EXPLORE

NUMBER 115 *Newsletter for the Association of Exploration Geochemists* APRIL 2002

Philippe Freyssinet

PRESIDENT'S MESSAGE

Dear colleagues,

I take the opportunity of **EXPLORE's** second issue in 2002 to address you all about AEG's mission on a few topics which I believe are essential to the life of our association. I am thinking of diffusion of information about our activities and AEG's rapid evolution towards environmental geochemistry.

Communication

Thanks to Steve Amor's efforts, our web site is coming along nicely with information already available on-line about the activities of AEG members from Australia, Scandinavia and even China. It is important that our web site brings us diversity from our activities worldwide and becomes a scientific and technical discussion portal for all geochemists. I strongly believe that we ought to make our respective domestic information available on-line, as well as those reference documents that are so useful to the whole of our profession. I am thinking, for example, about the excellent report by Linda Bloom "Writing Geochemical Reports, Second Edition". Making such documents available to the entire geochemical community is an excellent means of enhancing our Association's image. I look forward to the completion in the near future of an updated digital geochemical bibliography on our web site. Other documents, such as sampling protocols, sample preparation procedures, performance of new analytical devices, new data processing techniques, etc., would also be extremely valuable Please do not hesitate to contact Steve Amor or myself and let us know your proposals on this issue.

Workshops on Exploration Geochemistry

Although we won't be holding a symposium in 2002, our Association is actively represented at major conferences where it will offer a number of workshops. At the PDAC Convention in Toronto, Graham Closs, Linda Bloom and Mary Doherty presented a workshop entitled "Improving the odds: Effective exploration geochemistry". At the Global Exploration 2002 Conference in Denver, which will be held in April this year, Graham Closs, Mary Doherty and Ken Witherly will run a workshop entitled "Discovery Through Innovation – Putting Technology to Work in Mineral Exploration". The content of these workshops is a remarkable illustration of the evolution of the methods available in geochemical exploration and AEG members are the main presenters. No doubt these workshops will be extremely well received.

Environment

A significant number of our members are now actively involved in the field of environmental geochemistry and environmental management at large. It seems to me that AEG can play a key role on a number of issues, as our knowledge in exploration and mineralisation geochemistry can contribute significantly to the management of several current environmental issues. I can think of a number of examples, of which I will quote a couple, where contribution from exploration geochemists could prove highly valuable, mainly thanks to their thorough understanding of such notions as "geochemical backgrounds" and the characteristics of mineralisations:

- Europe is currently defining new directives on water management (European Water Directive). These directives require that new tools be used to monitor ground water quality throughout Europe. Besides contamination by mankind, the influence of the geochemical background on ground water quality can also be significant. For instance, high levels of As, Se and U in a number of aquifers, which are probably improper for human consumption, are solely due to geological factors.

- The European Commission has just released a text that sets the framework of a future environmental directive on soil management and protection. Once again, the definition of geochemical background is important, particularly when it comes to defining the

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Be the first to see this complete solution at work...

Geosoft and Metech will be holding a session on "Integrated Data Management - Oasis montaj and acQuire" in Denver during the SEG (April 14 - 16, 2002). In response to the growing interest in this presentation, we will run the same session on two separate days (April 15 and April 16). Who should attend?

- Geologists, Geochemists, and Geophysicists looking for a complete solution for working with all types of exploration data from collecting to reporting.
- Geoscientists looking to improve their exploration opportunities through better data management, quality control, analysis, integration and presentation.
- Exploration managers looking for a cost saving end-to-end solution from one provider enabling an easy exchange of data and results.
- Investment managers who wish to understand technologies available to provide better QA/QC for investment decisions

The presentation will include the following topics:

I. Work flow from 'Start' to 'Finish': acQuire and Oasis montaj - Vertical Integration.
II. Field Data Capture: The new Pocket acQuire.
III. Data Management and Synchronization Concepts.
IV. Quality Control and Quality Assurance.

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Be the first to see...

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V. acQuire: Link and relationship to Oasis montaj.
VI. Data Visualization and Map Production.

This session is complimentary but please note that seats are limited. To reserve a seat, please email info@geosoft or visit www.geosoft.com for more details.

Where: Holiday Inn Denver International Airport, Beaver Creek Room, located in the same hotel as the SEG conference
When: Monday, April 15 from 3:30pm to 4:30pm and on Tuesday, April 16 from 2:00pm to 3:00pm.

President's Message

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objectives of polluted site cleaning strategies or procedures for amending agricultural soils with sewage sludges or similar wastes, where only a handful of experts are qualified enough to handle information of this nature.

- In the mining field, a European directive is under review that deals with management of mine waste. Who better than an exploration geochemist could possibly best identify the long-term geochemical behaviour of tailings or treatment residues and predict their impact on surface and ground waters?

These few examples suffice to illustrate the environmental and scientific problems in which AEG can play an important role not only through its members, but also as an association that compiles and diffuses information on these topics. Our scientific journal GEOCHEMISTRY Exploration, Environment, Analysis (GEEA) is already addressing these topics and can play an important role in the scientific debates about these environmental issues . In doing so, GEEA represents a major asset for attracting new members given the number of research teams now working on these subjects worldwide.

AEG represents an efficient think tank for dealing with scientific and technical geochemical problems in the field of exploration and environment, mainly around mine sites.

Philippe Freyssinet
BRGM
Environment & Process Division
BP6009, F-45060 Orléans, France
Tel : 33-238.64.3005
Fax : 33-238.64.3680
Email : p.freyssinet@brgm.fr

Technical Note

Using the Correct Control Limits

Lynda Bloom[1], Maureen Leaver[2]
[1]Analytical Solutions Ltd. , 1214-3266 Yonge Street, Toronto, ON Canada M4N 2L6 (www.explorationgeochem.com)
[2] CCRMP, Canadian Certified Reference Materials Project, Natural Resources Canada, 555 Booth Street Ottawa, ON K1A 0G1

It is essential that regular submissions of standards and blanks be submitted to a laboratory to ensure that suitable data quality is being provided. Certified reference materials (CRM's) are generally sold with information stating an expected range of values for contained elements as determined by the manufacturer of the CRM.

The statistics usually supplied by the manufacturer are a measure of the homogenization of the CRM and agreement between the laboratories that participated in the round robin that was undertaken to determine the accepted values. These statistics cannot be applied to measure a laboratory's data quality. An understanding of the statistics underlying the expected range of values for the CRM is crucial.

Gold standard MA-1b, produced by the Canadian Certified Reference Materials Project, a division of Natural Resources Canada, is used to demonstrate this point. The Certificate of Analysis for MA-1b reads as follows:

REFERENCE GOLD ORE MA-1b

Recommended Value ± 95% Confidence Interval
Au 17.0 μg/g ± 0.3 μg/g

This is the label on the purchased bottles and many purchasers assume that 95 out of 100 times a laboratory's results for MA-1b should therefore fall within

16.7 to 17.3 μg/g Au.

However, it is stipulated in the literature that accompanies the bottle, "the uncertainty estimates the expected range of reproducibility of this mean within 95% probability were the measurement program to be repeated many times." In fact, the 95% confidence limit quoted denotes that if the certification program were to be conducted 100 times, the *overall mean* in 95 cases would be expected to fall within the prescribed limits. The certification program for MA-1b, which is similar to that used by most CRM manufacturers, included 175 acceptable analytical determinations produced by 28 laboratories.

When the typical user inserts standards into sample batches, there is only *one* determination by the laboratory

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Using the Correct Control Limits...

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and the 95% confidence limit quoted is not applicable for measuring the acceptability of this single reported value. Realistically, the range of values produced by having a single determination will be far greater than the 95% confidence limit quoted.

Along with the MA-1b documentation is an additional table of statistics that is reproduced below.

Distribution of results by method

Method	No. of Sets	No. of Results	(μg/g)				
			Mean	CI	S_{Lc}	S_{rc}	CV,%
FA/G	20	113	16.96	0.30	0.61	0.37	1.93
FA/AAS	8	44	17.26	0.85	0.99	0.42	2.30
INAA	3	20	17.21	1.85	0.66	0.65	3.88
FA/INAA	1	4	16.23			0.36	2.25
FA/ICP	1	5	17.36			0.29	1.66
Overall	**33**	**186**	**17.05**	**0.26**	**0.70**	**0.42**	**2.22**

S_{Lc} is the between-set standard deviation and S_{rc} is the within-set standard deviation. The bottles of MA-1b are labelled with the overall mean, 17.0 and the 95% Confidence Limit, 0.30 μg/g.

The more meaningful statistics for explorationists, when a single determination by a single laboratory is being evaluated, are the *overall* between- and within-set standard deviations. The within-set standard deviation is a reflection of the homogeneity of the material in the bottle received by the participating laboratory in combination with that laboratory's ability to reproduce the analytical method routinely. The between-set standard deviation is likely the most useful statistic, in addition to the factors described for the within-set standard deviation; it also takes into account slight biases between laboratories, the differences between the sub-samples received by the laboratories.

The mean ± two standard deviations approximates the expected range of values for 95% of the cases. Using S_{Lc}, the between-set standard deviation, of 0.70 μg/g and the calculated mean value of 17.0 μg/g , the results for MA-1b are expected to fall within 15.6 to 18.4 μg/g Au. Based on the 95% Confidence Limit as indicated on the label of the bottle, the range of results for MA-1b are 16.7 to 17.3 μg/g Au which is a considerably narrower range of acceptable values.

This is a complicated subject and using S_{Lc}, the between-set standard deviation, to estimate the allowable range of values is only a first approximation.

The International Standards Organization has several committees that have been working on these questions for 25 years. The titles of ISO Guides 30 to 35 are listed in the references for readers who are interested in researching the issue further (or visit www.iso.ch). There are several statistical approaches documented that evaluate the acceptance of single and replicate assays, which seem to involve rather sophisticated equations (as shown below) and each requiring different sets of conditions to be met.

$$| X_C - X_L | \leq 2\sqrt{\sigma_{Lm}^2 + \sigma_{Rm}^2}$$

Further details on the evaluation of results for certified reference materials are described in a condensed version of ISO Guide 33 available from the Canadian Certified Reference Materials Project at CANMET, Ottawa, Canada, ccrmp@nrcan.gc.ca or (613) 943-0573.

This discussion points out that a wider range of values, than those generally provided by suppliers of certified reference materials, are acceptable values. Although suppliers provide suitable data to verify that their materials are well homogenized and that the acceptable value is an accurate representation of the content, these values should not be used to determine which assays should be rejected for a quality control program.

References

ISO Guide 30, Terms and definitions used in connection with reference materials

ISO Guide 31, Contents of certificates of reference materials

ISO Guide 32, Calibration in analytical chemistry and use of certified reference materials

ISO Guide 33, Uses of certified reference materials

ISO Guide 34, Quality system guidelines for the production of reference materials

ISO Guide 35, Certification of reference materials— General and statistical principles

Steger, H.F., 1998. Uses of matrix reference materials. For presentation at the IUPAC/ISO/REMCO workshop on Reference Materials, Berlin, April 22-23, 1999 and the workshop of the conference of the Canadian Mineral Analysts, Kirkland Lake, ON, September 17, 2001, and for publication in the respective workshop proceedings. Project: MMSL No. 600637CCRMP DIVISION REPORT MMSL 98-024 (OP&J)

Verma, S.P., 1997. Sixteen statistical tests for outlier detection and rejection in evaluation of international geochemical reference materials: example of Microgabbro PM-S. Geostandards Newsletter, Vol.21, No.1, pp. 59-75.

CALENDAR OF EVENTS

International, national, and regional meetings of interest to colleagues working in exploration, environmental and other areas of applied geochemistry.

■ May 7-8, 2002, **GSA Rocky Mountain Section Meeting**, Cedar City, Utah. Information: Robert L. Eves, (435) 586-1934. Abstracts deadline: February 4, 2002.

■ May 13-15, 2002, **GSA Cordilleran Section Meeting**, Corvallis, Oregon. Information: Bob Yeats (541) 737-1226. Abstracts deadline: February 7, 2002.

■ May 15-17, 2002, **4th International Conference on Advances in Fluid Mechanics**, Ghent, Belgium , by the Wessek institute of Technology, UK and University of Ghent, Belgium. (Conference Secretariat, AFM 2002, EMail: shobbs@wessex.ac.uk Web: http://www.wessex.ac.uk/conferences/2002/afm02)

■ May 27-29, 2002, **47th Joint Annual Meeting of the GAC and MAC Of Canada**, University of Saskatchewan, Saskatoon, Saskatchewan, CANADA , by the Geological Association of Canada and the Mineralogical Association of Canada. (Mel Stauffer, Department of Geological Sciences, University of Saskatchewan, 114 Science Place, Saskatoon, SK, Canada. S7N 5E2, Phone: 306-966-5708 FAX: 306-966-8593 EMail: mel.stauffer@usask.ca Web: http://www.usask.ca/geology)

June 6-19, 2002, **Modern Management of Mine producing, Geology and Evironmental protection**, **International Conference SGEM 2002**, Varna City, BULGARIA. Information: SGEM, +359 2 975 3117, Email: office@stef92.com.

■ June, 8-14, 2002, **AMERICAN SOCIETY for SURFACE MINING and RECLAMATION (ASSMR) 18th National Meeting**, Lexington, KY. http://www.ca.uky.edu/assmr/Upcoming_Events.htm

■ June 15-20, 2002**, Mineral Surface Reactivity: EuroConference on Models of Mineral Surface Reactivity**, Castelvecchio Pascoli, Italy. Information: European Science Foundation, EURESCO Office, 1 quai Lezay-Marnésia, 67080 Strasbourg Cedex, France.

■ July 14-August 2, 2002, **9th International Platinum Symposium and Field Conference**, Bozeman, Montana. Organizers: IGCP (International Geological Correlation Programme) 427, Society for Geology Applied to Mineral Deposits. Information: Roger Cooper, (409) 880-8239, fax 409-880-8246.

■ July 21-25, 2002, **9th International Platinum Symposium,** Holiday Inn - Grand Montana, Billings, MT, USA , by the IGCP427/SEG/SGA. (Roger Cooper, Dept. of Geology, Lamar University,P.O. Box 10031, Beaumont, TX 77710, Phone: 409-880-8239 EMail: cooperrw@hal.lamar.edu Web: http://www.platinumsymposium.org)

■ July 22-27, 2002, **The Earth System and Metallogenesis: A Focus on Africa**, Windhoek, Namibia , by The Geological Society of Namibia, The Geological Society of South Africa, and The Geological Society of Zambia. (The Secretary, IAGOD/GEOCONGRESS 2002, P.O. Box 44283, Linden 2104, South Africa, EMail: gssa@pop.onwe.co.za Web: http://www.gssa.org.za)

■ Aug 31-Sep 04, 2002, **Emerging Concepts in Organic Petrology and Geochemistry**, The Banff Centre, Banff, Alberta, Canada , by the Canadian Society for Coal Science and Organic Petrology (CSCOP) & The Society for Organic Petrology (TSOP). (Dr. Martin Fowler, Geological Survey of Canada, 3303-33rd St. NW, Calgary, Alberta T2L 2A7 Canada, Phone: 403-292-7038 FAX: 403-292-7159 EMail: Mfowler@nrcan.gc.ca Web: http://www.cscop-tsop2002.com)

■ September 1-4, 2002, **AusIMM 2002 - 150 Years of Mining**, Auckland, New Zealand. Technical and poster sessions on Geoscience, Mining, Metallurgy, Environment and General topics. Field trips to geothermal systems, and epithermal and orogenic lode gold deposits. Details and registration form available on website http:/www.ausimm.co.nz EMail: conference2002@ausimm.co.nz

■ October 27–30, 2002, **Annual Meeting of the Geological Society of America**, Denver, Colorado. INFORMATION: TEL 1-800-472-1988, meetings@geosociety.org.

■ November 20-23, **Role of Natural Resources and Environment for Sustainable Development in South and Southeast Asia (NESDA**), Dhaka, Bangladesh. Information: Afia Akhtar, Geological Survey of Bangladesh, 153 Pioneer Road, Segunbagicha, Dhaka 1000, Bangladesh, 880-2-418545.

■ December 14-19, **Geochemistry of Crustal Fluids: The Role and Fate of Trace Elements in Crustal Fluids**, Seefeld in Tirol, Austria. Information: European Science Foundation, EURESCO Office, 1 quai Lezay-Marnésia, 67080 Strasbourg Cedex, France.

■ February 24-26, 2003, **Society for Mining, Metallurgy, and Exploration (SME) annual meeting,** Cincinnati, OH. INFORMATION: SME (sme@smenet.org). SME, Meetings Dept., P.O. Box 277002, Littleton, CO 80127, 800-763-3132. SME (sme@smenet.org)

■ May 12-16, 2003, **GeofluidsIV: Fourth international conference on fluid evolution, migration and interaction in sedimentary basins and orogenic belts**, Utrecht University, Utrecht, The Netherlands , by the Netherlands

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Calendar of Events

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Institute of Applied Geoscience TNO-National Geological Survey. (Ms. J.M. Verweij, PO Box 80015, 3508 TA Utrecht, The Netherlands, Phone: +31 30 256 4600 FAX: +31 30 256 46 05 EMail: j.verweij@nitg.tno.nl Web: http://www.nitg.tno.nl)

■ June 1-7, 2003, **AMERICAN SOCIETY for SURFACE MINING and RECLAMATION (ASSMR) 19th National Meeting and Billings Land Reclamation**, Billings, Montana. INFORMATION: Dennis Newman, dneuman@montana.edu, http://www.ca.uky.edu/assmr/Upcoming_Events.htm

■ July 12-18, 2003, **6th International Conference on Acid Rock Drainage (ICARD),** Cairns, Australia; INFORMATION: Clive Bell, c.bell@mailbox.uq.edu.au or website http://www.ausimm.com.au/events/event_writeups/icard.asp

■ October 5-10, 2003, **The XII International Mineral Processing Congress**, Cape Town, South Africa. Information: www.impc2003.org.za.

■ November 2–5, 2003, **Annual Meeting of the Geological Society of America**, Seattle, Washington. INFORMATION: TEL 1-800-472-1988, meetings@geosociety.org.

■ Oct 10-15, 2004, **SEG International Exposition & 74th Annual Meeting**, Denver, Colorado, US , by the SEG. (Debbi Hyer, 8801 S. Yale, Tulsa OK 74137, Phone: (918) 497-5500 EMail: dhyer@seg.org Web: http://meeting.seg.org)

Please check this calendar before scheduling a meeting to avoid overlap problems. Let this column know of your events.

Virginia T. McLemore
New Mexico Bureau of Mines and Mineral Resources
New Mexico Institute of Mining and Technology
801 Leroy Place
Socorro, NM 87801 USA
TEL: 505-835-5521
FAX: 505-835-6333
e-mail: ginger@gis.nmt.edu

New USGS Web-Based Newsletter

In March 2002, the U.S. Geological Survey Mineral Resources Program began a web-based newsletter providing information on current USGS minerals-related science activities. The newsletter highlights current activities, upcoming events, accomplishments, and recent publications.

The first issue of the newsletter contains articles on national maps and datasets for research and land management, mineral resources spatial data available on the Web, the latest developments with mineral resource databases, a summary of the recently completed Colorado Front Range Infrastructure Resources project, and an update on international work in northeast Asia.

While not limited to geochemistry, the newsletter provides information on the wide spectrum of the actives of the USGS Mineral Resources Program. The newsletter is available on the web only at the following URL: http://minerals.usgs.gov/news/

Robert G. Eppinger
U.S. Geological Survey
P.O. Box 25046, MS 973, Denver, CO 80225, USA
Email: eppinger@usgs.gov
Telephone: 303-236-2468
FAX: 303-236-3200

Laboratory Updates

ACTLABS

Actlabs have developed a number of new products for mineral exploration. The SGH (soil gas hydrocarbon) technique became commercially available in March of 2001 after the period of CAMIRO confidentiality expired on Project 97E01. This cutting edge research was supported by eight major exploration companies (BHP, Inco, Noranda, Outukumpu, WMC, Rio Algom, Cameco and Cominco). Ten case studies were carried out in areas which did not respond to conventional geochemistry. The new technique provided significant definitive heavy hydrocarbon anomalies in most cases. With this technique B soil horizon samples are collected and sent to Actlabs for analysis. Over 170 hydrocarbon compounds in the C5-C17 range are analyzed by GC-MS and GC-MS-MS to a detection limit in the low ppt range. The technique has been found to be very robust to surface organics and environmental degradation. A new two year CAMIRO project, designed to provide better understanding of the processes underlying this technology, was funded in 2001 by Anglo American, BHP-Billiton, Codelco, Outukumpu, Noranda, Barrick, Newmont , WMC, MIM and the provinces of Manitoba, Ontario and Alberta.

Several advances in selective extraction technology which bring 3D mapping into the realm of reality have also been introduced. These include an enhanced version of Enzyme Leach which allows the subsurface mapping of deep geological structures and features. It appears that the Enhanced Enzyme Leach will respond to targets at depths greater than any other selective extraction. The Terrasol Leach and a PGETerrasol version were developed specifically for platinum group metal and gold exploration and have proved to be particularly useful for mapping intermediate and shallow depth deposits and geological features. When these selective extractions are combined a uniquely powerful tool is available for 3D mapping. To round out these capabilities the Na-pyrophosphate leach on organic rich materials allows filling in the gaps in surveys where inorganic soils are not available.

It has become apparent that interpretation of selective extraction data is more complicated than originally thought and interpretative services have been added to improve the odds of success in exploration programs using these methods.

Dr. Colin Dunn and Actlabs have developed a biogeochemical tree-top sampling survey technique using helicopters. A newly introduced analytical packages for 60+ elements, including PGE enables the analysis of vegetation ash and raw vegetation from such surveys at detection levels and for elements previously not used in exploration biogeochemistry.

Our aqua regia Ultratrace 1 (ICP/MS) and Ultratrace 2 (ICP/MS and ICP) packages allow the exploration geochemist to extend the usefulness of conventional geochemistry to see more subtle geological features. "Near total" Au+48 (INAA and 4-acid ICP) package has been augmented with ICP/MS to produce two new packages Au+53 and Ultratrace 3. Pioneering development with lithium metaborate/lithium tetraborate/ lithium carbonate fusions combined with ICP and ICP/MS have allowed us to bring low cost lithogeochemistry into the realm of everyday use and allowed the geologist to make routine use of chondrite normalized REE and spider diagrams. Our hydrogeochemistry packages, which combine ICP, ICP/MS, and ion chromatography, provide the widest suite of elements to the lowest detection limits available. These packages have become widely used for both exploration and base line environmental surveys. Our Pb fire assay ICP/MS package virtually eliminates Pd and Pt blanks and allows a routine detection limit of 0.1 ppb for both Pt and Pd. This technique has been extensively used for lake bottom sediment surveys by the Ontario Geological Survey. We are nearing the completion of a research project which links the capillary electrophoresis technique to ICP/MS for metal speciation determination. The results to date are encouraging. Keep tuned for the environmental and exploration possibilities. Our addition of a geochronologist has allowed us to provide services for all age dating techniques including the popular Ar40/ Ar39, K/Ar, U-Pb, Rb-Sr,Sm-Nd and fission track methods. Isotope ratios for C, S, SO4, O, N, Pb, Nd, Sr, and D/H are also available.

Our commitment to quality is paramount and Activation Laboratories Ltd achieved accreditation to ISO 17025 for specific registered tests and to the mineral analysis standard, Can-P-1579. We are one of only two

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commercial laboratories to have achieved this ultimate status worldwide. Finally Activation Laboratories made use of all these techniques to provide complete chemical analyses of the Tagish Lake meteorite, the most primitive carbonaceous meteorite ever found. These data, which will assist in future chondrite normalization, was published in the journal Science, Volume 290, p320-325.

ALS CHEMEX

It is an exciting time at ALS Chemex. The company has charted an aggressive growth curve over the last two years, culminating in our recent acquisition of the venerable Bondar Clegg group of laboratories. We now stand as a true global provider of analytical chemistry and assays to the mining and exploration industries. Our objective is to continue to integrate new technology with attentive personal service.

Modern exploration geochemistry places a premium on technological innovation, but some assay methods still require the touch of an artist. Perhaps the fire assay methods best exhibit this blend of art and science. The classical lead collection fire assay is still best practice for gold, silver, platinum, and palladium, but success depends heavily on the skills and experience of the assayer. The resurgence of exploration for platinum group elements, particularly in North America, has highlighted the need for careful attention to the details of the fire assay process. As it is good food for thought, a very brief review of the procedure follows.

A nominal 30-grams of sample is mixed with a flux that is rich in litharge (lead oxide) to facilitate destruction of the rock forming matrix and collection of the precious metals during fusion. A silver inquart is added to alloy with the precious metals. The flux ingredients and sample to flux ratio may be adjusted based on sample matrix. For instance, samples that are high in chromite may require additional borax or an increase in the ratio of flux to sample to achieve a good fusion and optimum recovery of precious metals. The tendency of magnesium to emulsify the lead and increase the viscosity of the slag requires a similar remedy, increased borax and/or increased ratio of flux to sample. Samples containing very high sulfide or copper/nickel may also require extra care. Additional litharge (PbO) usually overcomes the problem and ensures full recovery of precious metals, but potassium nitrate (niter) may also be added to increase the oxidizing strength of the flux. The properly fluxed samples are fused in a reducing furnace at approximately 1,000 degrees Celsius. The molten lead collects the precious metals and sinks to the bottom of the crucible.

Once the molten mixture is poured into molds and a lead button is collected and separated from the slag, the precious metals are isolated from the sample matrix and the next step is cupellation. During cupellation the lead button is heated in an oxidizing furnace at approximately 900 degrees Celsius. The lead oxide sinks into the cupel leaving a precious metal bead on the surface. The analyst dissolves the dore bead in aqua regia and follows with an analytical finish by ICP-AES or ICP-MS.

It is here that technology has been brought to bear on a procedure that is hundreds, if not thousands, of years old. If the objective is only gold or silver, the dore bead can be weighed and the result reported gravimetrically. However, spectroscopic instrumentation can report all the elements in solution with good accuracy and precision because most of the potential interferents have been removed with the slag. The ICP-AES is efficient and accurate as an endpoint. Mineralized samples are likely to be reported with an ICP-AES finish. However, the sensitivity required for some exploration work requires that the ICP-MS be used because of its ability to measure precious metals at low ppb levels. The advent of mass spectrometer technology has enabled us to provide reporting limits of less than 1 ppb for Pt and Pd with some special care. This may be useful for the explorer who seeks to measure depletion of PGE's in some rocks. Further, we can easily read Au to 1 ppb following a fire assay without the need for an organic extraction as with AAS, thereby greatly simplifying the process.

We can see the influence of the ICP-MS elsewhere in ALS Chemex. For instance, the ultratrace multielement packages continue to be popular options because of the wide range of elements reported and excellent sensitivity. Until recently, it wasn't practical to include low-level bismuth, rhenium, selenium, tellurium, or thallium in multielement packages because the ICP-AES simply could not measure these elements at or near background levels. The ICP-MS expands the arsenal of elements and improves the quality of low-level geochemistry for the explorer.

The ICP-MS is also the workhorse instrument for selective and partial leach analyses. At ALS Chemex, we

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offer a range of partial leach packages, and we stand ready to modify most of these as needed based on the sample matrix. Under license from Wamtech Pty Ltd., we provide the entire family of MMI leaches, which are optimized to extract loosely bound metals in the soil. Different MMI packages are available for base or precious metals, as well as kimberlites. Regoleach is a unique partial leach developed by ALS Chemex and Rutherford Mineral Resource Consultants of Australia. Regoleach reports 33 elements by ICP-MS after leaching 50 to 100 grams of sample. It is designed to effectively dissolve Au, base metals, and pathfinder elements. ALS Chemex offers the complete range of non-proprietary weak leaches, including variants of hydroxylamine hydrochloride and sodium pyrophosphate. Hydroxylamine hydrochloride can be formulated to attack manganese and/or some of the iron oxides and the elements scavenged by those phases. Sodium pyrophosphate is designed to selectively extract the elements that are bound to organic components in the sample; it is best applied to humus. We also have experience with water, EDTA, and ammonium acetate leaches.

This combination of customized attention to details and adaptation of new technology for exploration geochemistry is evident in many aspects of our business. However, the key ingredient to successful analytical geochemistry remains the people. The combination of Bondar Clegg and ALS Chemex has resulted in an unparalleled team of experienced assayers, chemists, analysts, and professionals, so please feel free to tap into that resource by contacting your nearest ALS Chemex lab for more information!

SGS ANALABS

SGS's geochemical services expanded dramatically in late 2001 with the acquisition of Analabs Pty Ltd. A new entity SGS Analabs is being created by merging existing SGS geochemical laboratories such as XRAL with those of Analabs. Integration of this extensive global network of minesite and geochemical operations is expected to be completed by mid 2002.

The enlarged group provides a full range of services with a strong emphasis on quality. From classical methods, to a variety of methods for precious metals and a range of instrumental techniques such as INAA, XRF, ICP-OES and ICP-MS, we can cover almost any requirement in a geochemical exploration program.

The use of axial ICP-OES methods in Toronto has improved detection limits for a number of elements that

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can be problematic by ICP-MS. The determination of low level Fe in waters is an example. A new Hg analyzer using flow injection methods allows rapid determination of Hg at a 1ppb detection limit. A new Elan 6100 has allowed expansion of ICP-MS methods and improved sensitivity for many elements.

The MMI methods for deep penetrating geochemistry continue to see strong growth as their effectiveness has been proven in areas of deep cover such as much of the Canadian Shield for both precious and base metal targets. The MMI D for detecting buried kimberlitic bodies has developed into a useful tool for the diamond explorationist looking to prioritize geophysical targets for drilling.

BECQUEREL LABS

Instrumental neutron activation analysis (INAA) continues to be viewed as a highly reliable analytical technique for research, primary exploration and ore-body evaluation. With an increasing focus on quality in recent years we have experienced a major increase in use of INAA as part of integrated quality control systems. We now see it widely used as an independent check on analyses carried out by other techniques. This has been particularly important for gold analyses but the application has now expanded to a range of other elements, some of which can cause analytical problems in conventional techniques as they approach ore-grade levels e.g. Ag, U, W, Ta.

The focus on quality has also turned the spotlight on the reliability of reference materials. There can be no doubt that some of these are more homogeneous than others. Figure 1 compares 30 gram replicate INAA gold analyses of a clearly inhomogeneous international standard and an Australian reference material with similar gold content. It is probably best that the international standard remains anonymous (it is now defunct) but it does make the point that it is essential that the user should have some feel for the degree of homogeneity of reference materials when using them to monitor laboratory error.

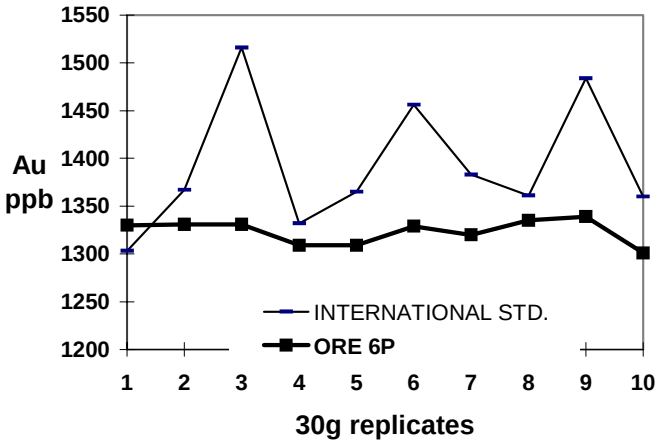

Figure 1. Replicate INAA gold analyses on 30 gram splits of an inhomogeneous international standard and a considerably more homogeneous reference material, ORE 6P.

How can this homogeneity be assessed? The most severe test is to take much smaller replicate samples than would be used in a normal analytical sample. If reproducibility is still reasonable then there can be increased confidence that the sample will behave well when used for routine quality control. Figure 2 shows results of INAA determination of gold on 0.2 gram and 1.0 gram replicates of a potential gold standard. In this case the results show that even though the replicates were either 250 or 50 times smaller than a normal 50 gram fire assay sample they still exhibit good reproducibility and are therefore fit for the purpose for which they were prepared. Such analyses are particularly well suited to INAA since there is good sensitivity for gold, the analysis is total and there is no danger of contamination from laboratory chemicals. Analytical stability can be readily assessed from the range of other elements determined at the same time.

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Laboratory Updates...

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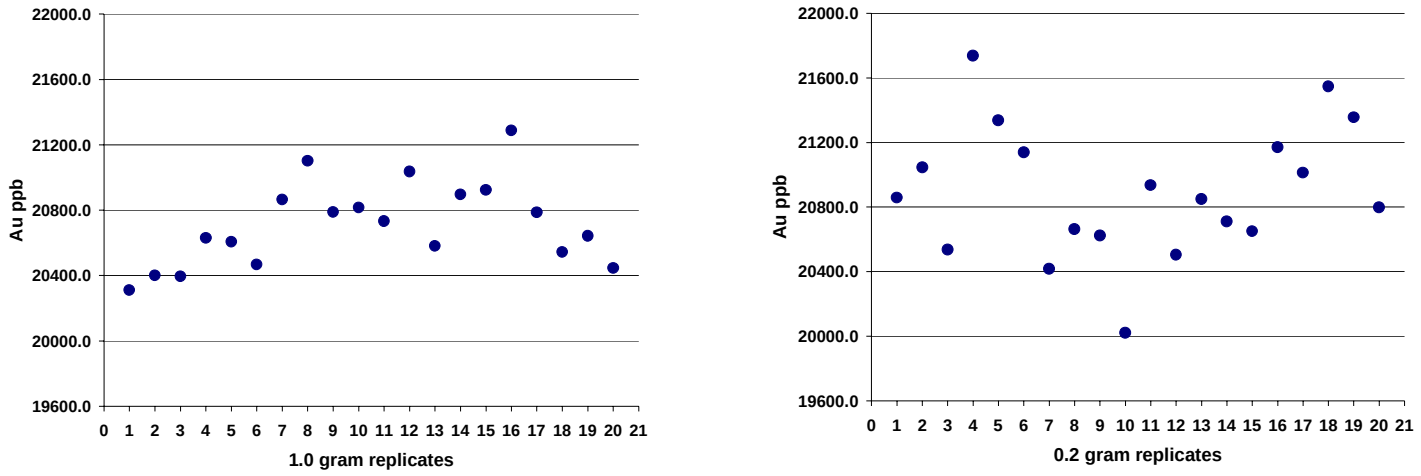

Figure 2. Replicate Au analyses of an ORE custom standard by INAA, using 0.2 gram and 1.0 gram sample weights in order to assess homogeneity.

There is a dangerous and unfortunate tendency to assume that all reference materials are homogeneous. They are not.

Our thanks to Paul Hamlyn, of Ore Research and Exploration, Melbourne, Australia who prepared the ORE samples and agreed to release of the analyses.

David Garnett and
Helen Waldron (naa@bq.com.au).

RECENT PAPERS

This list comprises titles that have appeared in major publications since the compilation in **EXPLORE** Number 114. 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,

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RECENT PAPERS

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Chairman AEG Bibliography Committee. Please send new references to Dr. Closs, not to **EXPLORE**.

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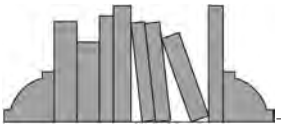

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New Members...

To All Voting Members:
Pursuant to Article Two of the Association's By-Law No.1, names of the following candidates, who have been recommended for membership by the Admissions Committee, are submitted for your consideration. If you have any comments, favorable or unfavorable, on any candidate, you should send them in writing to the Secretary within 60 days of this notice. If no objections are received by that date, these candidates will be declared elected to membership. Please address comments to David B. Smith, Secretary AEG, USGS, Box 25046, MS 973, Denver, CO 80225, USA.

Editors note: Council has decided that all new applicants will receive the journal and newsletter upon application for membership. The process of application to the Nepean office, recommendation by the Admissions Committee, review by the Council, and publication of applicant's names in the newsletter remains unchanged.

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Contact

If you have any questions, suggestions for the Symposium or would like to offer assistance to the Local Organising Committee please contact:

The Secretary LOC - Eibhlin Doyle (e-mail eibhlindoyle@gsi.ie)

The LOC comprises representatives from: the Geological Survey of Ireland; the Geological Survey of Northern Ireland; the Exploration and Mining Division of the Department of the Marine and Natural Resources; the Environmental Protection Agency; the Irish Association for Economic Geology; and the Institution of Mining and Metallurgy.

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EXPLORE

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Editors: Lloyd James (303) 741-5199 (Phone and Fax)
(l-njames@ecentral.com)
Mary E. Doherty (303) 278-6876 Fax: 303-215-0641
MaryEDoherty@earthlink.net
Associate Editor:
Sherman P. Marsh (303) 986-0939 (spmarsh@earthlink.net)
Assistant Editors:
Elizabeth Bailey (eabailey@usgs.gov)
Robert Eppinger (eppinger@usgs.gov)
David Gray (d.gray@per.dem.csiro.au)
Patrick Highsmith (phighsmith@alschemex.com)
Geoff Murphy (gckmurphy@acenet.net.au)
David Turner (dturner@swri.edu)
Marian Skwarnecki (Marian.Skwarnecki@adl.clw.csiro.au)
Business Manager:
David Kelley (303) 268-8318 (dave.kelley@wmc.com)

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Correction...

"Geosoft acquisition…." Explore, Number 114, page 3
PLEASE NOTE:

The article entitled *"Geosoft Inc (Toronto, Canada), Metech Pty Ltd (Perth, Western Australia) Sign Coop Agreement"* was incorrectly referred to as *"Geosoft acquisition…"* when the article was continued to another page of the last issue of Explore.

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Contributors's deadlines for the next four issues of **EXPLORE** are as follows:

Issue	Publication date	Contributor's Deadline
116	July 2002	May 31, 2002
117	October 2002	August 31, 2002
118	January 2003	November 30, 2002
119	April 2003	February 28, 2003

THE ASSOCIATION OF EXPLORATION GEOCHEMISTS

P.O. Box 26099, 72 Robertson Road, Nepean, Ontario K2H 9R0 CANADA
Telephone (613) 828-0199

OFFICERS

January - December 2002

Philippe Freyssinet, *President*
BRGM
BP6009
Orleans, France 45060
TEL: +33 238 64 3005
FAX: +33 238 64 3652
email: p.freyssinet@brgm.fr

Stephen D. Amor, *Vice President*
1235 Fairview Street, Suite 353
Burlington, Ontario
Canada L7S 2K9
TEL: +1 905 308 9514
FAX: +1 905 308 9414
email: SteveAmor@compuserve.com

David B. Smith, *Secretary*
U.S. Geological Survey
Box 25046, MS 973
Denver, CO 80225
USA
TEL: (303) 236-1849
FAX: (303) 236-3200
email: dsmith@helios.cr.usgs.gov

Gwendy E.M. Hall, *Treasurer*
Geological Survey of Canada
601 Booth Street, Room 702
Ottawa, ON K1A 0E8
CANADA
TEL: (613) 992-6425
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Steve Amor, *Webmaster*
e-mail: SteveAmor@compuserve.com

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