

President's Message

This is my last letter as President of the Association and as such is an opportunity for a number of important tasks.



Rob Bowell

Firstly I would like to thank the many members of council who have supported me during the last two years with valuable advice and challenging questions. It is perhaps only when one undertakes a position like this that one can appreciate the importance and value of each member's contribution to an association. Councillors give freely of their time to make the association a success, some often at anti-social hours for the quarterly conference call, many thanks to all of you.

Throughout my term I have had the privilege of working with four excellent people as officers of the association. Firstly, David Smith our dedicated and efficient Secretary without whom this association would not accomplish nearly as much or the president be anywhere as near organized for council meetings. Gwendy Hall, not only one of our more distinguished practitioners' but a superb Treasurer who has astutely managed our limited finances and provided valuable counselling and the benefit of her wisdom. Despite her many other professional commitments in the Geological Survey of Canada, she has also established the association's new applied geochemistry journal and in a short space of time obtained a citation index and made it the flagship of the association. I must also pay tribute to David Kelley, the past president, who despite two changes of employers in the last three years continued to find time to support the association and has been instrumental in the development of the Distinguished Applied Geochemists Fund. Finally many thanks to David Cohen my vice president who will succeed me as President in 2008. I am confident he will be an excellent president.

The association is more than just its officers though and in this respect I have seen several individuals give enormous amounts of their limited time. One of our founding members, Dr. Eion Cameron was justly honoured with a symposium celebrating his contribution to the association at the IAGS in Oviedo this summer. Eion has held several positions in the association including president and journal editor and he continues to manage our investment funds and has been invaluable in providing his time, wisdom and advice in our move to be registered as a charity in Canada.

Apart from the journal, AAG is committed to other forms of disseminating information and knowledge in applied geochemistry. Here again we have to extend gratitude to busy individuals who have

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Laboratory QA/QC Today – Its not just Control Charts

Ten years ago when a laboratory wrote an article about issues related to quality assurance (QA) and quality control (QC) they would have focused almost exclusively on control charts, frequency of QC items, and laboratory certification and accreditation. In the last decade, clients and laboratories have come to recognize that QA/QC issues include a number of other topics critical to ensuring data of suitable quality are provided for each project. In this article, a number of these current quality issues will be covered.

Changed relationship between client and laboratory

Regulatory requirements have changed the relationship between clients and laboratories with regards to QA and QC. Under the various codes of conduct including the Canadian National Instruments 43-101, and Australian Joint Ore Reserves Committee Code (JORC), minerals exploration and mining companies must now accept responsibility for the QA/QC program, including the activities of the laboratory. Clients submitting samples to any laboratory must review and oversee all of the activities of that laboratory, during analysis of their samples. Laboratories must be more open and accountable with their work. One of the impacts of this is that laboratories are asked for, and routinely provide, their internal QA/QC data. Results from participation in proficiency tests and external round robins are also requested. In addition, many companies require the laboratories use ISO17025 accredited test methods.

Even with all this evidence of laboratory quality, it is still not appropriate for any client to rely entirely on the laboratory for the QA/QC program. The laboratory QA/QC is the protocol used for running the laboratory portion of quality. Clients should have their own QA/QC program, which is focused on and covers all aspects of the project, the range of concentrations, and the sample matrices involved. This should include field duplicates, sampling protocols, and provision for oversight of the laboratory activities.

Analytical method selection – assay versus geochem precision

The first and most important QA/QC issue for any project is selection of appropriate methods and procedures. Multi-element methods now routinely report a wide range of elements and concentrations from a single digestion. The concentration range may be suitable for the project, but the completeness of the digestion, or the precision of the method, may not be. The issue can become confused by the requests for an Assay versus a Geochemical determination.

A base metals "Assay" determination used to refer to a total analysis with good precision and accuracy. The focus was

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on accurately determining the concentration of an element, and the method was typically tailored to a single element. In contrast, Exploration Geochemistry determinations focused on sufficiently low analytical detection limits to provide good contrast between “background” and “anomalous” results. “Geochem”, in its earliest applications, relied on patterns in the elements rather than absolute determinations. Total dissolution of all the elements was not critical, nor even desirable. Bias was not considered to be a problem, as long as results were consistent, and an “anomalous” result was still “anomalous” on retesting.

Precision and accuracy requirements for geochem increased as instrumentation improved. An old rule of thumb used by laboratories was that an assay had a precision of ± 5%, and geochem was ± 10%. Assays were for ore grade materials, and geochemical determinations were for ppm levels. The introduction of high quality multi-element methods, reporting concentrations from ppb to % levels, further blurred the lines between the two types of determinations.

Rather than specifying an Assay or a Geochem determination, the client is best served by selecting a procedure with the precision characteristics required for the data. A grass roots exploration program will have one precision criterion. Precision requirements in exploration drilling, where results might be used in the future for reserve calculations or estimates, will be different again. Precision specifications of a method are also useful in assessing pass or fail criteria on standards submitted to the laboratory. A method with a precision of ±10% will deliver failures for a control standard with limits set at ±5%.

Laboratories should be able to provide the precision estimates for their methods. Precision specification for every method and element are available from ALS Chemex through the Standard and Duplicate Tolerance values provided in the method descriptions and on the Webtrieve™. The formulas needed for using these values

to estimate ranges at any one concentration are listed below. The equations are based on work of Thompson and Howarth (1978). These limits define a range, within which values should fall 19 times out of 20. They provide useful guidance for selecting the optimum method for a particular program.

$$\text{Range on a Standard} = \pm \text{Standard Tolerance} \times \text{Concentration} + 2 \times \text{Detection Limit} \quad (1)$$

$$\text{Difference between Duplicate Pairs} = \pm \text{Duplicate Tolerance} \times \text{Concentration} + 2 \times \text{Detection Limit} \quad (2)$$

Copper (Cu) determinations can be used to illustrate the differences that method precision has on the results. Cu methods covering the range of concentrations are listed in Table 1.

Method	Range	Duplicate Tolerance (ARD at max conc)	Number of Duplicate Pairs used in Figure 1
Cu-ICP	1 – 10,000 ppm	10% (0.1)	3950
Cu-ICPa	10 – 100,000 ppm	7% (.07)	1617
Cu-OG	0.01 – 40%	5% (0.05)	947
Cu-VOL	0.01 – 100%	3% (0.03)	64

Table 1. Reporting Range and Duplicate Tolerance Percentage for Various Copper Methods.

With the exception of the Cu-VOL, all the procedures are multi-element ICP methods. Cu-ICPa is an intermediate method between low level exploration samples and determinations on ore grade samples.

Absolute Relative Difference (ARD) can be used to demonstrate precision of analytical data (Walsh and Shaw, 1999) by normalizing the difference between duplicate pairs, for the average value of concentration.

$$ARD = \frac{|X_1 - X_2|}{\text{Mean}(X_1, X_2)} \quad (3)$$

Duplicate pairs of results for the various methods were extracted from the ALS Chemex database. ARD was calculated on real data (as in (3) above), and the point plotted against the mean concentration. The colors show which method was used (Fig. 1). The Duplicate Tolerance specification (from (2) above) has also been added to

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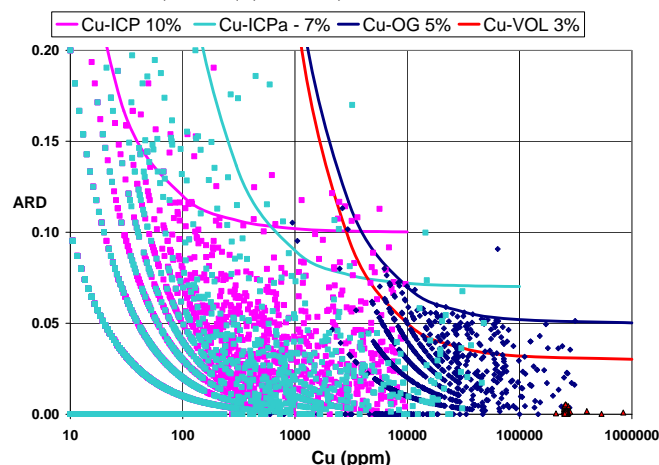


Figure 1. Absolute Relative Difference (ARD) of real data as a function of Cu concentration for various methods. (Curves represent theoretical method Duplicates Differences).

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show the theoretical method precision lines. In this case, theoretical tolerance of duplicate pairs is plotted against concentration to provide theoretical method ARD.

As is shown in Figure 1, method performance is a combination of the precision factor and the detection limit. Below 3000 ppm, the Cu-ICP method (Pink line) has the better precision (lower ARD) relative to the 100 ppm detection limit of the Cu-OG method (dark blue). Above 3000 ppm, the Ore Grade Assay method, Cu-OG (dark blue) has superior precision. The multi-element ICP assay method, Cu-ICPa (light blue), has precision performance between the two procedures, with a superiority in the range of 400 to 7000 ppm.

Method selection should be based on the precision performance required for each project. If the required precision of high level control standards for the project is $\pm 5\%$, the standard Cu-ICP method will not provide satisfactory results.

Sample tracking and control

One of the most critical QA/QC issues is sample handling and tracking. Regardless of analytical procedure and analytical quality, if the analysis is not attached to the correct sample, the result is 100% wrong. Errors in sample labeling can occur in numerous places, and it is a dual responsibility of the client and laboratory, to have

systems in place to reduce errors, and identify problems quickly.

Sample identifications

There is a trend towards using character strings as sample descriptions, to mask information about physical location. However, long character strings are easily misread, and prone to data entry errors. Providing the laboratory with a full electronic list of the sample ID's is a proactive solution to reducing data entry errors. The laboratory can then import these ID's into their database system directly. Integration of data back to the client will also be easier because sample ID formats are exactly as specified by the client.

Barcodes on samples take sample ID integrity one step further. The ALS Chemex system is set up to scan a client barcode, followed by the laboratory barcode (a unique identifier for every sample received), and to then capture the received weight. The client barcode is then transferred directly into the system as the sample ID, eliminating all clerical errors. The scan is a direct indication that the sample with that field identifier was received at the laboratory. Naturally, this system relies on the client barcodes being of sufficient quality to be reliably read by the scanner, following all the handling from the field to the sample preparation facility.

Sample received weight (SRW)

The capture and reporting of sample weight at receipt

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is an important aspect of quality and sample control. Review of Sample Received Weight (SRW) can alert the client to mislabeled, lost or spilled samples during shipment, and as a check that the collected sample mass is within specified limits. This is most valuable where the sample weights vary, as commonly occurs for drill core. SRWs are captured for all samples at ALS Chemex and reported without charge.

Audit trails

Audit trails for all aspects of laboratory systems are essential. Good protocols should allow easy and rapid review of a batch of samples to enable problems to be sorted out. ISO17025 quality systems require that a batch of samples in a laboratory can be traced back through a combination of electronic and hard copy records.

ALS Chemex is a leader in this aspect of quality management through the Open Lab initiative. Audit trails for all activities on a sample and submitted batch are generated and stored electronically. These complete

records are available online in real time, through the Webtrieve™ Audit Trail button. Tracking progress and review of activities are transparent and available to the client.

Monitoring sample preparation QC

Sample preparation protocols are designed to produce a sub-sample that is representative of the original. As stated by Pierre Gy, a sample is representative if *every particle in the lot of the material from which it is taken, has an equal probability of being included in the sample*. Two critical parameters for evaluation of preparation methods are the weight of material analyzed, and the particle size produced. Specification, measurement, and control, of grinding is required to produce quality results.

Sizing tests for sample preparation procedures, are done by the sample preparation laboratories daily, on each piece of equipment that is used at our laboratories. Results are reported as part of the QC data for each submission and available online, as shown for example in Figure 2.

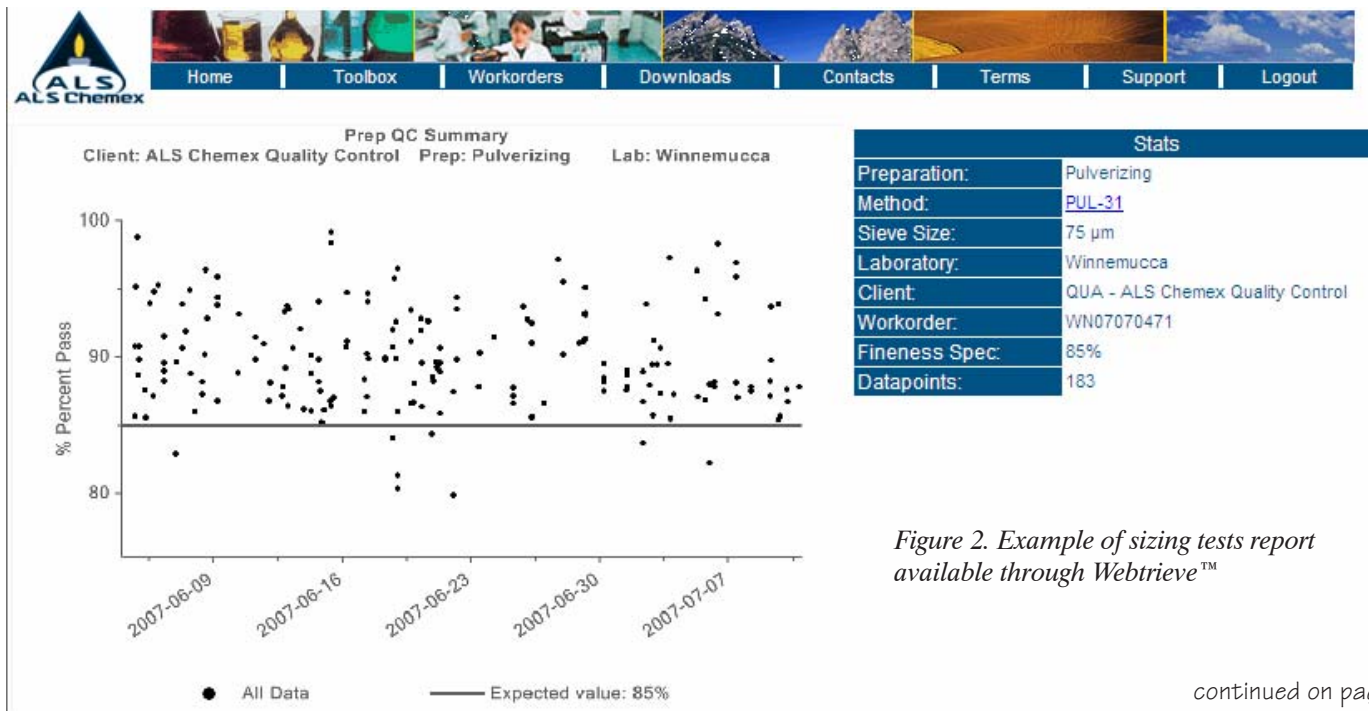


Figure 2. Example of sizing tests report available through Webtrieve™

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The industry commonly presents data as 75% passing 2 mm, or 85% passing 75 μm . While these specifications may be suitable for representative sampling, advanced QA/QC statistics are all developed around the 95th percentile measurements. Sample preparation procedures where the sizing criterion is also measured at the 95% level are now available. 95% passing 6 mm (for crushing) and 95% passing 105 μm (for pulverizing) are common.

Insertion of client standards, duplicates and blanks

Client QA/QC programs routinely require the insertion of their own standards, blanks and duplicates, in addition to those done by the laboratory. For these client control samples to truly reflect laboratory performance, it is important they are not treated differently than other samples. Also, they should be processed at the same time and in the same subgroups, e.g. furnace fusion groups, as critical client samples.

Ideally, control samples should be inserted in a manner completely blind to the laboratory, so the laboratory staff are not tempted to bias the estimation of performance by applying special treatment. This can be accomplished by having one laboratory prepare the samples and insert the controls, and then forwarding to another laboratory for the analytical work. An alternative is to have the laboratory prepare the samples, have the pulps returned to the client for insertion of the controls,

with return of the samples to the laboratory for analysis. The expense and time delays involved in this approach may not always be practical.

The goal is to ensure the controls are an unbiased representation of laboratory performance and that the groups of samples associated with each control sample can be clearly established. In turn, any samples requiring rework due to a failed control are readily identified. The ALS Chemex Full QC view provides the metadata required to establish this information. For each sample and analytical procedure, the sub-sample weight used, the fusion run number (or digestion run number) and the position in the fusion/digestion run are listed. Instrument runs and positions are also listed. These data can all be provided as a routine electronic format (CSVFMD), or retrieved for individual workorders, on-line through Webtrieve™ as required.

Example Gold (Au) Fire Assay data group is shown in Table 2. Sample numbers 1 to 12 and 16 to 21 were fused in the same fusion run. Results reported for sample numbers 13 to 15 come from another fusion run because the first fusions for these samples did not pass QC and the samples were re-weighed. The view also includes information on our internal QC samples for each fusion run.

Webtrieve™ also includes graphical tools for visualizing and reviewing sample order in fusion and digestion runs. Select a set of results, and click on the

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#	Sample ID	Au	WT. SAMPLE	Fusion_Seq	Fusion_Run	Instr_Seq	Instr_Run
1	144571	0.135	31.44	20	2211846	127	2216221
2	144572	0.029	31.11	21	2211846	128	2216221
3	144573	0.101	30.32	22	2211846	129	2216221
4	144574	1.550	29.93	23	2211846	309	2216221
5	144575	0.012	32.91	24	2211846	130	2216221
6	144576	0.570	30.11	25	2211846	131	2216221
7	144577	0.543	31.51	26	2211846	132	2216221
8	144578	0.465	31.02	27	2211846	133	2216221
9	144579	0.491	30.87	28	2211846	134	2216221
10	144580	0.022	31.27	29	2211846	135	2216221
11	144581	0.045	30.36	30	2211846	136	2216221
12	144582	0.044	31.28	31	2211846	137	2216221
13	144583	0.023	29.98	62	2216853	64	2218521
14	144584	0.035	30.79	63	2216853	65	2218521
15	144585	0.245	30.92	64	2216853	66	2218521
16	144586	0.342	30.34	35	2211846	141	2216221
17	144587	0.048	30.00	36	2211846	142	2216221
18	144588	0.046	31.57	37	2211846	145	2216221
19	144589	0.028	32.01	38	2211846	146	2216221
20	144590	0.010	30.66	39	2211846	147	2216221
21	144591	0.110	31.29	40	2211846	148	2216221
1	Blank03_07068920	<0.005	30.00	1	2211846	107	2216221
2	St01:OXD57_07068920	0.419	30.57	2	2211846	108	2216221
8	St07:ST-259_07068920	2.530	31.22	8	2211846	308	2216221
1	Blank02_07068920	<0.005	30.00	1	2216853	14	2218521
2	St03:OXD57_07068920	0.391	30.65	2	2216853	15	2218521
20	St09:ST-259_07068920	2.490	30.64	20	2216853	300	2218521

Table 2. Example of Full Laboratory Meta-Data Details

Sequence button in the Data Grid Display. Figure 3 shows results for the first Fusion Run, whereas Figure 4 displays the results for the reweighed samples in the second grouping. These tools can be rapid and easy ways of seeing if the laboratory is analyzing or processing control standards in an unexpected sequence or assaying smaller masses. It also allows views of sub-groups of your samples to ensure your control standards are included in fusion/digestion groups for critical samples.

Data verification and certificates of analysis

Reporting standards such as National Instruments 43:101 and the Australian Joint Ore Reserves Committee

Code (JORC) require data verification be done by the 'qualified' / 'competent' person taking professional responsibility for the results. One part of data verification involves reviewing a percentage of the data in the company's database against the original results reported by the Assay Laboratory to ensure no errors or misrepresentations have been made.

Formerly, signed printed hard copies of the Certificates of Analysis were used for this process. Today, most laboratories provide the certificates electronically as

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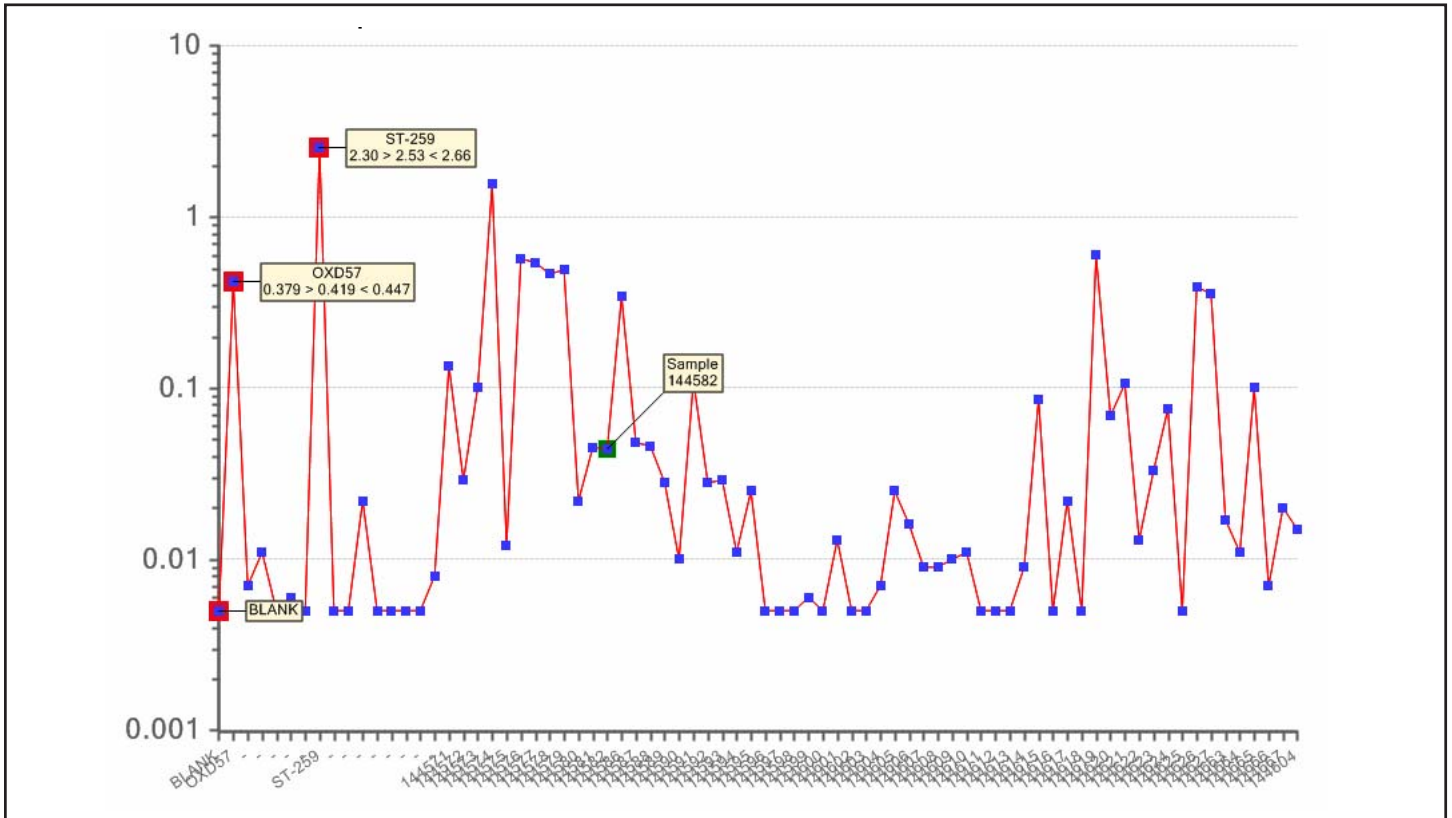


Figure 3. Gold sequence data for fusion furnace run number 2211846.

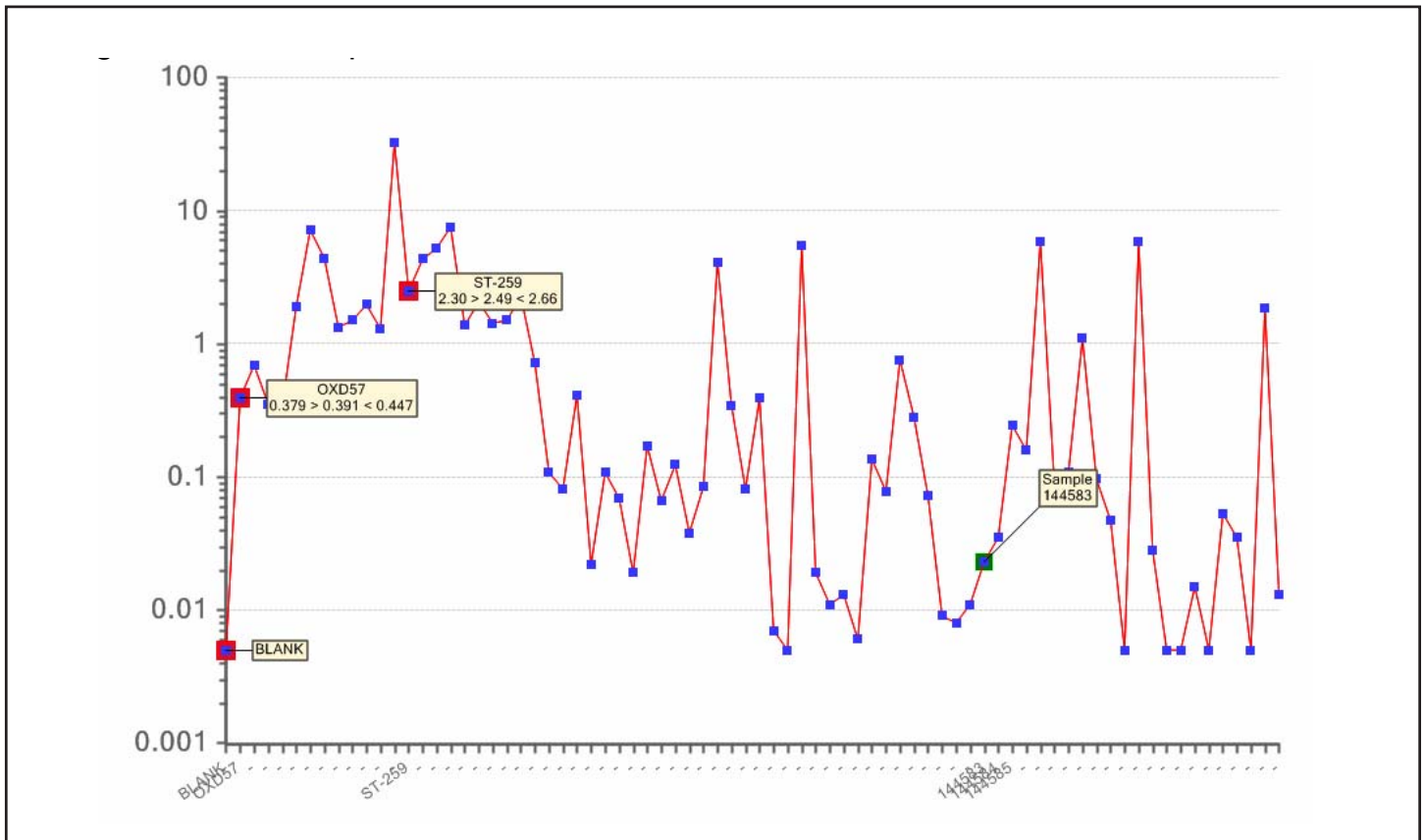


Figure 4. Gold sequence data for fusion furnace run number 2216853.

Laboratory QA/QC Today – Its not just Control Charts...

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encrypted PDFs. Some clients routinely ask that the laboratory remove the encryption so they can more easily put the PDF information into their reports. Meanwhile, regulators and other clients are asking for more sophisticated encryption on the PDF certificates, to prevent changes to the document after finalization. It is fairly apparent why a responsible laboratory cannot remove the encryption. In today's world, it is generally recognized that there is no electronic file that can not altered, and printed signed documents are no less secure.

Auditors and regulars doing data verification often ask the laboratory to provide copies of the Certificates of Analysis from the laboratory directly to them to avoid any questions about alterations. Certificates and datafiles can be redistributed electronically directly to these individuals. In addition, Webtrieve™ can allow direct access to the laboratory data and certificates once the client has given permission for the individual to view the results.

ISO 17025 – accreditation of methods

ISO17025 accreditation and ISO9001:2000 certification are external qualifications a laboratory can achieve, as evidence that its quality system meets international criteria. To become accredited for a testing method, the laboratory must pass a detailed, on-site,

technical audit of both the method, and the competence of the personnel performing it. In addition, the laboratory must correctly analysis unknown proficiency test samples, for the procedures they wish to be accredited. To maintain accreditation, the lab must continue to successfully analyze proficiency test samples twice a year, and pass biannual audits.

ISO17025 accreditation applies only for specific tests listed in the accreditation document. Sample preparation and sample handling protocols that occur prior to the analytical procedure are also critical to achieving quality outcomes. Registration to ISO9001:2000 includes independent site audits, and evidence that the location operates under a Quality Management System that meets international standards. At this time, many laboratories have ISO9001:2000 registration as evidence of the quality systems covering sample preparation activities. In the future, it is expected that specific sample preparation methods will be accredited under ISO17025.

Of course, ISO17025 accreditation or ISO9001:2000 certification is not a guarantee of quality results, but it is part of the body of evidence that the laboratory is capable of providing suitable data for your project.

Summary

It is important to recognize that quality and data suitability comes from a diverse set of activities. These activities are the dual responsibility of the person submitting the samples to the laboratory and the laboratory performing the work. Working together, the two groups can obtain the best outcome for both parties.

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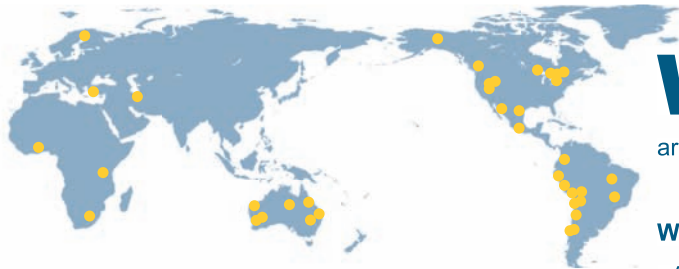
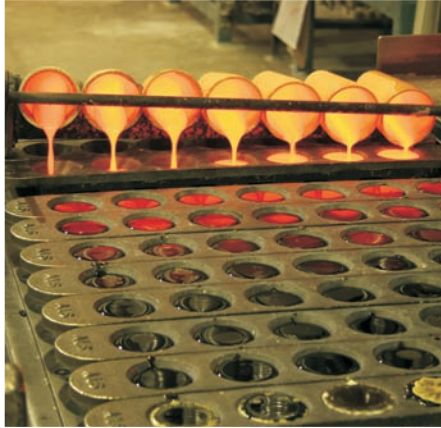
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A Practical Approach to Differentiate and Comprehend the QC Components of a Commercial Analytical Testing Laboratory

Commercial laboratories providing sample data to clients may provide the quality control information associated with the samples analyzed. In most cases, the quality control information provided or requested by the client is the reference material data that is run with the submitted samples and blank and duplicate data from the analysis. This QC information is not always defined or differentiated and may not completely cover all stages of the process; initial sample preparation to the final data. This can result in misleading and misunderstood information.

In a commercial laboratory it is not practical in both time and cost to provide estimations of the measurement uncertainties at each stage of the process. However, it is necessary for the laboratory to understand, identify and monitor the components of measurement uncertainty so QC information available to the client is useful. There are suitable and practical ways for commercial laboratories to provide the client with sufficient quality control information so that the variances can be differentiated within reason and therefore evaluated to meet the needs of the client.

In best practice situations, the reference materials used are certified with an established degree of confidence and associated uncertainties. In house reference materials are also deemed suitable if there is demonstrated path to a

certified source. In both cases, certain criteria must be met. Reference materials must be homogenous and stable for a specified time period, the analyte in question must be at a comparable concentration range and preferably with similar mineralogy. A good reference material provider will produce a certificate of analysis and report that includes the number of participants, the within laboratory standard deviation and the between laboratory standard deviation to ensure that method dependency is evaluated. The laboratory itself can suitably calculate the measurement uncertainty of reference materials when the material is in sufficient quantity to generate statistical data over a reasonably long time period. Involving different analysts, different environmental conditions, different instruments and/or equipment provides a degree of rigour that enables confidence in the data to be generated. Certified reference materials (CRMs) are prepared and purchased commercially. These are suitably homogenous and ready for use. These materials are introduced during weighing at the digestion or fusion stage and can only provide a partial estimation of the overall measurement uncertainty associated with the entire process. If used appropriately i.e. conditions of homogeneity, stability, concentration, mineralogy and method dependency are met, they aid in the determination of the accuracy associated with the digestion or fusion stage through to the finish technique. CRMs fail to provide a correlation to the sample preparation stage, which is commonly the largest source of error involved during the entire procedure, unless we consider the sampling error involved prior to arrival at the laboratory.

Duplicate data can provide a good estimation of the precision of the method but is dependent upon the stage of duplicate insertion and the number of duplicate pairs. Reporting duplicate data from the weighing stage during the digestion process provides a partial estimation of the precision of the method, but not the entire precision of the process. For best practice, the duplicates should be taken at both the crushing-splitting and weighing-digestion stage. The difference in the variances obtained from a minimum of twenty pairs of duplicate data can provide the overall precision of the process, the

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A Practical Approach to Differentiate...

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significance of the differences can also be assessed to differentiate the possible errors involved including sample heterogeneity.

The measurement uncertainty associated with the instrument or finish stage of a method is best differentiated with the use of certified calibration materials, secondary source control checks, duplicate insertion and in some cases spike recovery. To minimize the error associated with the instrument and the reference materials used to establish the instrument response, it is important to store the materials appropriately to ensure stability and to matrix match the materials as close as possible to that of the samples analyzed. In best practices, the calibration materials are checked against secondary source control materials purchased separately. This ensures the materials used to calibrate the instrument are suitably stable and correctly made, as these often involve serial dilutions from a master source. The degree of diligence involved in the calibration can contribute to the error involved and must be evaluated. The finish technique must have demonstrated linearity and the samples analyzed must fall within the linear range or be

diluted accordingly. Duplicates inserted at this stage differentiate the precision that can be associated with the instrument response.

The laboratory can best demonstrate and differentiate all of these quality control measures by the use of control charts. Most LIMS systems have the ability to chart data automatically to provide a quick visual aid when data evaluation is performed. Control charts are used to monitor performance and provide crucial audit trails. Almost all QC information, and therefore errors associated with the entire process, can be charted; this includes reference materials, calibration and control check materials, blanks, duplicates at different stages in the process, verification checks for balances, ovens, furnaces, dispensers and autopipets, spike recoveries and screen tests. Evaluating these errors and combining the significant errors, generates the overall measurement uncertainty, a useful and robust statistical value.

There are many types of control charts available for use, all which have the ability to demonstrate and monitor the accuracy and precision of a method. The Shewhart Chart ⁽¹⁾ is a reliable resource for demonstrating the accuracy or bias associated with the reference materials involved in the process. This chart involves drawing a horizontal line at the mean value and at locations two standard deviations (the warning level) and three standard deviations (the control limits) above and below the mean. After generating a minimum of twenty data points, the chart can easily demonstrate the accuracy and bias of the

continued on page 12

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A Practical Approach to Differentiate...

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method. There are specific rules for Shewhart charts ⁽¹⁾ that ensure statistical control of the measurement process.

The range control chart ⁽²⁾ is another reliable source for demonstrating the precision of a method. Using a minimum of twenty sets of duplicates, the mean is calculated from the absolute value of the differences between the duplicate pairs (the mean of the ranges). The mean value (\bar{R}) is plotted along with lines at $0.845\bar{R}$, $2.51\bar{R}$ and $3.27\bar{R}$. Statistical control is monitored and deemed acceptable when 50%, 95% and 99% of the ranges lie below the $0.845\bar{R}$, $2.51\bar{R}$ and $3.27\bar{R}$ lines, respectively. For best use, the concentration ranges of the duplicate data should be grouped according to orders of magnitude and charted individually.

A practical approach to providing the client with meaningful QC information without producing multiple control charts and error values is to report the combined estimation of the measurement uncertainty. This is calculated from the data generated by the use of reference materials preparation duplicates and digestion duplicates, over a reasonable time period. All associated errors involved in the entire process are accounted for and easily

differentiated by the laboratory's use of control charts as described above. Reporting the reference material and duplicate data, both preparation and digestion duplicates, also allow the clients to calculate the precision and accuracy and differentiate the variances of their own test data.

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23rd International Applied Geochemistry Symposium (IAGS) Pre-symposium field trip, June 2007

The 23rd IAGS pre-symposium field trip was a 4-day tour (10-13 June) of mines and cultural sites that travelled across Spain, from Madrid to Oviedo, via Seville and Salamanca. The tour group was led by Jorge Loredo (University of Oviedo), assisted by Alejandro Bel-Lan (Instituto Geológico y Minero de España: IGME) and Juan Locutura Rupérez (IGME). The participants consisted of 23 geologists/geochemists and two accompanying persons, representing eight countries. We met early on Sunday morning at the IGME in Madrid and were given a thick tour guide and two large rolled maps of the geology of Spain as we boarded our 50 seater bus.



Figure 1. Almaden bull ring: Lunch stop in Almaden at the Hotel Restaurante La Plaza, part of the only hexagonal bull ring in the world. (Photo: Tony Christie).

After leaving Madrid, we had a quick comfort stop in the small town of Puerto Lápice (Ciudad Real), famous for an association with Don Quixote, and then travelled on to Almaden for lunch at the Hotel Restaurante La Plaza attached to a hexagonal bull ring (Fig. 1). Many photos were taken of tour participants acting as pseudo-bulls in the ring. Our introduction to field trip food was a series of courses of ham and fish with Rioja red wine. When we thought we had finished, the main course was served – a large pork steak – the most magnificent pork I have ever tasted. Apparently, the secret ingredient is that the pigs eat acorns dropped from green oak trees.

Off to the **Almaden** mercury mine at the other end of town feeling a little sluggish but more than satisfied. Mercury (cinnabar) mining at Almaden commenced in Roman times (Fig. 2) and from 1499 produced about 275,000 t of mercury, one third of the global resource. The mine ceased production in 2002 and has since been developed as a tourist attraction. We descended a shaft to the 50 m level at the base of the hill. Our guide, a former metallurgist in the mill, led us through various tunnels, many lined with brick, to view a sequence of exhibits illustrating changing mining techniques from ancient to modern, as well as sections of slate and volcanic country rock, and quartzite ore with occasional splashes of red cinnabar and droplets of native mercury, originally deposited from sea floor volcanic exhalations. We didn't see the magnificent expanses of cinnabar impregnated

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(IAGS) Pre-symposium field trip...*continued from page 12*

Figure 2. Almaden miner: Ancient mining scene recreated in the 50 m level of the Almaden mercury mine. (photo: Tony Christie).

quartzite illustrated in our guidebook and exposed in levels 200 m or more below us. The total depth of the mine is 500 m. A mine train ride from the shaft took us out the side of the hill to a walk by the derelict mill, followed by a quick visit to the museum housing many magnificent specimens of the Silurian to Upper Devonian country rock and ores, as well as models of the mine and mill.

A three and a half hour bus drive took us to our home for two nights, the Al-Andalusia Palace Hotel in Sevilla near the south coast of Spain. We dined at the Tablao El Patio Andaluz Sevillano restaurant while watching an exhibition of flamenco dancing and then went for a walk around floodlit buildings in the old part of the city and down by the river.

Day two (Monday) started in the Iberian Pyrite Belt (IPB) with a visit to **Rio Tinto**, an Early Carboniferous volcanogenic massive sulphide (VMS) deposit mined from about 5000 years ago and the birthplace of the Rio Tinto company in the late 1800s. The mine closed about five years ago although there is still some exploration in the immediate mine area. While viewing the vista of Corta Atalaya open pit (San Dionisio VMS lens) (Fig. 3), the geology of Rio Tinto was described by Carmen Conde (IGME). Pre-mine resources in eight massive sulphide lenses were about 500



Figure 3. Rio Tinto pit: Corta Atalaya open pit on the San Dionisio VMS lens, Rio Tinto. The base of the pit flooded from 2004 when pumping of the underground workings stopped. (Photo: Tony Christie).

Mt at 0.9% Cu, 2.1% Zn, 0.8% Pb, 0.5 ppm Au and 26 ppm Ag. Our second stop was Cerro Colorado open pit, followed by a tourist train ride down the Red River valley for about 12 km to its terminus (Fig. 4). From the train we saw vast



Figure 4. Rio Tinto landscape: Rio Tinto landscape viewed from the train. The Red River is in the foreground and waste dumps are in the left distance. (Photo: Tony Christie).

tailings and waste areas and black slag left over from smelting and the heavily polluted Red River (Fig. 5). Talk of



Figure 5. Rio Tinto Red River: The colourful Red River draining Rio Tinto. The high levels of pollution date back to before mining when natural erosion exposed the Rio Tinto deposit. (Photo: Tony Christie).

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(IAGS) Pre-symposium field trip...

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rehabilitation seemed pointless when the moonscape landscape is an A1 tourist site. Lunch was at a restaurant in Minas de Riotinto village followed by a visit to another VMS deposit in the IPB, the **Las Cruces** mine, operated by Cobre Las Cruces SA. We were given a lecture on the deposit by Mike Doyle, the mine manager who was previously chief of exploration and responsible for discovering the blind deposit by drill testing a gravity anomaly. The open pit is working down through 100 m of Tertiary cover rocks and is expected to start producing ore in March 2008 with a 16 year life expectancy. The pyrite-chalcocite ore is localized at the apex and contact of an anticline of shale over volcanic rock. Weathering and development of a gossan occurred in the Jurassic. Mike described the unusual occurrence of galena as a secondary mineral in the gossan, which caused great debate amongst the tour participants. A late dinner, including paella, was at Hosteria del Laurel, Plaza de los Venerables in Sevilla, followed by more late night walking around the old city (Fig. 6).



Figure 6. La Giralda bell tower Sevilla: The La Giralda (weathervain) bell tower originally built as a minaret in 1198 and increased in height in 1568. One of the many floodlit historic sights viewed in our late night wanderings of Sevilla. (Photo by Bob Eppinger).

Day three (Tuesday) started at the **Aguablanca** (white water) Ni-Cu-PGM mine north of the IPB and operated by Rio Narcea (Fig. 7). Francisco Bellón and Cesar Martinez Chaparro presented lectures on the mine and its geology and were followed by an overview of the pit, and a scramble around a stockpile of boulders of country rock and pyrrhotite-pentlandite-chalcopyrite mineralisation.



Figure 7. Group photo Agua Blanca: The 2007 IAGS pre-symposium field trip group at the Aguablanca mine.

(Photo: Alejandro Bel-Lan and Juan Locutura Rupérez).

Two steeply dipping orebodies are hosted by a breccia pipe within a gabbro-diorite pluton (Aguablanca Stock ca 10 km²) all of Carboniferous age. The pluton represents a 'staging magma chamber' emplaced at shallow level (<2 km) into Cambrian limestones (with associated skarns) and other sedimentary rocks. The ore grades 0.66% Ni, 0.45% Cu, 1.5 – 2 g/t Pt, 1.5 g/t Pd, 100 g/t Co. The open pit is expected to finish in 2013, but work has already started on developing an underground mine which will start producing ore in 2008 and continue beyond the life of the open pit. The mine is almost totally surrounded by National Parks and operates under strict environmental regulations requiring zero water discharge. Sewage water is used for processing. About 4000 trees had to be relocated during mine development.

Lunch was hosted by Rio Narcea in the nearby very picturesque Real de la Jara village at the foot of a hill capped with a 1500s Moorish castle. After a two hour drive north, we stopped in Cáceres city for a quick tour of the old city, then another two and a half hours drive to Salamanca to the Hotel Rona Dalba. Dinner was at Restaurante Pata Negra celebrating Russia Day with toasts of vodka supplied by our Russian comrades on the tour.

Day four (Wednesday) started with a guided walking tour in the old part of Salamanca, including the University and new Cathedral. Late in the morning we hit the road to Ponferrada and lunch at a Bavarian/Swiss style restaurant/winery Restaurante Palacio de Canedo en Canedo, Prada a Tope. Our bus ride was marked by an extreme contrast in scenery as we left the arid plain of central and southern Spain and drove into some hilly landscape where the country was lush with dense tree cover. The transition was also marked by a change from towns of almost totally apartment dwellings to houses plus a few apartments.

After lunch, we visited the World Heritage Site **Las Médulas** Roman placer mine museum and walked the 3 km track through the excavated gullies. This was the largest of the Roman gold mines in Spain and was worked for 200 years in the 1st and 2nd century AD by up to 4,000 miners, producing about 5,000 kg or 160,000 oz of gold, exported to Rome and used mainly for the manufacture of coins. The

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(IAGS) Pre-symposium field trip...*continued from page 14*

Figure 8. Las Medullas: The Las Medullas Roman placer gold mine in Miocene fanglomerates and conglomerates, now a World Heritage Site. (Photo: Tony Christie).

Miocene red fanglomerates and alluvial conglomerates (Fig. 8) consist of a 5 m thick basal layer grading 60-300 mg/m³, overlain by 25 m grading 20-100 mg/m³ and up to 100 m grading 10-20 mg/m³. An estimated 100 M m³ of gravel were excavated by hydraulic mining with water channelled in from up to 80 km away. One novel technique of mining was to release large volumes of water into previously excavated galleries and wells to undermine the rock mass by collapse and in some cases blow out the side of the hill.

On leaving Las Médulas we had a three hour drive to Oviedo through spectacular scenery of forested high hills, then over a plain covered with some sparse trees, followed by mountainous country with rocky outcrops and peaks, grassy valleys and some lakes. As we neared Oviedo, we passed through coal country as evidenced by a very large coal fired power station.

In addition to the mine geology, I am left with many lasting memories of the tour including great company, very large and very late lunches and dinners, wine that got better and better during the trip (or was I getting the taste for Tempranillo), late nights that were completely out of balance with early morning starts, and a fridge on the bus from which we helped ourselves to bottles of water, and cans of coke and beer, with some care because of the infrequent comfort stops. Many thanks to the organisers and our host companies and mine staff for an informative and wonderfully enjoyable tour.

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**President's Message...** *continued from page 1*

volunteered to promote the association. Beth McCleghan, the Editor of EXPLORE has done an exceptional job in taking over this bulletin and enhancing its reputation. Many thanks to Dave Seneshen who actively managed the business matters of EXPLORE for several years. Dave will be succeeded in 2008 by Sarah Lincoln. In 2006, we joined Elements and this year has enjoyed the delivery of six periodicals with informative and interesting articles. The benefits of this wider audience for AAG would not be fully realized without the tireless contribution made by David Lentz in promoting AAG in this publication.

If you have not done so already you should also visit our web site at www.appliedgeochemists.org. This web site is constantly being evolved by our web master, Andrew Ransom, and website coordinator Bob Eppinger. Finally one of our more active committees, the Symposium Committee, is jointly coordinated by Paul Morris and Nigel Radford. Both contribute to the association's symposium and support local organizing committees. Many thanks to all of you for your valuable service to the association.

Our association continues to grow but we face several major challenges ahead. We have an aging membership with only limited graduates entering the field, despite the shortage of applied geochemists in many industries, particularly mining and energy. This shortage has given rise to non-specialists often assuming the role of a qualified geochemist and we need to improve recognition of our skills outside of the geosciences arena. There are signs that this is happening with many organizations, including financial houses and mining companies, asserting the need for geochemists to review and audit geochemical data prior to its application in exploration or resource statements, but I feel we must continue to do more to promote ourselves. In this respect we are limited to the members that volunteer their services to the association. Please consider becoming more active in the association. The more active the membership is the more we will attract new members and the greater the range of services we can offer.

So the challenge I leave you with is how you can promote and assist the association to grow?

Rob Bowell
President, Association of Applied Geochemists



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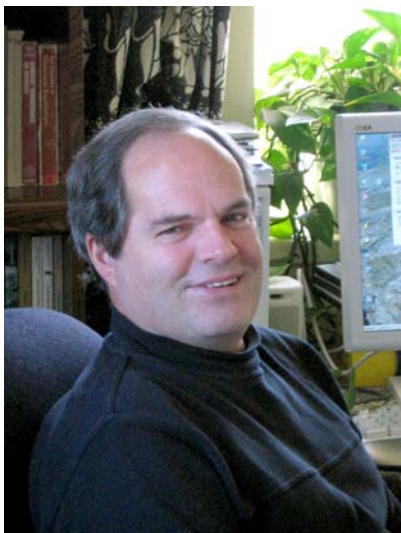
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Kurt Kyser is director of QFIR, the Queen's University Facility for Isotope Research, with research interests that include isotope geochemistry, evolution of fluids in basins, environmental and exploration geochemistry, and fluid-rock interactions. He received his BSc in chemistry from UC San Diego and his MA and PhD in geology from UC Berkeley. He came to Canada in 1981, first to the University of Saskatchewan and then to Queen's University in 1996. He has been a contributor to the understanding of processes associated with water-rock interactions and has helped developed or refine several novel analytical techniques for complex natural materials. His interests include sedimentary basins and many of the chemical processes that go on in these complex structures, as well as the processes by which elements move in the near-surface environment.

Three talks are offered as part of this lecture series:

1. Controls on ore forming processes in sedimentary basins and their implications for exploration strategies.
2. Using isotopes as tracers of sources and processes for element migration: new frontiers that add value to exploration geochemistry.
3. Using new techniques in biogeochemistry to monitor the environment and find undercover ore deposits

Organizations interested in putting on a lecture should contact Robert Bowell for further information.

(rbowell@srk.co.uk)



Geological Association of Canada Short Courses 2008

GAC-MAC Annual Meeting, Québec City, Canada
May, 2008

CI1

Recent and not so recent developments in uranium deposits and implications for exploration

Author(s): Michel Cuney (CNRS), Kurtis Kyser (Queen's University)

Sponsor: Society of Economic Geologists, Society for Geology Applied to Mineral Deposits

Abstract: Exploration for uranium is currently at a level that surpasses the last exploration boom some 30 years ago. Despite the lack of interest in uranium as a commodity during the past 30 years and the resulting loss of expertise and research, considerable progress has been made in research because of new ideas and technologies. These have allowed researchers to quantify models for all types of deposits. The purpose of this shortcourse is to highlight the data and research that has quietly developed over the last 30 years as well as results from new research that can be integrated into exploration for uranium. The shortcourse will consider models for different types of uranium deposits and the mechanisms that control their genesis, relating source, transport, deposition and preservation, and how these can be used to refine strategies for uranium exploration.

CI5

Exploring for Iron Oxide Copper-Gold (Ag-Bi-Co-U) Deposits: examples from Canada and Global Analogues

Author(s): Louise Corriveau (Geological Survey of Canada), Hamid Mumin (Brandon University)

Abstract: With their very large resource potential and polymetallic nature, iron oxide copper-gold (Co-Ag-Bi-U) (IOCG/U) deposits are becoming a key exploration target in Canada. Tracers of mineralization have significant lateral and vertical extent, including diagnostic alteration zones, overprinting relationships, structural control and geophysical and geochemical signatures. It is, however, a challenging deposit type to explore for in Canada as most prospective settings are frontier felsic-to-intermediate volcano-plutonic terranes and metamorphic derivatives that were largely mapped prior to the recognition of the deposit type in the 1990s. This short course aims at sharing knowledge from those who are currently working in the Great Bear Magmatic Zone with those who would like to join in or explore in other parts of Canada. It presents IOCG/U deposits from around the world, with a focus on the Great Bear and its well-exposed IOCG/U associated mineralization, alteration and structures. Particular attention will be paid to alteration mapping as vectors to mineralization and exploration methodologies and techniques that have proven successful.

For more information: Website: <http://quebec2008.net/>



Mineral Exploration Roundup 2008 - Short Courses

January 28 to January 31, 2008
Vancouver, British Columbia, CANADA

NI 43-101

Presented by AME BC, Robert Holland (BC Securities Commission) and Craig Waldie (Ontario Securities Commission)

Dates: Friday, January 25, 2008

The morning session will review the basics of NI 43-101 for those looking for an introduction to the principles and requirements of mining related disclosure regulations.

The morning session will include the following:

- Role of the qualified person
- Disclosing mineral resources, mineral reserves and other estimates
- Technical report triggers
- Certificates and consents of qualified persons
- Compliant technical reports - what is required
- Disclosure requirements of the TSX and TSX Venture Exchanges.

The afternoon session will provide a more advanced look at NI 43-101 and will review what can be learned from Canadian mining industry disclosure and filing practices in 2007. Topics will include the following and more:

- Learn from others - examples of good disclosure practices
- Technical disclosure in mining prospectus filings - getting it right the first time
- Technical reports: the good, the bad, and the ugly
- OTC BB and Pink Sheet mining issuers - targeting the problem
- How not to annoy the regulators

Exploration & Mining 101

Presented by AME BC and Dr. Rob Stevens (BCIT)

Dates: Saturday, January 26, 2008 and Sunday, January 27, 2008

Course Overview: This two-day course will present an overview of mineral exploration and mining for non-technical personnel working in this exciting industry

(investor relations personnel, accountants, lawyers, management, administrative support, and investors). Topics that will be discussed include geology and mineral deposits, exploration methods, drilling, resource and reserve calculations, and common mining methods. The course includes an overview of how to read technical news releases, understand drill and assay results, and evaluate exploration properties and companies. Case studies using companies and properties in the news will augment the material presented. This course is adapted from the popular 4-day course called *Exploration and Mining for Investment Advisors and Investors* offered by AME BC and the BC Institute of Technology.

Squeezing More out of Rocks

Presented by AME BC, Ken Hickey (MDRU) and Dick Tosdal (MDRU)

Dates: Saturday, January 26, 2008 and Sunday, January 27, 2008

Course Overview: Deformation plays a critical role in the formation and subsequent modification of epigenetic ore deposits. The application of structural geology in exploration requires both an understanding for the structural processes active in the deposit environment, as well as an appreciation of how to recognize, record, and interpret the products of deformation. This two-day course combines lectures directed towards exploring how structural features develop and examining their context in ore deposits. The course will span ore-forming environments from the near-surface brittle regime to deep, ductile systems. Topics will be illustrated with short case studies selected from a range of worldwide deposits.

Kimberlites: Geological Principles Relevant to Evaluation, Resource Classification and Mining

Presented by Mineral Services Canada Inc., Scott-Smith Petrology Inc., and SRK Consulting

Dates: Saturday, January 26, 2008 and Sunday, January 27, 2008

Course Overview: Day one of this two-day short course will lay the foundation for the application of geological principles to the evaluation, resource classification, and mining of kimberlites, post discovery. Day one topics will include an introductory overview of the nature of kimberlite; the structure and composition of the mantle; indicator mineral chemistry; diamonds: age, origin, characteristics and value; interpretation of diamond data in kimberlite exploration and evaluation; kimberlite petrography and the concept of diamond carrying capacity; and Mantle Mapper: integration of petrography, mineral chemistry, and diamonds in early stage evaluation of kimberlites. Day two of the short course will focus more specifically on the geology of kimberlite intrusions and the relevance of this to later stage economic evaluation and classification of kimberlite resources. Day two will close with a review of the relevance of geological factors in mine planning and production. Specific topics to be covered on day two will include: volcanological principles relevant to kimberlite emplacement; kimberlite



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Mineral Exploration Roundup...

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emplacement models – the nature and characteristics of type one, type two and type three kimberlites; the economics of kimberlite emplacement; principles of resource classification; resource classification case studies; and geological factors relevant to kimberlite mining.

Kimberlite Volcanology: Understanding and Interpreting Kimberlite Geology from a Modern Volcanological Perspective

Presented by AME BC, Raymond Cas (Monash University), and Kelly Russell (University of British Columbia)

Dates: Friday, February 1, 2008 and Saturday, February 2, 2008

Course Overview: This two-day course will provide participants with an overview on the geology and volcanology of kimberlites from a new, modern, and volcanological perspective. The course will include a review of what is known about kimberlite geology and identify some of the major problems in the interpretation of the formation, infilling, and deposit characteristics of kimberlite bodies. The problems associated with the pervasive alteration overprint affecting most kimberlites (in terms of understanding what preserved textures are secondary) and relicts of original emplacement textures will be addressed. The course will teach participants how to:

- deal with kimberlite rocks from a volcanological perspective;
- identify the types of volcanic deposits within a kimberlite body; and
- extract volcanic processes from altered or preserved kimberlite deposits.

For more information:

Website: <http://www.amebc.ca/roundupoverview.htm>



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Mineral Deposits of Canada - Geological Association of Canada Special Publication 5

A Synthesis of Major Deposit Types, District Metallogeny, the Evolution of Geological Provinces & Exploration Methods
Edited by Wayne D. Goodfellow.

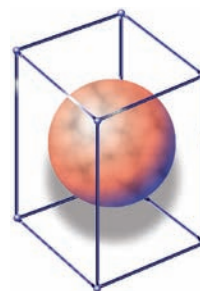
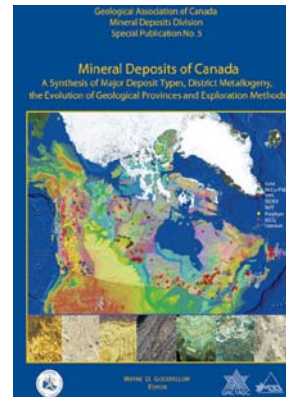
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The Mineral Deposits of Canada (MDC) volume is a collection of 44 papers that have a global perspective but a Canadian focus, and have been grouped under five major headings. Part I is an overview of the economic value of mineral resources in Canada; Part II provides a current synthesis of economically important deposit-types in Canada that include VMS, SEDEX, MVT, IOCG, porphyry, several types of lode gold, magmatic Ni-Cu-PGE, unconformity uranium, and kimberlite diamond deposits; Part III describes the metallogeny of economically important Canadian mining camps; Part IV documents the geological evolution and metallogeny of geological provinces in Canada; and Part V covers geophysical and geochemical exploration methods applied to specific types of mineral deposits. The volume is printed with unrestricted colour to take advantage of the wealth of knowledge and data captured by colour maps and sections, genetic models, images and photographs of representative rocks, ores and minerals. In addition, 4 high-capacity DVDs accompany the volume and contain an ore photo library, ArcGIS databases of major mineral deposits in Canada and the world, PDFs of all papers in the volume, digital files of all diagrams, tables and appendices, and Endnote databases of all papers referred to by volume papers. The book is published by the Mineral Deposits Division of the GAC in partnership with the Geological Survey of Canada.

<http://www.gac.ca/publications/bookstore.php>

Hardcover - 1068 pages, unrestricted colour; almost all diagrams and photos are in colour, Geological Association of Canada Mineral Deposits Division;
ISBN-13: 978-1-897095-24-9



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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

2008

- January 28-31, 2008. **Mineral Exploration Roundup 2008**, Vancouver, Canada. Website: <http://www.amebc.ca/roundupoverview.htm>
- March 2-5, 2008. **Prospectors & Developers International Convention, Trade Show and Investors Exchange, Toronto, Canada**
Website: <http://www.pdac.ca/pdac/conv/index.html>
- March 31-April 3, 2008. **Society of Environmental Geochemistry and Health 26th European Conference - SEGH 2008**
Website: <http://conferences.geol.uoa.gr/segh2008/>
- May 26 - 28, 2008. **Geological Association of Canada/Mineralogical Association of Canada Annual Meeting** Quebec City, Canada. Web site: <http://www.quebec2008.net>
- June 29 - July 4, 2008. **Geochemistry of Mineral Deposits**, Il Ciocco Lucca (Barga), Italy. <http://www.grc.org/programs.aspx?year=2008&program=geochem>
- July, 2008. **SEG-GSSA 2008 Resurgence of Economic Geology and the Minerals Industry in Africa**, Joint Conference of the Geological Society of South Africa and

SEG Incorporating GEOFORUM 2008. Johannesburg, South Africa. Website: <http://www.seg-gssa2008.org/>

- July 13 -18, 2008. **Goldschmidt 2008**, Vancouver, BC, Canada. Web site: www.goldschmidt2008.org
- August 5-14, 2008. **33rd International Geological Congress**, Oslo, Norway. Website: <http://www.33igc.org>.
- August 10-15, 2008. **9th International Kimberlite Conference (9IKC)** Frankfurt, Germany. Website: <http://www.9ikc.uni-frankfurt.de/>
- August 18-22, 2008. **Geochemistry of the Earth's Surface 8: Joint Meeting of the IAGC, Minsoc and Natural History Museum**, London, UK. Contact: M.E. Hodson, m.e.hodson@reading.ac.uk
- October 5-8, 2008. **Geological Society of America Annual Meeting**, Houston, Texas, USA.
Website: www.geosociety.org/meetings/index.htm

2009

- July 5-10, 2009. **Goldschmidt 2009**. Davos, Switzerland. Website: <http://www.goldschmidt2009.org/>
- September 2009. **Geoanalysis 2009**. Drakensberg Region, South Africa.
Website: <http://geoanalysis2009.org.za/>

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

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Geological Survey of Canada

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Geosource Consulting Inc.
58 Roseview Dr. NW
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Membership # 3952



Nominations are open for the 2007-2008 SGS Minerals Services
and the Association of Applied Geochemists



Student Paper Competition



Deadline for submissions: December 31st, 2008

Introduction

A prize for the best paper published by a student is awarded by the Association of Applied Geochemists every two years. The intent of the prize is to encourage prompt publishing of quality research by students in the field of exploration geochemistry or environmental geochemistry related to mining activities. The winner is determined by an international panel consisting of a chairman and three judges, drawn from our profession but reflecting the perspectives of academia, government and industry. Criteria include excellence and originality in research design, research execution, interpretation, presentation of the science and its practical application to exploration geochemistry. Honours, MSc and PhD students are encouraged to publish their research results and enter this competition. There is no limit to the number of papers that may be submitted for an individual student.

The Prize

1. From **SGS Minerals Services** a cash prize of **\$1000** CAD.
2. From the **Association of Applied Geochemists** a 2-year membership of the Association, including the AAG's journal (GEEA) and EXPLORE, a certificate of recognition and \$500 US towards expenses in attending an AAG-sponsored meeting where the award will be presented.

Rules

1. The paper must substantially address an aspect of exploration geochemistry or environmental geochemistry related to mineral exploration;
2. The paper must represent research performed as a student;
3. The student must be the principal researcher, as attested to by the student's supervisor, head of department/school or a senior scientist who is very familiar with the student's work;
4. The paper must have been published in *Geochemistry: Exploration, Environment, Analysis*, either during the course of the degree program that generated the research or within five years of the award of the degree. Final acceptance dates by the journal are acceptable in lieu of publication dates if adequately proven;
5. **A nomination may be made by anyone, apart from the student**, and preferably by a senior scientist familiar with the work of the student. Nominations must be accompanied by four copies of the paper (hard or digital);
6. Papers may be resubmitted if they are not awarded the prize in the original submission.
7. The decision of the Student Paper Prize Committee is final and no correspondence will be entered into.

Nomination Guidelines

1. This prize is essentially to promote (i) exploration geochemistry or (ii) environmental geochemistry related to mining activities or (iii) environmental geochemistry research that may be directly applied to exploration geochemistry. If the relevance of the research to these areas is not obvious, an explanation should be provided by the nominator(s).
2. The student must be first author. For papers with more than one author, the entry must be accompanied by a statement from the student's supervisor or another author on the paper indicating the student's level of involvement in the planning, execution, interpretation of the research and writing of the paper.
3. Independent and, preferably, international refereeing of the journal in which the paper is published is essential. Unpublished theses, internal publications or reports, or papers in non-refereed or unrecognised journals (eg. not listed in Science Citation Index or equivalent) will not normally be accepted.
4. The date when the paper was finally accepted for publication may be accepted in lieu of the actual publication date providing this is properly documented. Papers that have not been accepted for publications will not be considered.
5. If original or digital copies of the paper cannot be provided, high quality photocopies are acceptable.
6. Nominators should obtain a copy of the Rules and Nomination Guidelines from the Chair of the AAG Student Paper Competition or copy it from this Web Page. The nomination should clearly state the degree program for which the research was done and its commencement and completion dates. If the degree program is still underway, this should be made clear. A brief statement from the nominator as to why this nomination is being made should follow.

Entry

The closing date for entries for this cycle is **31st December 2008**, when the letter of nomination, and a digital copy of the paper and any necessary supporting documentation must have been received by the Chairman of the Student Paper Prize Committee (see below). Late entries or entries incomplete after the closing date may be held over until the 2010 round. The results of the 2008 round will be announced at the 24th IAGS.

Send all correspondence and entries to:

Dr David Cohen
Chair of Student Prize Committee
School of BEES
The University of New South Wales
UNSW NSW 2052
Phone: 61 2 9385 8084
Fax: 61 2 9385 1558
Email: d.cohen@unsw.edu.au



RECENT PAPERS

This list comprises titles that have appeared in major publications since the compilation in **EXPLORE** Number 136. Journals routinely covered and abbreviations used are as follows: Economic Geology (EG); Geochimica et Cosmochimica Acta (GCA); the USGS Circular (USGS Cir); and Open File Report (USGS OFR); Geological Survey of Canada papers (GSC paper) and Open File Report (GSC OFR); Bulletin of the Canadian Institute of Mining and Metallurgy (CIM Bull.); Transactions of Institute of Mining and Metallurgy, Section B: Applied Earth Sciences (Trans. IMM). Publications less frequently cited are identified in full. Compiled by L. Graham Closs, Department of Geology and Geological Engineering, Colorado School of Mines, Golden, CO 80401-1887, Chairman AAG Bibliography Committee. Please send new references to Dr. Closs, not to **EXPLORE**.

- Anand, R.R., Cornelius, M., and Phong, C., 2007. Use of vegetation and soil in mineral exploration in areas of transported overburden, Yilgarn Craton, Western Australia: a contribution towards understanding metal transportation processes. *Geochemistry: Exploration, Environment, Analysis* **7**(3): 267-288.
- Breward, N., 2007. Arsenic and presumed resistate trace element geochemistry of the Lincolnshire (UK) sedimentary ironstones, as revealed by a regional geochemical survey using soil, water, and stream sediment sampling. *Applied Geochem.* **22**(9): 1970-1993.
- Butler, T.W., 2007. Isotope geochemistry of drainage from an acid mine impaired watershed, Oakland, California. *Applied Geochem.* **22**(7): 1416-1426.
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I, _____, wish to apply for election as a ___Member / ___Student Member of the Association of Applied Geochemists. I have read the Code of Ethics of the Association and in the event of being elected a Member/ Student Member agree to honour and abide by them.

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I am actively engaged in scientific or technological work related to applied geochemistry exploration and have been so for the past two years.

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I certify that the applicant is a full-time student at _____ in pure or applied science.
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Witness my hand this _____ day of _____, 20_____. _____
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Association of Applied Geochemists
P.O. Box 26099, 72 Robertson Road, Ottawa, Ontario, CANADA K2H 9R0

TEL: (613) 828-0199, FAX: (613) 828-9288, email: office@appliedgeochemists.org WEBSITE: http://www.appliedgeochemists.org



ioStipend



In-kind Analytical Research Fund for BSc(Hons), MSc and PhD students

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.

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. 137

DECEMBER 2007

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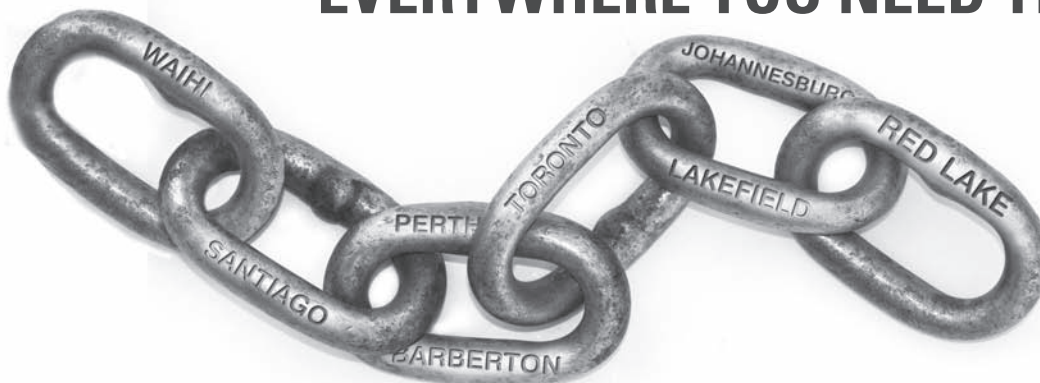
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