deep basin cover—implications for exploration](#)
- [How supergene laterite gold deposits form—new insights into anomaly formation processes](#)
- [Global-scale comparison of laterite and ferricrete forming processes in deeply weathered terrains of world and its implications to geochemical exploration](#)
- [Origin of ferruginous pisoliths in terrestrial environments—success in mineral exploration and clues to life on Mars](#)

**Bob Eppinger**  
President



## Lithological Discrimination in Deeply Weathered Terrains...

*continued from page 1*

termine the trace elements that were geochemically characteristic of the main lithologies, i.e. basalt, siliclastic sediments and mafic schists. Table 1 shows the elements that characterise the different lithologies. The main method of determination was to colour the sample plots according to lithology determined by the geologist and then construct bivariate plots of the more immobile elements such as Ti, Cr, and Zr. Spatially separate groupings for the different lithologies determined from the geologists logging were achieved with the plots for Ti-Zr, Ti-Cr and Mn-Sr. A Cr-Ti diagram produces

Rock Type	ME-MS61- High Values	ME-MS61- Low Values	Detectable by pXRF - High Values
Mafic schist	Cr, Cs, Ni, P, Sr		Cr, Sr
Basalts	Mn, Sc, Ti, V,	Ce, La, Th, Zr	Mn, Ti, V
Sandstones/siltstones	Rb, Th		Rb, Th

Based on 2230 samples

*Table 1. Elements that are elevated or depleted in the main lithologies (mafic schists, basalt, sandstones/siltstones) and those that are detectable by the pXRF.*

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Sample No	Start	End	Au	Ag	As	Bi	Cd	Co	Cu	Fe	Mn	Ni	Pb	Pt	Sb	Se	Te	Tl	Zn
Sample 14	79	79	0.187	0.25	2.76	2.5	100	0.23											
Sample 20	79	80	0.148	0.25	3.25	7	40	0.23											
Sample 22	80	83	0.136	0.25	1.83	31	20	0.23											
Sample 23	83	84	0.187	0.25	3.04	9	30	0.23											
Sample 24	86	91	0.213	0.25	2.87	2.5	30	0.23											

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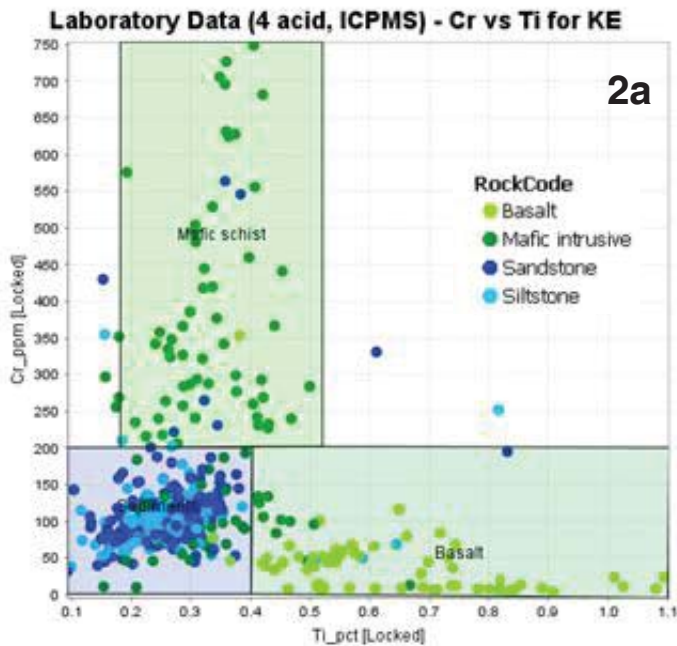


Lithological Discrimination in Deeply Weathered Terrains...

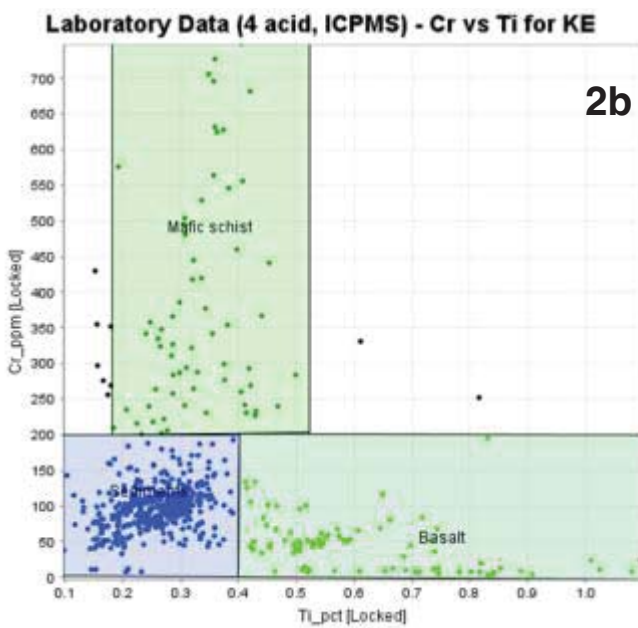
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particularly good discrimination of the main lithologies and further discrimination between sandstone and siltstones is achieved with the Sr-V plot. When sufficient separation of lithologies on these diagrams was achieved, then templates could be created and used. The templates were then entered in a software program iogas© that is optimized for geochemical data analysis (iogas.net/).

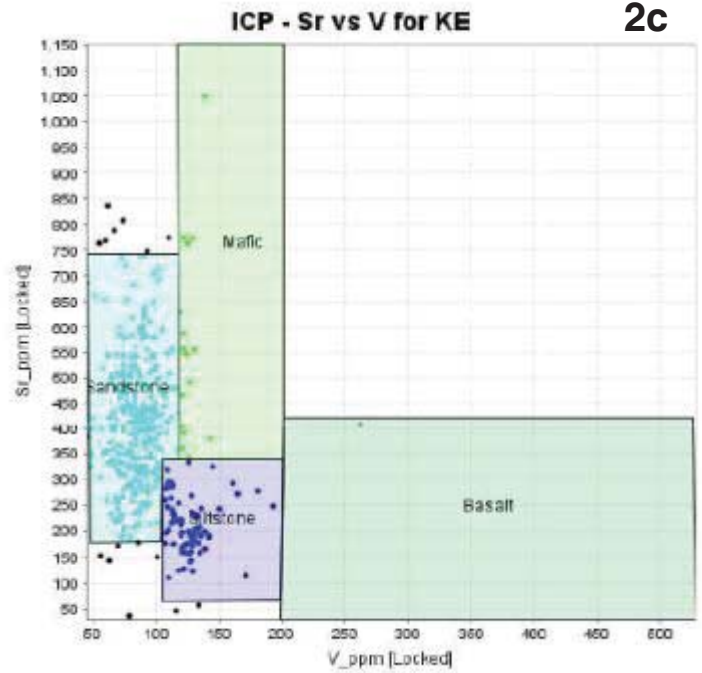
Application of the Cr-Ti template is shown in Figure 2. Figure 2a shows the classification according to the geologist's logging and then classified using the Cr-Ti template (Fig. 2b).



2a



2b



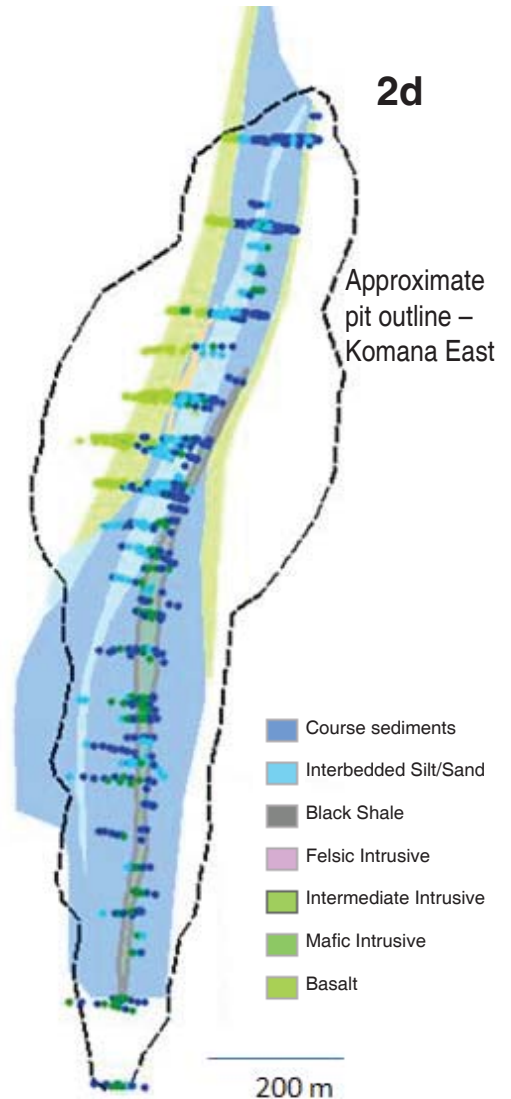
2c

Figure 2a. Cr- Ti classification diagram with samples coloured according to the geologists' logging.

Figure 2b. The same classification template as in 2a but with samples not classified according to this template.

Figure 2c. Sr-V classification diagram for just the samples classified as sediments in the Cr-Ti diagram.

Figure 2d. Classification from the Cr-Ti and Sr-V templates plotted on the geological map produced from logging of drill core.



2d

Approximate pit outline – Komana East

- Course sediments
- Interbedded Silt/Sand
- Black Shale
- Felsic Intrusive
- Intermediate Intrusive
- Mafic Intrusive
- Basalt

200 m

continued on page 5

### Lithological Discrimination in Deeply Weathered Terrains...

continued from page 4

The sediments were classified into sandstone and siltstones using the Sr-V template, which is shown in Figure 2c. The resulting classification is plotted on the bedrock geology map which was produced from logging of the diamond drill core (Fig. 2d). The classification using geochemistry corresponds reasonably well with the geological interpretation and gives confidence to the methodology.

The next stage was to determine if a similar outcome with the geochemical classification could be achieved using the portable XRF instrument. Portable field instrumentation is becoming more widely used and is a major change for how some fieldwork using exploration geochemistry is carried out. The instrument is portable and provides results at the actual sample location or in the field camp quickly – for example the project team in Mali is set up to analyze about 200 sample pulps or sieved soil samples per day.

Validation of the pXRF instrument and data are important. Before using the instrument for characterisation work, the pXRF data were calibrated with lab or “real data”. Quality control protocols were also set up for the routine readings and these included using certified standards.

Pulps from five lines of drill holes across the northern part of Komana East were analysed using the pXRF. The Cr-Ti template constructed from the laboratory data was modified by using equivalent breaks on the probability plots for pXRF data. Figure 3 shows the results, after classification, with

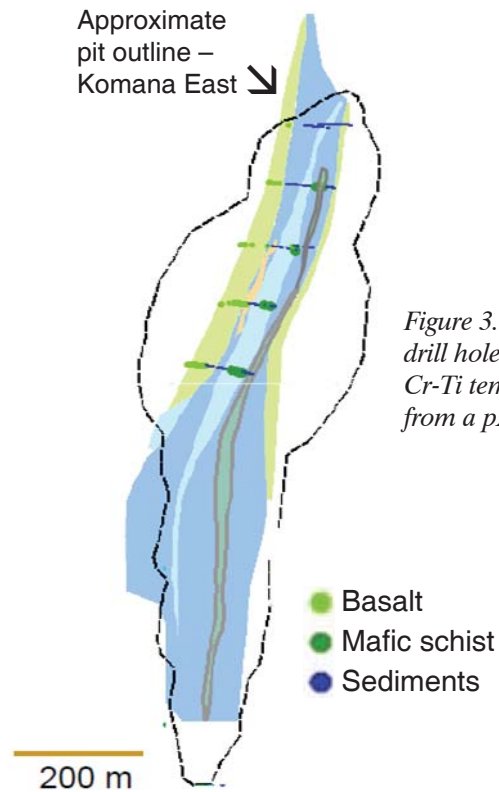


Figure 3. Classification of drill hole samples using a Cr-Ti template with data from a pXRF.

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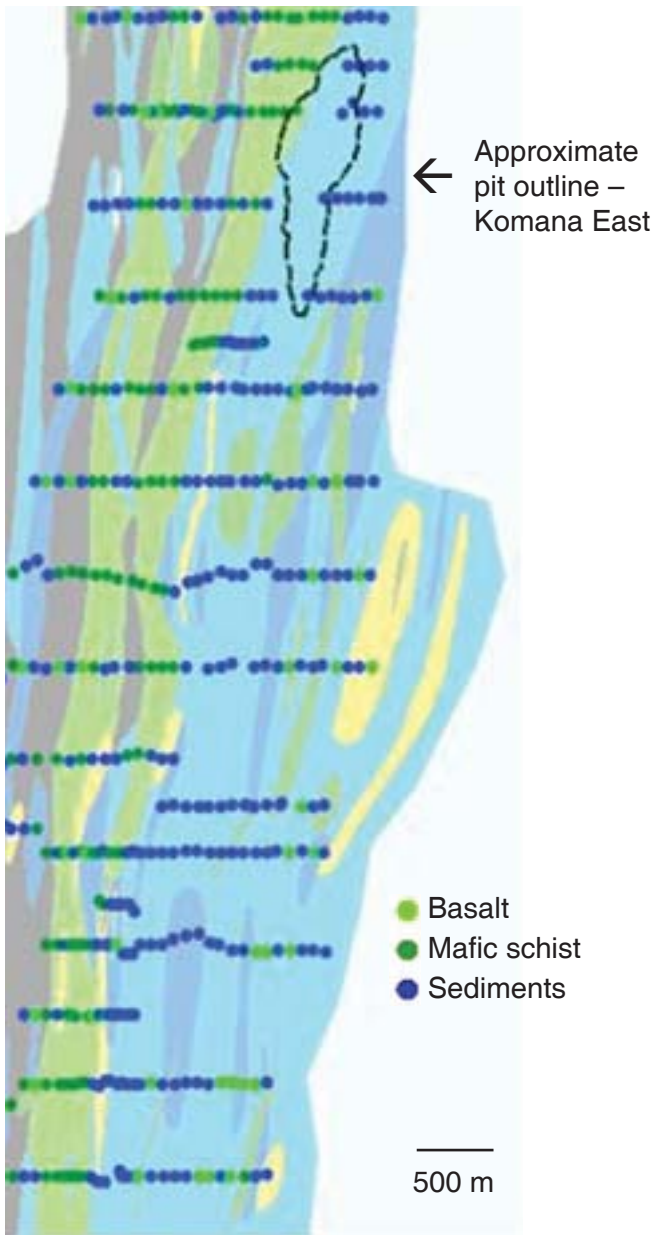
# Lithological Discrimination in Deeply Weathered Terrains...

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basalts and mafic schists being correctly identified.

Use of the pXRF becomes even more useful in the weathered environment. There is moderate to deep weathering of up to ~50 m in the Yanfolila area. The project uses angled air core drilling to obtain a consistent sample at blade refusal (which is usually 20-50 meters) and this is usually from the lower saprolite. Geologists can find it difficult to identify the primary bedrock lithology because of the intense weathering.

Samples from the bottom of the hole were sent to the laboratory for analysis by the same analytical method described for the drill core. Figure 4 shows the distribution of air core



**Laboratory Data (4 acid, ICPMS) Cr vs Ti for KE**

Figure 4. Classification of bottom of hole air samples (weathered samples) laboratory data using the Cr-Ti template. The samples are plotted on the geology map made by geologists from logging of drill core.

drilling for the Yanfolila project plotted on the district scale bedrock geology map. These samples have been classified with the Cr-Ti template constructed using fresh material using laboratory data and the results show that basalts and mafic schists are distinguished from the sediments.

As with the fresh material, the practical value of classification templates can be significant if the data from a portable XRF can be used. Field portable XRF data of the district wide bottom of hole air core samples are not available, so bottom of hole samples from a line of air core holes that traverses from Komana West to East were analysed using a pXRF. The results were classified using the Cr-Ti plot that was used with p-XRF discrimination parameters for fresh material. Figure 5 shows that sample classification using pXRF data agrees with the district scale geological map. The results shown here and other work carried on classifying weathered samples from RC drilling using laboratory and pXRF data have given the project geologists confidence in using lithogeochemical data to discriminate between rock types and has led to much improved consistency with the logging. The project team is now analysing all bottom of hole

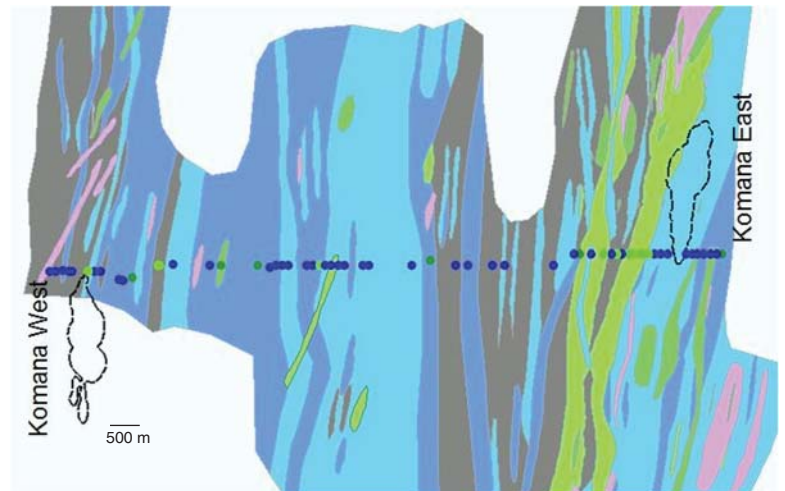


Figure 5. Classification of bottom of hole air samples (weathered samples) of pXRF data using the Cr-Ti template. The samples are plotted on the district scale geology map made by geologists from logging of drill core

- Course sediments
- Interbedded Silt/Sand
- Black Shale
- Felsic Intrusive
- Intermediate Intrusive
- Mafic Intrusive
- Basalt

air core samples from the weathered zone using the pXRF.

Soil sampling is used as a first pass exploration technique and also as a follow up technique for target definition. While used primarily for the detection of Au and, in some cases, pathfinder elements such as As and W, the possibility of applying the classification templates so as to characterise conceptually important basalt and other mafic lithologies was also investigated.

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**Lithological Discrimination in Deeply Weathered Terrains...**

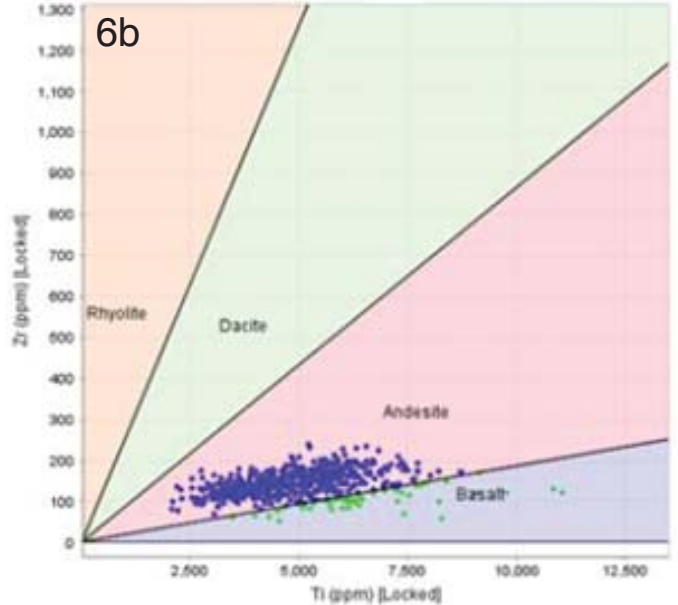
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The regolith in the Yanfolila area is a result of savannah type climate and is made up of a lateritic duricrust or cuirasse plateau underlain by a thin mottled zone and then an upper and lower saprolite. The landscape is formed by the scarp retreat and stripping through erosion of these distinct cuirasse plateaus which gives rise to erosional scarps and larger areas of proximally redistributed cuirasse material. With the exception of areas with depositional cover the regolith is thought to be relatively in situ.

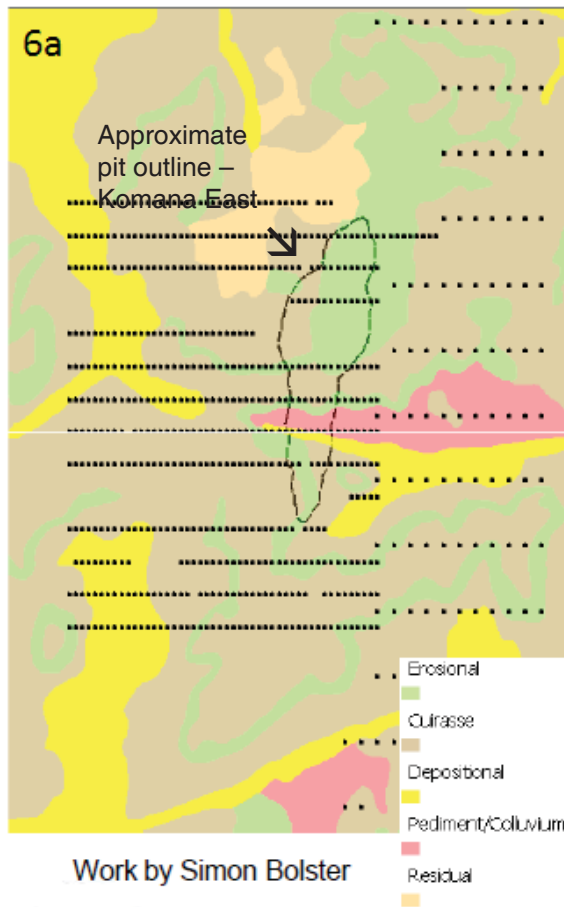
Komana East is covered by 200 m x 50 m soil samples and the locations are shown in Figure 6a. Samples that cover the areas of transported cover (called the depositional regime on the regolith map) were considered to be ineffective and were removed from further consideration in this study. Classification using results from the laboratory analysis was carried out using a published classification plot for volcanic rocks using Ti-Zr (Hallberg 1984). The results of this classification plotted on the district scale regolith map illustrate that a broad distinction can be made between the mafic and sedimentary sequences in the belt.

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**Ti vs Zr (Hallberg, 1984)**



**Regolith Map**



**6c**

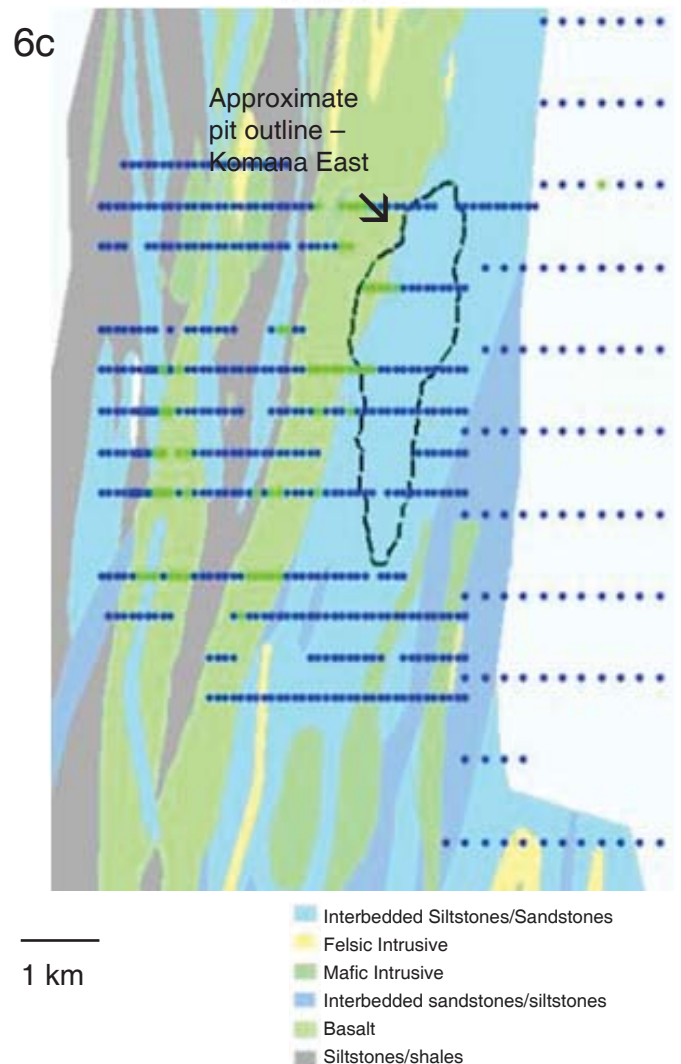


Figure 6a. Location of soil samples plotted on top of regolith map Figure 6b. Classification of soil samples using Ti-Zr plot and laboratory data. Samples that are from a depositional regime have been removed. Figure 6c. Results of the classification plotted on the district scale geology map



## Lithological Discrimination in Deeply Weathered Terrains...

continued from page 6

This case history is an example from an exploration project in SW Mali showing how multielement geochemistry can be used to distinguish between different lithologies in fresh material and how this knowledge can be applied in the weathered environment and to a lesser extent with surface soil samples. These methods are particularly useful where consistent identification of the different lithologies by the project geologists is almost impossible.

While there have been other examples of this approach described in the last few years, a new dimension has been added here by using a portable field instrument to achieve the same outcomes. The exciting possibility is that the role of exploration geochemistry is expanding to the world of real time data and this is likely to significantly change how exploration work is carried out.

### Acknowledgements

Bill Coker is thanked for his review of this article and making very helpful comments and corrections.

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Fields, and Rael Lipson and Serge Nitiema are also thanked for reviewing the article. Beth McClenaghan is thanked for her editorial help.

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## Student-industry field trip in Canada

In an effort to attract more students into the mineral exploration industry, the Prospectors and Developers Association of Canada (PDAC) ran its sixth annual Student-Industry Mineral Exploration Workshop (S-IMEW) from May 5 -18, 2012 in Sudbury. The top 26 post-secondary Canadian geoscience students were selected from across the country to participate in this workshop. Students participated in lectures, presentations and hands-on courses covering exploration techniques, mineral deposits, geophysics, geochemistry, environmental, health and safety and corporate social responsibility issues. Field trips to Timmins and Rouyn-Noranda, were included in the workshop, allowing students from across the country to see what these world-class mining regions have to offer.

Among the highlights of this program is 'Geochemistry Day', organized and taught by Association of Applied Geochemists members Stew Hamilton and Richard Dyer from the Ontario Geological Survey, Beth McClenaghan from the Geological Survey of Canada, and Noelle Shriver from Vale. They introduced students to exploration geochemical techniques but the main focus of the day was to provide the students with hands-on experience that they were unlikely to have been exposed to in the University setting. To that end, students experienced lake sediment sampling first hand on boats out on Ramsey Lake in Sudbury. Beth then introduced the students to the microscopic world of indicator minerals and provided hands-on mineral picking using microscopes. Noelle took the students on a short field traverse to explore and review soil profiles and soil sampling that they would typically encounter in the glaciated terrain of Canada.

The field trip was a great opportunity for students to see new parts of Canada, learn about the wide variety of career opportunities in mineral exploration, gain experience with



*Students learning to use lake sediment sampler as part of S-IMEW Geochemistry Day.*

exploration techniques not typically taught to undergraduate students and experience some of the adventures of being a geoscientist.

**S-IMEW Geochemical Team**





## Chris Gleeson (1931-2012)



*Chris working on the Ogilvy River in July 1976*

Chris Gleeson, one of our founder members, died after a final struggle with cancer on Saturday, May 19<sup>th</sup>, 2012. Chris was born in Ottawa, Canada on August 13<sup>th</sup>, 1931, and educated in Montreal. After gaining his Bachelor's degree at Loyola College in 1953, he went on to McGill University to study and obtained a MSc in economic geology in 1956. He continued on at McGill to study for a doctorate in Economic Geology-Applied Geochemistry with John Riddell. His work was supported by Kennco, where he met Joe Brummer with whom he would have a life-long association. His thesis, 'Geochemical studies on the distribution of metals in bogs, lake sediments, tills and glaciolacustrine deposits' using a powered auger to collect samples to study geochemical dispersion in three-dimensions, was completed in 1960. This was at a time when the geochemistry of glacial materials and derived soils was not accepted as a bona fide exploration tool in Canada, and helped set the science on a firm footing. Many years later, in conjunction with Vern Rampton and Roger Thomas, he completed studies on the distribution of metals and geochemical indicators in peats and saturated sediments in the Kirkland Lake area. These studies, which were complementary to the theory of electrochemical dispersion in overburden, were published by the Ontario Geological Survey in 1986 as OGS Misc. Paper 131.

Following graduation, he worked as an exploration geologist in Chibougamau, Quebec, and Wabash, Labrador before joining the Geological Survey of Canada (GSC) in Ottawa in 1962. At the GSC, he worked on the gold deposits of the Klondike, undertaking detailed heavy mineral studies of the stream gravels (GSC Bull. 173), and later with Bob Boyle in 1965 on Operation Keno, a regional stream sediment, water and lithochemistry surveys. This was in effect a pilot study regarding the use of stream sediments, stream and spring waters, heavy minerals and lithochemistry in mineral exploration and was utilized as a model for

later exploration by both the private and public sector. It is also noteworthy that the maps (GSC Maps 19-1964 to 31-1964, 45-1965 to 57-1965) and data (GSC Papers 71-51, 75-14, 76-31 and 77-31) from that survey were still being used to support exploration 40 years later in the Keno area of the Yukon.

Chris left the GSC late in 1965 to join the newly formed Société québécoise d'exploration minière (SOQUEM) as their exploration and research geochemist. He was responsible for SOQUEM's applications of exploration geochemistry and it was there that he pioneered the use of the Pionjar portable hammer drill to sample basal tills overlying geophysical anomalies in order to determine which ones were associated with base or precious metals and might merit further exploration (CIMM Spec. Vol. 11, 159-165). His work with overburden drilling techniques led to the discovery of the Louvem Mine East Zone zinc deposit near Val d'Or, Quebec. At SOQUEM he also directed numerous geochemical surveys in Gaspé and the Eastern Townships. He left SOQUEM in 1969, and after a brief association with Bondar-Clegg, the analytical service laboratory in Ottawa, and Fabian Forgeron and Arthur Smith, formed his own company, C.F. Gleeson & Associates in 1970.

As a consultant economic geologist-geochemist, Chris worked extensively in Canada, the U.S., and overseas for both industry and governments. He qualified himself as a Professional Engineer (Ontario) early in this period. Besides the World Bank, CIDA, Saudi Arabia Government, Geological Survey of Canada, Swedish Geological Survey, Indian Affairs and Northern Development, Ontario Geological Survey, New Brunswick Department of Mines, Saskatchewan Mining and Development Corporation and Queen's University, he consulted to over 60 different firms. His overseas work took him to Europe – Ireland, Slovakia, Sweden and Spain; to Malaysia, Jamaica, Columbia, Brazil and Saudi Arabia; and to Africa – Algeria, Ghana, Guinea, Burkina Faso, Niger, Cameroon, Zambia and Botswana. In Malaysia, he designed and directed exploration programs, which led to the discovery of base metals, precious metals, molybdenum, tin and uranium, for example the 100 million tonne Megapour Deposit (Cu-Mo-Au skarn-porphyry). In Burkina Faso, his work with Incanore (Con Salamis and Jacques Beauregard), was material in expanding the extent of the Youga Deposit to where it was an economic deposit. In 1984 he co-founded Kinbauri Gold Corp., a junior exploration company that under his direction completed exploration projects in such diverse jurisdictions as eastern and northeastern Ontario, northwestern Quebec, southern New Brunswick, Nevada, Burkina Faso and northern Spain.. In all this work Chris was an innovator and a stickler for good field practice, 'how could a survey be worthwhile if the sampling was not done right'. And very suspect of any thoughts that manipulation of data by 'black boxes' could replace knowledge gained from careful field observations.

An early contribution to the principals of exploration geochemistry was his work as a co-author of the Peter Bradshaw led volume of the Journal of Geochemical

## Chris Gleeson (1931-2012)

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Exploration (JGE 4(1):1-213) entitled 'Conceptual models in exploration geochemistry – The Canadian Shield and the Canadian Cordillera'. For many years Chris worked in association with Joe Brummer and Roger Wallis of the Minerals Division of Canadian Occidental Petroleum in western Canada.

The Gleeson-Brummer-Wallis association led to their 1978 paper (CIMM Bull. 81:64-79) 'Geological Implications of Regional Stream-Sediment geochemical data from South-Central British Columbia' that won them the Canadian Institution of Mining and Metallurgy's Barlow Medal for 1978. On the occasion of the 1985 11<sup>th</sup> International Geochemical Exploration Symposium in Toronto, Brummer, Gleeson and John Hansuld prepared the keynote address, entitled 'A historical perspective of exploration geochemistry in Canada – the first 30 years', they were well suited as authors, having participated in much of the activity (JGE 28(1/3), 1-39). In 1987 Chris won a second Barlow Medal for his paper with Denis Sheehan entitled, 'Humus and till geochemistry over the Doyon, Bousquet and Williams gold deposits' (CIMM Bull. 80:58-66), this work resulted in the discovery of the Williams "C" gold zone at Hemlo in 1982. Chris's accumulated fifty years of geochemical experience was huge. Over those years he worked with bedrock, residual soils, recent soils developed on glacial overburden, glacial sediments, lake and stream sediments, humus and waters. Again with Vern Rampton and Roger Thomas, he conducted a comparative study of various media (Humus, B-soil, C-soil, -250 mesh, -80 mesh, heavy minerals) to determine the most effective media for gold exploration in Eastern Ontario, which was published as OGS Open File Report 5613. Throughout all his work he was always looking for ways to utilize heavy minerals in the search for mineral deposits, whether they be gold, diamonds or base metals. Regional surveys completed by Gleeson in utilizing heavy minerals for diamond and other metal deposits in the James Bay lowlands for KWG Resources identified a large chromium anomaly that upon follow-up led to the discovery of the major chromite deposit in the Attawapiskat River area (Ring of Fire). He was an excellent exploration geologist always utilizing his immense knowledge of economic geology, exploration geochemistry and field methods.

He was always driven by curiosity. An example of his early innovative spirit was his use of termitaria in West Africa (JGE 31(3):253-283) to deep sample residual soils for gold exploration, which led to discovery of the Koma Bangou deposit in Niger. Chris was also involved in environmental research, completing a two year in-depth review on the geochemistry of mercury and its environmental impact in Venezuela for a major mining company.

Chris was one of the founding members of the Association of Exploration Geochemists, he was our first Treasurer, 1970-72, a Councilor from 1972 to 1974, and a Vice President from 1974 to 1976. He returned to be a Councilor again between 1984 and 1986. He authored

numerous maps and papers with the Geological Survey of Canada. He contributed papers to the Association's Journal of Geochemical Exploration, and the CIMM Bulletin. Chris in total has published over 50 notes, maps and papers with various government agencies and journals. He was a Life Member of the Canadian Institution of Mining and Metallurgy, the Society of Economic Geologists, and the Prospectors and Developers Association.

At a personal level we all knew Chris in Ottawa and as a field geologist. He was great company and one always wound up learning something interesting and useful. He will be missed by the exploration industry and his colleagues and friends around the world. He resided for most of his career at Iroquois on the St-Lawrence Seaway where he was able to pursue his hobbies of gardening and golf with the same vigor that he conducted his professional activities. Chris leaves his wife Marion (VP of Public Relations to anyone who has phoned C.F. Gleeson & Associates Ltd), sons Christopher (Karen), Timothy (Alice) and Darcy and daughter Erin plus many adoring grandchildren.

**Bob Garrett and Ian Jonasson**

*Geological Survey of Canada, Ottawa*

**Roger Wallis**

*Roger Wallis & Associates*

**Vern Rampton**

*Rampton Resources Group Inc.*



Sampling a fumarole, White Island, New Zealand

## 26th International Applied Geochemistry Symposium, incorporating the New Zealand Geothermal Workshop

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[www.gns.cri.nz/iags](http://www.gns.cri.nz/iags) for  
First Circular & information on

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- Field trips
- Partner activities








## 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) <<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)

### 2012

16-21 September 2012. IWA World Water Congress & Exhibition. Busan, Korea. Website: [www.iwa2012busan.org](http://www.iwa2012busan.org)

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



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23-26 September 2012. XVI Peruvian Geological Congress & SEG 2012 Conference. Lima, Peru. Website: [www.lima2012.com](http://www.lima2012.com)

23- 27 September 2012. International Conference on Heavy Metals in the Environment. Rome, Italy. Website: <http://ichmet16.iaa.cnr.it>

23-28 September 2012. European Planetary Science Congress 2012. Madrid, Spain. Website: [www.epsc2012.eu](http://www.epsc2012.eu)

24-26 September 2012. 2nd International Conference on Contemporary Problems of Geochemistry. Kielce, Poland. Website: [www.ujk.edu.pl/geochemia2012](http://www.ujk.edu.pl/geochemia2012)

27-29 September 2012. Calcium and magnesium in groundwater - distribution and significance. Katowice, Poland. Website: [www.pigog.com.pl/CaMgSeminar](http://www.pigog.com.pl/CaMgSeminar)

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

7-10 October 2012. 5th International Symposium on Environmental Geochemistry in the Tropical Countries. Buzios, Brazil, Website: [www.isegtropic.com/site/isegt.php](http://www.isegtropic.com/site/isegt.php)

15-19 October 2012. 7th Annual Short Course: Fluids in the Earth. Naples Italy. Website: [www.fluidenv.unina.it](http://www.fluidenv.unina.it) <<http://www.fluidenv.unina.it/>>

22-26 October 2012. Short Course: Introduction to Secondary Ion Mass Spectroscopy in the Earth Sciences. Potsdam Germany. Website: <http://tinyurl.com/cye2ljs>

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

16-17 November 2012. 10th Swiss Geoscience Meeting. Bern, Switzerland. Website: <http://tinyurl.com/buk87ps>

*continued on page 10*



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## CALENDAR OF EVENTS

*continued from page 11*

19-21 November 2012. 5th Water Contamination Emergencies: managing the threats. Muelheim an der Ruhr, Germany. Website: [www.wcec5.eu](http://www.wcec5.eu)

3-4 December 2012. Annual International Conference on Geological & Earth Sciences (GEOS 2012). Singapore. Website: <http://geoearth.org>

3-7 December 2012. Northwest Mining Association: 118th Annual Meeting, Exposition & Short Courses. Spokane WA USA. Website: [www.nwma.org](http://www.nwma.org)

5-8 December 2012. 13th European Meeting on Environmental Chemistry. Moscow, Russia. Website: [www.europeanace.com/about/meetings2013](http://www.europeanace.com/about/meetings2013)

8- 2 December 2012. International Workshop on Magmatic Ore Deposits. Karnataka, India. Website: <http://tinyurl.com/cavq8jn>

### 2013

16-19 January 2013. Granulites & Granulites 2013. Hyderabad, India. Website: <http://ggindia2013.com>

28-31 January 2013. Mineral Exploration Roundup 2013. Vancouver BC, Canada. Website: <http://tinyurl.com/cvt4jng>

10-15 February 2013. 2013 European Winter Conference on Plasma Spectrochemistry. Krakow, Poland. Website: [www.chemia.uj.edu.pl/ewcps](http://www.chemia.uj.edu.pl/ewcps)

3-6 March 2013. Prospectors and Developers Association of Canada Annual Convention. Toronto ON, Canada. Website: [www.pdac.ca/pdac/conv/index.aspx](http://www.pdac.ca/pdac/conv/index.aspx)

13-15 March 2013. IsoG2013 — Environmental geochemistry - methods, trends, questions. Warsaw, Poland. Website: [www.ing.pan.pl/IsoG2013](http://www.ing.pan.pl/IsoG2013)

18-22 March 2013. 44th Lunar and Planetary Science Conference. Pasadena CA, USA. Website: [www.lpi.usra.edu/meetings/lpsc2013](http://www.lpi.usra.edu/meetings/lpsc2013)

27-29 March 2013. Volcanism, Impacts, and Mass Extinctions: Causes & Effects. London, UK. Website: <http://massextinction.princeton.edu>

7-12 April 2013. European Geosciences Union General Assembly. Vienna, Austria. Website: [www.egu2013.eu](http://www.egu2013.eu)

23-25 April 2013. 7th International Conference on the Impact of Environmental Factors on Health. Budapest, Hungary. Website: <http://tinyurl.com/cf2yp73>

24-28 April 2013. Basalt 2013 - Cenozoic Magmatism in Central Europe. Goerlitz, Germany. Website: <http://tinyurl.com/cybv74v>

5-8 May 2013. Canadian Institute of Mining, Metallurgy, and Petroleum 2013 Conference & Exhibition. Toronto ON, Canada. Website: <http://web.cim.org/toronto2013beta>

19-22 May 2013. AAPG 2013 Annual Convention & Exhibition. Pittsburgh PA, USA. Website: [www.aapg.org/pittsburgh2013](http://www.aapg.org/pittsburgh2013)

*continued on page 13*

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## CALENDAR OF EVENTS

*continued from page 12*

22-24 May 2013. Geological Association of Canada/  
Mineralogical Association of Canada Annual Meeting.  
Winnipeg MB Canada. Website: <http://gacmacwinnipeg2013.ca>

9-14 June 2013. Water-Rock Interaction XIV Symposium.  
Avignon, France. Website : [www.wri14-2013.fr](http://www.wri14-2013.fr)

16-20 June 2013. 12th International Conference on the  
Biogeochemistry of Trace Elements. Athens GA USA.  
Website: <http://tinyurl.com/ca39d7g>

30 June – 4 July 2013. 12th International Estuarine  
Biogeochemistry Symposium. Plymouth, UK. Website: [www.iebs2013.org](http://www.iebs2013.org)

28 July-2 August 2013. 11th International Conference on  
Mercury as a Global Pollutant Edinburgh UK. Website:  
[www.mercury2013.com](http://www.mercury2013.com)

4-8 August 2013. Microscopy & Microanalysis 2013.  
Indianapolis IN USA. Website: [www.microprobe.org/events](http://www.microprobe.org/events)

25-30 August 2013. Goldschmidt 2013. Florence, Italy.  
Website: [www.goldschmidt.info/2013](http://www.goldschmidt.info/2013)

2-10 September 2013. 10th International Eclogite  
Conference. Courmayeur, Italy. Website: [www.iec2013.unito.it/](http://www.iec2013.unito.it/)

24-27 September 2013. SEG Conference: Geoscience for  
Discovery. Whistler BC, Canada. Website: [www.seg2013.org](http://www.seg2013.org)

27-30 October 2013. GSA 2013 Annual Meeting. Denver CO  
USA. Website: [www.geosociety.org/meetings/2013](http://www.geosociety.org/meetings/2013)

29-31 October 2013. 9th Fennoscandian Exploration and  
Mining Meeting. Levi, Finland. Website: <http://fem.lappi.fi/en>

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




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## AAG Member News

Matt Leybourne has accepted a position as Senior  
Geochemist with ALS Global Minerals and is now  
based in Vancouver, Canada.



## New AAG Members

### Fellow (Voting):

Maurizio Barbieri  
Sapienza University of Rome - Earth Sciences  
P.le Aldo Moro 5  
Rome, Italy 00185  
Membership # 4121

### Member (Non voting):

Auri Koivuhuhta  
Ramboll Finland Oy  
Luistelijantie 5 C 21  
Kuopio, Finland 70200  
Membership # 4092

Barry A. Frey  
Minnesota DNR-Division Lands & Minerals  
Natural Resources  
1525 3rd Avenue East  
Hibbing, Minnesota USA 55746  
Membership # 4093

Arne F. Stenseth  
Auric Resources International, Inc.  
1020 West Wickenburg Way  
Suite E-9  
Wickenburg, Arizona USA 85390  
AAG Membership # 4094

Julietta Zamora  
Anglo American  
Av Pedro de Valdivia 291  
CP 7500524  
Santiago, Chile 7500524  
Membership # 4095

Andrew Menzies  
Universidad Católica del Norte  
Facultad Ingeniería y Ciencias Geológicas Avenida Angamos  
0610 Antofagasta  
Region II Chile  
Re: Membership # 4097

Romarico Fernandez  
Aruntani SAC  
Geologist Exploration  
Calle Independencia 753  
Miraflores, Lima, PERU 18  
Membership # 4098

Cecil W. Calhoun  
1503 Gordon Drive  
Ruston, Louisiana USA 71270  
Membership # 4100

Anne Marie Ryan  
Dalhousie University  
1459 Oxford Street  
Halifax, Nova Scotia  
Canada B3H 4R2  
Membership # 4103

*continued on page 14*

## New AAG Members... *continued from page 13*

Peter R. Darch  
121 Beringarra Ave.  
Malaga, WA  
Australia 6090  
Membership # 4105

Hannu Ahola  
Tuohitie 9  
Kello, Finland  
90820  
Membership # 4109

Limin Ren  
China University of Geosciences  
Faculty of Earth Sciences  
No. 388, Lumo Rd.  
Hongshan District  
Wuhan, Hubei  
China 430074  
Membership # 4110

Thomas Hart  
2404 Alquonquin Road  
Sudbury, ON  
Canada P3E 5V1  
Membership # 4111

Mehmet Evren Yucel  
Koza Altin Isletmeleri A.S.  
Istanbul Yolu 10. km No:310  
Batikent/Yenimahalle  
Ankara, Turkey 06370  
Membership # 4112

Russell Staines  
10 Richardson Street  
West Perth  
Perth, Australia 6005  
Membership # 4113

Mitchel E. Metzger  
Jr. Tiziano 301 San Borja  
Lima, Peru  
Lima 41  
Membership # 4114

Juan Ordenez-Calderon  
Hudbay  
PH01-110 Erskine Avenue  
Toronto, Ontario  
Canada M4P 1Y4  
Membership # 4117

Jorge E. Cortes  
Laboratory Director  
Petromarkers Inc.  
830 Bay Star Blvd  
Webster, Texas USA 77598  
Membership # 4119

Pablo Andrada de Palomera  
at Fomicruz S.E., Government Company  
Cordoba 361  
Santa Cruz, Argentina 9400  
Membership # 4122

### Students:

Dr. John Kozuskanich  
NCGRT at Flinders University  
Earth Sciences Building, Rm 105B  
Bedford Park, SA 5042 Australia  
Membership # 4099

Ellen L. Raimondi  
1305 N. Annie Glidden Rd.  
Apt. 1616  
Dekalb, Illinois, USA 60115  
Membership # 4101

*continued on page 15*

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## New AAG Members... *continued from page 14*

Morgan J. Williams  
40 Daley Road  
Acton, ACT Australia 2601  
Membership # 4102

Camilo Sanchez Yanez  
University of Chile  
Region Metropolitana  
Santiago, Chile 8300204  
Membership # 4104

Paul Ekwutoziam  
Highly Brothers Wuse 2  
Wuse, F.C.T.  
Abuja, Nigeria  
Membership # 4106

Luis A. Parra  
M006, 35 Stirling Highway  
Crawley, WA Australia 6009  
Membership # 4107

Elkin Mauricio Hernandez Rios  
Universidad de Chile  
c/o Edna C Para M  
Avenida Santa Isabel 765 Apartamento 1909  
Santiago, Region Metropolitana  
8320000 Chile  
Membership # 4108

Katherine Stoate  
University of Adelaide  
5 Emerald Street, Sals East  
Adelaide, SA, Australia 5109  
Membership # 4115

Amanda M. Isnor  
7 Rembec Drive  
New Minas, Nova Scotia  
Canada B4N 4A4  
Membership # 4116

Manuel G. Quiring  
Freie Universitaet Berlin  
Geygerstrasse 8  
Berlin, Germany 12043  
Membership # 4118

Juan P. Giraldo  
University of Antioquia - Columbia  
Medellin, Antioquia  
Columbia  
Membership # 4120



## AAG medals; some revision of guidelines and simplification of nomination procedures

Significant contributions to applied geochemistry or service to AAG are recognised by award of either the AAG Gold or Past Presidents' (Silver) medals respectively. The history of how the medals came about and the formulation of guidelines for their award are discussed in the April 1992 issue of **EXPLORE**.

Guidelines for nominating individuals for either medal are posted in 'The Association' section of the AAG website ([www.appliedgeochemists.org](http://www.appliedgeochemists.org)) under the 'Awards' area. Some discussion of these guidelines has indicated that the process for nominating individuals for either medal is a little cumbersome, to the extent that some nominations may not be made, and others take an unnecessarily long time to resolve. With this in mind, the 2012-2013 Awards & Medals Committee (Chair: Paul Morris. Committee members Eion Cameron, Pertti Sarala, and Chris Benn) have revisited

the guidelines in an effort to make the nomination process a little friendlier, with a more concise timeframe for resolution. The revised guidelines are presented below, and appear on the website in place of the earlier version. In short:

- The physical size of each nomination has been reduced
- Nominations for either medal should be made to the Chairman of the Awards & Medals Committee by December 1<sup>st</sup> of any year
- For simplicity, the past Presidents' Medal will be known in the future only as the Silver Medal
- Successful nominees will be presented with their medal at the first IAGS meeting following ratification of the medal award by AAG Council

Although the guidelines have been simplified, the current Awards & Medals Committee emphasises the significance of both medals. This is shown by those who have been medal recipients.

### Gold Medal

Recipient	Year	Affiliation
Charles Butt	1995	Government
Ray Smith	1995	Government
Robert Boyle	1999	Government
Gwendy Hall	2005	Government
Xie Xuejing	2007	Government
Gerry Govett	2009	Academia
Eion Cameron	2011	Government, academia

### Past Presidents' Medal (Silver Medal)

Recipient	Year	Affiliation
Eion Cameron	1993	Government, academia
Alan Coope	1995	Industry
Sherman Marsh	1997	Government
John Hansuld	1999	Industry
Dave Smith	2009	Government

## REVISED GUIDELINES FOR MEDAL NOMINATION

### 1.0 THE MEDALS AND THEIR PRESENTATION

1.1 The Association of Exploration Geochemists (now the Association of Applied Geochemists, or AAG) inaugurated two (2) medals to be awarded to worthy and deserving persons in accordance with the guidelines set out below. A full discussion of the history of the medals and the guidelines for awarding them is presented in EXPLORE 75, April 1992.

1.2 The medals are of a design approved by the Council of the Association. They are referred to as the “GOLD MEDAL” and the “PAST PRESIDENTS’ MEDAL”. The latter has also been known as the Association’s “SILVER MEDAL”, and, for simplicity, will be known only as the Silver Medal in future.

1.3 The Gold Medal, to be awarded to a person for outstanding scientific achievement in applied geochemistry, will be engraved with the name of the recipient and the year of the award.

1.4 The Silver Medal, to be awarded to a member of the Association of Applied Geochemists for dedicated service to the Association, will be engraved with the name of the recipient and the year of the award.

1.5 Both the Gold Medal and the Silver Medal will be presented by the President of the Association at the first International Applied Geochemistry Symposium (IAGS) following endorsement of nominations.

1.6 The award citations for both the Gold Medal and the Silver Medal shall be prepared by the President from information provided by the Awards and Medals Committee.

1.7 The award citations for each medal and the acceptance speeches of the recipients will be included in full in the first issue of the Association newsletter, EXPLORE, published following the IAGS at which the awards are presented.

1.8 The Secretary of the Association will issue a press release at the time of the awards naming the recipients and a description of the services and/or scientific achievements for which they are honoured. The press release will be prepared by the Chairman of the Awards and Medals Committee, and will be delivered to appropriate newspapers, journals (e.g. EXPLORE, ELEMENTS), and societies around the world.

### 2.0 THE AWARDS AND MEDALS COMMITTEE

2.1 The immediate Past President of the Association will be the Chairman of the Awards and Medals Committee. He or she will select either three (3) or four (4) other Voting Members for the Committee, all of whom must be Fellows of the Association. Following selection, the composition of the committee will be endorsed by Council. Consideration should be given to Past Presidents, Councillors and Regional

Councillors of the Association as suitable Committee members.

2.2 The Chairman of the Awards and Medals Committee for each year will assume his or her responsibilities immediately following the end of his or her term as President of the Association. He or she will serve as Chairman of the committee for a two (2) year period.

2.3 The Awards and Medals Committee will be responsible for soliciting nominations for both the Gold Medal and the Silver Medal through notices in EXPLORE, other newsletters, and other appropriate procedures, including the Association’s website.

### 3.0 NOMINATIONS

3.1 To be eligible for consideration for either award, nominations must be received by the Chairman of the Awards and Medals Committee on or before December 1<sup>st</sup> of any year.

3.2 For acceptance by the Awards and Medals Committee, nominations must be signed by a minimum of four (4) Fellows (voting members) of the Association in good standing. Nominations should include:

- (a) A one page recommendation from each of the four nominators;
- (b) A resume or curriculum vitae of the nominee;
- (c) An itemized list of the outstanding scientific achievements (Gold Medal) or the dedicated service to the Association (Silver Medal) of the nominee (maximum two pages).

Since members of the Awards Committee may not have personal knowledge of the nominee, the completeness and quality of the nomination will be critical in terms of evaluation and selection.

3.3 The Awards and Medals Committee will review all nominations and the Chairman of the committee will report the committee’s selection for each award to Council at the first Council Meeting in the year following the nomination(s). The Committee, in its judgement, may elect not to select any of the nominees entered for consideration and not more than one Gold Medal and one Silver Medal will be awarded in any one year. Council will confirm the Committee’s selections by majority vote. Nominations for 2012-2013 should be sent to Paul Morris, Chairman AAG Awards & Medals Committee, Geological Survey of Western Australia, 100 Plain Street, East Perth 6004, Western Australia. ([paul.morris@dmp.wa.gov.au](mailto:paul.morris@dmp.wa.gov.au))

**Paul Morris, Eion Cameron, Pertti Sarala, Chris Benn**  
AAG Awards & Medals Committee (2012-2013)





# The Association of Applied Geochemists

announces the

**2012 AAG  
Student**

**Paper**

**Competition**

**SGS**



The AAG announces the 9th biennial Student Paper Competition. The paper must address an aspect of exploration geochemistry or environmental geochemistry related to mineral exploration and be based on research performed as a student.

The student must be the principal author and the paper must have been published in *Geochemistry: Exploration, Environment, Analysis* no more than three years after completion of the degree. All eligible papers in 2011 and 2012 volumes of GEEA will be reviewed by the selection panel.

The winner will receive:

- A cash prize of \$1000CAD generously donated by SGS Minerals Services;
- A 2-year membership of AAG, including the society's journal (GEEA); EXPLORE newsletter, publication of an abstract and CV of the winner;
- a certificate of recognition; and
- \$500US towards expenses to attend an AAG-sponsored meeting, courtesy of AAG.

The results of the 2012 competition will be announced at the 26th IAGS in Rotorua, New Zealand. Details are available from the Chair of the committee or the AAG Students' page (<http://www.appliedgeochemists.org/>).

David Cohen

Chair, Student Paper Competition  
School of BEES

The University of New South Wales

UNSW NSW 2052 Australia

Email: [d.cohen@unsw.edu.au](mailto:d.cohen@unsw.edu.au)



# ioStipend



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

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

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

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

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

The application form is available at [www.ioglobal.net](http://www.ioglobal.net).

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

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

### **Eligibility Criteria**

Preference will be given to:

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

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

Some technical input may be provided by ioGlobal on request.

### **Requirements for receiving the ioStipend**

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

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

**David Lawie, John Gravel**





# EXPLORE

Newsletter No. 156

SEPTEMBER 2012

Editor: Beth McClenaghan ([beth.mcclenaghan@NRCan-RNCan.gc.ca](mailto:beth.mcclenaghan@NRCan-RNCan.gc.ca))

Business Manager:

Sarah Lincoln, 1 (720) 881-6980 ([SARAH.LINCOLN@MMG.COM](mailto:SARAH.LINCOLN@MMG.COM))Back Issues contact: Betty Arseneault ([office@appliedgeochemists.org](mailto:office@appliedgeochemists.org))

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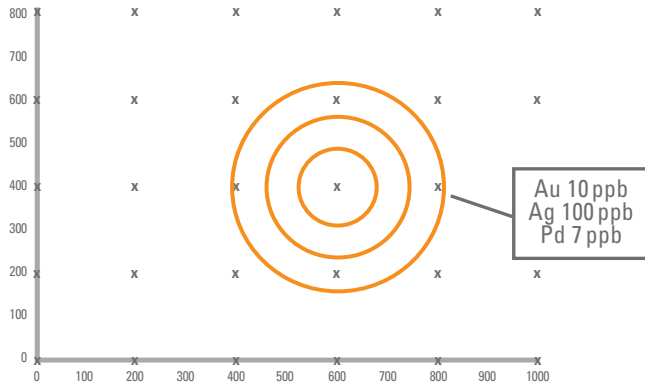
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